

Membranes, Protein, DNA and Gene Expression - Mark Scheme

Q1.

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)	<ul style="list-style-type: none"> diffusion of water molecules down a water potential gradient through a partially permeable membrane 	(1)

Question number	Answer	Additional guidance	Mark
(c)	<p>An answer that includes the following points:</p> <p>similarities:</p> <ul style="list-style-type: none"> both used to transport large particles / large quantities of material (1) both involve (phospholipid) membrane vesicles (1) <p>difference:</p> <ul style="list-style-type: none"> exocytosis is export and endocytosis is import of material (1) 	Accept a description of both processes	(3)

Question number	Answer	Mark
(d)	<p>An explanation that includes the following points:</p> <ul style="list-style-type: none"> 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)

Q2.

Question number	Answer	Additional guidance	Mark
(a)	<p>A calculation in which:</p> <ul style="list-style-type: none"> actual height of elephant how many times taller the elephant is than the mouse 	<p>Example of calculation:</p> <p>$4.5 \div 0.02 = 225 / 230 / 235$ (cm)</p> <p>75 / 76.67 / 76.7 / 77 / 78 / 78.3 / 78.33</p> <p>IGNORE units</p>	(2)

Question number	Answer	Additional guidance	Mark
(b)	<p>A description that includes the following points:</p> <ul style="list-style-type: none"> attachment of lungs to {chest cavity / diaphragm} {increases volume / decreases pressure} (1) <p>Any two from:</p> <ul style="list-style-type: none"> <u>alveoli</u> provide a large surface area for faster diffusion (1) 	<p>ACCEPT to {take in / hold} large volume of air</p> <p>ACCEPT thin walls</p>	(3)

	<ul style="list-style-type: none"> <u>alveoli</u> 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) 	<p>ACCEPT large network of capillaries</p>	
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Question number	Answer	Mark
* (c)	<p>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.</p> <p>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.</p> <p style="text-align: center;">Indicative content</p> <ul style="list-style-type: none"> • 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)
	<p style="text-align: center;">greater than the elephant</p> <ul style="list-style-type: none"> • 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.

Q3.

Question number	Answer	Additional guidance	Mark
(a)(i)	A calculation in which: <ul style="list-style-type: none"> • substitute values correctly into the equation (1) • correct answer with units (1) 	<u>Example of calculation</u> $V = \frac{4 \times \pi \times 50 \times 50 \times 50}{3}$ <p>volume = 523 599 / 5.2 x10⁵ nm³ 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 x10⁵ nm³ / 523 333 nm³ gains 2 marks e. g. 4 186 667 / 4.2 x10⁶ nm³ gains 1 mark</p>	(2)

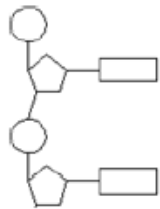
Question number	Answer	Additional guidance	Mark
(a)(ii)	<p>An explanation that includes the following points:</p> <ul style="list-style-type: none"> because {hydrophobic / non-polar} tails {move away from / repelled by} the {aqueous environment / water} (1) {hydrophilic / polar} heads {interact with / associate / dissolve in} the {aqueous environment / water} (1) 	<p>NB if no other marks awarded, allow 'hydrophilic heads face water and hydrophobic tails face away from water' for 1 mark</p>	(2)

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

Question number	Answer	Additional guidance	Mark
(b)(ii)	<p>A description that includes the following points:</p> <ul style="list-style-type: none"> 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) 	<p>ACCEPT converse throughout</p>	(3)

Question number	Answer	Additional guidance	Mark
(b)(iii)	<p>An explanation that includes the following points:</p> <ul style="list-style-type: none"> because an increase in temperature increases the movement of phospholipids (1) because the cholesterol decreases fluidity (of the membrane) (1) 	<p>ACCEPT fills the gaps between the phospholipid tails / acts as a barrier / reduces movement of phospholipids</p>	(2)

Q4.

Question number	Answer	Additional guidance	Mark
(a)	<p>An answer that includes the following points:</p> <ul style="list-style-type: none"> 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) 	<p>IGNORE labels</p> <p>including second strand if drawn / additional mononucleotides / one mononucleotide</p> <p>including second strand if drawn / additional mononucleotides</p> <p><u>example of diagram</u></p> 	(3)

Question number	Answer	Additional guidance	Mark
(b)(i)	<ul style="list-style-type: none"> 0.38 (nm) 	ACCEPT 0.4	(1)

Question number	Answer	Additional guidance	Mark
(b)(ii)	<p>An explanation that includes the following points:</p> <ul style="list-style-type: none"> R (or Q) because it forms two hydrogen bonds (1) R (or S) because it is {large / double-ring / purine} base (1) 	<p>ACCEPT not bases P and S because they form 3 hydrogen bonds</p> <p>ACCEPT not bases P and Q because they are {small / single-ring / pyrimidine}</p> <p>ACCEPT Q for correct reason or S for correct reason if neither mark points awarded</p>	(2)

Question number	Answer	Additional guidance	Mark
(c)	<p>An answer that includes at least one similarity and one difference:</p> <p>similarities:</p> <ul style="list-style-type: none"> • both contain {RNA (mono)nucleotides / ribose sugar / uracil (and adenine, cytosine and guanine) / phosphodiester bonds} (1) • both are single stranded (1) <p>differences:</p> <ul style="list-style-type: none"> • 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) 	<p>DO NOT PIECE TOGETHER</p> <p>ACCEPT letters for bases</p>	(4)

Q5.

Question number	Answer	Additional guidance	Mark
(a)(i)	<ul style="list-style-type: none"> • 9 : 1 	ACCEPT 6 : 1 / 5 : 1	(1)

Question number	Answer	Additional guidance	Mark
(a)(ii)	<p>A description that includes the following points:</p> <ul style="list-style-type: none"> • 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)	<p>A description that includes the following points:</p> <ul style="list-style-type: none"> • 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) 	<p>NB thromboplastin catalyses prothrombin into thrombin = 2 marks</p>	(4)

Question number	Answer	Additional guidance	Mark
(b)	<p>An explanation that includes the following points:</p> <ul style="list-style-type: none"> • 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) 	<p>ACCEPT inhibitor blocks the active site / fewer active sites available</p> <p>ACCEPT {less / no} thrombin to bind to fibrinogen / fewer collisions / fewer enzyme substrate complexes formed</p> <p>ACCEPT slower conversion</p>	(4)

Q6.

Question number	Answer	Marks
(a)	An explanation that includes the following points: <ul style="list-style-type: none"> • 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: <ul style="list-style-type: none"> • 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: <ul style="list-style-type: none"> • 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)

Q7.

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: <ul style="list-style-type: none"> • 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)	<p>A explanation that includes the following points:</p> <ul style="list-style-type: none"> • 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)	<p>A answer that includes the following points:</p> <ul style="list-style-type: none"> • 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, $\frac{1}{2}$	(3)

Q8.

Question number	Answer	Additional guidance	Mark
(a)	<p>An answer that includes two of the following points:</p> <ul style="list-style-type: none"> • because it would be {unethical / wrong} to {kill / harm} the insects (1) • because the insects would contain {protein / amino acids} (1) • it would give an {incorrect / higher} value (for the {protein / amino acid} content of the galls) (1) 		(2)

Question number	Answer	Mark
(b)(i)	<p>The only correct answer is B.</p> <p><i>A is incorrect because aspartate is the most polar molecule.</i></p> <p><i>C is incorrect because aspartate is the most polar molecule.</i></p> <p><i>D is incorrect because aspartate is the most polar molecule.</i></p>	(1)

Question number	Answer	Additional guidance	Mark
(b)(ii)	<p>A calculation in which:</p> <ul style="list-style-type: none"> solubility of leucine calculated (1) solubility comparison with histidine calculated (1) 	<p>Example of calculation:</p> <p>5.5g in 250 cm³ = 22.0 (g dm⁻³)</p> <p>43.5 ÷ 22 = 1.98 / 2.0</p>	(2)

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	<ul style="list-style-type: none"> for use by the insects {alanine / arginine / histidine} are very abundant in the galls because these amino acids are abundant in the protein in the galls none of the amino acids are abundant in the tissues of the leaf with galls because they have moved into the gall leucine and tryptophan are not abundant in the galls as they have been used by the insects 	

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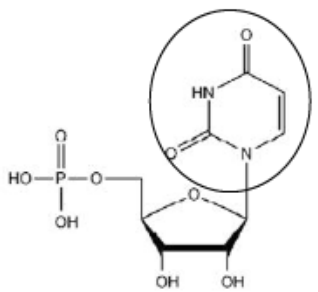
Q9.

Question number	Answer	Mark
(a)	A description that includes any five of the following points: <ul style="list-style-type: none"> • an mRNA molecule codes for each of the polypeptide chains in collagen (1) • mRNA carries a copy of the genetic code for collagen out of the nucleus to ribosome (1) • each tRNA carries its own specific amino acid to the {ribosome / mRNA} (1) • anticodon on tRNA binds to codons on the mRNA (1) • tRNA holds the amino acid in place while peptide bonds form (1) • reference to start and stop codons on mRNA (1) 	(5)

Question number	Answer	Mark
(b)	An explanation that includes any four of the following points: <ul style="list-style-type: none"> • insoluble because there are hundreds of amino acids (1) • insoluble because there are many hydrophobic R groups (1) • strong because of the triple helix (1) • therefore there are many repeating amino acid sequences (1) • many small R groups so that the triple helix can form (1) 	(4)

Q10.

Question number	Answer	Mark
(a)(i)	D ribose	(1)

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

Question number	Answer	Mark
(a)(iii)	<ul style="list-style-type: none"> • synthesis of RNA 	(1)

Question number	Answer	Additional guidance	Mark
(b)(i)	<p>An answer that includes the following points:</p> <ul style="list-style-type: none"> • OMP decarboxylase acting as a biological catalyst (1) • it lowers the activation energy of this reaction (1) 	Allow forms an enzyme - substrate complex	(2)

Question number	Answer	Mark
(b)(ii)	<p>An explanation that includes the following points:</p> <ul style="list-style-type: none"> • OMP decarboxylase is specific (for this substrate) (1) • because the active site of this enzyme has a particular shape (1) • therefore binds only with orotidine monophosphate (1) 	(3)