PEARSON EDEXCEL A-LEVEL BIOLOGY A · 9BN0

BIOLOGY



MARK SCHEME

TOPIC 3: VOICE OF THE GENOME

SCORE	PERCENTAGE
/485	%

STEMUP

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Mark Scheme

Q1.

Question Number	Answer	Mark
(i)	The only correct answer is –A *amino acids* B is incorrect because nitrates are not found in cellulose C is incorrect because nitrates are not found in starch D is incorrect because nitrates are not found in sucrose	Computer (1)

Question Number	Answer	Mark
(ii)	The only correct answer is –C *nucleic acids* A is incorrect because phosphate is not found in cellulose B is incorrect because phosphate is not found in chlorophyll D is incorrect because phosphate is not found in sucrose	Computer (1)

Question Number	Answer	Mark
(iii)	The only correct answer is – C *chlorophyll* A is incorrect because magnesium is not found in amino acids B is incorrect because magnesium is not found in cellulose D is incorrect because magnesium is not found in starch	Computer (1)

Q2.

Question Number	Answer	Additional guidance	Mark
	An explanation that makes reference to three of the following • (because) { one triplet is affected / a different triplet code is produced } (1) • (the mutation) could change one of the amino acids (1) • this would {change the bonds formed between the R groups / cause a change in the tertiary structure}(1) • the haemoglobin would no longer be able to bind to oxygen (1)	ALLOW produce a stop codon IGNORE reference to secondary or quaternary structure	(3)

Q3.

Question Number	Acceptable Answer	Additional Guidance	Mark
	An explanation that makes reference to the following: • partially permeable membrane is a barrier to some solutes but not water (1) • enables a concentration gradient of { solutes / water } (1)		**(2)**

Q4.

Question Number	Answer	Mark
(i)	**The only correct answer is B -** against a solute concentration gradient | through a partially permeable membrane A is not correct because in osmosis water moves against a solute concentration gradient - through a partially permeable membrane C is not correct because in osmosis water moves against a solute concentration gradient - through a partially permeable membrane D is not correct because in osmosis water moves against a solute concentration gradient - through a partially permeable membrane	**1**

Question Number	Answer	Mark
(ii)	**The only correct answer is A – Active transport** B is not correct because exocytosis s an export process C is not correct because osmosis describes the movement of water (solvent) molecules D is not correct because passive diffusion take place down a concentration gradient	**1**

Question Number	Answer	Mark
(iii)	**The only correct answer is D – Protein** A is not correct because carrier molecules or channel used for facilitated diffusion are proteins B is not correct because carrier molecules or channel used for facilitated diffusion are proteins C is not correct because carrier molecules or channel used for facilitated diffusion are proteins	**1**

Q5.

Question Number	Answer	Additional guidance	Mark
(i)	• using carbon (14) dating	ALLOW the deeper the layer in the peat, the older it is	graduate (1)

Question Number	Answer	Additional guidance	Mark
(ii)	An explanation that makes reference to three of the following • conditions are anaerobic (1) • therefore less (aerobic) respiration by decomposers (1) • acidic conditions {inhibit /denature} enzymes (1) • therefore (enzymes) cannot {digest / break down} organic material (1)	ALLOW (waterlogging) reduces the oxygen content ALLOW microorganisms / named decomposers ALLOW decomposers respiring anaerobically ALLOW description of denaturing eg change in shape of active site ALLOW break down plants / animals /peat	Expert (3)

Q6.

Biology A (Salters-Nuffield) Advanced Paper 3 (9BN0/03)

Question Number	Acceptable Answer	Additional Guidance	Mark
(a)	Tonoplast		**(1)**

Question Number	Acceptable Answer	Additional Guidance	Mark
(b)	• selection of correct points from the graph (1) • calculation of percentage (1) • difference in percentage (1)	0.17 AU , 0.23 AU , 0.26 AU Example of calculation: 35.3% ÷ 13.0% = 22.3% Allow full marks for correct answer with no working	**(3)**

Question Number	Acceptable Answer	Additional Guidance	Mark
(c)(i)	An explanation that makes reference to the following: • interferes with { tertiary / 3-D } shape of the channel proteins (1) • therefore causes channel proteins to		**(2)**

Question Number	Acceptable Answer	Additional Guidance	Mark
(c)(ii)	An answer that makes reference to four of the following: • solutions with a range of pH values (1) • pieces of beetroot of same surface area (1) • control of other named relevant variables (1) • measurement of absorbance of solution using colorimeter (1) • repeats at each pH value to calculate mean (1)	e.g. temperature / volume of solution / time left in solution /	**(4)**

Q7.

Question Number	Answer	Additional guidance	Mark
	An explanation that makes reference to four of the following • a mutation will lead to a change in the sequence of bases (in the DNA) (1) • (therefore a mutation) may lead to {a different amino acid /change in the sequence of amino acids} (1) • so different R groups would change the tertiary structure of the enzyme (1) • therefore the (shape of the) active site is changed (1) • therefore substrate does not fit active site of enzyme / substrate-enzyme complexes cannot form (1)	ALLOW change to triplet code (of DNA) ALLOW reference to STOP codon being produced	Expert (4)

Q8.

Question Number	Acceptable Answer	Additional guidance	Mark
	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)**

Q9.

Question Number	Acceptable Answer	Additional guidance	Mark
(a)(i)	49 182 000 x 0.05 (1) 2 459 100 (1)	Correct answer gains full marks	**(2)**

Question Number	Acceptable Answer	Additional guidance	Mark
(a)(ii)	An explanation that makes reference to the following: • can dilate bronchioles /airways (1) • therefore allowing more oxygen into lungs /alveoli (1)		**(2)**

Question Number	Acceptable Answer	Additional guidance	Mark
(a)(iii)	An explanation that makes reference to the following: • sympathetic neurotransmitters are released at the SAN (1) • therefore if beta-2 agonists are present the SAN will increase its rate of stimulation (1) • so impulses will spread faster and more often over the atria (1) • therefore the heart muscle will contract more often which increases the heart rate (1)		**(4)**

Question Number	Acceptable Answer	Additional guidance	Mark
(b)	An explanation that makes reference to four of the following: • HGH binds to receptor in cell surface membrane (1) • activation of messenger molecule in cytoplasm (1) • reference to protein kinase cascade (1) • transcription factor produced (1) • gene for IGF-1 switched on (1)		**(4)**

Question Number	Acceptable Answer	Additional guidance	Mark
(c)	An explanation that makes reference to the following: • occur naturally / would have some present in body (1) • therefore difficult to detect additional HGH (1)		**(2)**

Question Number	Acceptable Answer	Additional guidance	Mark
(d)	An explanation that makes reference to the following: • no need for blood transfusion (1) plus any one from: • therefore no risk of rejection / agglutination/ delay in {tissue/blood} typing (1) • they supply the oxygen requirements for the body (1)		**(2)**

Question Number	Acceptable Answer	Additional guidance	Mark
(e)	An explanation that makes reference to four of the following: • reference to {sodium ion channels / voltage gated sodium ion channels} (1) • binding blocks movement of sodium ions into neurone (1) • membrane is not depolarised (1) • action potential is not generated (1) • no impulses conducted to brain (1)	Accept more sophisticated answers that refer to the effect on calcium ion movement	**(4)**

Question Number	Acceptable Answer	Additional guidance	Mark
(f)	An explanation that makes reference to two of the following: • (they) increase the removal of {water/salts} from blood (1) • (removal of water) lowers blood volume and therefore pressure (1) • (removal of salt) lowers uptake of water into blood (by osmosis from tissue fluid) and therefore blood pressure (1)		**(2)**

Question Number	Acceptable Answer	Additional guidance	Mark
(g)	An explanation that makes reference to the following: • normal ratio is 1:1 (1) • taking testosterone and epitestosterone in equal measures maintains this ratio (1) • therefore it is not possible to detect cheats (1)		**(3)**

Question Number	Acceptable Answer	Additional guidance	Mark
(h)	An explanation that makes reference to the following: • drug E has been retained in the gas phase longer (1) • because it has {greater solubility / smaller mass} (1)	Accept more sophisticated answers related to charge	**(2)**

Question Number	Acceptable Answer	Additional guidance	Mark
(i)	An explanation that makes reference to two of the following: • longitudinal monitoring / to be followed over time (1) • therefore can identify individual differences in naturally occurring drug concentrations (1) • therefore can see pattern or link to competition / injury / look for changes (1)		**(2)**

Question Number	Acceptable Answer	Additional guidance	Mark
(j)	An answer that makes reference to the following: • the absolutist's view would be that they should never be used (1) plus any one from: • because of the damage to the body by the side effects (1) • athletes should compete using their innate {anatomical / physiological} abilities / fair competition should be promoted (1) and • the rationalist's view would be that their use is acceptable if there is a justifiable outcome (1) Plus any one from: • because it is a personal choice (1) • because it could help to overcome the inequalities in {training / medical support} (1)		**(4)**

Q10.

Question Number	Answer	Mark
(i)	**The only correct answer is D – 5** ***A*** *is not correct because oxygen has to travel across both sides of a cell in the alveolus wall plus both sidesof the capillary wall cell as well as across the cell surface membrane of a red blood cell. This summates to5, not 2.* ***B*** *is not correct because oxygen has to travel across both sides of a cell in the alveolus wall plus both sidesof the capillary wall cell as well as across the cell surface membrane of a red blood cell. This summates to5, not 3.* ***C*** *is not correct because oxygen has to travel across both sides of a cell in the alveolus wall plus both sides of the capillary wall cell as well as across the cell surface membrane of a red blood cell. This summates to5, not 4.*	**(1)**

Question Number	Answer	Mark
(ii)	**The only correct answer is B (diffusion)** ***A*** *is not correct because oxygen does not enter a red blood cell by active transport* ***C*** *is not correct because oxygen does not enter a red blood cell through facilitated diffusion* ***D*** *is not correct because oxygen does not enter a red blood cell through osmosis*	**(1)**

Q11.

Question Number	Answer	Additional guidance	Mark
(i)	An explanation that makes reference to three of the following • ribosome shape is altered (1) • mRNA is prevented from binding (to the ribosome) / causingchange in tRNA binding (1) • therefore translation cannot occur (1) • { protein / polypeptide } is not synthesised (1)	ALLOW translation is affected /reduced / altered ALLOW faulty protein produced	(3)

Question Number	Answer	Additional guidance	Mark
(ii)	An answer that makes reference to two of the following • bacteria have not been exposed to new antibiotics before /bacteria do not have mechanisms to make them resistant to the new antibiotics (1) • bacteria have developed resistance (to other antibiotics) by { evolving / natural selection } (1) • therefore there has been {no advantage to possessing amutation to bypass the new antibiotic / no mutation present to give resistance } (1)		**(2)**

Question Number	Answer	Mark
(iii)	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 genericmark scheme. The indicative content below is not prescriptive and candidates are not required to include all thematerial which is indicated as relevant. Additional content included in the response must be scientific and relevant. Indicative content • prepare agar plates with bacterial cultures / bacterial lawn / seeded with bacteria –use bacteria that are resistant to other antibiotics • prepare solutions of new antibiotic and penicillin • place onto paper discs / into wells in the agar / prepare mast rings • control time and temperature of incubation • same concentration and volume of both antibiotics • measure the area of inhibition • repeat for effective antibiotics • description of serial dilution of each antibiotic • range of dilutions on each plate-one antibiotic per plate • statistical test to determine which is the most effective • repeat with different strains of resistant bacteria	**(6)**

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

Q12.

Question Number	Answer	Additional guidance	Mark
(i)	A description that makes reference to three of the following • the proteins are folded in the rough endoplasmic reticulum (RER) (1) • the proteins are {packaged into/transported in} vesicles (1) • the protein is modified in the Golgi apparatus (1) • exocytosis (1)	ALLOW processed/ description of modification ALLOW description of exocytosis	**(3)**

Question Number	Answer	Additional guidance	Mark
(ii)	An explanation that makes reference to the following • (if the protein is not folded correctly) the {tertiary structure / 3D shape} would be different (1) • therefore the active site of the enzyme would not { fit / bind with } the substrate / it would not be able to form an enzyme substrate complex (1) • therefore it would not be able to catalyse the reaction (1)	ALLOW not complementary	(3)

Q13.

Question Number	Answer	Additional Guidance	Mark
(i)	• correct values taken from the graph (1) • correct answer with units (1)	Example of calculation 55 – 45 (= 10) = 2 au min^{-1} ALLOW an answer between 1.6 au and 2 au per minute or 0.0267 to 0.0333 au per second Correct answer with units, with no working gains full marks Correct answer with no units, gains one mark only	2

Question Number	Answer	Additional Guidance	Mark
(ii)	An answer that makes reference to the following: • DNA contents doubles twice / two stages of DNA synthesis (1) • therefore two divisions (1)	ALLOW two increases in uptake of bases ALLOW twice	2

Question Number	Answer	Additional Guidance	Mark
(iii)	An explanation that makes reference to two of the following: • because thymine is found only in DNA (1) • other radioactive bases taken up by all nucleic acids (1) • only DNA would be measured (1)	 ALLOW RNA does not contain thymine ALLOW other bases taken up by RNA ALLOW no need to separate DNA from RNA	**2**

Q14.

Question Number	Answer	Additional guidance	Mark
	An answer that makes reference to four of the following: • selection of two temperatures that are not above theoptimum temperature (1) • named variable kept constant (1) • record the distance travelled by the coloured liquid ina set time (1) • description of how to calculate rates (1) • data collected during the initial rate of reaction / before a factor (other than temperature) becomes limiting (1)	 ALLOW: below a temperature that causes enzyme denaturing or not above optimum tempALLOW any two temperatures between 10 and 40°C e.g. pH of solution, {sucrose/glucose} concentration, yeast {concentration / volume} ALLOW time taken for coloured liquid to travel aset distance e.g. by dividing distance travelled by time	**(4)**

Q15.

Question Number	Answer	Additional Guidance	Mark
(i)	A description that makes reference to three of the following: • chloride ions leave cells (through the CFTR channel protein) (1) • sodium ions leave the cells (following the chloride ions) (1) • increasing the solute concentration in the mucus (1) • water moves out of the cells by osmosis (into the mucus) (1)	NOT active transport of chloride ions ALLOW chloride ions move into the mucus ALLOW NaCl, Na^+ or Cl^- instead of solute ALLOW description of osmosis	3

Question Number	Answer	Additional Guidance	Mark
(ii)	An explanation that makes reference to the following: • (triplet code) is shown by three bases coding for an amino acid (1) • non-overlapping code e.g. ATT codes for amino acid I and then AAA code for amino acid K (1) • degenerate code as both ATT and ATC code for amino acid I (1)		3

Q16.

<table>
<tr><th>Question Number</th><th colspan="2">Indicative content</th></tr>
<tr><td></td><td colspan="2">Answers will be credited according to candidates' deployment of knowledge and understanding of 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.

Candidates are expected to offer a range of appropriate examples to support a comment on the roles of phosphorylation in Biology.
• Description of phosphorylation as an addition of phosphate.
• Examples of phosphorylation in respiration to include glycolysis, oxidative phosphorylation, substrate level phosphorylation.
• Examples of phosphorylation in photosynthesis to include RuBP, GP, NADP, non-cyclic photophosphorylation.
• Role of phosphorylation of ADP to store energy.
• Phosphorylation of lipids to make phospholipids and their roles in membranes.
• Addition of phosphates to help form the DNA backbone / involved in phosphodiester bonds.
• Appreciation of the consequences of phosphorylation such as activation of molecule for further reactions.</td></tr>
<tr><td>Level</td><td>Mark</td><td>Descriptor</td></tr>
<tr><td></td><td>0</td><td>No rewardable material</td></tr>
<tr><td>1</td><td>1-3</td><td>Demonstrates isolated elements of biological knowledge and understanding.

Provides little or no references to a range of</td></tr>
</table>

Level	Mark	Descriptor
		scientific idea, processes, techniques and procedures. Scientific arguments may be attempted, but fails to link biological concepts and/or ideas in order to support decision/conclusion. Limited attempt to address the question.
2	4-6	Demonstrates adequate biological knowledge and understanding with selection of some biological facts/concepts to support an argument or decision/conclusion being made. Scientific reasoning occasionally supported through the linkage of a range of scientific ideas, processes, techniques and procedures. Scientific argument is partially developed. Attempts to synthesise and integrate relevant knowledge with linkages to biological concepts and/or ideas, leading to a notional scientific argument or decision/conclusion.
3	7-9	Demonstrates comprehensive knowledge and understanding by selecting and applying relevant knowledge of biological facts/concepts to support an argument or decision/conclusion being made. Scientific reasoning supported throughout by sustained linkage of a range of scientific ideas, processes, techniques and procedures. Scientific argument is well developed and logical. Demonstrating throughout the skills of synthesising and integrating relevant knowledge with consistent linkages to biological concepts and/or ideas, leading to nuanced and balanced scientific argument or decision/conclusion based on evidence.

Q17.

Question Number	Answer	Additional Guidance	Mark
	• hydrolysis		**(1)**

Q18.

Question Number	Answer	Additional guidance	Mark
	An answer the makes reference to two of the following: • {biological / protein} catalyst (1) • lowers the activation energy (for a reaction) (1) • increasing the rate of reaction (1)		**(2)**

Q19.

Question Number	Acceptable Answer	Additional Guidance	Mark
	An explanation that makes reference to four of the following: • three { polypeptide / collagen } chains tightly coiled around each other (1) • due to every third amino acid { being glycine / having a small R group } (1) • chains are held together by { hydrogen bonding / covalent cross links } (1) • flexible without stretching (due to triple helix) (1) • chains of collagen associate together to form fibrils (1) • (fibrils) have a high tensile strength (and function to support tissues) (1)		**(4)**

Q20.

Question Number	Answer	Additional Guidance	Mark
(i)	A description that makes reference to three of the following: • primary structure described as a repeating amino acid sequence (1) • three polypeptide chains (1) • chains coiled around each other (1) • cross-linking between the chains (1)	ALLOW {proline / glycine / hydroxyproline} rich polypeptide chains IGNORE alpha helix ALLOW {covalent / hydrogen / disulphide} bonding between chains	3

Question Number	Answer	Additional Guidance	Mark
(ii)	An answer that makes reference to one of the following: • to provide {strength / flexibility} (1) • holds walls of capillaries and alveoli close together (1)	ALLOW to support alveoli IGNORE to support capillaries	1

Q21.

Question Number	Answer	Additional guidance	Mark
	A description that makes reference to three of the following • cell membrane is (mainly) phospholipids and protein (1) • phospholipids form a bilayer (1) • proteins float in the phospholipids / change position / fluidmosaic model (1) • proteins may span the bilayer or be located in only onelayer (1)	ALLOW proteins embedded in the phospholipid bilayer ALLOW proteins may be intrinsic /extrinsic IGNORE function of proteins such as carrier/ channel	(3)

Q22.

Question number	Answer	Additional guidance	Mark
	An answer that makes reference to four of the following: • seeds treated with sodium chloride and with sodium chloride and gibberellin (1) • description of how an abiotic factor can be controlled (1) • extract amylase from the seeds (1) • description of assay (1) • description of how quantitative results will be obtained to enable comparison (1)	ALLOW with sodium chloride and different concentrations of gibberellin e.g. use a water bath to control the temperature ALLOW method of standardising quantity of amylase e.g. same volume of {amylase extract / seed extract} / same {mass / number / type / size} of seed e.g. iodine starch test or Benedict's test to measure reducing sugars e.g. length of time to remove starch or use of a colorimeter ALLOW a description of how gibberellin might affect the result e.g. 'if giberrellin increases amylase activity time for iodine solution to go colourless will be shorter'	**(4)**

Q23.

Question number	
*	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. **Indicative content** Information • there are 20 000 different proteins • these proteins carryout different functions • there are a {large number of / 20} different {R groups / amino acids} • most R groups are non-polar, some are polar a few have a charge Linkage to **s**tructure • R groups determine {3D shape / structure} of proteins • {large number of / 20 R groups} • many combinations of amino acids required to give wide variety of protein structures • R groups can form bonds to stabilise 3D structure (e.g. cysteine) • role of R-groups in structure of haemoglobin • role of R-groups in structure of collagen • location of cysteine allows formation of disulfide bonds Linkage to **f**unction • R groups variety of protein shapes are required to allow proteins to carry out wide range of functions • examples of functions that require specific structure e.g. antibodies specific to an antigen / enzymes specific for a substrate / receptors e.g. neurotransmitters and (acetylcholine) and ion-gated channels • polar / ionic R groups increase solubility • non-polar R groups will be on outside of insoluble proteins / structural proteins / collagen / proteins inserted into membranes • role of R-groups in function of haemoglobin • role of R-groups in function of collagen Linkage to **l**ocation • polar R groups will be in aqueous environment /non-polar regions in a non-aqueous environment

	• polar /ionic R groups soluble in {plasma/ tissue fluid / cytoplasm} / line the inside of ion channels / found on the outside of soluble proteins such as hormones / transport proteins / immunoglobulins / cytokines • role of R-groups in location of haemoglobin • role of R-groups in location of collagen

Level	Marks		
0	0	No awardable content	
1	1-3	Demonstrates isolated elements of biological knowledge and understanding to the given context with generalised comments made. Vague statements related to consequences are made with limited linkage to a range of scientific ideas, processes, techniques and procedures. The discussion will contain basic information with some attempt made to link knowledge and understanding to the given context.	Selection of some information from the table – little or no linkage Linkage to one aspect – 2 marks Two linkages for same aspect – 3 marks
2	4-6	Demonstrates adequate knowledge and understanding by selecting and applying some relevant biological facts/concepts. Consequences are discussed which are occasionally supported through linkage to a range of scientific ideas, processes, techniques and procedures. The discussion shows some linkages and lines of scientific reasoning with some structure.	Linkage between R groups and two aspects from structure, function and location One comment on each - 4 marks An additional comment - 5 marks An additional 2 comments – 6 marks
3	7-9	Demonstrates comprehensive knowledge and understanding by selecting and applying relevant knowledge of biological facts/concepts. Consequences are discussed which are supported throughout by sustained linkage to a range of scientific ideas, processes, techniques or procedures.	Linkage between R groups and all three aspects (structure, function and location) One comment on each - 7 marks
		The discussion shows a well-developed and sustained line of scientific reasoning which is clear and logically structured.	An additional comment - 8 marks An additional 2 comments – 9 marks

Q24.

Question Number	Answer	Additional Guidance	Mark
(i)	An explanation that makes reference to the following: • the parents were {heterozygous / had a dominant and a recessive allele} as the offspring had both yellow and nonyellow coats (1) • (because the parents had yellow coats) the recessive allele was for non-yellow coat (1)	ALLOW parents were carriers	(2) Exp

Question Number	Answer	Additional Guidance	Mark
(ii)	<table><tr><td>offspring with a yellow coat</td><td>offspring with a non-yellow coat</td></tr><tr><td>1199.25</td><td>399.75</td></tr></table> 1 mark for each predicted number	ALLOW 1199 for 1199.25 ALLOW 400 for 399.75	(2) Clerical

Question Number	Answer	Additional Guidance	Mark
(iii)	An explanation that makes reference to the following :		(3) Exp
	• ratio is 2 : 1 rather than 3 : 1 (1) • random fertilisation (1) • due to no homozygous dominant individuals surviving / homozygous dominant is lethal (1)	ALLOW description of random fertilisation	

Q25.

Question Number	Answer	Additional Guidance	Mark
(i)	An answer that includes: • a line that shows a positive correlation with lung, liver and colon points below the line and breast, bladder and pancreas above the line		(1)

Question Number	Answer	Additional Guidance	Mark
(ii)	An explanation that makes reference to the following: • there is a correlation between age and level of DNA methylation (1) • as there is only a 5% likelihood of these results being produced by chance (1)	ALLOW converse, e.g. 95% probability that DNA methylation increases with age ALLOW as the calculated value is greater than the critical value at p=0.05	(2)

Question Number	Indicative content
*(iii)	Answers will be credited according to candidates' deployment of knowledge and understanding of 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 relevant. Additional content included in the response must be scientific and relevant. Give examples of relevant biological knowledge and understanding: • mutation is a change in the { base sequence in DNA / gene } / different amino acid sequence / primary structure of the enzyme succinate dehydrogenase • succinate dehydrogenase { less / non- } functional • succinate therefore accumulates • accumulation of succinate inhibits TET • therefore methyl groups not removed / increased methylation of DNA • affects transcription of a gene / therefore alters amount of product formed • greater methylation is of DNA is associated with increased risk of cancer

			Additional Guidance
Level 0	Marks	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 piece of scientific information. The explanation will contain basic information with some attempt made to link knowledge and understanding to the given context.	Only one point of basic information referred to: e.g. mutation results in more succinate, or high succinate and inhibition of TET, or less TET and more methylation of DNA
Level 2	3-4	An explanation will be given with occasional evidence of analysis, interpretation and/or evaluation of both pieces of scientific information. The explanation shows some linkages and lines of scientific reasoning with some structure.	Link between high levels of succinate and inhibition of TET
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.	Links made to include all of these points: mutation leads to higher levels of succinate, which inhibits TET, therefore increasing DNA methylation, which increases risk of cancer Logical explanation of the reasons why a mutation in the enzyme succinate dehydrogenase can increase risk of developing cancer

Mark Scheme

Q1.

Question Number	Answer	Mark
(i)	**The only correct answer is D – the sperm cell releases enzymes that digest the zona pellucida** A is not correct because the enzymes are released by the sperm and digest the zona pellucida B is not correct because enzymes are released by the sperm C is not correct because the enzymes digest the zona pellucida	**1**

Question Number	Answer	Mark
(ii)	**The only correct answer is A –** one copy of each gene | different alleles of some genes B is not correct because sperm can contain a different allele of a gene C is not correct because sperm will contain one copy of each gene D is not correct because sperm contain one copy of each gene and can have a different allele of some genes	**1**

Q2.

Question Number	Answer	Additional Guidance	Mark
(i)	An answer that makes reference to two of the following: • pyruvate (1) • oxygen (1) • reduced NAD / ADP (1)		**(2)**

Question Number	Answer	Additional guidance	Mark
(ii)	An explanation that makes reference to four of the following: • to stop H^+ diffusing out (of mitochondrion) / into cytoplasm (1) • (therefore) maintaining a high concentration (of H^+) in the intermembrane space (1) • so {hydrogen ions / protons / H^+} can move down {concentration / electrochemical} gradient (1) • (by) chemiosmosis (1) • to synthesise ATP (1)	ALLOW moves out for diffuses out ALLOW enabling/allowing/establishing formaintaining	(4)

Q3.

Question number	Answer	Additional guidance	Mark
	An explanation that makes reference to three of the following: • {chemicals in smoke / carcinogens / radiation} can damage DNA (1) • by changing the {DNA base sequence / chromosome number} (1) • with age there have been a greater number of cell divisions (1) • therefore a greater chance of an error (being introduced) in the base sequence of the DNA (during replication) (1)	IGNORE they cause mutations ALLOW 'they damage DNA' ALLOW causing {epigenetic changes / methylation of DNA / acetylation of histones} ALLOW longer period of exposure (to mutagens) ALLOW (with age) there is a greater chance of change in chromosome number	Expert (3)

Q4.

Question Number	Answer	Additional Guidance	Mark
(i)	C (amino acids joined by peptide bonds)		**(1)**

Question Number	Acceptable Answer	Additional Guidance	Mark
(ii)	A description that makes reference to • carboxyl group / COOH (1) • amine group / NH_2 (1) • R group (1)		**(3)**

Q5.

Question Number	Answer	Mark
(i)	**The only correct answer is A - ligaments only** ***B*** *is not correct because the tendons do not join bones to bones in the elbow joint* ***C*** *is not correct because the tendons do not join bones to bones in the elbow joint* ***D*** *is not correct because the ligaments do join bones to bones in the elbow joint*	**(1)**

Question Number	Answer	Mark
(ii)	**The only correct answer is D rows 3 and 4** ***A*** *is not correct because the tendons showing a change is not a change in genotype* ***B*** *is not correct because the tendons also show a physiological adaptation* ***C*** *is not correct because the tendons showing a change is not a change in genotype*	**(1)**

Question Number	Answer	
* (iii)	Answers will be credited according to candidates' deployment of knowledge and understanding of materialin 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 materialwhich is relevant. Additional content included in the response must be scientific and relevant. **Indicative content Valid because:** • {sufficient replicates / 12 individuals} used and a mean calculated • All same gender • Means of both heart rate and blood lactate agree with conclusion • Spread of data (standard deviation / error bars) between cycling and running does not overlap **Not valid because:** • Insufficient / only 12 individuals involved • Insufficient detail relating to the athletes e.g. they maybe athletes that focus on different sports/have done more than one previous triathlon / more experienced • The three disciplines are always done in the same order / different distances covered • Spread of cycling data (standard deviation / error bars) for blood lactate overlaps with swimming • As no time allowed to recover between sports, some of blood lactate shown for cycling could havebeen produced during swimming • Agree or not agree with conclusion	**(6)**

			Additional Guidance
Level 0	Marks	No awardable content	
Level 1	1-2	Limited scientific judgement made with a focus on mainlyjust one method, with a few strengths/weaknesses identified. A conclusion may be attempted, demonstrating isolatedelements of biological knowledge and understanding butwith limited evidence to support the judgement being made.	Considers one area only e.g. comparingmean data or spread of data only Conclusion based on only one set of data or only one sport considered e.g. cycling ismost demanding
Level 2	3-4	A scientific judgement is made through the application of relevant evidence, with strengths and weaknesses of each method identified. A conclusion is made, demonstrating linkages to elements of biological knowledge and understanding, with occasionalevidence to support the judgement being made.	Considers both a valid and an invalid aspect e.g. relevance of spread of data forlactate concentrations overlap in some cases or elements of the study Conclusion given that takes both valid andinvalid aspects into account
Level 3	5-6	A scientific judgement is made which is supported throughout by sustained application of relevant evidencefrom the analysis and interpretation of the scientific information. A conclusion is made, demonstrating sustained linkages tobiological knowledge and understanding with evidence to support the judgement being made.	Considers both a range of valid and invalidaspects A conclusion based on a range of considered evidence

Q6.

Question Number	Answer
	Answers will be credited according to candidates' deployment of knowledge and understanding of 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. Comparisons between phospholipid bilayer and proteins in the cell surface membrane: • judgement about the relative importance of the phospholipid bilayer and the proteins within that bilayer Use of data: • most proteins in the cell are associated with the cell membrane • whilst quantities of phospholipid are the same the proteins have more functions Importance of proteins in the cell surface membrane: • immune response e.g. as antigens and therefore body defence, antibodies, MHC proteins • receptors e.g. receptor proteins on tip of sperm allowing acrosome reaction when encounters zona, for neurotransmitters • regulation e.g. with regards to hormones such insulin • signal / transcription e.g. transcription factors, secondary messengers • transport e.g. active transport, as channel proteins allowing facilitated diffusion, as {voltage-gated / eq} channels for the nerve impulse / resting potential or / and role of Na^+-K^+ pump Importance of phospholipid bilayer in some of: • the role of fluidity and structure of cell the membrane • inhibiting polar substances moving across due to having a hydrophobic component • having both hydrophilic and hydrophobic components which leads to the separation of the aqueous contents of the cell from its aqueous external surroundings • allowing diffusion of gases directly across it • myelin sheath / nerve impulse

Level	Marks	Descriptor	Additional guidance
0		No awardable content	
1	1-3	An explanation may be attempted but with limited interpretation or analysis of the scientific information with a focus on mainly just **one** piece of scientific information. The explanation will contain basic information with some attempt made to link knowledge and understanding to the given context.	Discussion of one type of membrane protein linked to its role May have lots of irrelevant information
2	4-6	An explanation will be given with occasional evidence of analysis, interpretation and/or evaluation of **more than one** piece of scientific information. The explanation shows some linkages and lines of scientific reasoning with some structure.	Discussion of more than one membrane protein linking them to their function Also discussing the role of phospholipids
3	7-9	An explanation is made which is supported throughout by sustained application of relevant evidence of analysis, interpretation and/or evaluation of **several** pieces of scientific information. The explanation shows a well-developed and sustained line of scientific reasoning which is clear and logically structured.	Good discussion of role of proteins and phospholipids – reaching a judgement Linking role of proteins and phospholipids Number of specific examples of membrane proteins Very little if any irrelevant information

Q7.

Question Number	Indicative content
*	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. Basic information • All the treatment combinations were effective at treating TB • All treatments had some { relapses / individuals with TB } 3 years after treatment • { Group 1 / Groups 1 and 2 / Rifampicin + Pyrazinamide / Rifampicin + Isoniazid } had the lowest number of patients with TB (3 years later) Evidence for linkages made • Percentage relapse varies depending on second part of treatment • Combinations involving Rifampicin most effective • The antibiotics tested act on different targets in bacteria • Gaps in information - not all combinations tested, other combinations might be more effective • Other time scales may have been more effective Evidence for sustained scientific reasoning • Could be other reasons for infections with TB 3 years later not due to the antibiotic treatment • No information about dormant TB (only percentage of active cases) • Bacterial RNA polymerase possibly the best target for antibiotics • Antibiotics targeting synthesis of cell wall fatty acids least effective in terms of relapses • Idea of combination of antibiotics with different mode of activity most effective

Level	Mark	Descriptor	
Level 0	Marks	No awardable content	
Level 1	1-2	An answer may be attempted but with limited interpretation or analysis of the scientific information with a focus on mainly just one piece of scientific information. The answer will contain basic information with some attempt made to link knowledge and understanding to the given context.	Reference to effectiveness of different combinations of antibiotics.
Level 2	3-4	An answer will be given with occasional evidence of analysis, interpretation and/or evaluation of both pieces of scientific information. The answer shows some linkages and lines of scientific reasoning with some structure.	Reasons for differences in effectiveness considered.
Level 3	5-6	An answer 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 answer shows a well-developed and sustained line of scientific reasoning which is clear and logically structured.	Information about action of antibiotics related to effectiveness. Evaluation of study design considered.

Q8.

Question Number	Answer	Additional Guidance	Mark
(i)	C (significant and positive)		**(1)**

Question Number	Acceptable Answer	Additional Guidance	Mark
(ii)	An explanation that makes reference to the following: • greater number of cell divisions means more opportunities for errors in DNA replication (1) • more mutations result in greater chance of cancer (1)		**(2)**

Question Number	Acceptable Answer	Additional Guidance	Mark
(iii)	• correct risks identified (1) • correct calculation (1)	0.08 and 0.004 <u>Example of calculation:</u> 0.08 ÷ 0.004 = 20.0 Allow full marks for correct answer with no working	**(2)**

Question Number	Acceptable Answer	Additional Guidance	Mark
(iv)	An explanation that makes reference to two of the following: • cigarettes { are an environmental risk factor / contain carcinogens } (1) • that increases the number of mutations in cells (1) • resulting in uncontrolled cell division (1)	Accept description of how mutations arise	**(2)**

Q9.

Question Number	Answer
*	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. <u>Indicative content</u> Adult screening advantages and disadvantages • Identifies risk of developing a particular disease in the future so choices can be made e.g. extra screening for breast cancer or preventative mastectomy/screening and lifestyle changes for some types of CVD • Identification of carriers so choices can be made about family planning – both partners tested, risk can be identified and have prenatal screening • May not want to know if you have a high likelihood of developing a disease, if one person is tested it may give other family members information they would chose not to know, may potentially affect life insurance
	Prenatal screening advantages and disadvantages • Amniocentesis – prepares parents for child with disease/gives choice of abortion • Chorionic villus sampling – as amniocentesis, carried out earlier in pregnancy • Some of the conditions tested for are very unpleasant and may be life limiting • NIPD non-invasive, less traumatic procedure, no increased risk of miscarriage • PGD only implant healthy embryos, do not have to make decision about abortion • Both amniocentesis and CVS carry increased risk of miscarriage, especially CVS (although it can be carried out earlier in the pregnancy) • Can't cure the disease, only choice is to have an abortion-not acceptable to everyone • For conditions such as CF, where there is more than one possible mutation, test is only for most common mutations so there may be false negatives • NIPD currently only available for chromosome disorders such as Down's syndrome • PGD involves IVF, which can be emotionally traumatic and only has about 30% success rate • All pre-natal screening has a risk of false positives with abortion of a healthy fetus. • Procedures involving IVF can be regarded as unethical because many embryos are discarded • Invasive nature of some of the tests

Level	Mark	Descriptor	Additional Guidance
0	Mark	No awardable content	
1	1-2	Limited scientific judgement made with a focus on one side of the argument only. A conclusion may be attempted, demonstrating isolated elements of biological knowledge and understanding but with limited evidence to support the judgement being made.	Only considered one benefit or one risk without further explanation beyond a brief description. A generalised discussion without focusing on the details of specific types of screening
2	3-4	A scientific judgement is made through the application of relevant evidence to both sides of the argument. A conclusion is made, demonstrating linkages to elements of biological knowledge and understanding, with occasional evidence to support the judgement being made.	Considers at least two types of screening One advantage and one disadvantage of each type of screening discussed.
3	5-6	A scientific judgement is made, which is supported throughout by sustained application of relevant evidence from the analysis and interpretation of the scientific information. A conclusion is made, demonstrating sustained linkages to biological knowledge and understanding with evidence to support the judgement being made.	Advantages and disadvantages of blood tests and pre-natal tests discussed fully. Discussion of blood tests to identify adults with genetic disorders. Conclusion or judgement made, e.g. identifying genetic disorders by blood tests in adults is better as the disadvantages have less impact than disadvantages of genetic testing on embryos / fetuses.

Q10.

Question Number	Answer	Additional guidance	Mark
	An answer that makes reference to: • no (in row two) (1) • some (in row five) (1)		**(2)**

Q11.

Question Number	Answer	Additional Guidance	Mark
(i)	A answer that makes reference to the following: • {alternative form / different form / version / variation} of a gene (1)	IGNORE type of gene	1

Question Number	Answer	Additional Guidance	Mark
(ii)	• correct use of Hardy-Weinberg equation (1) • correct calculation of probability of each homozygote (1) • correct answer (1)	Example of calculation $p^2+2pq+q^2= 1$ p^2= either 0.185 or 0.325 q^2= either 0.325 or 0.185 or 2pq = 0.43 x 0.57 x 2 = 0.4902 frequency = 50.98 % / 51% (which is greater than 50%) Correct answer with no working gains full marks	3

Q12.

Question Number	Answer	Additional Guidance	Mark
	An explanation that makes reference to three of the following: • thinner blood-gas barrier (1) • because of thinner { alveolar walls / capillary walls / extracellular matrix layer } (1) • therefore a reduced diffusion distance (1) • a faster rate of { diffusion / gas exchange } (1)	ALLOW greater rate	3

Q13.

Question Number	Answer	Additional Guidance	Mark
	• width of X to Y ÷ magnification **(1)** • correct answer with appropriate units **(1)**	Example of calculation 50(mm) ÷ 5 000 000 / 5(cm) ÷ 5 000 000 10 nm / 0.01 µm	**(2)**

Q14.

Question Number	Answer	Additional guidance	Mark
	An explanation that makes reference to three of the following: • less oxygen available for aerobic respiration (1) • deoxygenated blood mixes with oxygenated blood (1) • therefore reducing the concentration of oxygen in the bloodcirculating in the body (1) • because some deoxygenated blood {does not leave right ventricle / is transferred to the left ventricle / does not go to thelungs / goes to the respiring tissues} (1)	ALLOW lack of oxygen leads to (some) anaerobic respiration ALLOW some oxygenated blood {does not leave left ventricle / is transferred to the right ventricle / does not go to the respiring tissues / goes to the lungs}	**(3)**

Q15.

Question Number	Answer	Additional Guidance	Mark
	An answer that makes reference to three of the following: Differences: • only actin has a tertiary structure (1) • collagen has three chains whereas an actin (filament) has one chain (1) Similarities: • both are made up of (a sequence of) amino acids joined together by peptide bonds (1) • both have a secondary structure / both have { more than one polypeptide chain / a quaternary structure } (1)		**(3)**

Q16.

Question Number	Answer	Mark
	B - lowering the activation energy of a reaction *The only correct answer is **B*** ***A** is incorrect because enzymes do not increase activation energy* ***C** is incorrect because enzymes do not provide energy to reactants* ***D** is incorrect because enzymes do not remove energy from reactants*	**(1)**

Q17.

Question Number	Answer	Additional Guidance	Mark
	An explanation that makes reference to three of the following: • decreases betalain concentration (in the cells) (1) • due to betalain {diffusing out / moving down a concentration gradient} (1) • (because) the alcohol increases membrane permeability (1) • membrane {lipids/ phospholipids} dissolve in alcohol (1)	IGNORE reference to cell wall	**(3)** **Exp**

Q18.

Question Number	Answer	Additional Guidance	Mark
	An answer that makes reference to the following: • tranexamic acid has a (very) similar {structure / shape} to lysine • tranexamic acid { binds to the active site on plasmin / acts as a competitive inhibitor } • stopping plasmin binding to { fibrin / lysine }	ALLOW preventing plasmin and fibrin forming enzyme – substrate complex	**(3)**

Q19.

Question Number	Answer	Additional Guidance	Mark
(i)	An answer the makes reference to the following: • sequence of {bases / nucleotides} in DNA • that codes for the {primary structure / amino acid sequence / polypeptide}	ALLOW that codes for a protein	**(2)**

Question Number	Answer	Additional Guidance	Mark
(ii)	A description that makes reference to the following: • tRNA molecules {transport amino acids to the ribosome} • tRNA molecule has an anticodon that {binds to / recognises} a codon on the mRNA • each tRNA carries a particular amino acid	ALLOW the amino acid on the tRNA is determined by the anticodon	**(3)**

Question Number	Answer	Additional Guidance	Mark
(iii)	A description that makes reference to three of the following: • {primary structure / sequence of the amino acids} determines the folding (of the polypeptide) • forming a globular structure • hydrophobic (R) groups located in the centre of the protein / hydrophilic (R) groups located on the outside of the protein • water forms hydrogen bonds with { protein / hydrophilic groups}	ALLOW position of R groups ALLOW determines tertiary structure ALLOW polar for hydrophilic / non-polar for hydrophobic ALLOW dipole-dipole / hydrophilic interactions (between water and the protein)	**(3)**

Q20.

Question Number	Answer	Additional Guidance	Mark
	A description that makes reference to two of the following: • (adding or removing one or two nucleotides) changes the triplet code • introducing a new {start / stop} codon • coding for a shorter sequence of amino acids (1)	ALLOW different codons produced (1) ALLOW one amino acid shorter	**(2)**

Q21.

Question Number	Answer	Additional guidance	Mark
	A description that makes reference to the following: • (a peptide bond is formed by a) condensation reaction (1) • between the {amine group / NH_2} and the {carboxyl group / COOH} of adjacent amino acids (1)	ALLOW 'amino' for 'amine' and 'carboxylic acid' for 'carboxyl'	**(2)**

Q22.

Question Number	Answer	Additional Guidance	Mark
(i)	A description that makes reference to the following: • { P / troponin } changes shape (1) • causing { Q / tropomyosin } to move away from the myosin-binding sites (on actin) (1)	ALLOW P binds with calcium ions ALLOW Q is displaced away from myosin binding sites	**(2)**

Question Number	Answer	Additional Guidance	Mark
(ii)	An explanation that makes reference to three of the following: • (primary structure) determines interaction between {amino acids / R groups} (1) • (primary structure) determines { folding / tertiary structure } (1) • (therefore) affecting the shape of the active site (1) • (active site is) complementary to ATP (1)	e.g. bonds formed between R groups ALLOW 3D shape ALLOW ATP fits active site	(3)

Q23.

Question Number	Answer	Additional Guidance	Mark
(i)	A description that makes reference to two of the following: • carrier protein (in cell surface membrane) • (glucose moves from) high to low concentration • glucose binds to (carrier) protein / (carrier) protein changes shape to move glucose (across the membrane) (1)	IGNORE channel protein ALLOW 'down a concentration gradient'	(2)

Question Number	Answer	Additional Guidance	Mark
(ii)	An explanation that makes reference to three of the following: • polymer of glucose • to provide glucose for respiration • {branched / contains 1,6-glycosidic bonds / has many terminal ends} for rapid hydrolysis • compact to allow large amount (of glucose / energy) to be stored in a small space / insoluble therefore no osmotic effect on cells	ALLOW polysaccharide /made of many glucose monomers DO NOT ALLOW β- glucose IGNORE 'easy to hydrolyse' ALLOW break down instead of hydrolyse	(3)

Q24.

Question number	Answer	Additional guidance	Mark
	A description that makes reference to three of the following points: • calcium ions released from sarcoplasmic reticulum (1) • in response to { nerve impulse / action potential / depolarisation } (at neuromuscular junction) (1) • calcium channels open (to allow calcium ions to cross the membrane / enter the sarcoplasm) (1) • calcium ions taken back up into the sarcoplasmic reticulum by active transport (1)	ALLOW Ca^{2+} for calcium ions ALLOW calcium ions moving through channel protein	(3)

Q25.

Question Number	Answer	Additional Guidance	Mark
	A description that makes reference to the following: • vesicles (containing hormone) (1) • fuse with the cell (surface) membrane (of fat cells) / by exocytosis (1)		**(2)**

Mark Scheme

Q1.

Question Number	Answer	Additional Guidance	Mark
	A description that makes reference to the following: • vesicles (containing hormone) (1) • fuse with the cell (surface) membrane (of fat cells) / by exocytosis (1)		**(2)**

Q2.

Question Number	Acceptable Answer	Additional Guidance	Mark
	A description that makes reference to the following: • fluid refers to the movement of the phospholipids in the plane of the membrane (1) • mosaic refers to the random association of proteins (of different shapes and sizes) within the membrane (1)		**(2)**

Q3.

Question Number	Answer	Additional guidance	Mark
	An answer that makes reference to the following • correct genetic diagram used to determine genotypesof offspring (1) • correct probability 0.5 linked to correct genotypes ofoffspring (1)	e.g. S s s Ss ss s Ss ss Ss and ss ALLOW 50% / ½ / 1 in 2	**(2)**

Q4.

Question Number	Answer	Additional guidance	Mark
	An answer that makes reference to the following: • 0.5 probability for being { same sex / female} (1) • person 1 is heterozygous for MPS 1 (1) • (therefore) person 2 has a 0.75 probability of having same phenotype as person 1 for MPS 1(1) • therefore probability of being female and nothaving MPS 1 will be 0.375 (1)	ALLOW 50% for 0.5 ALLOW detail of proof of phenotype of person 1 e.g. does not show condition therefore has to have one dominant allele but (at least) one daughter has condition so received a recessive allele from person 1 ALLOW carrier for heterozygous ALLOW 75% for 0.75 ALLOW $^{3}/_{8}$ or 37.5% for 0.375	**(4)**

Q5.

Question Number	Answer	Mark
	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. Indicative content For DNA • Double stranded so more stable • Allows for a template strand • Larger as includes promotor / site for transcription factors to bind For mRNA • Ribose rather than deoxyribose and uracil rather than thymine • Smaller as not bound to other genes / fewer bases (minimum of 396) • So can {exit the nucleus / move through the nuclear pore} • Single-stranded • So {bases / codon} exposed to (tRNA's with) complementary anticodons / bases can bind • Amino acids {brought/joined} in the correct sequence • Removal of introns / post-transcriptional modification	**(6)** **Exp**

Level 0	Marks	No awardable content	Additional guidance
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 piece of scientific information. The explanation will contain basic information with some attempt made to link knowledge and understanding to the given context.	Basic description of differences between DNA and mRNA
Level 2	3-4	An explanation will be given with occasional evidence of analysis, interpretation and/or evaluation of both pieces of scientific information. The explanation shows some linkages and lines of scientific reasoning with some structure.	Reasons provided for differences in structure of DNA and mRNA.
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.	Explanation for differences in the gene described and the mRNA – greater number of bases in DNA than in the mRNA.
		The explanation shows a well-developed and sustained line of	

		scientific reasoning which is clear and logically structured.	Reference to removal of introns and post transcriptional changes to RNA before it is translated.

Q6.

Question Number	Answer	Additional guidance	Mark
(i)	• correct calculation of Q_{10} value	Example of calculation (240 ÷ 80 =) 3	**(1)**

Question Number	Answer	Additional guidance	Mark
(ii)	An explanation that makes reference to three of the following: • (between 20 °C and 30 °C) there is more kinetic energy available (1) • therefore there will be more frequent collisions (between enzyme and substrate) (1) • more enzyme-substrate complexes formed (1) • (the Q_{10} value indicates) the activity triples with the 10 °C temperature rise (1)	ALLOW more frequent collisions between catalase and hydrogen peroxide	**(3)**

Question Number	Answer	Additional guidance	Mark
(iii)	An explanation that makes reference to two of the following: • Q_{10} value is less than 1.0 (1) • because the enzyme is denatured (1) • therefore no increase in formation of enzyme-substrate complexes / substrate no longer fits active site (1)	ALLOW Q_{10} value of 0.59 ALLOW fewer enzyme-substrate complexes formed	**(2)**

Q7.

Question Number	Answer	Mark
(i)	***The only correct answer is B*** Bb and Bb ***A*** *is not correct because the parent who is bb would have Batten disease* ***C*** *is not correct because neither parent has the b allele* ***D*** *is not correct because the parent who is bb would have Batten disease and the parent who is BB would not have the b allele*	**(1)**

Question Number	Answer	Additional guidance	Mark
(ii)	An answer that makes reference to the following: • correct genetic diagram with reference to offspring genotypes (1) • correct probability of inheriting Batten disease (1)	e.g. BB, Bb, Bb and bb 1 in 4 / 25% / 0.25 IGNORE ratios	**(2)**

Q8.

Question Number	Acceptable Answer	Additional Guidance	Mark
(i)	An explanation that makes reference to the following: • a (random) change in the sequence of bases in the DNA (1) • involving { deletion / substitution / addition } of a base (1) • this affects the triplet code / changes sequence of amino acids in the enzyme molecule (1) • change in shape of active site (1)		**(3)**

Question Number	Acceptable Answer	Additional Guidance	Mark
(ii)	An explanation that makes reference to the following: • the severity of symptoms is related to the proportion of mitochondria with damaged DNA in the mother only (1) • because (the child's mitochondria) are derived from the { oocyte / egg cell } (1) • mitochondria in sperm do not enter the egg on fertilisation (1)		**(3)**

Q9.

Question Number	Answer		Mark
(a)	1. {scientific / peer reviewed} {papers / journals / magazines / article} ; 2. (scientific) {conferences / lecture / forums} ; 3. media reports ;	 3. e.g. TV, radio. newspaper ' internet	 **(2)**

Question Number	Answer	Additional Guidance	Mark
***(b)(i)**	(QWC – spelling of technical terms must be correct and the answer must be organised in a logical sequence)	**QWC focussing on spelling**	
	1. idea of using *proteomics* (to study protein); **Any 5 from :** 2. idea of using DNA {*profiling / fingerprinting*} (to study DNA) ; 3. idea of obtaining {*tissue / cell*} sample from tomcod ; 4. multiple copies of DNA made / eq ; 5. using {PCR / *polymerase chain reaction*} ; 6. ref to *restriction* {*enzymes / endonucleases*} to produce DNA {fragments / eq} ; 7. reference to *(gel) electrophoresis* ; 8. idea of {loading / eq} the DNA onto the {*gel / named gel*}; 9. idea that an {*electric current / charge*} is applied ; 10. reference to use of {dye / *fluorescent staining* / UV light /*Southern blotting / gene probes / radioactive labelling* / eq};	 4. IGNORE refs to amplification, large amounts 8. e.g. *agarose, agar* 9. ACCEPT apply *potential difference*	 **(6)**

Question Number	Answer	Additional Guidance	Mark
(b)(ii)	1. same number of chromosomes ; 2. idea that the mutation affected the sequence of DNA ; **OR** 3. idea that (all / most of) the {bands / eq} are the same (size / position / width) ; 4. idea that only {a small region of DNA / the AHR2 gene} is affected ;	1. ACCEPT both contain AHR2 gene	**(2)**

Question Number	Answer	Additional Guidance	Mark
(b)(iii)	1. a protein with a different {structure / amino acids / function} / eq ; 2. idea that the mutation will affect the DNA ;	1. ACCEPT two AAs missing 2. e.g. two codons missing	**(2)**

Q10.

Question number	Answer	Additional guidance	Mark
	An answer that makes reference to the following: • {C^B / C^P} is dominant and C^Y is recessive • the order of dominance is C^B over C^P over C^Y	ALLOW C^B is dominant over C^P / C^P is dominant over C^Y / C^B is dominant over C^Y ALLOW brown is dominant to yellow and pink / pink is dominant to yellow ALLOW both marks if correct order of dominance stated	**(2)**

Q11.

Question Number	Answer	Additional guidance	Mark
(i)	• (the genotype is) heterozygous and (the phenotype is) affected with the disease (1)	ALLOW any upper case and lower case letter to show heterozygous e.g. Pp IGNORE male/female	Graduate (1)

Question Number	Answer	Additional guidance	Mark
(ii)	The only correct answer is B 0.25 A, C and D are not correct.		Computer (1)

Q12.

Question Number	Acceptable Answer	Additional Guidance	Mark
(a)	A description that makes reference to the following: • no UV (1) • water added but not from tank with fish in it that have eaten snails (1)		**(2)**

Question Number	Acceptable Answer	Additional Guidance	Mark
(b)(i)	An explanation that makes reference to the following: • calculating increase above control for 'fish' and for 'UV' (1) • adding effects of 'fish' and 'UV' (1)	fish exposure effect is 12% (above control) and (UV is) 28%	**(2)**

Question Number	Acceptable Answer	Additional Guidance	Mark
(b)(ii)	An explanation that makes reference to the following: • interferes with DNA replication (1) • (potentially) leading to mutations (1)		**(2)**

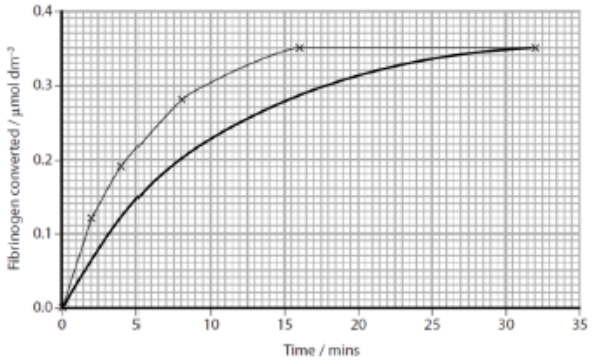
Q13.

Question Number	Acceptable Answer	Additional guidance	Mark
(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
(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)**

Q14.

Question Number	Answer	Additional Guidance	Mark
(i)	• correct values taken from the graph (1) • correct answer with correct units (1)	Example of calculation 0.12 ÷ 2 = = 0.06 μmol dm^{-3} min^{-1} = 0.06 μmol per dm^3 per minute or = 0.001 μmol dm^{-3} s^{-1} = 0.001 μmol per dm^3 per second Correct answer with no units gains one mark Correct answer with correct units but no working gains full marks	**2**

Question Number	Answer	Additional Guidance	Mark
(ii)	• curve that is less steep but reaches the same plateau (1)	e.g. 	**1**

Question Number	Answer	Additional Guidance	Mark
(iii)	An explanation that makes reference to the following: • the slower the initial rate of reaction the longer it will take for a clot to form (1) • because fibrin will be produced more slowly (1)	Allow converse arguments	**2**

Q15.

Question number	Answer	Additional guidance	Mark
(i)	• conversion of surface area from m^2 to cm^2 (1) • correctly dividing surface area by volume to determine ratio (1)	<u>Example of Calculation:</u> 97 x 10000 = 970 000 divided by lung volume of 6232 Correct ratio of **155.6 : 1** (ALLOW 155.65 :1) ALLOW one mark only for **0.0155 : 1 / 0.156 : 1 / 155.6** Correct answer with no working gains full marks	(2)

Question number	Answer	Mark
(ii)	**The only correct answer is D – Student's t-test** ***A*** *is not correct because chi- squared does not test difference between means* ***B*** *is not correct because there is no correlation to test* ***C*** *is not correct because SD does not compare means*	(1)

Question number	Answer	Additional guidance	Mark
(iii)	An answer that makes reference to two of the following points: • different { height / weight / mass } (1) • different { gender / sex } (1) • different age (1)	IGNORE 'size' ALLOW 'men have larger lungs than women'	(2)

Question number	Answer	Additional guidance	Mark
(iv)	• to allow (valid) comparison / show differences (1)		(1)

Q16.

Question Number	Answer	Additional Guidance	Mark
	An explanation that makes reference to five of the following: • as a result of a mutation **(1)** • (cyanobacteria) produce proteins containing the amino acid cysteine **(1)** • (cysteine rich proteins) produce {heat stable enzymes / proteins resistant to unfolding} **(1)** • other adaptations such as {enzymes with large hydrophobic cores / simpler protein folds / amino acids that do not bond to metal ions } **(1)** • high temperatures act as a selection pressure **(1)** • allowing them to {survive / replicate} and pass advantageous allele to next generation **(1)**	ALLOW 'pass alleles for heat tolerance to next generation'	**(5)**

Q17.

Question Number	Answer	Additional guidance	Mark
	An explanation that makes reference to three of the following: • {screen / produce} a (large) population of mice (1) • cross (two) heterozygous mice (1) • select the homozygous recessive mice (1) • and breed from these for subsequent generations (1)	ALLOW labelled genetic diagrams ALLOW carriers for heterozygous ALLOW breed for select ALLOW select mice expressing the recessive trait	**(3)**

Q18.

Question Number	Acceptable Answer	Additional Guidance	Mark
	An explanation that makes reference to the following: • mucus contained in membrane bound vesicles inside the cell (1) • (these vesicles) fuse with the cell membrane releasing the mucus (1)		**(2)**

Q19.

Question Number	Answer	Additional Guidance	Mark
	An explanation that makes reference to the following:	ALLOW converse	
	• hydrophilic parts associate with water (1)	ALLOW phosphate groups associate with water	
	• hydrophobic parts {associate with each other / repel water }(1)	ALLOW fatty acids face away from water	
	• a bilayer forms with hydrophobic parts pointing { in towards the centre of the bilayer / towards each other } (1)	ALLOW annotated diagram to show arrangement of phospholipids	**3**

Q20.

Question Number	Answer	Additional Guidance	Mark
(i)	An explanation that makes reference to the following: • changing a base results in a change in the triplet code • this changes the codon(s) in the mRNA • resulting in a different { amino acid / amino acid sequence } (in the primary structure)	ALLOW deletion / substitution / insertion / frameshift. ALLOW illustration of change in triplet code e.g. ATT to ATG ALLOW introducing a stop codon / terminating translation	(3)

Question Number	Answer	Additional Guidance	Mark
(ii)	An explanation that makes reference to the following: • sequence the genome of people with MPS1 • sequence the genome of a number of people without the condition • compare the base sequences to identify mutations found only in individuals with the condition	ALLOW comparison of base sequences of people with MPS1 and people without MPS1	(3)

Q21.

Question Number	Answer	Additional guidance	Mark
	An explanation that makes reference to the following: • (a recessive disorder is one) caused by a faulty allele (1) • that is only expressed in the { homozygous condition / absence of a normal allele } (1)	ALLOW faulty gene ALLOW only expressed if genotype is { homozygous recessive / bb } or if two recessive alleles are inherited	(2)

Q22.

Question Number	Answer	Additional Guidance	Mark
	An explanation that makes reference to two of the following: • use a range of concentrations between 0 and 2.0 (ng cm^{-3}) • so that enzyme concentration is the only limiting factor • because the initial rates of reaction have to be compared		**(2)**

Q23.

Question Number	Answer	Additional guidance	Mark
(i)	An explanation that makes reference the following: • hydrolysis of ATP (1) • provides energy for the reaction (1) • provides phosphate group for phosphorylation of F-6-P (1)	ALLOW as the reaction requires energy ALLOW provides {phosphate / Pi} that is added to F-6-P	**(3)**

Question Number	Answer	Additional guidance	Mark
(ii)	An answer that makes reference to three of the following: • as concentration of { F-6-P / F-2,6-BP } increases so does the (initial) rate of reaction of the phosphofructokinase (1) • an increasing in the concentration of { F-6-P / F-2,6BP } will increase the rate of glycolysis (1) • up to a maximum (rate) (1) • increasing the concentration of F-2,6-BP reduces the concentration of F-6-P required to achieve the maximum rate of glycolysis (1)	ALLOW 'enzyme' for 'phosphofructokinase' ALLOW F-2,6-BP provides positive feedback to the enzyme activity	(3)

Q24.

Question number	Answer	Additional guidance	Mark
	An explanation that makes reference to three of the following: • { thick / sticky / viscous } mucus (1) • (accumulation of mucus) which cannot be moved by cilia (1) • restricting air flow through { bronchioles / bronchi } (1) • {increases diffusion distance / reduces surface area for gas exchange } in the alveoli (1)	IGNORE 'airways' ALLOW narrowing of bronchioles	(3)

Q25.

Question number	Answer	Additional guidance	Mark
	An explanation that makes reference to three of the following points: • { smaller surface area / increased diffusion distance } for gas exchange (1) • therefore reduction in oxygen uptake (1) • therefore less oxygen for aerobic respiration (1) • leading to more anaerobic respiration (causing fatigue) (1)	ALLOW smaller SA:vol	(3)

Mark Scheme

Q1.

Question Number	Answer	Additional Guidance	Mark
	An explanation that makes reference to the following: • hydrophilic region (of phospholipid) orientated towards water (1) • (and) hydrophobic regions away from the water (1) • (but need the two layers as) { water-based / aqueous } solution either side of the cell membrane (1)	ALLOW phosphate head / polar region ALLOW hydrocarbon chain / fatty acid tails e.g. separating tissue fluid from cytoplasm	(3)

Q2.

Question Number	Acceptable Answer	Additional Guidance	Mark
	A description that makes reference to the following: • increased diffusion distance / decreased surface area (1) • reduced (rate of) gas exchange (1)		**(2)**

Q3.

Question Number	Answer	Mark
(i)	The only correct answer is C – polynucleotides and phospholipids *A is incorrect because phosphate is not in cellulose* *B is incorrect because polysaccharides do not contain phosphate* *D is incorrect because phosphate is not in polysaccharides*	**(1)**

Question Number	Answer	Additional guidance	Mark
(ii)	An explanation that makes reference to three of the following • the stems contain starch or cellulose (1) • enzymes are {secreted / released} by the microorganisms (1) • which break down the glycosidic bonds (1) • which releases glucose that is used by the microorganisms in respiration (1)	ALLOW lignin ALLOW enzymes from microorganisms digest (starch / cellulose)	**(3)**

Q4.

Question number	Answer	Additional guidance	Mark
(i)	• values substituted into the equation (1) • correct answer (1)	Example of calculation: (30 x 9) ÷ 0.5 = 540 Correct answer with no working gains full marks	(2)
(ii)	• calculation of the difference using the value from (i) (1) • correct answer (1)	Example of calculation: 2124 – 540 (= 1584) 1584/ 2124 x 100 = 74.6% or 75% **ECF** full marks if calculated correctly for value other than 540 Correct answer with no working gains full marks	(2)

Q5.

Question Number	Answer	Additional Guidance	Mark
(i)	A (K)		**(1)**

Question Number	Acceptable Answer	Additional Guidance	Mark
(ii)	C (M)		**(1)**

Question Number	Acceptable Answer	Additional Guidance	Mark
(iii)	D (N)		**(1)**

Question Number	Acceptable Answer	Additional Guidance	Mark
(iv)	• measures width on diagram (1) • correct answer (1)	Example of calculation (500 x width of K) ÷ length of bar = 940 nm Allow full marks for correct answer with no working	**(2)**

Q6.

Question Number	Answer	Additional guidance	Mark
	An explanation that makes reference to the following • oxygen enters the cells by diffusion (1) • change in shape {reduces surface area to volume ratio /increases diffusion distance} (1) • therefore gas exchange decreases / less oxygen enters thecells (1)		**(3)**

Q7.

Question Number	Answer	Additional guidance	Mark
	An answer the makes reference to four of the following: • both have same volume (1) • animal A has a larger surface area (1) • animal A has a larger surface area to volume ratio (1) • so sufficient (surface area in animal A) for diffusion (1) • distance to cells in centre of A is shorter than for B allowing {quicker/sufficient} diffusion / shorter diffusion distance (in A) (1)	ALLOW both have a volume of 64 mm^3 ALLOW converse ALLOW figures given (e.g. 168 mm^2 v 96mm^2) or difference given as 72 mm^2 ALLOW {168:64 / 2.6:1} compared to {96:64 / 1.5:1} ALLOW converse ALLOW converse	**(4)**

Q8.

Question Number	Answer	Mark
	The only correct answer is A - DNA which codes for a different amino acid *B is incorrect because DNA does not code for monosaccharides* *C is incorrect because the change is not in RNA* *D is incorrect because the change is not in RNA and it does not code for monosaccharides*	**(1)**

Q9.

Question Number	Answer	Additional guidance	Mark
	An answer that makes reference to the following • siRNA binds to the mRNA (from the mutated allele) (1) • mRNA cannot bind to ribosome (1) • tRNA is prevented from binding with mRNA(1) • {polypeptide / protein} not synthesised (1) • (no development of porphyria) as the faulty enzyme is not produced (1)	ALLOW amino acids not brought to mRNA ALLOW functioning gene transcribed instead	Expert (4)

Q10.

Question Number	Answer	Additional Guidance	Mark
(a)(i)	{Met Gly Ile} / {methionine glycine isoleucine} ;	**Not** other abbreviations	**(1)**

Question Number	Answer	Additional Guidance	Mark
(a)(ii)	idea that each {triplet is discrete / base is only used once in a triplet / eq} ;	**Accept** a description of how the code could be read if overlapping	**(1)**

Question Number	Answer	Additional Guidance	Mark
(b)(i)	1. idea that each amino acid needs a code ; 2. idea that {using three bases give enough codes / using less bases does not give enough codes} ; 3. idea of three bases means there can be 64 {triplets / codes / combinations / eq} ;	**Accept** codons	**(2)**

Question Number	Answer	Additional Guidance	Mark
(b)(ii)	1. idea that {effects of mutations are reduced / the amino acid may not be altered} ; 2. reference to the third base (being the one that can be changed with no effect) ; 3. no effect on (resulting) {polypeptide / protein} / eq ;	**1. Accept** description of effect **Accept** from a description of a specific example **Accept** always results in same amino acid **Not** similar amino acid **2 NB** If mp 2 is awarded it will usually incorporate mp 1 as well = 2 marks	**(2)**

Question Number	Answer	Additional Guidance	Mark
(c)	1. reference to (TAA, TAG and TGA as) stop codons ; 2. occur at the end of the gene (on the DNA) / eq ; 3. reference to transcribed as mRNA / eq ;	**1. Not** codes, triplets	

	4. as AUU, AUC and ACU ; 5. idea that they are recognised by ribosome ; 6. idea that they signal the end of the polypeptide (chain) ; 7. reference to (during) translation ;	**6. Accept** stops the synthesis of the polypeptide / the polypeptide is finished	**(4)**

Question Number	Answer	Additional Guidance	Mark
(d)	1. ref to peptide {bond / link} ; 2. between (amino group / NH_3 / NH_4^+} and {carboxyl group / COOH / COO^-} ; 3. ref to condensation (reaction) ; 4. idea of role of {tRNA / ribosome / enzymes / correctly named enzyme} in joining amino acids together ;	**Accept** mp 1 and 2 from correctly drawn and labelled diagram **2. NB** formulae must be correct if only these are given **4. Accept** e.g. hold the amino acids next to each other, ribosome contains enzyme	**(3)**

Q11.

Question Number	Answer	Additional Guidance	Mark
(a)	A = adenine C = cytosine G = guanine T = thymine ;	**Accept** reasonable phonetic spellings **Not:** adenosine cysteine glycine thiamine, thyosine, tyrosine	**(1)**

Question Number	Answer	Additional Guidance	Mark
(b)(i)	1. idea that each amino acid is coded for by three {nucleotides / bases} ; 2. credit quoted example / idea that 12 {nucleotides / bases} code for 4 amino acids ;	**Accept** in context of RNA AAT / AAC = leucine, CAG = valine, TTT = lysine	**(2)**

Question Number	Answer	Additional Guidance	Mark
(b)(ii)	1. idea that each {triplet is discrete / each base is only used once in a triplet / eq } ; 2. idea that AAT + AAC + CAG + TTT gives 4 (distinct) {triplets / codes} ;	**Accept** a specific example eg the first T can only be used in code for first leucine **Accept** a description of how the code could be read if overlapping	**(2)**

Question Number	Answer	Additional Guidance	Mark
(b)(iii)	1. idea that more than one code can be used for a {particular amino acid/ stop code} ; 2. AAT and AAC code for leucine ;	**Accept** more codes than are needed to code for all the amino acids (and stop code)	**(2)**

Question Number	Answer	Additional Guidance	Mark
(c)	B ;		**(1)**

Question Number	Answer	Additional Guidance	Mark
*(d)	QWC – Spelling of technical terms must be correct and the answer must be organised in a logical sequence 1. reference to mRNA with sequence UUA UUG GUC AAA ; 2. idea that ribosome is involved ; 3. idea that each tRNA molecules is attached to one (specific) amino acid ; 4. credit example of tRNA anticodon with specific amino acid 5. reference to anticodons on tRNA {bind / link to / line up against / eq} codons on mRNA ; 6. credit a specific example (from this DNA) ; 7. idea of hydrogen bonds between bases (of tRNA and mRNA) ; 8. reference to formation of peptide {bonds / links} between (adjacent) amino acids ;	**QWC emphasis is logical sequence** **NB The mps do not have to be given in this order necessarily** **Not** tRNA carries amino acids AAU /AAC = leucine, CAG = valine, UUU = lysine **Ignore** complementary eg UUA codon and AAU anticodon **Accept** between codon and anticodon	**(5)**

Q12.

Question Number	Acceptable Answer	Additional Guidance	Mark
(i)	An explanation that makes reference to the following: • low blood glucose levels (1) • less glucose for respiration (1) • less { energy / ATP } in muscle tissue (1)		**(3)**

Question Number	Acceptable Answer	Additional Guidance	Mark
(ii)	An answer that makes reference to the following: • range of enzyme concentration (1) • control of other named variables (1) • measurement of rate of glucose production (1)	e.g. temperature, pH, concentration of substrate	**(3)**

Q13.

Question Number	Answer	Additional Guidance	Mark
(a)	1. proteins consist of amino acids joined together by peptide bonds; 2. credit reference to named bonds (between R groups) involved in holding {3D structure / eq} ; 3. carbohydrates consist of {monsaccharides / glucose / eq} ; 4. reference to glycosidic {bonds / eq} between (adjacent) {glucose / eq} molecules ;		**(3)**

Question Number	Answer	Additional Guidance	Mark
(b)	1. idea that the drugs could {bind to / alter shape of} {glycoproteins / gp120} ; 2. idea that drugs bind to {receptors / antigens} on membrane / eq ; 3. called CD4 (antigen / molecules) ; 4. preventing virus attaching to T (helper / $CD4^+$) cells / eq ;		**(3)**

Question Number	Answer	Additional Guidance	Mark
***(c)**	(QWC – spelling of technical terms must be correct and the answer must be organised in a logical sequence) 1. reference to reverse transcriptase ; 2. idea of formation of (viral) DNA ; 3. from (viral) RNA ; 4. reference to integrase ; 5. idea of integration of (viral) DNA into (host) DNA ; 6. idea that {T helper cells / eq} would be {destroyed / killed / burst / eq} (by virus particles leaving cell) ; 7. idea that more T (helper) cells would become infected ;	**QWC focussing on clarity of expression** 2. reject idea that RNA is {turned into / converted into} DNA 5. ACCEPT idea of {latency / formation of provirus / eq}	**(5)**

Q14.

Question Number	Answer	Additional Guidance	Mark
(a)	1. (structure G is {glycoprotein / gp120} ; 2. used for {attachment / eq} to CD4 (molecules / receptors /antigens) ; 3. on T helper {cells / lymphocytes} ;	1. IGNORE gp 41 and gp 160 and other wrong numbers 3. ACCEPT macrophages / dendritic cells / CD4 cells	(3)

Question Number	Answer	Additional Guidance	Mark
(b)(i)	1. they are globular proteins ; 2. it has an active site ; 3. idea of {charged R groups on outside of molecules / composed of many small R groups} ;	2. idea of active site R groups enable binding of substrate 3. idea of hydrophilic on the outside	(3)

Question Number	Answer	Additional Guidance	Mark
*(b)(ii)	(QWC – spelling of technical terms must be correct and the answer must be organised in a logical sequence) 1. idea that drugs would prevent viral replication ; 2. idea that T (helper) {cells / lymphocytes} will not be { killed / burst / destroyed}(by virus particles leaving cell) ; 3. idea of {inhibition / eq} of reverse transcriptase ; 4. idea that (viral) DNA could not be made; 5. from the (viral) RNA ; 6. idea of {inhibition / eq} of integrase ; 7. idea that (viral) DNA cannot integrate into (host) {DNA / genome} / eq ;	QWC emphasis on **clarity** of expression 1. ACCEPT description of virus formation 3. ACCEPT drugs prevent action of reverse transcriptase 4. reject idea that RNA is {turned into / converted into} DNA 6. ACCEPT drugs prevent action of integrase 7. ACCEPT idea that drugs would prevent {latency / formation of provirus / eq} ;	**(5)**

Q15.

Question Number	Answer	Additional Guidance	Mark
	A description that makes reference to four of the following: • the structure of the enzyme is determined by the sequence of amino acids (1) • { tertiary structure / globular shape } provides an active site (1) • active site complementary to { (part of) phospholipid / ester bond } (1) • to break { ester bonds / bonds between glycerol and fatty acids } (1) • relevant detail concerning bonding { within the enzyme molecule / between enzyme and substrate } (1)	ALLOW primary structure for sequence of amino acids e.g. hydrophilic R groups / hydrophobic R groups	**(4)**

Q16.

Question Number	Answer	Mark
(i)	***The only correct answer is D because there is RNA in the cytoplasm, nucleus and mitochondria*** 1, 2 and 3 *A is incorrect because there is also RNA in the nucleus and mitochondria* *B is incorrect because there is also RNA in the nucleus* *C is incorrect because there is also RNA in the cytoplasm (as tRNA, mRNA or in ribosomes)*	**(1)**

Question Number	Answer	Additional Guidance	Mark
(ii)	An answer that makes reference to two of the following: • (lactate is) { oxidized to form / converted to } pyruvate (1) • (pyruvate is) converted to { glucose / glycogen } (1) • (pyruvate / glucose) used in respiration (1)	ALLOW glucose produced from the lactate ALLOW correct named stage e.g. glycolysis for glucose or link reaction for pyruvate	**(2)**

Question Number	Answer	Additional Guidance	Mark
(iii)	An answer that makes reference to the following: • dipeptide correctly drawn with peptide bond (1) • water molecule released (1)		(2)

Q17.

Question Number	Answer	Mark
(i)	***The only correct answer is B*** 3 and 4 only ***A*** *is incorrect because 1 and 2 do not transport charged molecules or ions across membranes* ***C*** *is incorrect because 1 and 2 do not transport charged molecules or ions across membranes and 4 does transport* ***D*** *is incorrect because 1 and 2 do not transport charged molecules or ions across membranes*	(1)

Question Number	Answer	Mark
(ii)	***The only correct answer is D*** 1, 2, 3 and 4 ***A*** *is incorrect because 3 and 4 also have both these regions* ***B*** *is incorrect because 1 and 2 also have both these regions* ***C*** *is incorrect because 4 also has both these regions*	(1)

Question Number	Answer	Mark
(iii)	D - x 5 000 000 ***The only correct answer is D*** *– (2.5 ÷ 5) x* 10^7 *A is incorrect* *B is incorrect* *C is incorrect*	(1)

Q18.

Question Number	Answer	Mark
(i)	The only correct answer is B - 2.5 x Q *The only correct answer is B because 50% of the base pairs are A-T with 2 hydrogen bonds and 50% C-G with 3 hydrogen bonds making a mean of 2.5 x Q* *A is incorrect because 2.0 x Q is only correct if all base pairs were A-T* *C is incorrect because it assumes that each base in a pair has 4 hydrogen bonds and all the base pairs are A-T* *D is incorrect because it assumes that each base in the A-T base pair has 4 hydrogen bonds and each base in the G-C has 6 hydrogen bonds*	**(1)**

Question Number	Answer	Additional Guidance	Mark
(ii)	An explanation that makes reference to two of the following: • (different mutations) will have different effects on the protein produced (1) • chloride ion transport affected by the extent of changes to the (CFTR) protein (1) • varying the { stickiness / thickness } of the mucus (1)	ALLOW absence of protein / different { folding / tertiary structure / shape } of the protein ALLOW faulty CFTR protein has less impact on chloride ion transport than a missing CFTR protein	**(2)**

Q19.

Question number	Answer	Mark
	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 role of ions in • nerve conduction • release of neurotransmitters • muscle contraction Mention of • passive diffusion through ion channels • active transport against concentration gradients Examples of ion transport • active transport – sodium potassium pump • hydrogen ions in chemiosmosis • calcium channels in pre-synaptic knob • sodium and potassium channels in neurones Idea that ions moving down a concentration gradient can do work • ATP synthase in chemiosmosis • cotransporters Ion channels in disease • chloride channels in cystic fibrosis • credit any other sensible suggestions • Ideas around control • lots of different genes/proteins involved in transporting ions across membranes • specificity of channels for particular ions • control of opening and closing of different channels	**(9)**

Level	Marks		Additional Guidance
0	0	No awardable content	
1	1-3	Demonstrates isolated elements of biological knowledge and understanding to the given context with generalised comments made. Vague statements related to consequences are made with limited linkage to a range of scientific ideas, processes, techniques and procedures. The discussion will contain basic information with some attempt made to link knowledge and understanding to the given context.	simple description of data provided or discussion of one aspect from specification e.g. role of ions in action potentials / muscle contraction / mucus production
2	4-6	Demonstrates adequate knowledge and understanding by selecting and applying some relevant biological facts/concepts. Consequences are discussed which are occasionally supported through linkage to a range of scientific ideas, processes, techniques and procedures. The discussion shows some linkages and lines of scientific reasoning with some structure.	Level 1 criteria plus disscussion of another aspects from specification including consideration in {disease / ill-health} in at least one
3	7-9	Demonstrates comprehensive knowledge and understanding by selecting and applying relevant knowledge of biological facts/concepts. Consequences are discussed which are supported throughout by sustained linkage to a range of scientific ideas, processes, techniques or procedures.	Level 2 criteria plus appropriate use of data from tables linked to health or disease or
		The discussion shows a well-developed and sustained line of scientific reasoning which is clear and logically structured.	attempt at higher level reasoning e.g explaining role of {ion gradients / active transport of ions} expanding on role of mutations in disease beyond cystic fibrosis / discussion of channel specificity or evolution of variety of channels with many functions

Q20.

Question Number	Answer	Additional guidance	Mark
	An answer the makes reference to four of the following: • use pH buffers at a range of pH values below 7 (1) • provide an excess of ATP (1) • (use) F-6-P at an appropriate concentration (1) • suitable variable controlled (1) • measure quantity of F-2,6-BP produced per unit time (1)	e.g. 2 mmol dm^{-3} (values between 1 and 2.5 mmol dm^{-3}) e.g. {enzyme / phosphofructokinase } concentration / temperature ALLOW measure change in concentration of F-2,6-BP / phosphate incorporated	**(4)**

Q21.

Question Number	Answer	Additional guidance	Mark
	An answer the makes reference to three of the following: • no offspring from the cross between weary and upright lettuce had the weary phenotype (1) • the ratio of weary to upright lettuce in the F_2 generation was 1: 3 (1) • the chi-squared test value was below the critical value (1) • result not statistically different from expected result (1)	ALLOW none of the F_1 generation had the weary phenotype / all the F_1 generation were upright ALLOW {25% / ¼ / 27.7%} of the F_2 generation were weary lettuce ALLOW less than a critical value of 3.84 IGNORE degrees of freedom or incorrect cv ALLOW the null hypothesis can be accepted	**(3)**

Q22.

Question Number	Answer	Additional Guidance	Mark
(a)	C (phospholipid)		**(1)**

Question Number	Acceptable Answer	Additional Guidance	Mark
(b)(i)	rhodopsin		**(1)**

Question Number	Acceptable Answer	Additional Guidance	Mark
(b)(ii)	(cis) retinal		**(1)**

Question Number	Acceptable Answer	Additional Guidance	Mark
(c)	A description that makes reference to the following: • opsin released causing sodium ion channels to be blocked (1) • which causes hyperpolarisation in the rod cell (1) • causing action potential in bipolar cell (results in action potential in the optic nerve) (1)		**(3)**

Q23.

Question Number	Answer	Additional guidance	Mark
(i)	A description that makes reference to the following • sequence of amino acids (1) • joined together by peptide bonds (1)		graduate (2)

Question Number	Answer	Additional guidance	Mark
(ii)	A description that makes reference to five of the following • folding of protein inside the {rough endoplasmic reticulum / rER } (1) • bonds formed between R groups (1) • rER {forms / packages proteins in} vesicles (1) • vesicles transport the protein to the Golgi apparatus (1) • protein modified in Golgi apparatus (1) • detail of modification (1)	ALLOW formation of named bonds ALLOW processed e.g. carbohydrates/sugar molecules added / prosthetic group	Expert (5)

Q24.

Question number	Answer	Additional guidance	Mark
	A description that makes reference to the following • (mineral ions) are taken up by active transport (1) • through carrier proteins (1) • this requires {energy / ATP} (1)	IGNORE channel ALLOW protein pumps	Expert (3)

Q25.

Question Number	Answer	Mark
(i)	The only correct answer is –A *amino acids* B is incorrect because nitrates are not found in cellulose C is incorrect because nitrates are not found in starch D is incorrect because nitrates are not found in sucrose	Computer (1)

Question Number	Answer	Mark
(ii)	The only correct answer is –C *nucleic acids* A is incorrect because phosphate is not found in cellulose B is incorrect because phosphate is not found in chlorophyll D is incorrect because phosphate is not found in sucrose	Computer (1)

Question Number	Answer	Mark
(iii)	The only correct answer is – C *chlorophyll* A is incorrect because magnesium is not found in amino acids B is incorrect because magnesium is not found in cellulose D is incorrect because magnesium is not found in starch	Computer (1)