PEARSON EDEXCEL IAL BIOLOGY · YBI11

BIOLOGY



MARK SCHEME

UNIT 1: MEMBRANES, PROTEINS, DNA AND GENE EXPRESSION

SCORE	PERCENTAGE
/563	%

STEMUP

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Mark Scheme

Q1.

Question number	Answer	Additional guidance	Mark
(a)	A diagram that shows: • COOH group and NH_2 group (1) • H and the aspartate R group (1) • all attached to a central C (1)	**Accept** charged groups	(3)

Question number	Answer	Additional guidance	Mark
(b)	An explanation that includes the following points: • because (the urea cycle has) many {stages / steps / reactions} (1) • therefore, the product of one stage is the substrate of the next stage (1) • and enzymes are **specific** to one substrate (1) • substrates {bind / attach / fit} to (specific) active site / credit reference to lock and key theory / credit reference to induced fit (1)	**ACCEPT** each stage has {new / different} substrate / different substrates (in the process) **ACCEPT** if active site is referred to in the context of an enzyme-substrate complex	(3)

Question number	Answer	Additional guidance	Mark
(c)(i)	An answer that includes three of the following points: • genetic screening / named screening method / looking for a mutation • biochemical test / blood test / description of named molecule whose level would be different • family history / pedigree analysis	**IGNORE** where the molecules maybe found	(3)

Question number	Answer
* (c)(ii)	Indicative content: Table of results: • OTC mRNA treatment reduces the levels of ammonia back to nearly normal (Diagram of urea cycle: • ammonia levels will build up if carbamyl phosphate is not combined with ornithine • OTC deficiency will result in carbamyl phosphate not combining with ornithine Diagram of particle: • particle targets liver and this is where the urea cycle takes place • the phospholipids will fuse with the liver cells to enable the mRNA to enter the cells • because the phospholipids can move • the phospholipids will protect the mRNA • from hydrolytic enzymes • the mRNA will be translated inside the liver cells • producing functional OTC • the OTC will combine carbamyl phosphate with ornithine • reducing the levels of urea

	Aspects to cover : D_d - description of data E_d - explanation of data : ammonia converted to urea because ornithine cycle functioning D_r - recognition of mRNA involved in translation E_r - explanation that functional OTC can be produced D_p - comment on role of particle E_p - explanation of phospholipid particle **Level 1** 1 mark : one description 2 marks : one description and one explanation or two descriptions **Level 2** 3 marks : two descriptions and one explanation or three descriptions 4 marks : two descriptions and two explanations **Level 3** 5 marks : three descriptions and two explanations 6 marks : three descriptions and three explanations

Q2.

Question number	Answer	Additional guidance	Mark
(a)	An explanation that includes the following points: • because the mutated gene results in a faulty (CFTR) protein (1) • so chloride ions do not move out of the cells (1) • decreasing the water potential inside the cell (1) • therefore water {leaves the mucus / enters the cells} by <u>osmosis</u>(1)	**ACCEPT** less effective **ACCEPT** reduced movement of chloride ions / sodium ion channelnot inhibited / sodium ions not prevented from entering cell **ACCEPT** decreasing {osmotic potential / solute potential} / increasing solute concentration **IGNORE** decreasing water concentration	**(3)**

Question number	Answer	Additional guidance	Mark
(b)	An explanation that includes five of the following points: • because the mucus blocks the airways (1) • therefore {air flow to lungs / gas exchange} is reduced (1) • because mucus prevents pancreatic enzymes from entering thesmall intestine (1) • therefore large food molecules not broken down (and cannot beabsorbed) (1) • because the mucus prevents sperm passing through the cervix(1) • therefore sperm cannot reach the egg cell (1)	**ACCEPT** duodenum / gut / digestive tract named enzyme secreted by pancreas **ACCEPT** named large food molecule **ACCEPT** reach the {oviducts / fallopian tubes}	(5)

Question number	Answer	Mark
(c)(i)	**C** 40 The only correct answer is C. *A is incorrect because* ***B** is incorrect because* ***D** is incorrect because*	(1)

Question number	Answer	Additional guidance	Mark
(c)(ii)	An explanation that includes the following points: • because (the graph shows that) the level of CFTR proteinfunction varies between 3 and 18% (1) • because (the graph shows that) individuals diagnosedwith cystic fibrosis have a range in concentration of chloride ions in sweat (1) • therefore the CFTR protein must be affected to differentextents (by different mutations) (1)		(2)

Q3.

Question number	Answer	Additional guidance	Mark
(a)	• change in the base {sequence / order} of DNA	**ACCEPT** change in the number of chromosomes / damage to chromosome / loss of part of chromosome	(1)

Question number	Answer	Additional guidance	Mark
(b)(i)	• a change in one variable is reflected in a change in another variable	**ACCEPT** a description that onlymentions 'change' once **DO NOT ACCEPT** causes / results in	(1)

Question number	Answer	Additional guidance	Mark
(b)(ii)	A description that includes the following points: • incidence of skin cancer increases with (an increase in) age (1) • incidence of skin cancer increases with an increase in the years (1) • males have higher incidence of skin cancer than females (1)	**ACCEPT** converse throughout **ACCEPT** in either context of males or females or both **ACCEPT** in either context of males or females or both	(3)

Question number	Answer	Additional guidance	Mark
(b)(iii)	An answer that includes three of the following points: • as age increase there is more time for mutations to {build up / occur} (1) • people are spending more time in the sun (1) • more UV light reaching the earth's surface (1) • more men have {jobs / hobbies} outside (1) • men have a greater genetic disposition to skin cancer (1)	**ACCEPT** the older you are the more exposure to risk factors / the more cell divisions the more chance of mutations **ACCEPT** an example of why this may happen e.g. going on more holidays in hot countries **ACCEPT** ozone layer depletion **ACCEPT** men smoke more	**(3)**

Question number	Answer	
* **(c)**	Indicative content: Repeatability: • sample size is small • smokers are being studied and their sample size is very small* • no statistical data available • no indication of the location of the individuals (could be a validitycomment as well) Validity: • mean age at diagnosis is similar but not identical • there is a greater range of ages for males than females • no indication of the actual ages of the people • so there could be more people at the extremes in one group • no information about other lifestyle factors • e.g. working in polluted environment, living in the city • no information about non-lifestyle factors • e.g. ethnicity • no indication if individuals lived with other smokers (passivesmokers) • no indication of how long people been smoking for* • no indication of how many cigarettes were smoked by the smokerseach day* • no indication if the non-smokers had ever smoked previously* • no indication of severity of emphysema* • no indication if emphysema is self-diagnosed or clinical diagnosis*	**Level 1 : comments on the design of the study** 1 mark = 1 comment 2 marks = 3 comments **Level 2 : comments on the design of the study** 3 marks = 4 comments, at least one of which isfrom each category 4 marks = 5 comments, at least one of which isfrom each category **Level 3 : comments on the design of the studyand makes at least one link correctly with repeatability or validity** 5 marks = 5 comments at least one of which islinked to repeatability or validity 6 marks = 6 comments at least one of which is linked to repeatability or validity **and** includes aspecific comment about {smoking / emphysema}* **ACCEPT** reproducible / reliable **IGNORE** accurate / precise **(6)**

Q4.

Question number	Answer	Mark
(a)	**C** glycogen The only correct answer is C. *A is incorrect because amylopectin is found in plant cells only* ***B** is incorrect because cellulose is found in plant cells only* ***D** is incorrect because starch is found in plant cells only*	(1)

Question number	Answer	Mark
(b)	**D** lactose and sucrose The only correct answer is D. *A is incorrect because fructose is a monosaccharide and therefore not digested* ***B** is incorrect because fructose and galactose are both monosaccharides and therefore not digested* ***C** is incorrect because galactose is a monosaccharide and therefore not digested*	(1)

Question number	Answer	Additional guidance	Mark
(c)(i)	• 190 900 000 / 191 000 000 / 191 million / 1.909×10^8 / 1.91×10^8		(1)

Question number	Answer	Additional guidance	Mark
(c)(ii)	An explanation that includes three of the following points: • because (prenatal testing) can cause abortion (1) • because false negative or false positive results can be avoided (ifpatient already has diabetes) (1) • because of issues arising if another genetic condition is found (1) • because an individual could live a healthy life (as only a geneticpredisposition) (1) • because of the ethics associated with destroying embryos (IVF) (1)		(3)

Q5.

Question number	Answer	Additional guidance	Mark
(a)	An answer that makes reference to the following points: • {protein / found in organisms} (1) • that {decreases activation energy / speeds up (the rate of) reaction} (without being used up) (1)	**ACCEPT** in our {bodies / cells / cytoplasm} / in a named organism **ACCEPT** description of activation energy	(2)

Question number	Answer	Mark
(b)	**The only correct answer is B** (Q) A is incorrect because Q is the activation energy C is incorrect because Q is the activation energy D is incorrect because Q is the activation energy	(1)

Question number	Answer	Additional guidance	Mark
(c)	An explanation that includes the following points: • substrate {binds / fits / forms enzyme-substrate complex} to the active site of the enzyme (1) • due to the shape of the {active site / enzyme / substrate} (1) • which is due to the {R groups / amino acids} (forming the active site) (1) • AB and AC {are a different shape to A and B / do not fit into E_1} (1)	**ACCEPT** are not complementary to (E_1) enzyme	(3)

Question number	Answer	Additional guidance	Mark
(d)	A description that includes the following points: • pH 4 is the {most suitable / best} pH (1) • 30°C is the {most suitable / best} temperature (1) • pH 2 and 60°C (both) denature the enzyme (1)		(2)

Q6.

<table>
<tr><th>Question number</th><th>Answer</th><th>Additional guidance</th><th>Mark</th></tr>
<tr><td>(a)</td><td>
<table>
<tr><th>Name</th><th>Role</th><th>Property</th></tr>
<tr><td>thromboplastin</td><td>(catalyses the) conversion of prothrombin into thrombin (1)</td><td>soluble</td></tr>
<tr><td>thrombin (1)</td><td>catalyses the conversion of fibrinogen into fibrin</td><td>soluble (1)</td></tr>
<tr><td>fibrin</td><td>Any two of the following points:
• form a network of fibres / mesh (1)
• trap {platelets / blood cells} (1)
• form a scab to {seal the wound / stop bleeding} (1)
• form a scab to prevent the entry of bacteria (1)</td><td>insoluble (1)</td></tr>
</table>
</td><td>IGNORE reference to calcium ions / vitamin K

ACCEPT unsoluble

ACCEPT two points made in one sentence
DO NOT ACCEPT completely wrong statements</td><td>(6)</td></tr>
</table>

Question number	Answer	Additional guidance	Mark
(b)	An explanation that includes the following points: • because {gene / (defective) allele} located on the X chromosome (1) • because defective allele is recessive (1) • therefore, males with {defective / haemophilia} **allele** will only have that **allele** (1)	**ACCEPT** X-linked disease / sex-linked disease / inherited on the X chromosome **ACCEPT** {mutated / affected} allele / {haemophilia / disease} is recessive **ACCEPT** males will not carry a {healthy / normal} allele females need {both defective alleles / to be homozygous for defective alleles} to have haemophilia	(3)

Q7.

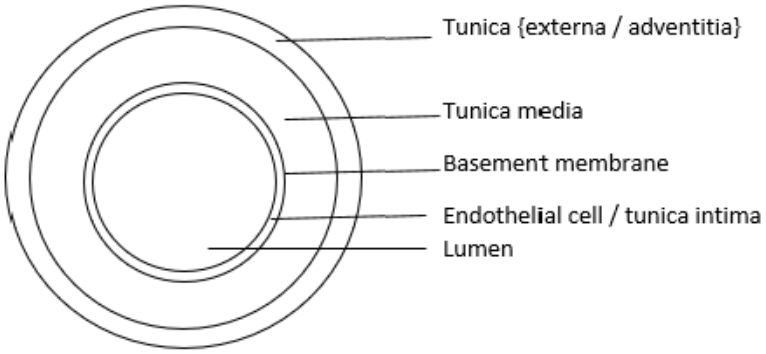
Question number	Answer	Additional guidance	Mark
(a)(i)	An answer that includes the following points: • thromboplastin (1) • active site (1) • platelets / (red / white) blood cells / erythrocytes (1)	**IGNORE** calcium ions / Ca^{++} **IGNORE** clot / scab	(3)

Question number	Answer	Mark
(a)(ii)	A The only correct answer is **A**. ***B** is incorrect because antihypertensives are used to lower blood pressure* ***C** is incorrect because platelet inhibitors affect platelets* ***D** is incorrect because statins lower blood cholesterol*	(1)

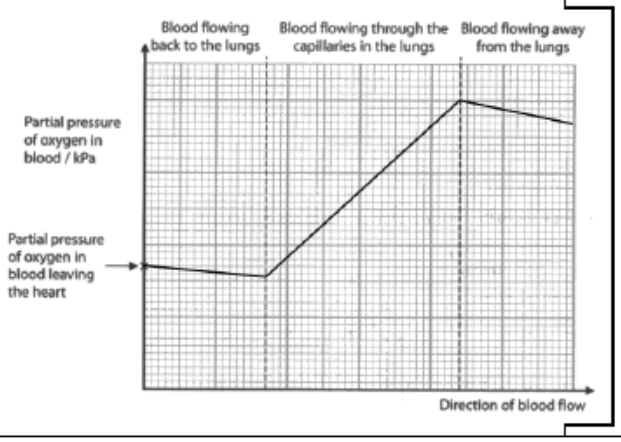
Question number	Answer	Additional guidance	Mark
(b)	• tangent drawn at 2 days (1) • correct answer up to 2 decimal places and units (1)	**Example of calculation:** **ACCEPT** straight line touching outsideof curve at 2 **ACCEPT** in range of 2.7 to 4.5 {s day^{-1} /s per day / s/day} **ACCEPT** with or without a minus sign	(2)

Q8.

Question number	Answer	Additional guidance	Mark
(a)	A description that makes reference to the following points: • one structure (1) • linked function (1)	e.g. single layer of cells / pores / small diameter **ACCEPT** thin cells / walls e.g. (single layer) gas exchange / diffusion of gases (in the lungs) (pores) plasma forced out / WBC leave / molecules can leave (small diameter) all cells close to capillaries	(2)

Question number	Answer	Additional guidance	Mark
(b)	A drawing that shows the following points: • lumen + {three layers / three other layers + endothelial layer / two layers + endothelial layer} (1) • one feature correctly labelled (1) • a second feature correctly labelled (1)	 **ACCEPT** Epithelial {layer / lining / cells} / fenestrated membrane Tunica interna Layer of (smooth) muscle and elastic fibres (and collagen) for 1 layer Award marks for longitudinal section **NB** regards mp 2 and 3 1 right + 1 wrong label = 1 mark 2 right + 1 wrong label = 1 mark 1 right + 2 wrong labels = 0 marks	(3)

Question number	Answer	Additional guidance	Mark
(c)	An explanation that makes reference to the following points: • to prevent backflow (of blood) (1) • (as blood is usually returning) {under low pressure / (often) against gravity} (1)	**ACCEPT** so that blood returns to the heart blood flow is in one direction	(2)

Question number	Answer	Additional guidance	Mark
(d)	A drawing that shows the following points: • pp of O_2 remaining constant as blood flows to lungs (1) • pp of O_2 rising as blood flows through the capillaries (1) • pp of O_2 remaining constant as blood flows away from lungs (1)	**ACCEPT** within 1 sm square of the verticals in each section **ACCEPT** slightly decreasing (within 1 large square) **ACCEPT** slightly decreasing (within 1 large square) 	(3)

Q9.

Question number	Answer	Mark
(a)(i)	**B** The only correct answer is **B**. ***A** is incorrect because fructose is a monosaccharide* ***C** is incorrect because both glucose and fructose are monosaccharides* ***D** is incorrect because fructose is a monosaccharide*	(1)

Question number	Answer	Mark
(a)(ii)	**C** peptide | condensation The only correct answer is **C**. ***A** is incorrect because ester bonds are in lipids* ***B** is incorrect because ester bonds are in lipids and hydrolysis splits bonds* ***D** is incorrect because hydrolysis splits bonds*	(1)

Question number	Answer	Mark
(a)(iii)	**B** absent / lower The only correct answer is **B**. *A is incorrect because saturated fatty acids have more hydrogens than unsaturated fatty acid of same length* ***C** is incorrect because there are no carbon carbon double bonds in saturated fatty acids* ***D** is incorrect because there are no carbon carbon double bonds in saturated fatty acids*	(1)

Question number	Answer	Additional guidance	Mark
(b)(i)	• volume of cylinder calculated (1) • ratio of surface area : volume to max 2 dps (1)	**Example of calculation:** $(3 \times 2 \times 2 \times 28 / \pi \times 2 \times 2 \times 28 / {}^{22}/_{7} \times 2 \times 2 \times 28)$ 336 / 352 (mm^3) e.g 1.02 : 1 / 1.07 : 1 / 1 : 1 **ACCEPT** ratio given the wrong way round e.g. 1 : 09 **NB** ecf if {incorrect rounding from above / diameterused} for 1 mark	(2)

Question number	Answer	Additional guidance	Mark
(b)(ii)	An explanation that includes two of the following points: • (because the insect is small) the cells will not be far from the {sinuses / blood} (1) • (so) diffusion can supply the {oxygen / nutrients / named nutrient} (from the blood) (1) • because the insect is small it does not have {double circulation /blood vessels / closed circulatory system / complex circulatory system / high pressure} **OR** • because the insect has a low {metabolic rate / oxygen demand}(1) • diffusion can supply the oxygen (from blood / tracheoles) / theoxygenated and deoxygenated blood does not need to be kept separate (1) • because the insect is small it does not have {double circulation /blood vessels / closed circulatory system / complex circulatory system / high pressure}	**IGNORE** ref to surface area to volumeratio **ACCEPT** small diffusion distance between cells and {sinuses / blood} **ACCEPT** remove carbon dioxide diffusion supplies oxygen to cells from the tracheoles **IGNORE** has an open system becausethis is in the question **IGNORE** has an open system becausethis is in the question	(2)

Question number	Answer	Additional guidance	Mark
(b)(iii)	A description that includes two of the following points: • fibrous protein (1) • {triple / three stranded} helix (held with hydrogen bonds) (1) • (short) repeating sequences of amino acids / high {hydroxyproline / proline / glycine} content / every third amino acid is glycine(1)	**IGNORE** refs to secondary / tertiary /quaternary structure throughout **NB** piece together **IGNORE** alpha	(2)

Q10.

Question number	Answer	Additional guidance	Mark
(a)	• number of deaths not due to cancer calculated (1) • 0.45 : 1 / 0.45 (1)	(541589 - 166800) 374 789 **ACCEPT** 1 : 2.25 Bald answer of 0.45 : 1 or 0.45 or 1 : 2.25 = 2 marks	(2)

	Answer	Additional guidance	Mark
(b)(i)	An answer that includes the following points: • insertion and deletion (1)	**ACCEPT** chromosome or translocation **IGNORE** point / gene / frameshift / addition / subtraction / substitution / named disorders / missense / nonsense / inversion / duplication	(1)

Question number	Answer	Additional guidance	Mark
(b)(ii)	• 65 (%)	**ACCEPT** any number to one decimal place in the range 58.0 to 67.0	(1)

Question number	Answer	Additional guidance	Mark
(b)(iii)	An explanation that includes four of the following points: • substitution mutation swaps one base (in the DNA sequence / gene) (1) • this will result in a different base being inserted into the mRNA (during transcription) (1) • the genetic code is degenerate (1) • therefore codes for the same amino acid (1) • and therefore the protein will have the same {structure / function} as the R groups will be the same (1)	**ACCEPT** substitution only affects one base example using two sets of bases	**(4)**

Question number	Answer	Mark
(c)(i)	The only correct answer is **B**, 0.125 ***A*** *is incorrect because 1 in 4 chance of having child with PKU and 1 in 2 chance of having a boy* ***C*** *is incorrect because 1 in 4 chance of having child with PKU and 1 in 2 chance of having a boy* ***D*** *is incorrect because 1 in 4 chance of having child with PKU and 1 in 2 chance of having a boy*	**(1)**

Question number	Answer	Additional guidance	Mark
*(c)(ii)	**Group 1 : Individuals 1 and 2** • must be carriers / heterozygous (S) • because they did not have PKU but some of their children did (E) **Group 2 : Individuals 3 and 4** • must be homozygous (S) • because they both had PKU (E) • because both alleles need to be recessive (E) **Group 3 : Individuals 5 and / or 6** • cannot tell if homozygous dominant or heterozygous / carrier (S) • because both these genotypes will give an individual without PKU (E) • we do not know anything about individual 6' family (U) • because no evidence in individuals 7, 8 or 9 of the disease (U) • so less likely that they are both carriers (U) **Group 4 : Individuals 7 and / or 8 and / or 9** • cannot tell if they are homozygous dominant or heterozygous (S)	**Level 1** 1 mark = genotypes for one group of individuals stated OR women are XX and men are XY OR a description of what pedigree diagrams {show / can be used for} 2 marks = explanation for one group OR genotypes for two groups stated **Level 2** 3 marks = explanations for two groups 4 marks = explanations for three or four groups with no uncertainty **Level 3** 5 marks = three groups explaining the uncertainty of either group 3 or 4 6 marks = four groups explaining the uncertainty of both groups 3 and 4	(6)

	• because both these genotypes will give an individual without PKU (E) • and we cannot determine genotypes of individuals 5 and 6 (U) • no offspring to give any clues (U) • but PKU is in individual 5's family (U) • so any of individuals 7, 8 or 9 could be carriers (U)	**NB** max 2 marks if they have discussed in relation to sex linkage	

Q11.

Question number	Answer	Mark
(a)(i)	D the hydrophobic tails move away from the aqueous (water) environment	(1)

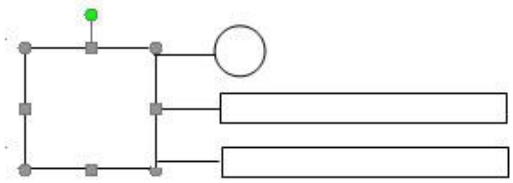
Question number	Answer	Mark
(a)(ii)	B Q	(1)

Question number	Answer	Mark
(b)	• diffusion of water molecules down a water potential gradient through a partially permeable membrane	(1)

Question number	Answer	Additional guidance	Mark
(c)	An answer that includes the following points: similarities: • both used to transport large particles / large quantities of material (1) • both involve (phospholipid) membrane vesicles (1) difference: • exocytosis is export and endocytosis is import of material (1)	Accept a description of both processes	(3)

Question number	Answer	Mark
(d)	An explanation that includes the following points: • oxygen molecule is small (1) • oxygen molecule is non-polar (1) • (it can, therefore) pass between gaps {in cell membrane / between hydrophobic tails} (1)	(3)

Q12.

Question number	Answer	Additional guidance	Mark
(a)(i)	A diagram that makes reference to the following points: • one glycerol (squarish / labelled), two fatty acids (rectangular / labelled), one phosphate and three bonds shown (1) • all components drawn together correctly (1)	 ecf if: {one / three} fatty acids drawn attached to glycerol but rest correct glycerol missing but two fatty acids attached to head with bonds bonds missing but all four components are touching correctly	(2)

Question number	Answer	Mark
(a)(ii)	**The only correct answer is A** (ester) B is incorrect because glycosidic bonds are found in carbohydrates C is incorrect because there are no hydrogen bonds in phospholipids D is incorrect because peptide bonds are found in proteins	(1)

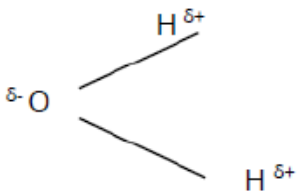
Question number	Answer	Mark
(b)(i)	**The only correct answer is B** (by diffusion) A is incorrect because active transport moves polar molecules C is incorrect because nonpolar molecules can diffuse through the nonpolar fatty acids D is incorrect because only water moves by osmosis	(1)

Question number	Answer	Mark
(b)(ii)	**The only correct answer is B** (one) A is incorrect because the second statement is the only correct one C is incorrect because the second statement is the only correct one D is incorrect because the second statement is the only correct one	(1)

Q13.

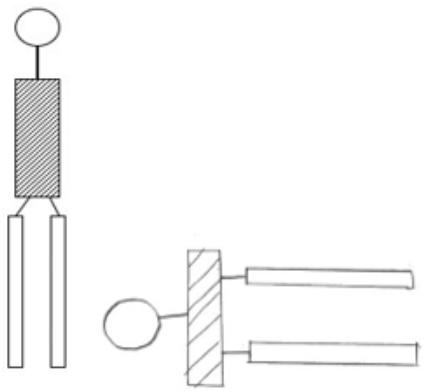
Question number	Answer	Additional guidance	Mark
(a)	An explanation that includes the following points: • because it shows that it is {made of two layers of phospholipid / abilayer} (1) • the size of a phospholipid is in the range 2.05 nm to 2.65 nm (1) • therefore the width of the membrane (5 nm) is within a bilayerrange (of 4.1 nm to 5.3 nm) (1)	**Accept** it shows two layers of phosphate heads separated by a band of lipids	(3)

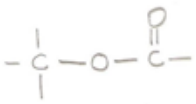
Question number	Answer	Additional guidance	Mark
(b)	An explanation that includes three of the following points: • cholesterol is a non-polar molecule (1) • fatty acid tails are non-polar (1) • cholesterol will be located within the {fatty acid tails / non-polarpart} of membrane (1) • OH group will be located near the phosphate heads (1)	**Accept** hydrophobic for non-polar inall points Accept {hydrocarbon tail / hydrocarbonrings} are non-polar	(3)

Question number	Answer	Additional guidance	Mark
(c)(i)	A description that includes the following points: • {small / weak / delta / partial} positive charge on hydrogen (1) • {small / weak / delta / partial} negative charge on oxygen (1)	Accept both points from a diagram 	(2)

Question number	Answer	Additional guidance	Mark
(c)(ii)	An explanation that includes the following points: • water is small enough to move by {osmosis / diffusion} (betweenthe phospholipids) (1) • steroid (is non-polar so) can diffuse through the {membrane / phospholipids} (1) • glucose (is polar so) passes through {protein channels / carrierproteins / by facilitated diffusion} (1) • ions (are polar so) pass through {protein channels / carrier proteins / by facilitated diffusion / active transport} (1)	**Accept** description of water movingthrough {protein channels / aquaporins} **Accept** steroid is not repelled by fattyacid tails **Accept** movement by active transport **Accept** ions are repelled by fatty acidtails so cannot get through membrane	(4)

Q14.

Question number	Answer	Additional guidance	Mark
(a)(i)	A diagram that includes the following points: • one glycerol (shaded / labelled), two fatty acids (not shaded / labelled), one phosphate and three bonds shown (1) • all components drawn together correctly (1)	 ecf if: {one / three} fatty acids drawn attached to glycerol but rest correct glycerol missing but fatty acids attached to head with bonds bonds missing but all four components are touching correctly {all shaded / nothing shaded} with no labels	(2)

Question number	Answer	Mark
(a)(ii)	 The only correct answer is **C,** ***A** is incorrect because it is not an ester bond* ***B** is incorrect because it is not an ester bond* ***D** is incorrect because it is not an ester bond*	**(1)**

Question number	Answer	Additional guidance	Mark
(b)(i)	An explanation that includes two of the following points: • because {phospholipids / molecules} have more (heat / kinetic) energy (1) • because {forces / interactions} between {fatty acid chains / phospholipids} break (1) • therefore <u>phospholipids</u> can move around (within the membrane) / phospholipid bilayer} more (1)	**IGNORE** proteins **ACCEPT** bonds break bonds between {fatty acids and cholesterol / phospholipids} Van der waals forces	**(2)**

Question number	Answer	Mark
(b)(ii)	The only correct answer is **C** **Has double bonds between two carbons:** yes **Number of hydrogens:** fewer than the saturated fatty acid ***A** is incorrect because unsaturated fatty acids have double bonds between carbons* ***B** is incorrect because unsaturated fatty acids have double bonds between carbons* ***D** is incorrect because unsaturated fatty acids have fewer hydrogen*	**(1)**

Question number	Answer	Additional guidance	Mark
(b)(iii)	An explanation that includes the following points: • cholesterol interacts with {phospholipids / fatty acids} (1) • (if less cholesterol) movement of <u>phospholipids</u> no longer restricted (by interaction with cholesterol) (1)	**NB** we are not looking for the idea that cholesterol is acting as a barrier or taking up space **ACCEPT** bonds **ACCEPT** so <u>phospholipids</u> can move around more	(2)

Question number	Answer	Additional guidance	Mark
(b)(iv)	• will require less (kinetic) energy to move / because there are fewer interactions (with {other fatty acids / phospholipids / cholesterol}) (1)	**ACCEPT** bonds converse for longer chains	(1)

Question number	Answer	Additional guidance	Mark
(c)(i)	An answer that includes the following points: • convert saturated fatty acids into unsaturated fatty acids (1) • convert long side chains into shorter ones (1)	**ACCEPT** become unsaturated / increase in unsaturated / decrease in saturated fats **ACCEPT** become shorter	(2)

Question number	Answer	Additional guidance	Mark
(c)(ii)	An answer that includes two of the following points: • to maintain the fluidity of the membrane (1) • so that membrane can change shape (1) • so that fusion of membranes can occur (1) • so that substances can continue to move across membrane (1)	**ACCEPT** otherwise the fluidity will decrease **ACCEPT** named example e.g phagocytosis, endocytosis, exocytosis, red blood cells, formation of vesicles **ACCEPT** named example e.g. of nuclei (during fertilisation) fusion of vesicles **ACCEPT** named substance	**(2)**

Q15.

Question number	Answer	Additional guidance	Mark
(a)(i)	A description that includes three of the following points: • fibrous protein (1) • (protein) composed of {three polypeptide chains / three-stranded / triple} helix (1) • held by hydrogen bonds (between the chains) (1) • credit details of the chains (1)	e.g every third amino acid is a glycine, repeating sequences of amino acids, high content of {glycine / proline / hydroxyproline}	**(3)**

Question number	Answer	Additional guidance	Mark
(a)(ii)	An explanation that includes the following points: • gives (the wall) (tensile) strength (1) • so that the aorta {does not get damaged by / can withstand} pressure (of the blood leaving the heart) (1)	**IGNORE** refs to elastic properties and recoil **IGNORE** prevents aorta from collapsing	**(2)**

Question number	Answer	Additional guidance	Mark
* **(b)**	Indicative content: Graph 1 • older male monkeys have more stiffness than younger males (D) • older female monkeys have more stiffness than younger females (D) • older males have more stiffness than older females (D) • probably significant as error bars do not overlap (C) • not much difference in stiffness between younger males and females (D) • as error bars overlap (C) • age increases aortic stiffness in both males and females (C) • age has a greater effect on aortic stiffness in males than females (C) Graph 2 • density of collagen decreases slightly with age (D) • males of all ages have (slightly) more collagen that females (C) • probably not significant as error bars overlap (C) • neither age nor sex affects density of collagen (C) • changes in stiffness do not appear to be related to the density of collagen (C) Graph 3 • higher type 1 in younger monkeys than older ones (D)	**Level 1** 1 mark = description made from one graph (D) 2 marks = descriptions made from two graphs (D) **Level 2** 3 marks = plus one conclusion made (C) 4 marks = plus two conclusions made (C) **Level 3** 5 marks = two conclusions and comments on the other two graphs 6 marks = three conclusions that includes the asterisked conclusion (C*) and comments on the other two graphs **Description = comparison of one variable** **Conclusion = summary statement that includes both age and sex**	**(6)**

	• more type 1 in females than males at each age (D) • no error bars shown to judge significance (C) Graph 4 • more type 8 in older male monkeys (D) • may not be a difference in type 8 between older and younger females (D) • no error bars to judge significance (C) • the type of collagen appears to determine stiffness (C) • stiffness associated with decrease in type 1 and increase in type 8 (C*)	**interpretation of error bar and significance of data – not reliability** **links between 2 graphs**	

Q16.

Question number	Answer	Additional guidance	Mark
(a)	7 ☐ and 8 ■ and 9 ○		**(1)**

Question number	Answer	Additional guidance	Mark
(b)(i)	A description that includes the following points: • gene is a sequence of bases coding for a {(poly)peptide / sequence of amino acids} + gene for bitter-taste receptor (1) • allele is a {version of the gene / information coded by the gene} + {tasting / not tasting} (receptor) (1)	**ACCEPT** protein **NB Two correct definitions but no examples = 1 mark**	**(2)**

Question number	Answer	Additional guidance	Mark
(b)(ii)	A description that includes the following points: • genotype is the combination of alleles + {TT / tt / Tt} (1) • phenotype is the {expressed / observable} {characteristic / trait / feature} + {taster / non-taster}	**ACCEPT** any pair of letters **ACCEPT** characteristic that can bemeasured {tasting / not tasting} (receptor) **NB Two correct definitions but no examples = 1 mark**	(2)

Question number	Answer	Additional guidance	Mark
(c)	An explanation that includes the following points: • dominant allele is (having a receptor that) can taste bitter taste(1) • because individuals 1 and 2 were tasters who had children ofboth phenotypes (1)	**ACCEPT** children who could taste andchildren who could not taste	(2)

Question number	Answer	Additional guidance	Mark
(d)	An explanation that includes the following points: • because individual 6 was a female non-taster (1) • and her father was a taster (1)		(2)

Q17.

Question number	Answer	Additional guidance	Mark
(a)	A calculation in which: • actual height of elephant • how many times taller the elephant is than the mouse	Example of calculation: 4.5 ÷ 0.02 = 225 / 230 / 235 (cm) 75 / 76.67 / 76.7 / 77 / 78 / 78.3 / 78.33 **IGNORE** units	(2)

Question number	Answer	Additional guidance	Mark
(b)	A description that includes the following points: • attachment of lungs to {chest cavity / diaphragm} {increases volume / decreases pressure} (1) Any **two** from: • alveoli provide a large surface area for faster diffusion (1)	**ACCEPT** to {take in / hold} large volume of air **ACCEPT** thin walls	(3)
	• alveoli formed from {one cell layer / flattened / squamous} epithelial cells for small diffusion distance (1) • concentration gradient maintained by {ventilation / blood flow / good blood supply} (1)	**ACCEPT** large network of capillaries	

Question number	Answer	Mark
* (c)	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 indicated as relevant. Additional content included in the response must be scientific and relevant. **Indicative content** • oxygen dissociation curve for the mouse is shifted to the right • mouse haemoglobin has a lower affinity for oxygen than the elephant haemoglobin • therefore haemoglobin can supply oxygen to the tissues at lower pp of oxygen • because the rate of respiration in the mouse is higher • a mouse has a higher mass-specific metabolic rate than the elephant • because the mouse loses more body heat • because it has a larger surface area to volume ratio • because the mouse is more active • because it has to escape predators • the rate of respiration of the mouse is going to be	(6)

	greater than the elephant • therefore pp of oxygen in mouse tissues will be lower • therefore haemoglobin needs to be releasing oxygen • when blood cannot supply oxygen at a fast enough rate	

Level	Marks	
	0	No awardable content.
1	1-2	An explanation may be attempted but with limited interpretation or analysis of the scientific information and 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.
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.
3	5-6	An explanation is made that 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.

Q18.

Question number	Answer	Additional guidance	Mark
(a)(i)	A calculation in which: • substitute values correctly into the equation (1) • correct answer with units (1)	Example of calculation $V = \frac{4 \times \varpi \times 50 \times 50 \times 50}{3}$ volume = 523 599 / 5.2 x10^5 nm^3 CE applies if 100 has been used in calculation instead of 50 **ALLOW** correct conversions with different units No working: e.g. 523 599 / 5.2 x10^5 nm^3 / 523 333 nm^3 gains 2 marks e. g. 4 186 667 / 4.2 x10^6 nm^3 gains 1 mark	**(2)**

Question number	Answer	Additional guidance	Mark
(a)(ii)	An explanation that includes the following points: • because {hydrophobic / non-polar} tails {move away from / repelled by} the {aqueous environment / water} (1) • {hydrophilic / polar} heads {interact with / associate / dissolve in} the {aqueous environment / water} (1)	**NB** if no other marks awarded, allow 'hydrophilic heads face water and hydrophobic tails face away from water' for 1 mark	(2)

Question number	Answer	Mark
(b)(i)	**The only correct answer is B.** ***A*** *is incorrect because the liposome has no protein and cannot generate ATP.* ***C*** *is incorrect because liposomes cannot take up molecules by endocytosis.* ***D*** *is incorrect because water only moves by osmosis.*	(1)

Question number	Answer	Additional guidance	Mark
(b)(ii)	A description that includes the following points: • increase in temperature increases membrane permeability (1) • increase in cholesterol decreases membrane permeability (1) • cholesterol has a greater effect on membrane permeability at higher temperatures (1)	**ACCEPT** converse throughout	(3)

Question number	Answer	Additional guidance	Mark
(b)(iii)	An explanation that includes the following points: • because an increase in temperature increases the movement of phospholipids (1) • because the cholesterol decreases fluidity (of the membrane) (1)	**ACCEPT** fills the gaps between the phospholipid tails / acts as a barrier / reduces movement of phospholipids	(2)

Q19.

<table>
<tr><th>Question number</th><th>Answer</th><th>Additional guidance</th><th>Mark</th></tr>
<tr><td>(a)</td><td>
<table>
<tr><th>Polymer</th><th>Monomer</th><th>Elements in monomer</th><th>Type of bond</th></tr>
<tr><td>Carbohydrates</td><td>monosaccharide</td><td>carbon, hydrogen and oxygen</td><td>glycosidic</td></tr>
<tr><td>Nucleic acids</td><td>(mono)nucleotide</td><td>carbon, hydrogen, oxygen, phosphorus and nitrogen</td><td>phosphodiester</td></tr>
<tr><td>Proteins</td><td>amino acid</td><td>carbon, hydrogen, oxygen, (sulfur) and nitrogen</td><td>peptide</td></tr>
</table>
</td><td>ACCEPT chemical symbols C, H, O

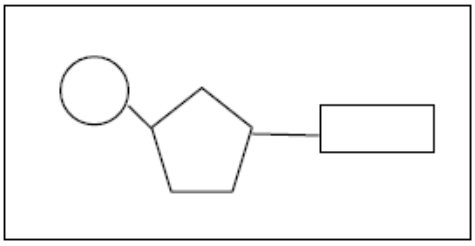
ACCEPT chemical symbols C, H, O, N, S</td><td>(4)</td></tr>
</table>

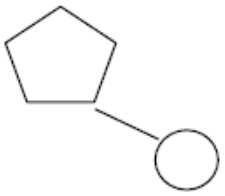
Question number	Answer	Additional guidance	Mark
(b)	A description that includes three of the following points: **TWO FROM** • (one) glycerol and three fatty acids (1) • joined by {condensation reaction / ester bond} (1) • by enzymes (1) **AND** • (at least) one fatty acid is {unsaturated / has a CC double bond}(1)		(3)

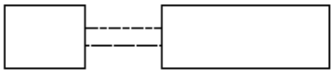
Q20.

Question number	Answer	Additional guidance	Mark
	A description that includes the following points: DNA only • deoxyribose • thymine DNA andmRNA accept two from • phosphate (group) • cytosine • guanine • adenine mRNA only • ribose • uracil	Items should not be written in "both" space as well as "mRNA" or "DNA" space Names of bases should be written in full (not just letter abbreviations) and broadly correct IGNORE nitrogenous base, pentose sugar, purine, pyrimidine	(6)

Q21.

Question number	Answer	Mark
(a)(i)	**B**  *A is incorrect because the phosphate should be joined to C4* *C is incorrect because the base should be attached to C1* *D is incorrect because the phosphate should be joined to C4 and the base should be attached to C1*	(1)

Question number	Answer	Mark
(a)(ii)	**B**  ***A*** *is incorrect because a phosphate is attached to the sugar not the base* ***C*** *is incorrect because a phosphodiester joins a sugar with a phosphate, not two phosphates* ***DC*** *is incorrect because the phosphate is joined to the sugar not the base*	**(1)**

Question number	Answer	Mark
(a)(iii)	**C**  ***A*** *is incorrect because complementary bases are joined by hydrogen bonds* ***B*** *is incorrect because one large base and one small base are joined together by hydrogen bonds* ***D*** *is incorrect because one large base and one small base are joined together*	**(1)**

Question number	Answer				Mark
(b)(i)					
Statement	**Correct statement about**				
	both strands	only the complementary DNA strand	only the mRNA strand	neither strand	
The number of guanines will be the same as in the template strand				X	
The number of thymines will be the same as the number of adenines in the template strand		X			
There will be no adenine present				X	
					(3)

Question number	Answer	Additional guidance	Mark
(b)(ii)	transcription (1)	**IGNORE** {post-transcription modification /protein synthesis} **DO NOT ACCEPT** {translation / reverse transcription}	**(1)**

Q22.

Question number	Answer	Additional guidance	Mark
(a)(i)	An answer that includes the following points: • decrease in diameter measured and calculated (1) • percentage decrease calculated (1)	ACCEPT (4.6 – 2.9) or 1.7 (1.7 ÷ 4.6) x 100 = 36.96 / 37 IGNORE 37.0 Correct answer gets 2 marks. ACCEPT correctly calculated and rounded answer from wrong measurements for one mark	(2)

Question number	Answer	Mark
* (a)(ii)	Indicative content: **Descriptions of diagrams (D points)** • reduced diameter of lumen (in person with CF) • thicker or inflamed muscle layer (in person with CF) • more mucus (in person with CF) **Cystic fibrosis (C points)** • CF results in the production of very {sticky / thick} mucus (credit this point only once) • CF is due to a {mutation in the CFTR gene / faulty CFTR allele} • (resulting in) {the CFTR protein not functioning properly / abnormal or defective CFTR protein / abnormal channel proteins / CFTR channel blocked} • this affects transfer of chloride ions out of cells • (Cl^- accumulate in cells so) {water moves out of mucus / water remains in cytoplasm} / mucus is dehydrated } **Change in lumen diameter (L points)** • CF results in the production of very {sticky / thick} mucus (credit this point only once) • diameter of lumen in patient with CF is reduced • because the mucus builds up • (because the) cilia cannot move / beat (idea of cilia normally clearing mucus) • (because the) cilia cannot move mucus away (it is too thick) (credit this only once) • Inflammation of muscle (narrows lumen) (credit this only once) **Inflammation (I points)** • cilia cannot move mucus away (it is too thick) (credit this only once) • mucus (is very sticky and) traps bacteria • bacteria have ideal growth conditions (in mucus) • bacteria can cause (chest) infections • CF characterised by coughing {to remove mucus / as a result of infection} • {coughing / infection} damages {cells / tissues} (lining airways) • (leading to) inflammation of muscle (credit this only once)	**(6)**

Level	Marks	
	0	No awardable content
1	1 - 2	Level 1: description of diagrams 1 mark: one D or one C point 2 marks: second D or C point
2	3 - 4	Level 2: explanation of either change in diameter of lumen or inflammation linked to CF 3 marks: three L points or 3 I points 4 marks: as 3 marks plus additional C point
3	5 - 6	Level 2: explanation of both change in diameter of lumen and inflammation linked to CF 5 marks: three L points and 3 I points 6 marks: as 5 marks plus additional C point

Question number	Answer	Additional guidance	Mark
(b)(i)	An explanation that includes the following points: • because parents (who are carriers) may decide {not to have a child / to adopt a child} (1) • because parents (who are carriers) may choose {IVF / PIGD} (1) • because embryos identified as having cystic fibrosis may be aborted (1)	ACCEPT screening allows choice of unaffected partner Not just "make an informed choice" ACCEPT idea that affected foetus can be identified by CVS / amniocentesis / pre-natal screening (leading to abortion) ACCEPT only healthy embryos implanted (after IVF/ PIGD) IGNORE references to CVS / amniocentesis except in context of mp3	(3)

Question number	Answer	Additional guidance	Mark
(b)(ii)	An answer that includes three of the following points: • screening may result in {an abortion /taking a human life} that is {unethical / against religious or cultural beliefs of some people} (1) • spare embryos from IVF are destroyed which is taking a human life (1) • individuals who are genetically linked may be {exposed to unwanted facts / disadvantaged} following testing (1) • screening may produce false results or {CVS / amniocentesis} increases risk of miscarriage (which results in death of foetus)	ACCEPT foetus for embryo ACCEPT embryo has a right to life (in context of abortion) / embryo cannot give consent / parents can make informed choice (after test)/ comment on perceived worth of (affected) child ACCEPT embryo has a right to life in context of IVF / comment on potential selection of traits of embryo in IVF (not just "designer babies") IGNORE references to foetus / baby in this context ACCEPT reference to family members IGNORE violation of privacy (too vague)	(3)

Q23.

Question number	Answer	Mark
(a)(i)	The only correct answer is **D** ***A*** *is incorrect because diffusion does not use proteins* ***B*** *is incorrect because diffusion does not use proteins* ***C*** *is incorrect because diffusion does not use proteins*	**(1)**

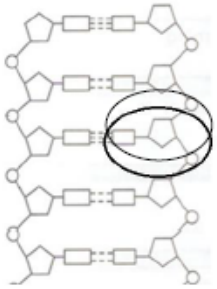
Question number	Answer	Mark
(a)(ii)	The only correct answer is **B** ***A*** *is incorrect because diffusion does not use energy* ***C*** *is incorrect because facilitated diffusion does not use energy* ***D*** *is incorrect because facilitated diffusion does not use energy*	**(1)**

Question number	Answer	Mark
(a)(iii)	The only correct answer is **B** ***A*** *is incorrect because solutes can move against their concentration gradient in active transport* ***C*** *is incorrect because solutes can move against their concentration gradient in active transport* ***D*** *is incorrect because solutes can move against their concentration gradient in active transport*	**(1)**

Question number	Answer	Additional guidance	Mark
(b)	An explanation that includes the following points: • (free water molecules) because some water molecules are {restricted / prevented} from movement (1) • (partially permeable membrane} because membrane allows some (types of) molecules to pass through it (1) • (down a water potential gradient) because water molecules move {from a dilute solution to a more concentrated one / from a high osmotic potential to a lower one / from a high solute potential to a lower one} (1)	**ACCEPT** a description **ACCEPT** from a low concentration of solute to a high concentration of solute from hypotonic to hypertonic solution **IGNORE** from a high water concentration to a lower one	**(3)**

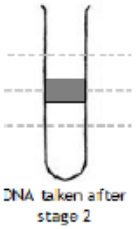
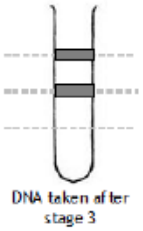
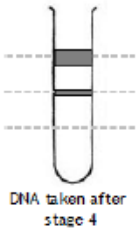
Question number	Answer	Additional guidance	Mark
* (c)	Indicative content: • water content decreases when crabs first moved (D) • because water passes out of cells by {osmosis / description of osmosis} (E) • water content then increases gradually (D) • because of the increase in amino acid concentration (E) • amino acid increases (D) • sharply at first and then rate decreases (D) • because {insoluble / muscle} proteins broken down into amino acids (E) • by hydrolysis (E) • because crab eats more {protein / amino acids} (E) • which is digested into amino acids (E) • which are taken up into the cells by {active transport / facilitated diffusion} (from the blood) (E) • water content increases because the amino acid content increase (E) • which makes the cytoplasm more concentrated than the sea water (E) • therefore crabs do not die from dehydration (E)	**Level 1** **1 mark** = simple description of one graph **2 marks** = simple description of both graphs **Level 2** **3 marks** = and a simple explanation of one graph **4 marks** = and a simple explanation of both graphs **Level 3** **5 marks** = a simple explanation of one graph and a more detailed explanation for the other graph **6 marks** = a more detailed explanation for both graphs	**(6)**

Q24.

Question number	Answer	Additional guidance	Mark
(a)(i)	• circle drawn around R, the attached sugar and a phosphate group	 **ACCEPT** the phosphate group on either C3 or C5	**(1)**

Question number	Answer	Mark
(a)(ii)	**The only correct answer is D** phosphodiester | covalent | hydrogen *A is incorrect because S is a phosphodiester bond, T is a covalent bond and U is a hydrogen bond* *B is incorrect because S is a phosphodiester bond and U is a hydrogen bond* *C is incorrect because T is a covalent bond and U is a hydrogen bond*	**(1)**

Question number	Answer	Mark
(a)(iii)	**The only correct answer is C Thymine** *A is incorrect because adenine is complementary to thymine* *B is incorrect because adenine is complementary to thymine* *D is incorrect because adenine is complementary to thymine*	**(1)**

Question number	Answer	Additional guidance	Mark
(b)(i)	A diagram that shows the following points: • a band the same width as stage 1 in the middle of the tube (1) • bands drawn at the top and middle of tube (1) • both bands narrower than stage 1 (1) • bands drawn at the top and middle of tube (1) • top band drawn narrower than stage 1 but wider than stage 3 and lower band drawn narrower than stage 3 (1)	  	**(5)**

Question number	Answer	Mark
(b)(ii)	**The only correct answer is B** *A is incorrect because neither DNA molecule is made of all heavy nitrogen or light nitrogen* *C is incorrect because neither DNA molecule is made of all heavy nitrogen or light nitrogen + bands are too wide* *D is incorrect because it has only one band*	**(1)**

Q25.

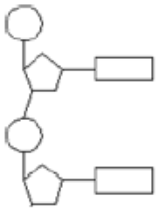
Question number	Answer	Additional guidance	Mark
(a)	• methionine leucine isoleucine tyrosine (1)	**ACCEPT** met leu iso tyr combinations of names and abbreviations	**(1)**

Question number	Answer	Additional guidance	Mark
(b)(i)	Base number 3 becomes cytosine (C) **substitution** Base number 6 becomes number 5 in the sequence **deletion** Base number 9 becomes number 10 in the sequence **insertion**	All three correct = 2 marks Any one or two correct = 1 mark **IGNORE** point mutation throughout **IGNORE** swapping mutation **IGNORE** elimination / frameshift **IGNORE** addition / frameshift	**(2)**

Question number	Answer
* (b)(ii)	Indicative content: Substitution: • only affects one triplet codon • may not change the amino acid • e.g. number 6 becomes A, would still code for leucine • may change amino acid • e.g. number 1 becomes G, resulting in valine • may result in a stop codon • e.g. number 12 becomes G Deletion: • one base removed will shift the reading frame back one place • all amino acids after the mutation will be affected • closer to the start of the gene the greater the affect • fewer amino acids coded for • e.g. remove base 4 and sequence becomes methionine serine phenylalanine threonine Insertion: • one base added will shift the reading frame forward one place • all amino acids after the mutation will be affected • closer to the start of the gene the greater the affect • e.g. add C between numbers 9 and 10 and sequence becomes leucine proline serine

	Aspects to comment on: 1. Substitution changing the amino acid 2. Deletion changing sequence 3. Insertion changing sequence 4. Stop codons appearing shortening the sequence 5. Substitution may have no effect 6. Position of {insertion / addition} significant **Level 1** 1 mark : correct statement about mutations 2 marks : 1 aspect commented on with a corresponding illustration **OR** 2 or more aspects commented on but no illustrations **Level 2** 3 marks : 2 aspects commented on with corresponding illustrations **OR** 3 or more aspects commented but only 1 or 2 illustrations 4 marks : 3 aspects commented on with corresponding illustrations **Level 3** 5 marks : 4 aspects commented on with corresponding illustrations 6 marks : 5 aspects commented on with corresponding illustrations

Q26.

Question number	Answer	Additional guidance	Mark
(a)	An answer that includes the following points: • two mononucleotides shown (joined in one strand only) (1) • each base bonded to C1 of pentose sugar (1) • phosphate group bonded to C3 of one sugar and C5 of the other sugar (1)	**IGNORE** labels including second strand if drawn / additional mononucleotides / one mononucleotide including second strand if drawn / additional mononucleotides example of diagram 	(3)

Question number	Answer	Additional guidance	Mark
(b)(i)	• 0.38 (nm)	**ACCEPT** 0.4	(1)

Question number	Answer	Additional guidance	Mark
(b)(ii)	An explanation that includes the following points: • R (or Q) because it forms two hydrogen bonds (1) • R (or S) because it is {large / double-ring / purine} base (1)	**ACCEPT** not bases P and S because they form 3 hydrogen bonds **ACCEPT** not bases P and Q because they are {small / single-ring / pyrimidine} **ACCEPT** Q for correct reason **or** S for correct reason if neither mark points awarded	(2)

Question number	Answer	Additional guidance	Mark
(c)	An answer that includes at least one similarity and one difference: similarities: • both contain {RNA (mono)nucleotides / ribose sugar / uracil (and adenine, cytosine and guanine) / phosphodiester bonds} (1) • both are single stranded (1) differences: • mRNA is a straight chain and tRNA is {folded / clover-leaf shaped} / mRNA does not have hydrogen bonds and tRNA does (1) • {size / length} of mRNA is variable and the {size / length} of tRNA is constant (1) • mRNA has codons and tRNA has {anticodons / amino acid binding sites} (1)	**DO NOT PIECE TOGETHER** **ACCEPT** letters for bases	**(4)**

Q27.

Question number	Answer	Additional guidance	Mark
(a)	The correct answer is **C**, protein *A is incorrect because enzymes are proteins* *B is incorrect because enzymes are proteins* *D is incorrect because enzymes are proteins*		**(1)**

Question number	Answer	Additional guidance	Mark
(b)	An explanation that includes the following points: • because they are found in living organisms (1) • because they speed up the rate of reaction (without being used up) (1)	**ACCEPT** in our bodies / named organism / are proteins / in cells / in cytoplasm **ACCEPT** lower {activation energy / description of activation energy}	(2)

Question number	Answer	Additional guidance	Mark
(c)(i)	• 8.5 (a.u. per °C)	**IGNORE** decrease of / ↓ / -	(1)

Question number	Answer	Additional guidance	Mark
(c)(ii)	• because the {enzyme is denatured / active site to change shape / bonds to break} (1)	**DO NOT ACCEPT** starts to	(1)

Q28.

Question number	Answer	Additional guidance	Mark
(a)(i)	• 9 : 1	**ACCEPT** 6 : 1 / 5 : 1	(1)

Question number	Answer	Additional guidance	Mark
(a)(ii)	A description that includes the following points: • will not have any effect on the total membrane phospholipids (1) • the inner layer will have a relatively higher content of the other phospholipids / the outer layer will have a relatively lower content of the other phospholipids (1)	**ACCEPT** increase phospholipid content in outer layer and decrease content in inner layer	(2)

Question number	Answer	Additional guidance	Mark
(a)(iii)	A description that includes the following points: • will alter membrane {properties / permeability / fluidity} (1) • so that platelets will release thromboplastin (1) • thromboplastin is {an enzyme / a catalyst} (1) • that converts prothrombin into thrombin (1)	**NB** thromboplastin catalyses prothrombin into thrombin = 2 marks	(4)

Question number	Answer	Additional guidance	Mark
(b)	An explanation that includes the following points: • thrombin is an <u>enzyme</u> (1) • because the inhibitor will change the shape of the active site (of thrombin) (1) • therefore thrombin cannot bind to fibrinogen (1) • therefore {less / no} fibrinogen will be converted into fibrin (1) • therefore there is {less / no} {mesh / fibrin / fibres} to trap {blood cells / platelets} (1)	**ACCEPT** inhibitor blocks the active site / fewer active sits available **ACCEPT** {less / no} thrombin to bind to fibrinogen / fewer collisions / fewer enzyme substrate complexes formed **ACCEPT** slower conversion	(4)

Q29.

Question number	Answer	Additional guidance	Mark
(a)(i)	An answer that includes two of the following points: • (46 / 48 /94 patients is) not a very large sample size (1) • {18 countries / variety of people} probably means that othervariables not taken into account (1) • but AHP is a very rare disorder so not many patients available (1)	**IGNORE** refs to reliability, validity **ACCEPT** in the context of 'these' people named variable e.g. lifestyle,diet, other diseases **IGNORE** sex / age	(2)

Question number	Answer	Additional guidance	Mark
(a)(ii)	• mass of drug needed for that patient (1) • {0.8 / 0.85 / 0.847} cm^3 (1) **OR** • volume of drug to give 2.5 mg (1) • {0.8 / 0.85 / 0.847} cm^3 (1)	**Example of calculation:** 64 × 2.5 / 160 **IGNORE** units **ACCEPT** cc / mls 2.5 ÷ 189 / 0.0132275 **ACCEPT** cc / mls **NB** Bald answer of {0.8 / 0.85 / 0.847} cm^3 = 2 marks Bald answer of {160 / 0.01 / 0.013 / 0.132} = 1 mark	(2)

Question number	Answer	Additional guidance	Mark
(a)(iii)	• 27% of 48 calculated (1) • 12 / 13 (1)	**Example of calculation:** 27 × 48 ÷ 100 / 12.96 **ACCEPT** 25 as an ecf for 1 mark (27% of94)	(2)

Question number	Answer	Additional guidance	Mark
(b)(i)	G U C U U U C	All correct = 2 marks One wrong base given OR one wrongbase given consistently = 1 mark	(2)

Question number	Answer	Additional guidance	Mark
(b)(ii)	A description that includes three of the following points: • phosphodiester bonds between (adjacent) {ribose and phosphate / (mono)nucleotides} (in each strand) (1) • covalent bonds attaching base to a {ribose (sugar) / sugar} (1) • {hydrogen / H} bonds between (complementary) bases (holdingtwo strands together) (1) • {hydrogen / H} bonds holding double helix together (1)	**ACCEPT** sugar **DO NOT ACCEPT** deoxyribose **ACCEPT** between {C and G / U and A} **DO NOT ACCEPT** between {T and A / other incorrect base pairs} **IGNORE** incorrect number of H bonds	(3)

Question number	Answer	Additional guidance	Mark
(b)(iii)	An answer that includes three of the following points: • {no / less / affected} translation of the mRNA (1) • (altered mRNA) affects shape of {protein / active site} (1) • {no / less / slower} haem production (1) • {no / less} (toxic) porphyrin (1)	**ACCEPT** a description of translation**DO NOT ACCEPT** transcription / description of transcription **ACCEPT** no {protein / enzyme} formed	(3)

Q30.

Question number	Answer	Marks
(a)	An explanation that includes the following points: • many small alveoli to provide a large surface area to increase the rate of diffusion (1) • thin epithelium to increase rate of diffusion (1) • good blood supply to maintain diffusion gradient (1)	(3)

Question number	Answer	Mark
(b)(i)	• a version of a gene	(1)

Question number	Answer	Mark
(b)(ii)	An explanation that includes the following points: • there will be a different sequence of R groups (1) • therefore the CFTR protein has a different tertiary structure (1) • because of different {types of / position of} bonds between the R groups (1) • therefore the movement of chloride ions through the cell membrane is affected (1)	(4)

Question number	Answer	Mark
(b)(iii)	An explanation that includes any four of the following points: • produces very thick, sticky mucus (1) • because of reduced water transport from cells (1) • cilia lining airways are unable to move mucus (1) • therefore microorganisms get trapped in the mucus (1) • mucus provides suitable growth conditions for growth of microorganisms (1)	(4)

Mark Scheme

Q1.

Question number	Answer	Additional guidance	Mark
(a)	• Fick's (Law of Diffusion) (1)		**(1)**

Question number	Answer	Mark
(b)	**The only correct answer is C** (it will halve) A is incorrect because the value will halve B is incorrect because the value will halve D is incorrect because the value will halve	**(1)**

Question number	Answer	Additional guidance	Mark
(c)	A description that includes the following points: • lots of alveoli for large surface area (1) • {single-celled / thin-walled} {alveoli / capillaries} for short diffusion distance (1) • good blood supply for high concentration gradient (1)	**ACCEPT** lots of capillaries for large surface area air sacs for alveoli ref to lots of alveoli <u>and</u> thin-walled <u>and</u> good blood supply = 1 mark if no other marks awarded	**(3)**

Question number	Answer
* (d)	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 indicated as relevant. Additional content included in the response must be scientific and relevant. Structure • salamanders have both lungs and their skin for more gas exchange • lungs allow oxygen from air and skin oxygen from water • the skin is folded to increase surface area • flattened body to increase surface area • so that gas exchange will be faster • skin has a good blood supply so that there will be high concentration gradient • skin is very permeable to gases so that they can diffuse in faster Behaviour • salamanders live in fast-flowing water which will have high levels of oxygen • shallow water will also have higher levels of oxygen • shallow water will make breathing with lungs easier • the rocking / swaying movements stir up the water • which helps to aerate the water • so that water with higher oxygen content is in contact with their skin • so that there is a higher concentration gradient • so that {gas exchange / diffusion of gases} will be faster • the rocking / swaying maintains the levels of oxygen in the blood Graph • at low levels of oxygen in the water the frequency of rocking is high • accompanied by an increase in blood pO_2 • as oxygen levels in the water increase the frequency of rocking decreases • but the blood pO_2 continues to increase • sufficient oxygen in water to diffuse into lungs and skin • to maintain levels of oxygen • rocking stops to conserve energy **(6)**

			Additional guidance
Level 0	0	No awardable content	
Level 1	1-2	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 links made between gas exchange and information given or own knowledge 1 mark = 1 comment which can include a description of data 2 marks = 3 comments which can include a description of data
Level 2	3-4	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.	Extended links made between gas exchange and information given 3 marks = comments on both structure and behaviour with extended comment on one 4 marks = extended comments made on both structure and behaviour
Level 3	5-6	Demonstrates comprehensive knowledge and understanding by selecting and applying relevant biological facts / concepts. Consequences are discussed which supported throughout by sustained linkage to a range of scientific ideas, processes, techniques and procedures. The discussion shows a well-developed and sustained line of scientific reasoning which is clear and logically structured.	Understanding of graph used to support discussion 5 marks = plus some discussion of graph to support answer 6 marks = plus an understanding of the relationships shown in the graph

Q2.

Question number	Answer	Additional guidance	Mark
(a)	• the {length of DNA / sequence of (DNA) bases} that code for {amino acids / (poly)peptide / protein} (1)	**ACCEPT** nucleotides for bases primary structure of protein	**(1)**

Question number	Answer	Additional guidance	Mark
(b)	An explanation that includes the following points: • because the mutation is in the gene coding for the CFTR (protein) (1) • therefore the CFTR (protein) does not function correctly (1) • credit details of dysfunction (resulting in very thick sticky mucus) (1) • therefore the mucus will be (very) {thick / sticky} (1)	**ACCEPT** mutation in CFTR gene **ACCEPT** change in structure e.g. reduced transport of chloride ions out of the cell sodium ions move into the cell water leaves the mucus and enters the cell	**(3)**

Question number	Answer	Additional guidance	Mark
(c)	An answer that includes three of the following points: • couples (both) carrying one copy of the mutation can be identified (1) • they can then make (an informed) {decision / choice} (about having a child) (1) • credit an example of their options (1) • resulting in fewer babies being born who are homozygous (1)	**ACCEPT** couples who are (both) heterozygous / have a CF allele **DO NOT ACCEPT** choose which embryos to implant e.g not having a child / adoption / IVF **DO NOT ACCEPT** have an abortion **ACCEPT** two copies of the mutation fewer heterozygous babies born	**(3)**

Q3.

Question number	Answer	Additional guidance	Mark
(a)(i)	A description that includes the following points: • gene is the {length of DNA / sequence of bases} coding for a (poly)peptide (1) • allele is the (different) {version / form / variation} of the gene (1) • gene for feather colour and allele for {white / black} feathers (1)	**ACCEPT** protein / sequence of aminoacids **NB** piece together **DO NOT ACCEPT** speckled feathers	(3)

Question number	Answer	Additional guidance	Mark
(a)(ii)	A description that includes the following points: • genotype is the combination of alleles (1) • phenotype is the {(observable) characteristics / appearance /traits} (1) • phenotype is the colour of the feathers and genotype is the presence of white and or black alleles (1)	**ACCEPT** mixture of alleles / the allelespresent **DO NOT ACCEPT** genes **ACCEPT** feature / ref to colour offeathers **IGNORE** ref to environment **ACCEPT** phenotype is {white / black / speckled / mixture of black and white} (feathers) genotype is {WW / BB / WB} or any other letters used **NB** piece together	(3)

Question number	Answer	Additional guidance	Mark
(b)	An answer that includes the following points: • parent's genotypes shown as BB and BW (1) • offspring's genotypes shown as BB and BW (1) • number of speckled chicks given as 12 or 13 (1)	**ACCEPT** other letters, including B and b **DO NOT ACCEPT** X and Y B for white and W for black **ACCEPT** other letters, including B and b **CE** from 1 **CE** from 2 provided whole number **NB** Bald answer = I mark	(3)

Question number	Answer	Additional guidance	Mark
(c)(i)	Chi squared (1)	**ACCEPT** Chi square / X squared / xsquared / X^2 / x^2 / chi^2 distribution (test) / chi (test) / closeness of fit / goodness of fit **phonetic spellings e.g** kai / cai / khi	(1)

Question number	Answer	Additional guidance	Mark
(c)(ii)	An answer that includes the following points:	All correct = 2 marks One row correct = 1 mark	

Steps in the calculation for the statistics test	Colour of feathers of chicks		
	Speckled	White	Black
Observed number (O)	243	125	112
Expected number (E)	240	120	120
(O-E)	3	5	-8
$\frac{(O-E)^2}{E}$	0.0375 9/240 3/80	0.2083 25/120 5/24	0.5333 64/120 8/15

ACCEPT 8
DO NOT ACCEPT -3 / -5

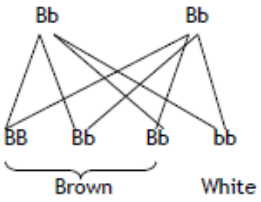
ACCEPT 2 or 3 or 4 dps but not necessarily consistentl y the same number.
DO NOT ACCEPT recurring

(2)

Question number	Answer	Additional guidance	Mark
(c)(iii)	0.8 / 0.78 / 0.779 / 0.7791 (1)	CE / rounding effect from (c)(ii) **DO NOT ACCEPT** 0 NB 187/240 = 0.7792	(1)

Question number	Answer	Additional guidance	Mark
(c)(iv)	An explanation that includes two of the following points: • {calculate / use} the number of degrees of freedom • use (a probability) value of (up to or equal to) 5%/0.05 (1) • compare (calculated) {value / result} to (critical) value (1) • if the (calculated) {value / result} is greater than (critical)value then null hypothesis is rejected (1)	**ACCEPT** description of how to work outdegrees of freedom **NB** mp 4 alone = 2 marks **ACCEPT** the converse argument any quoted figures for the calculated value	(2)

Q4.

Question number	Answer	Additional guidance	Mark
(a)	A diagram that shows the following: • genotype of parents / alleles in the gametes (1) • genotypes of offspring as BB, Bb and bb (1) • corresponding phenotypes shown as brown (BB and Bb) and white (bb) (1)	**Accept** other letters used for alleles  **ACCEPT** if clear from any ratios or percentages given CE throughout	(3)

Question number	Answer	Additional guidance	Mark
(b)	An answer that includes the following points: • number of homozygous brown rabbits shown (1) • number of heterozygous brown rabbits shown (1) • number of white rabbits shown (1)	CE from part (a) BB = 71 Bb = 142 bb = 71 **ACCEPT** 1 2 1 for 1 mark	(3)

Q5.

Question number	Answer	Additional guidance	Mark
(a)	• combination of alleles (1)	**IGNORE** genetic composition / combination of information carried in the genes / all genetic {information / make up} **DO NOT ACCEPT** genes	(1)

Question number	Answer	Additional guidance	Mark
(b)	• 1 in 2 / 50:50 / 50% / 0.5 / ½	**ACCEPT** 2 in 4 / 1:1 / 2:2	(1)

Question number	Answer	Additional guidance	Mark
(c)	An answer that makes reference to the following points: • parents shown as heterozygotes (1) • genotypes of offspring shown (1) • 3 (orange) : 1 (white) (1)	CEs throughout **ACCEPT** any pair of letters chosen to represent alleles from Punnet square **ACCEPT** 1 white : 3 orange	(3)

Question number	Answer	Additional guidance	Mark
(d)	• 1 in 30 / 0.03 / 3.3% / $\frac{1}{30}$	ACCEPT 0.03 recurring / 3.3% recurring	(1)

Q6.

Question number	Answer	Mark
(a)(i)	A α glucose molecules join together by a condensation reaction B is incorrect because bonds form by condensation reactions C is incorrect because α glucose molecules join together D is incorrect because α glucose molecules join together by condensation reactions	(1)

Question number	Answer	Additional guidance	Mark
(a)(ii)	glycosidic (bond / link)	**Accept covalent** (bond) Ignore any numbers eg 1,4 glycosidic	(1)

Question number	Answer	Additional guidance	Mark
(a)(iii)	An explanation that includes the following points: • {polymer of glucose / polysaccharide} therefore has a highenergy content (1) • {large molecule / polymer / polysaccharide} therefore {insoluble / has no osmotic effect} (1) • branched structure therefore {broken down / energy released /hydrolysis is} faster (1) • compact therefore has a high energy density (1)	**Accept** {large molecule / polymer} sodoes not diffuse **Accept** branched so can be broken down from several points at the sametime **Ignore** easier to break down **Accept** compact so {high energy stored in a small space / many glucosemolecules stored in a small space}	(3)

Question number	Answer	Additional guidance	Mark
(b)(i)	Answer that includes the following points: • estimate of number of babies with GSD (1) • estimate of mean number of babies with Von Gierke disease (1)	Accept any value between 150 and 200 Accept any value between 38 and 50 Accept non-whole numbers eg 38.5 Correct answer with no working (2)	(2)

Question number	Answer	Additional guidance	Mark
(b)(ii)	An answer that includes the following points: • because allele for Von Gierke disease may be recessive (1) • therefore (both) parents may be heterozygous (1) • because individuals with Von Gierke disease are less likely to have babies (1)	**Accept** disease caused by tworecessive alleles **Do not accept** {gene / disease} is recessive **Accept** parents may be carriers (of theallele) **Ignore** mutation	(2)

Q7.

Question number	Answer	Additional guidance	Mark
(a)(i)	• bind to an {oxygen (molecule) / O_2} (1)	**Do not accept** O **Ignore** binding to carbon dioxide	(1)

Question number	Answer	Additional guidance	Mark
(a)(ii)	An explanation that includes the following points: • must have R groups that are {polar / hydrophilic} (1) • so that the {haemoglobin / protein} {can dissolve in (red bloodcell) cytoplasm / is soluble in water} (1)	**Accept** they are {polar / hydrophilic} **Ignore** dissolve in blood / plasma	(2)

Question number	Answer	Additional guidance	Mark
(b)(i)	An explanation that includes two of the following points: • oxygen dissociation curve for {maternal / adult} Hb is shifted tothe right of curve for fetal Hb (1) • because oxygen needs to diffuse from {maternal / adult} bloodinto fetal blood (1) • therefore fetal haemoglobin needs to have a higher affinity foroxygen (1)	Accept shifted down for shifted to theright Accept converse Accept converse Accept because oxygen needs to dissociate from maternal haemoglobinand bind to fetal haemoglobin	(2)

Question number	Answer	Additional guidance	Mark
(b)(ii)	An answer that includes the following points: • total number of amino acids in haemoglobin calculated (1) • percentage of amino acids that are different calculated (1)	574 / 287 14 / 13.6 / 13.59 Correct answer with no working (2)	(2)

Q8.

Question number	Answer	Mark
(a)	**The only correct answer is A** (position R, position P) *B is incorrect because P will have a carboxyl group and R will have an amino group (Q will have a carboxyl group)* *C is incorrect because P will have a carboxyl group and R will have an amino group (Q will have a carboxyl group)* *D is incorrect because P will have a carboxyl group and R will have an amino group (Q will have a carboxyl group)*	(1)

Question number	Answer	Additional guidance	Mark
(b)(i)	• 39 / 39.3 / 39.29 (1)		(1)

Question number	Answer	Additional guidance	Mark
(b)(ii)	• 0.13 : 1 / 0.1 : 1 / 0.13 / 0.1 (1)	ACCEPT 1 : 7.5 / 1 : 8	(1)

Question number	Answer	Additional guidance	Mark
(c)	A description that includes the following points: • hydrolysis / using enzymes (1) • of the peptide bonds between P and the connecting chain and R and the connecting chain (1)	 **ACCEPT** protease **ACCEPT** of peptide bonds between A chain and connecting region and B chain and connecting region	(2)

Question number	Answer	Additional guidance	Mark
(d)	An answer that includes the following points: Similarities : • αlpha glucose (1) • contain C, H and O (only) (1) Differences : • glucose is a monosaccharide and glycogen is a polysaccharide (1) • glycogen has (1-4 / 1-6) glycosidic bonds but glucose does not (1)	**DO NOT PIECE TOGETHER**	(3)

Question number	Answer	Mark
* (e)	Indicative content: Healthy rats given water • levels of glucose {fell slightly / maintained} (D) • because the healthy rats were producing insulin (E) • so were controlling the blood glucose levels naturally (E) Healthy rats given cinnamon • levels of glucose very slightly lower (D) • as cinnamon was adding to the effect of insulin (CE) OR • levels of glucose very similar (D) • as cinnamon had no (added) effect in healthy rats (CE) Diabetic rats given water • levels of glucose rose (D) • levels of glucose were higher that healthy rats (D) • because diabetic rats had no insulin to control their blood glucose levels (E) Diabetic rats given cinnamon • unhealthy rats given cinnamon had fairly constant levels of glucose (D) • cinnamon lowered blood glucose by moving it into the liver (E) • cinnamon stimulated enzymes to convert glucose into glycogen (E) • so that it could not diffuse back into the blood (E) • levels of glucose were higher than in the healthy rats (D) • because cinnamon not as effective as insulin (CE) • possibly {not absorbed well / worked slowly / did not stimulate so many enzymes} (CE) • fluctuations in levels of glucose (D) • depending on how much glucose is used (E)	(6)

			Additional guidance
Level 0	0	No awardable content	
Level 1	1-2	An explanation may be attempted but with limited interpretation or analysis of the scientific information and 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.	Simple descriptions of data with no real attempt of an explanation 1 mark = some description of the data 2 marks = detailed description of the data
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.	Some explanation given using the information given / own knowledge (E) 3 marks = simple explanation of what {cinnamon / insulin} is doing 4 marks = more detailed explanation of how {cinnamon / insulin} decreases glucose level
Level 3	5-6	An explanation is made that 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.	Data logically explained with extended use of information provided (CE) 5 marks = plus a comparison made of effectiveness of cinnamon compared to insulin 6 marks = data explained in detail

Q9.

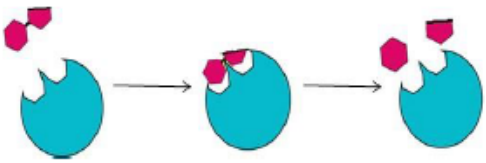
Question number	Answer	Additional guidance	Mark
(a)	An explanation that includes the following points: • because the rate of miscarriage increases with (increase in) age(1) • there is no evidence age is causing the miscarriage (1)	**ACCEPT** directly proportional to eachother it shows that an increase in onevariable is reflected by an increase in the other variable **ACCEPT** no evidence of causation	(2)

Question number	Answer	Additional guidance	Mark
(b)(i)	An explanation that includes the following points: • aneuploidy results in miscarriage because the screened embryosresult in fewer miscarriages (1) • other {factors / named factor} cause miscarriages because {screened embryos / embryos that do not have aneuploidy} aremiscarried (1)	**ACCEPT** converse where appropriate **e.g.** age, mutations, the process of implanting embryos, smoking, alcohol, dietary factors **IGNORE** lifestyle / screening causes miscarriage	(2)

Question number	Answer	Additional guidance	Mark
(b)(ii)	An explanation that includes three of the following points: • because no indication of sample size (1) • because no statistics presented (1) • because no idea how many of the unscreened embryos had aneuploidy (1) • other {lifestyles / factors / named factor} not {taken into account / not shown} (1) • false (negative / positive) results (1)	**ACCEPT** small sample size **IGNORE** age / sex	(3)

Question number	Answer	Additional guidance	Mark
(c)	An answer that includes three of the following points: • (preimplantation) screened embryos still result in miscarriages soraising false hopes (1) • issues surrounding the embryos (that have aneuploidy) (1) • false (positive) results resulting in unnecessary {wastage / destruction} of embryos (1) • other (genetic) defects may be found (1)	**DO NOT ACCEPT** {fetus / baby} e.g. discarding the embryos is unethical **ACCEPT** false (negative) result leads touse of that embryo	(3)

Q10.

Question number	Answer	Mark
(a)(i)	**B**  The only correct answer is **B**. ***A** is incorrect because it shows the substrate unchanged* ***C** is incorrect because it shows lactose being made not broken down* ***D** is incorrect because the two substrates have not been bonded together*	(1)

Question number	Answer	Mark
(a)(ii)	**B** galactose and glucose The only correct answer is **B**. ***A** is incorrect because sucrose is not a monosaccharide* ***C** is incorrect because glucose and fructose are the monomers of sucrose* ***D** is incorrect because sucrose is not a monosaccharide*	(1)

Question number	Answer	Mark
(b)	C reaction without enzyme | Q The only correct answer is **C**. ***A** is incorrect because line P shows the reaction without enzyme* ***B** is incorrect because line P shows the reaction without enzyme* ***D** is incorrect because R is the activation energy with the enzyme not the decrease*	(1)

Question number	Answer	Additional guidance	Mark
(c)(i)	An explanation that includes the following points: • as the concentration (of substrate) increases there are more (substrate) molecules / particles (1) • (therefore) a greater chance of {collisions with active site / enzyme substrate complexes forming} increasing the rate of reaction • {rate/graph} levels off when {all active sites are filled (at any one time) / enzyme is saturated} (1)	ACCEPT converse for mp1 and 2 Piece together ACCEPT substrate concentration is limiting factor in the first part of the graph ACCEPT {greater frequency of collisions / collisions more likely to occur} etc ACCEPT enzyme for active site / "successful collisions" for collisions with active site} IGNORE {more collisions / more enzyme-substrate complexes forming} ACCEPT {rate / graph} levels off {when enzyme becomes rate limiting / as enzyme is limiting factor} IGNORE idea of substrate being used up as reaction proceeds	(2)

Question number	Answer	Additional guidance	Mark
(c)(ii)	An answer that includes the following points: • correct values for V_{max} and K read from the graph (1) • correct answer for values substituted into the formula (1)	V_{max} = 50 K = 1.9 $V = \frac{50 \times 4}{1.9 + 4} = 33.898 / 34$ (ignore units) ACCEPT 33.9 IGNORE 33.90 / 33.89 Correct answer gets 2 marks ecf for mp2 if wrong values read from graph	(2)

Q11.

Question number	Answer	Mark
(a)(i)	C galactose and glucose A is incorrect because lactose consists of glucose and galactose monomers B is incorrect because lactose consists of glucose and galactose monomers D is incorrect because lactose consists of glucose and galactose monomers	(1)

Question number	Answer	Additional guidance	Mark
(a)(ii)	An explanation that includes three of the following points: • lactase is soluble because of its {globular shape / external polarR groups} (1) • (and therefore) lactase collides with lactose (1) • active site of lactase is complementary to the lactose (1) • Formation of enzyme-substrate complex lowers the activationenergy (1)	**Accept** hydrophilic for polar **Accept** active site of lactase binds tolactose / active site allows enzyme-substrate complex to form **Accept** R group interactions break the glycosidic bonds	(3)

Question number	Answer	Additional guidance	Mark
(b)(i)	• {lactase / enzyme} is reusable / milk is not contaminated with {lactase / enzyme} (1)	**Accept** higher enzyme activity	(1)

Question number	Answer	Additional guidance	Mark
(b)(ii)	An explanation that includes four of the following points: • pH {below 5 / above 5} reduces lactase activity (1) • because pH affects the shape of the active site (1) • due to ionisation of the R groups (1) • immobilised lactase is active at wider range of pH values (1) • immobilisation holds the R groups in place so active site does notchange shape (1)	**Accept** pH 5 is the optimum for both enzymes / pH 4-6 is the optimum for both enzymes **Accept** active site denatured by pH **Accept** bonds between R groups are broken	(4)

Question number	Answer	Additional guidance	Mark
(b)(iii)	An answer that includes the following points: • measure the decrease in concentration of lactose over time • see table for units OR • measure the increase in concentration of {glucose / galactose} over time • see table for units	**Accept** measure rate of loss of lactose Ignore: measure how long it takes for lactose to be fullybroken down **Accept** measure rate of production of {glucose /galactose} Units can be expressed as: • mass per volume per time • mass volume^{-1} time^{-1} • amount per volume per time • amount volume^{-1} time^{-1}	(2)

mass	volume	time
g / mg / µg / kg	cm^{-3} / mm^{-3} / dm^{-3} / litre^{-1}	s^{-1} / min^{-1} / hour^{-1}
amount	volume	time
mmol / mol / µmol	cm^{-3} / mm^{-3} / dm^{-3} / litre^{-1}	s^{-1} / min^{-1} / hour^{-1}

Question number	Answer	Additional guidance	Mark
(c)	An answer that includes two of the following points: • mutation (that resulted in CLI) occurred in the {gene / DNA} (of people living in one country) (1) • people from this country (had children that) stayed in this country(1) • relatively new mutation so has not had the chance to spread (1)	**Accept** limited emigration from this country / reproduction with others from same country Ignore idea that mutation is causedby drinking milk / not drinking milk	(2)

Q12.

Question number	Answer	Additional guidance	Mark
(a)(i)	An explanation that includes the following points: • because both lines rise and fall (in parallel) (1) • but the line for deaths from lung cancer is a period of time afterthe line for cigarettes smoked (1)	**Accept** {delay / timelag} for deaths	(2)

Question number	Answer	Additional guidance	Mark
(a)(ii)	An explanation that includes the following points: • alveoli will have a smaller surface area (to volume ratio) (1) • therefore the (rate of) diffusion of oxygen into the bloodstreamwill be slower (1)	**Accept** gas exchange area will besmaller **Accept** gas exchange for diffusion **Ignore** less gas exchange / diffusion	(2)

Question number	Answer	
*(b)	Indicative content:	
	Egg points (E)	1. {number / density of pores} 2. {width / size} of pores 3. area of pores 4. thickness of shell and membranes 5. rate of respiration of developing embryo 6. rate of blood flow of embryo 7. temperature 8. shell is impermeable / pores are permeable 9. shell supports membrane so there is a large SA for gas exchange
	Theory points (T)	10. Ficks Law of diffusion can be used to calculate diffusion rate 11. State Fick's Law (3) 12. because rate of diffusion depends on surface area / mp11 13. because rate of diffusion depends on diffusion distance / mp11 14. because rate of diffusion depends on concentration gradient / mp11 15. speed of molecules depends on temperature 16. because rate of diffusion depends on what substances oxygen is passing through egwater / air 17. diffusion coefficient through air 18. diffusion coefficient through membranes
	Explanation points (X) Accept converse for all	19. increasing SA (or any named factor increasing this) causes increase in rate of diffusion 20. increasing distance (or any named factor increasing this) causes decrease in rate ofdiffusion 21. increasing conc gradient (or any named factor increasing this) causes increase in rateof diffusion 22. increasing temperature increases rate of diffusion

	Level 1 Up to 4 points from anywhere; 2 points for one mark and 4 points for 2 marks Level 2 5 points or more, from two best categories; 5 points for 3 marks, 6 points for 4 marks. Must achieve 6 marks to progress to level 3 Level 3 As level 2 plus up to 2 points from third category; 7 points for 5 marks and 8 points for 6 marks

Q13.

Question number	Answer	Additional guidance	Mark
(a)(i)	An answer that includes the following points: • an increase in the number of (DNA) {molecules / double helices} (1) • each (new molecule) consists of one {parent / original / old} strand and one new strand (1)	ACCEPT {two / new} molecules are made (from one molecule)	(2)

Question number	Answer	Additional guidance	Mark
(a)(ii)	(DNA) helicase / polymerase / ligase (1)	ACCEPT swivelase / untwistase / topoisomerase	(1)

Question number	Answer	Additional guidance	Mark
(a)(iii)	An explanation that includes the following points: • because it results in genetically identical (daughter) cells (1) • that will have the same {structure / function} (as the parent cell) (1)	ACCEPT same {genetic information / genotype / alleles / DNA sequence}	(2)

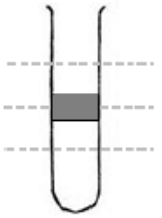
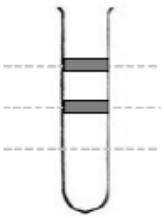
Question number	Answer	Additional guidance	Mark
(b)	<table><tr><th rowspan="2">Stage</th><th colspan="3">Percentage of the DNA molecules containing</th></tr><tr><th>heavy nitrogen only</th><th>light nitrogen only</th><th>both heavy and light nitrogen</th></tr><tr><td>1</td><td>100</td><td>0</td><td>0</td></tr><tr><td>2</td><td>0</td><td>0</td><td>100</td></tr><tr><td>3</td><td>0</td><td>50</td><td>50</td></tr></table>	N.B. mark the rows not the columns DO NOT ACCEPT empty boxes	(3)

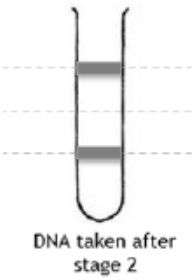
Q14.

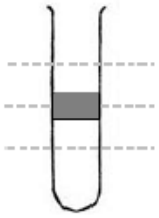
Question number	Answer	Additional guidance	Mark
(a)	An explanation that includes the following points: • form base pairs to hold the two {polynucleotide / strands} together (1) • because of the number of hydrogen bonds that each type of base can form (1) • a {large base / purine} bonds with a {small base / pyrimidine} (1) • so that the strands are parallel (1)	**ACCEPT** adenine and thymine form two hydrogen bonds <u>and</u> guanine and cytosine form three hydrogen bonds **ACCEPT** single ring bonds to double ring	**(3)**

Question number	Answer	Additional guidance	Mark
(b)(i)	• 6.6×10^2 (1)	**ACCEPT** 6.596×10^2	**(1)**

Question number	Answer	Additional guidance	Mark
(b)(ii)	• mass of DNA after three divisions calculated (1) • {4 / 4.1 / 4.14 / 4.142} × 10^{-14} (1)	($3.1 \times 10^9 \times 8$) 24.8×10^9 NB Correct answer but wrong standard form = 1 mark ECF {2 / 1.6 / 1.55} × 10^{-14} = 1 mark	(2)

Question number	Answer	Additional guidance	Mark
(c)(i)	A diagram that shows the following points: • a band the same width as stage 1 in the middle of the tube (1) • bands drawn at the top and middle of tube (1) • both bands half the width of stage 1 (1)	  **NB** For mp 3, if 1 band is drawn allow 1 mark if same width as the band in stage 1 level and above it	(3)

Question number	Answer	Additional guidance	Mark
(c)(ii)	A diagram that shows the following points: • bands drawn at the top and bottom of tube (1) • both bands half the width of stage 1 (1)	 **NB** If 1 band is drawn allow 1 mark if same width as the band in stage 1 and above it	(2)

Question number	Answer	Additional guidance	Mark
(c)(iii)	A diagram that shows the following points: • one band drawn in the middle (1) • of similar thickness to band in stage 1 (1)	 DNA taken after stage 2	(2)

Q15.

Question number	Answer	Mark
(a)	C The only correct answer is C. *A is incorrect because amino acids are not found in DNA* ***B** is incorrect because a mutation is a change in DNA* ***D** is incorrect because there are no bases in protein*	(1)

Question number	Answer	Additional guidance	Mark
(b)	Any two from: deletion insertion substitution (1)	**ALLOW** {chromosome / translocation} {point / gene} and {chromosome / translocation} **IGNORE** subtraction / addition / swapping / frameshift / nonsense / duplication / specific examples	(1)

Question number	Answer	Additional guidance	Mark
(c)	An answer that includes three of the following points: • as age increase the number of cases increases (in both males andfemales) (1) • up to 57 years of age {males and females have a similar number ofcases / females have a higher incidence} (1) • above 57 the number of cases is higher in males (1) • onset of cancer is later in males than females (1)	**ACCEPT** converse where appropriate **ACCEPT** men and women throughout **ACCEPT** positive correlation **IGNORE** risk for cases **ACCEPT** 58 **ACCEPT** 58 **NB** penalise wrong age once **IGNORE** just figures quoted	(3)

Q16.

Question number	Answer	Additional guidance	Mark
* **(a)**	Indicative content: • triplet codon system (D) • because (at least) 20 codes needed for the amino acids (E) • e.g. AAC is code for asparagine (x) • degenerate code (D) • therefore some amino acids have more than one code (E) • e.g. threonine can be coded for by ACA, ACC, ACG or ACT (x) • non-overlapping code (D) • so each base on DNA is used in only one triplet codon (E) • e.g. AAC AGA codes for two amino acids (x)	**ACCEPT** three bases code for one amino acid **ACCEPT** each amino acid has its own code **ACCEPT** there are more codes than necessary **ACCEPT** discrete	**(6)**

Level 1 : refers to triplet codon system, degenerative code **or** non-overlapping code but no examples or explanation given
1 mark = 1 out of 3
2 marks = 2 out of 3 or 1 out of 3 + a linked example or explanation
Level 2 : refers to triplet codon system, degenerative code **or** non-overlapping code with either examples or explanation given
3 marks = at least 2 examples or 2 explanations or 1 of each
4 marks = at least 3 examples or 3 explanations or any combination of each
Level 3 : refers to triplet codon system, degenerative code **and** non-overlapping code with examples and explanation given
5 marks = at least 4 examples or explanations or any combination of each
6 marks = at least 5 examples or explanations or any combination of each

Question number	Answer	Additional guidance	Mark
(b)(i)	• methionine alanine cysteine proline isoleucine leucine	**ACCEPT** phonetic spelling / reasonable abbreviations / M A C P I L	**(1)**

Question number	Answer	Additional guidance	Mark
(b)(ii)	An explanation that includes the following points: • it will have no effect (on the polypeptide) if the ninth base becomes a T as this still codes for {cysteine / same amino acid} (1) • will code for a stop codon if the ninth base becomes an A (1) • therefore the {protein / polypeptide} will be {shorter / not formed} (1) • will code for tryptophan if the ninth base becomes G (1) • this could change the bonding in the protein (1) • changing the {structure / activity} of the protein (1)	**ACCEPT** only two amino acids will join together **ACCEPT** even if tryptophan not given / given wrongly **ACCEPT** even if tryptophan not given / given wrongly	**(5)**

Q17.

Question number	Answer	Additional guidance	Mark
(a)	A description that includes the following points: • contain {deoxyribose / pentose / 5 carbon sugar}, phosphate and bases (1) • (mononucleotides / bases) held together by hydrogen bonds (1) • between {complementary bases / named example} (1)	**NB** ignore statements clearly relating to RNA **ACCEPT** pair contains purine and pyrimidine / (mono)nucleotide contains either purine or pyrimidine phosphate group / PO_4^{3-} **DO NOT ACCEPT** P / Pi / wrong formulae **IGNORE** stated number of H bonds **ACCEPT** A / T / C / G **IGNORE** descriptions of mononucleotides joined by phosphodiester bonds in a strand **NB** points can be awarded from clearly labelled diagrams	**(3)**

Question number	Answer	Additional guidance	Mark
(b)	• number of seconds for molecules to replicate calculated (1) • 833 (1) **OR** • number of molecules replicated in 1 hour (1) • 833 (1)	(150 million ÷ 50) 3 000 000 (50 × 60 × 60 =) 180 000 Bald answer of 833 = 2 marks Bald answer of 833.3 = 1 mark unless given as a recurring number	**(2)**

Question number	Answer	Additional guidance	Mark
(c)(i)	An explanation that includes the following points: • bind to each strand of the DNA (to initiate replication) (1) • credit function of DNA polymerase (1) • so that the DNA can be synthesised in both directions (1)	**ACCEPT** works at both ends of the bubble **IGNORE** ref to 3' / 5' **e.g.** lines up nucleotides (along each strand) forms phosphodiester bonds (between adjacent nucleotides) repairs mistakes in replication **IGNORE** forms hydrogen bonds between nucleotides	**(2)**

Question number	Answer	Additional guidance	Mark
(c)(ii)	An answer that includes the following points: • to speed up the process (of DNA synthesis) (1) • so that S phase {is shorter / lasts 8 hours and not 833 hours} (1) • so that cell division is fast enough (1)	**ACCEPT** wrong figures implied from a wrong calculation	**(3)**

Q18.

Question number	Answer	Mark
(a)(i)	The only correct answer is C. fructose and glucose | sucrose only A is incorrect because glucose is also a monosaccharide not a disaccharide B is incorrect because fructose is also a monosaccharide and not a disaccharide D is incorrect because sucrose is not a monosaccharide and fructose is not a disaccharide	(1)

Question number	Answer	Mark
(a)(ii)	The only correct answer is B glycosidic A is incorrect because ester bonds join organic acids and alcohols together C is incorrect because peptide bonds join amino acids together D is incorrect because phosphodiester bonds joins mononucleotides together	(1)

Question number	Answer	Additional guidance	Mark
(b)(i)	A calculation showing the following steps: • the mean calculated (1) • the mean converted to g dm^{-3} (1)	Example of calculation : (1.22 + 1.02 + 1.00) ÷ 3 / 1.08 0.00108 / 0.0011 / 1.08 × 10^{-3} Correct answer with no working shown gains both marks.	(1)

Question number	Answer
(b) (ii)	Indicative content: • sugar solution with a lower water potential than the cytoplasm of the cell (D) • sugar solution should be hypertonic (D) • so that water will pass out of the cytoplasm by osmosis (E) • concentration of sugar solution should be the same as the cytoplasm (D) • so that sugars will not diffuse out (E) • each individual sugar concentration should be the same as the cytoplasm (D) • mean concentration of sugars stated (fructose = 1.52, glucose = 1.08, sucrose = 8.55) (D) • range of sugar concentrations stated (from table) (D) • so that concentration of each sugar remains the same (E) • another solute needs to be used (D) • so that the sugar concentration remains the same but the water passes out (E)

	Level 1 : description of conditions needed for osmosis and maintaining sugar concentration 1 mark = a description of one condition 2 marks = a description of each condition or an explanation of one condition Level 2 : explanation of conditions needed for both osmosis and maintaining sugar concentration 3 marks = a description of one condition and an explanation of the other condition 4 marks = an explanation of each condition Level 3 : indicates that concentration of each sugar needs to be the same as in the pineapple and another solute needs to be included. 5 marks = and includes one of the above 6 marks = and includes both of the above

Q19.

Question number	Answer	Additional guidance	Mark
(a)(i)	An explanation that includes the following points: • pond water has a higher water potential than {cytoplasm / Paramecium} (1) • (therefore water moves by) osmosis (1)	ACCEPT converse for all points ACCEPT symbol for water potential (Ψ) ACCEPT inside of cell for {cytoplasm / Paramecium} and outside of cell for pond water Acceptable alternative terms All statements must be comparative eg hypertonic to / higher than… ACCEPT water moves {from an area of high to low water potential / down a water potential gradient / from low to high solute concentration}	(2)

	Cytoplasm / inside cell	Pond water / outside cell
Water potential	lower	higher
	hypertonic	hypotonic
Solute potential / osmotic potential	lower	higher
Conc of solute molecules	higher	lower

Question number	Answer	Additional guidance	Mark
(a)(ii)	An explanation that includes the following points: • paramecium does not have a cell wall (1) • (therefore) cannot stop the entry of water (1) • (therefore if the water is not pumped out) {the cell will swell / pressure will increase} (1) • cell will burst (1)	ACCEPT cell for paramecium in all marking points ACCEPT paramecium is surrounded by (only) a cell membrane ACCEPT Cell will (continue to) fill with water ACCEPT cell membrane breaks	(3)

Question number	Answer	Additional guidance	Mark
* (b)	Indicative content: **O marking point** (credit once for correct reference, anywhere) reference to {osmosis / concentration gradient / concentration gradient of water molecules / area of high and low water potential} **Pond water** • E contractile vacuole pumping out water to prevent cell from swelling • C acting as a control to compare to solutions A and B **Solution A** • D contractile vacuole is not pumping so frequently (than in pond water) / less water is pumped out • E (therefore) less water entering the cell • C because the water potential of solution A is lower than that of the pond water • C water potential of {solution A / outside the cell} is higher than that of {the cytoplasm / inside the cell} so water is still entering • D refers to delay at start	IGNORE reference to isotonic ACCEPT correct statement including: hypertonic / hypotonic; solute potential; solute concentration; concentration of water; ACCEPT converse in all cases IGNORE reference to isotonic	(6)

	Solution B • D contractile vacuole is pumping more often (than in pond water) • E (therefore) more water entering the cell • C because the water potential of solution B is greater than that of the pond water • C water potential of Solution B is (much) higher than the cytoplasm so water is still entering the cell • C water potential of solution B > solution A • D refers to delay at start • E delay in increase is due to time to produce sufficient energy	ACCEPT correct statement including: hypertonic / hypotonic; solute potential; solute concentration; concentration of water; ACCEPT converse in all cases IGNORE reference to isotonic	

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Level	Mark	
	0	**No awardable content**
1	1-2	**Level 1: correct description of graphs with some reference to idea of osmosis** 1 mark: one D or one O marking point 2 marks: second D marking point
2	3-4	**Level 2: correct comparison of Solutions A and B with pond water or cytoplasm** 3 marks: one C marking point 4 marks: second C marking point
3	5-6	**Level 3: correct explanation of graphs** 5 marks: one E marking point 6 marks: second E marking point

Q20.

Question number	Answer	Additional guidance	Mark
(a)(i)	pressure exerted by one (type of) gas in a mixture of gases (1)	ACCEPT pressure exerted by oxygen in a mixture of gases/air ACCEPT is a measure of concentration of a gas / concentration of oxygen (ignore location) IGNORE amount of oxygen / amount of gas / % of gas / proportion of gas	(1)

Question number	Answer	Additional guidance	Mark
(a)(ii)	An explanation that includes three of the following points: • haemoglobin is composed of four sub-units (1) • binding of the first oxygen molecule is difficult (1) • binding of the other molecules becomes easier (1) • due to a conformational change (1) • as Hb becomes saturated less oxygen can bind (so the curve flattens out) (1)	ACCEPT context of release of oxygen from Hb for mp 2, 3 and 4 ACCEPT 4 haem groups / 4 polypeptide chains / 4 iron ions IGNORE slow binding ACCEPT cooperative binding ACCEPT increased affinity for other molecules IGNORE faster binding ACCEPT due to a change in the {3D / tertiary} structure IGNORE change of shape	(3)

Question number	Answer	Additional guidance	Mark
(b)(i)	An explanation that includes one of the following points: • {water vapour / carbon dioxide} is added to the air (1) • oxygen {used by cells / used in respiration} (1) • oxygen moves into {capillaries / blood} (1)	ACCEPT idea of carbon dioxide diffusing into the alveoli ACCEPT oxygen transported by blood IGNORE "to maintain a gradient for oxygen to diffuse"	(1)

Question number	Answer	Additional guidance	Mark
(b)(ii)	An explanation that includes the following points: • arteries take blood to {tissues / cells}, veins take blood away from {tissues /cells} (1) • oxygen diffuses (out of the capillaries) into {the tissues /cells} (1) • because there is a lower {partial pressure / concentration} in tissues / cells (1) • carbon dioxide is {increasing in / entering} (the blood) (1)	ACCEPT arteries take blood away from the heart and veins take it towards the heart. Can be pieced together. ACCEPT oxygen diffuses out of the blood ACCEPT oxygen {unloaded / released / dissociates} from haemoglobin ACCEPT because the {tissues / cells} are respiring (aerobically)	(3)

Question number	Answer	Additional guidance	Mark
(b)(iii)	Correct value for percentage saturation given (1)	81 ACCEPT 80 - 82	(1)

Question number	Answer	Additional guidance	Mark
(b)(iv)	An explanation that includes four of the following points: • partial pressure of oxygen (in the atmosphere) at high altitudes is low / lower (than at sea level)} (1) • (therefore) the partial pressure of oxygen in the alveoli will be lower (1) • the concentration gradient between the alveoli and the blood will be smaller (1) • (therefore) the rate of diffusion of oxygen into the blood will be slower (1) • (therefore) the haemoglobin will not be able to bind to as much oxygen (1)	ACCEPT converse for all marking points ACCEPT {concentration of oxygen / level of oxygen} for partial pressure in all marking points ACCEPT less oxygen (available) at high altitude ACCEPT difference in concentration of oxygen between the alveoli and the blood IGNORE less diffusion, this is about rate ACCEPT lower partial pressure of oxygen in the blood ACCEPT less oxyhaemoglobin produced IGNORE saturation of Hb is low	(4)

Q21.

Question number	Answer	Additional guidance	Mark
(a)	peptide (1) amino / NH_2 / NH_3^+ / amine (1) carboxyl / COOH / CO_2H / COO^- / carboxylic (acid) (1) condensation (1) translation (1)	**DO NOT ACCEPT** dipeptide / polypeptide / amide **ACCEPT** second and third point either way round **ACCEPT** polymerisation / addition elimination	**(5)**

Question number	Answer	Mark
(b)	<table><tr><th>Structure</th><th>Hydrogen bonds only</th><th>Ionic bonds only</th><th>Both hydrogen and ionic bonds</th><th>Neither of these bond</th></tr><tr><td>secondary structure</td><td>X</td><td>☒</td><td>☒</td><td>☒</td></tr><tr><td>three-dimensional structure</td><td>☒</td><td>☒</td><td>X</td><td>☒</td></tr></table>	(2)

Q22.

Question number	Answer	Mark
(a)	• sequence of bases of DNA that code for a polypeptide	(1)

Question number	Answer	Mark
(b)	A description that includes the following points: • complementary bases / named pair of complementary bases (1) • it enables the formation of {two hydrogen bonds between adenine and thymine / three hydrogen bonds between cytosine and guanine} (1)	(2)

Question number	Answer	Additional guidance	Mark
(c)	A explanation that includes the following points: • enough codons needed for 20 different amino acids (1) • four bases are used in the genetic code (1) • (triplet code) provides {enough / 43 / 64} possible codons (1)	Allow descriptions of single and doublet code providing insufficient alternatives	(3)

Question number	Answer	Additional guidance	Mark
(d)	A answer that includes the following points: • correct genotypes of parents (1) • affected genotype of children correctly identified (1) • correct calculation of probability is 0.5 (1)	Accept 50%, 1 in 2, ½	(3)

Q23.

Question number	Answer	Additional guidance	Mark
(a)(i)	• GUG	**ACCEPT** guanine uracil guanine / CAC / cytosine adenine cytosine **IGNORE** val / valine	(1)

Question number	Answer	Additional guidance	Mark
(a)(ii)	• substitution	**DO NOT ACCEPT** frameshift / deletion / addition / insertion **IGNORE** {gene / point} mutation	(1)

Question number	Answer	Additional guidance	Mark
(a)(iii)	An answer that includes the following points: • the R groups (of these two amino acids) have different {properties / bonding} (1) • glu may have repelled polar groups on other haemoglobin molecules (1) • {val / hydrophobic R group / hydrophobic part} might form other (hydrophobic) interactions (with other haemoglobin molecules) (1) • (part of haemoglobin containing) val (R group) turns away from {water / cytoplasm} (1)	**ACCEPT** amino acids have different properties **ACCEPT** bonds / Van der Waals **DO NOT ACCEPT** incorrect named bonds **ACCEPT** repels water **DO NOT ACCEPT** blood / plasma	(3)

Question number	Answer	Additional guidance	Mark
(b)	• number of non-affected babies calculated (1) • 0.002 : 1 / 2 × 10^{-3} : 1 (1)	(140 million - 305 800 =) 139 694 200 0.002189 **ACCEPT** 0.0022 / 0.00219 / 0.002189 **ACCEPT** 1 : 457 / 456.8 **NB** 1 mark for 1 : 458 / 1 : 457.8 0.002184 : 1 (0.002 / 0.0022 / 0.0218) Bald answer = 2 marks	**(2)**

Question number	Answer	Additional guidance	Mark
(c)(i)	• values read correctly from the graph (1) • 3.3 / 3.4 (1)	**ACCEPT** 4.4 / 4.9 and 5.7 / 5.8 / 7.7 / 7.8 **ACCEPT** ecf for correct subtraction using {4.4 / 7.7 / 7.8} and one incorrect value Bald answer = 2 marks	**(2)**

Question number	Answer	Additional guidance	Mark
(c)(ii)	An answer that includes the following points: • person without the disease has higher saturation than person with the disease (at all partial pressures of oxygen) (1) • there is {greater variability / wider range} (in the saturation) of a person with the disease than a person without the disease (at a particular partial pressure of oxygen) (1)	**NB** accept converse throughout but all conclusions must be comparative **ACCEPT** refs to affinity (for oxygen) **IGNORE** graph shifted	**(2)**

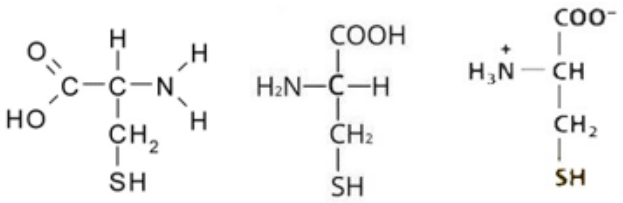
Question number	Answer	Additional guidance	Mark
(c)(iii)	• 120 (days) (1)		**(1)**

Question number	Answer	Additional guidance	Mark
(c)(iv)	An explanation that includes three of the following points: • (change in structure of haemoglobin) haemoglobin {binds / carries} less oxygen (1) • (shape of red blood cell) smaller surface area so less oxygen diffuses in / red blood cells get lodged in blood vessels preventing flow of blood to cells (1) • therefore less oxygen to {cells / tissues} so {less available for (aerobic) respiration / switch to anaerobic respiration} (1) • credit an example of why less oxygen to cells could be fatal (1)	**NB** accept converse where appropriate **ACCEPT** named cell / tissue e.g. heart attack, stroke, sepsis, infection	**(3)**

C1

Q24.

Question number	Answer	Additional guidance	Mark
(a)(i)	A description that includes two of the following points: • long (chains of amino acids / polypeptides / proteins) (1) • repeating sequences of amino acids (1) • high proportion of {small / non-polar / hydrophobic} {R groups / amino acids} (1) • (parallel) chains held with {cross links / hydrogen bonds}	**IGNORE** large **ACCEPT** a description **IGNORE** named amino acids **ACCEPT** hydrophobic groups on the outside **IGNORE** stated number of chains / refs to triple helix **DO NOT ACCEPT** other named bonds	**(2)**

Question number	Answer	Additional guidance	Mark
(a)(ii)	A diagram that includes the following points: • a central carbon atom (1) • an amino group and a carboxyl group (1) • a hydrogen and the cysteine R group (attached by the C) (1)		(3)

Question number	Answer	Additional guidance	Mark
(b)(i)	A description that includes the following points: • ß {pleated / sheet} / α helix (1) • (held together by) hydrogen bonds (between amino acids) (1)	**DO NOT ACCEPT** {double helix / triple helix} even if ß sheet named **IGNORE** B / A **DO NOT ACCEPT** other bonds **DO NOT ACCEPT** between the R groups	(2)

Question number	Answer	Additional guidance	Mark
(b)(ii)	An explanation that includes four of the following points: • primary structure remains the same length and secondary structure is longer with higher temperature (1) • (primary structure remains the same length) because the peptide bonds are not affected (by the heat) (1) • secondary structure is shorter than primary structure because of the {folding / winding} (1) • (secondary structure gets longer) because (the heat) hydrogen bonds break (1) • due to increase in vibration of the {R groups / amino acids / molecule} (1)	Piece together **ACCEPT** strong / hard to break **ACCEPT** increase in kinetic energy results in more movement within the molecule.	(4)

Q25.

Question number	Answer	Additional guidance	Mark
(a)	An answer that includes three of the following points: Similarities **Any two from:** • both contain a glycerol (1) • both contain fatty acids (1) • both contain ester bonds (1) Differences • triglycerides have three fatty acids and phospholipids have two fatty acids (1) • triglycerides do not contain a phosphate group but phospholipids do contain a phosphate group (1)	**NB** Do not piece together from two descriptions in separate sentences **IGNORE** diagrams	**(3)**

Question number	Answer	Additional guidance	Mark
(b)	An explanation that includes the following points: • {protein / phosphate heads / phospholipid heads} are {soluble / hydrophilic / polar} and interact with {blood / plasma} (1) • {fatty acids / triglycerides /cholesterol} is {insoluble / non-polar / hydrophobic} (1) • therefore cholesterol is surrounded by {fatty acid tails / triglycerides} (1)		**(3)**

<table>
<tr><th>Question number</th><th>Answer</th><th>Additional guidance</th><th>Mark</th></tr>
<tr><td>(c)(i)</td><td>• volume of sphere calculated / values substituted into the equation (1)

• volume of sphere rounded up to nearest whole number (1)

• ratio calculated (1)</td><td>Example of calculation

= 6912 if using π = 3
= 7142.4 if using π = 3.1
= 7234.56 if using π = 3.14
= 7239.168 if using π = 3.142
= 7241.472 if using π = 3.143
= 7238.22947387 if pressing π on calculator

= 6912 / 7142 / 7235 / 7239 / 7238 / 7241
ACCEPT 6910 / 7140 / 7240
NB Just these values given = 2 marks

14 : 1
13 : 1 if 6910 / 6912

CE apply throughout
NB mark answer in table if different from in the working e.g.
<table><tr><th>Diameter of LDL / nm</th><th>Volume of LDL / nm^3</th><th>Volume of cholesterol / nm^3</th><th>Ratio of LDL volume to cholesterol volume</th></tr><tr><td></td><td></td><td></td><td></td></tr><tr><td></td><td>7235

= 2 marks</td><td></td><td>14 : 1

= 1 mark</td></tr></table></td><td>(3)</td></tr>
</table>

Question number	Answer	Additional guidance	Mark
* (c)(ii)	Indicative content: • as LDL increases, risk increases (K / G) • several factors beside LDLs can increase the risk of CVD (K) • example of a factor given e.g. high blood pressure (K) • LDLs can be different sizes (Q) • and therefore be absorbed by endothelial cells differently (Q) • and therefore get broken down at different rates (K / Q) • and therefore carry different volumes of cholesterol (Q) • level of HDL (in blood) affects risk (of CVD) (K / G) • example given from graph e.g. 0.65 a.u. has greater risk than 2.20 a.u. (G) • ratio of LDL : HDL affects risk (of developing CVD) (K / G) • the lower LDL : HDL the ratio the lower risk of CVD (K / G)		**(6)**
Own knowledge (K), information given in the graph (G), information in the question (Q) **Level 1 :** uses either (K), (G) **or** (Q) 1 mark = 1 comment, 2 marks = 2 comments **Level 2 :** uses two from (K), (G) **or** (Q) 3 marks = 3 comments, 4 marks = 4 comments **Level 3 :** uses (K), (G) **and** (Q) 5 marks = 5 comments, 6 marks = 6 comments			

Q26.

Question number	Answer	Mark
(a)(i)	**D** nm The only correct answer is D. *A is incorrect because cm would be* 1×10^{0} ***B** is incorrect because mm would be* 1×10^{-1} ***C** is incorrect because µm would be* 1×10^{-4}	**(1)**

Question number	Answer	Mark
(a)(ii)	**B** Q and T The only correct answer is B. *A is incorrect because R is a fatty acid and only contains C, H and O* ***C** is incorrect because R is a fatty acid and only contains C, H and O, S is cholesterol and only contains C, H and O* ***D** is incorrect because S is cholesterol and only contains C, H and O*	**(1)**

Question number	Answer	Mark
(a)(iii)	**D** S : T The only correct answer is D. *A is incorrect because* ***B** is incorrect because* ***C** is incorrect because*	**(1)**

Question number	Answer	Additional guidance	Mark
(b)	An explanation that includes the following points: • because the sequence of amino acids determine the {tertiary /quaternary} structure of the protein (1) • by determining the {position / type} of bonds that form betweenthe R groups (1) • {hydrophobic / non-polar} {(R) groups / amino acids on (the outside of) the part of the protein that is embedded in the fattyacid tails (1) • {hydrophilic / polar} {(R) groups / amino acids} (on the outside of)the part of the protein that is {amongst the phosphate heads / facing the cytoplasm / facing the aqueous environment} (1)	**ACCEPT** pieced together **ACCEPT** a named bond between R groups	**(4)**

Question number	Answer	
* (c)	Indicative content: **Molecule E** •enters by osmosis •because it is water •the number of the molecules F, G and H lower the water potential •so E moves down the water potential gradient **Molecule F** •enters by facilitated diffusion •down its concentration gradient •because it is polar and cannot pass through the fatty acid tails •therefore needs a protein to provide a polar channel for it to diffusethrough **Molecule G** •enters by diffusion •because it is at a higher concentration outside the cell •and it is non-polar so can pass through the fatty acid tails **Molecule H** •enters by active transport •because it is at a higher concentration inside the cell •and therefore needs ATP and a protein to pump it across the membrane	**Level 1 :** 1 mark = 1 relevant comment 2 marks = 3 relevant comments **Level 2 :** 3 marks = 4 relevant comments for at least **two** molecules 4 marks = 5 relevant comments for at least **two** molecules **Level 3 :** 5 marks = 6 relevant comments for at least **three** molecules 6 marks = 7 relevant comments from all **four** molecules **(6)**