HELICATE · AS AND A-LEVEL BIOLOGY · TOPIC BANK

3.3.3 Digestion and absorption

Mark scheme

Version 1 · 9 October 2026

TOTAL MARKS	QUESTIONS
59	7

How to use this mark scheme

;	Separates marking points. Each semicolon marks the end of one creditable point, and each point is worth one mark.
;;	Two marks for this answer (used for calculations).
/	Alternative words or phrases that are credited for the same point.
OR	An alternative answer for the same mark.
( )	Words in brackets are not needed to gain the mark.
max	More marking points are listed than marks available. Award up to the number of marks shown.
Accept	An alternative answer that gains credit.
Reject	A wrong answer. It does not gain credit and cancels a correct point it contradicts.
Ignore	Neither credited nor penalised. Mark the rest of the answer.
ECF	Error carried forward: credit correct working that uses an earlier wrong answer.
AO	Assessment objective: AO1 knowledge and understanding; AO2 applying knowledge; AO3 analysing, interpreting and evaluating.

Where an answer is correct but not listed, credit it if it is biologically accurate and answers the question at the depth the marks require. Right + wrong = wrong: a contradiction cancels a correct point.

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Digestion of carbohydrates 3.3.3

Question	Marking guidance	Mark	Comments
01.1	1. Starch molecules are too large to pass through (the pores in) the Visking tubing; 2. Amylase hydrolyses (glycosidic bonds in) starch; 3. To maltose; 4. Maltose (molecules) are small enough to pass through the tubing/pores OR maltose diffuses out (of the tubing) down a concentration gradient;	**3 max** (1 × AO1) (2 × AO2)	1. **Accept** starch is a polymer/polysaccharide/large molecule, so cannot pass through 2. **Ignore** 'breaks down' or 'digests' unless hydrolysis is mentioned 3. **Reject** glucose as the product of amylase. Reject 'disaccharide' or 'sugar' for maltose 4. **Accept** reducing sugar for maltose in point 4 only **Reject** amylase passes through the tubing

Question	Marking guidance	Mark	Comments
01.2	Correct answer for 2 marks: 1.6×10^{-2} (mg cm^{-3} min^{-1});; Accept for 1 mark: 0.32 ÷ 20 **OR** 0.016 (not in standard form)	**2** (2 × AO2)	Plotted points lie on a straight line through 0.08 at 5 min, 0.16 at 10 min, 0.24 at 15 min, 0.32 at 20 min **Accept** answers from 1.55×10^{-2} to 1.65×10^{-2} for 2 marks (readings within ± 0.01 mg cm^{-3}) **Accept** the gradient calculated from any two points on the straight part of the line

Question	Marking guidance	Mark	Comments
01.3	1. Boiling denatures amylase OR changes the (shape of the) active site, so no enzyme-substrate complexes form/no starch is hydrolysed; 2. Shows that the reducing sugar outside the tubing (with active amylase) was produced by amylase OR was not already present in the starch/amylase solution;	**2** (1 × AO1) (1 × AO3)	1. **Accept** description of a change in tertiary structure 1. **Accept** E-S complex / ES complex. E-S alone only if 'enzyme-substrate complex' is written elsewhere. Ignore ESC 1. **Reject** 'kills' the enzyme 2. **Accept** 'as a control' only if the purpose is explained **Ignore** 'to make it a fair test' unqualified

Question	Marking guidance	Mark	Comments
01.4	1. (In the ileum) maltose is hydrolysed to glucose (before absorption) by a disaccharidase bound to the cell-surface membranes of epithelial cells OR in the model maltose is the molecule that crosses the membrane/no enzyme is attached to the membrane; 2. Glucose is absorbed by co-transport with sodium ions OR glucose can be absorbed against its concentration gradient OR the tubing has no carrier/co-transporter proteins; 3. Epithelial cells have microvilli OR the ileum wall has villi/is folded, giving a large surface area; 4. Blood carries absorbed glucose away, maintaining a concentration gradient OR in the model reducing sugar builds up outside the tubing because it is not removed OR the concentration levels off because the sugar is no longer absorbed/removed; 5. The gut contents are mixed/moved, bringing maltose/glucose into contact with the epithelium/membrane-bound enzymes OR maintaining a concentration gradient at the cell surface;	**3 max** (1 × AO2) (2 × AO3)	Each point is one difference: two statements about the same difference gain only one mark 1. Either the glucose product or the membrane-bound enzyme is enough for the mark. Accept maltase for disaccharidase. Accept on the microvilli for on the cell-surface membrane 2. **Accept** co-transporter for co-transport. Accept absorption in the ileum involves active transport/carrier proteins/ATP, as the model has only diffusion through pores 2. **Accept** Na^+ for sodium ions. Reject 'sodium' without reference to ions once, then accept 3. **Accept** brush border for microvilli. Accept villi as a separate structure of the ileum wall, but reject villi used to describe microvilli (eg 'each epithelial cell has villi'). Ignore 'SA' for surface area **Ignore** living versus non-living, and differences in temperature or pH, unqualified 4. **Ignore** 'the concentration levels off' or 'sugar builds up' unless linked to the sugar no longer being absorbed/removed (eg no blood flow to carry it away) 5. **Ignore** movement of the gut contents unqualified, eg 'food moves along the ileum' **Ignore** where amylase is made or where else starch digestion starts, eg the mouth (sites are not assessed: these are not differences in what happens in the ileum)

Question	Marking guidance	Mark	Comments
01.5	It is bound to the cell-surface membranes of epithelial cells and hydrolyses a glycosidic bond;	**1** (1 × AO1)	

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Digestion of lipids and the action of bile salts 3.3.3

Question	Marking guidance	Mark	Comments
02.1	1. Lipase hydrolyses (ester bonds in) triglycerides/lipids; 2. Producing fatty acids, which lower the pH (below 8.3);	**2** (1 × AO1) (1 × AO2)	1. **Accept** breaks ester bonds by adding water 1. **Reject** glycosidic, peptide or hydrogen bonds 2. **Accept** fatty acids are acids/release H^+ OR fatty acids neutralise the sodium carbonate 2. **Reject** glycerol lowers the pH

Question	Marking guidance	Mark	Comments
02.2	222 (s);	**1** (1 × AO2)	**Accept** 222.0

Question	Marking guidance	Mark	Comments
02.3	1. Bile salts emulsify lipids OR break large lipid droplets into smaller droplets; 2. Increasing the surface area (of lipid) for lipase (to act on); 3. (So) more enzyme-substrate complexes form OR faster hydrolysis of (ester bonds in) triglycerides; 4. (So) fatty acids are produced faster and the pH falls (below 8.3) sooner OR the mean time falls (from 405 s to 161 s);	**3 max** (1 × AO1) (2 × AO2)	1. **Accept** descriptions of emulsification 2. Must be linked to lipase/hydrolysis: 'smaller droplets have a larger surface area' alone gains point 1 only 2. **Ignore** 'volume ratio' 3. **Accept** E-S complex / ES complex. E-S alone only if 'enzyme-substrate complex' is written elsewhere. Ignore ESC 3. **Ignore** 'digestion' or 'breakdown' for hydrolysis 1. and 2. Reject bile salts hydrolyse/digest lipids **Ignore** bile salts neutralise acid/change the pH

Question	Marking guidance	Mark	Comments
02.4	1. The lipid droplets are already as small as possible/fully emulsified (at 1.0%) OR surface area of lipid is no longer limiting; 2. Lipase (concentration) is the limiting factor OR all lipase active sites are occupied; 3. The times for 1.0% (152–171 s) and 2.0% (150–158 s) overlap, so the difference may not be real/significant;	**2 max** (2 × AO3)	2. **Accept** the enzyme is working at its maximum rate 3. **Accept** the difference in means is small compared with the variation in the repeats

Question	Marking guidance	Mark	Comments
02.5	To keep the total volume the same OR so that the concentrations of lipase/milk/sodium carbonate are the same as in the other tubes;	**1** (1 × AO3)	**Accept** so the mixture is diluted by the same amount **Ignore** 'fair test' or 'as a control' unqualified

Question	Marking guidance	Mark	Comments
02.6	1. Compare the colour with a colour standard (showing the end point); 2. View the tube against a white background/tile; 3. Use a colorimeter and record the time to reach a set absorbance/transmission; 4. Use a pH meter/pH probe (with a data logger) and record the time to reach a set pH; 5. The same person judges the end point each time;	**2 max** (2 × AO3)	1. **Accept** compare with a tube containing a mixture that has reached the end point **Ignore** 'repeat more times' or 'calculate a mean' **Reject** calorimeter

Digestion of proteins 3.3.3

Question	Marking guidance	Mark	Comments
03.1	1. Endopeptidase hydrolyses internal peptide bonds OR peptide bonds within the polypeptide; 2. (Producing) more/shorter polypeptides, so more ends/terminal peptide bonds for the exopeptidase; 3. Exopeptidase hydrolyses terminal peptide bonds, releasing amino acids/dipeptides; 4. Together they produce 6.8 µmol cm^{-3} compared with 1.3 µmol cm^{-3} for the two enzymes separately OR about 5 times as much;	**3 max** (1 × AO1) (1 × AO2) (1 × AO3)	**Max 2** if hydrolyse/hydrolysis is not used at least once 1. **Accept** bonds in the middle of the chain 2. **Accept** more surface area for the exopeptidase 3. **Accept** bonds at the ends/external bonds **Reject** 'hydrolyses amino acids' (rather than the bonds between them) **Reject** dipeptide bonds/polypeptide bonds for peptide bonds

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Question	Marking guidance	Mark	Comments
03.2	Correct answer for 2 marks: 96 (%);; Accept for 1 mark: 5.4 **and** 5.6 (µmol cm^{-3}) **OR** 96.4 (not to the nearest whole number)	**2** (2 × AO2)	**Reject** 48 (%) for 2 marks (dipeptides not multiplied by 2)

Question	Marking guidance	Mark	Comments
03.3	1. Amino acids are produced at/close to the cell surface OR close to the co-transporter/carrier proteins; 2. Maintains a high concentration of amino acids at the cell surface OR maintains a concentration gradient (for absorption); 3. (So) amino acids are absorbed faster;	**2 max** (2 × AO2)	1. **Accept** on the microvilli/brush border for at the cell surface **Ignore** references to dipeptides being absorbed

Question	Marking guidance	Mark	Comments
03.4	It hydrolyses peptide bonds at the ends of a polypeptide chain;	**1** (1 × AO1)	

Absorption of the products of digestion 3.3.3

Question	Marking guidance	Mark	Comments
04.1	Monoglyceride OR glycerol;	**1** (1 × AO1)	**Accept** monoacylglycerol **Reject** glucose or glycogen

Question	Marking guidance	Mark	Comments
04.2	Correct answer for 2 marks: 4.7;; Accept for 1 mark: 19.8 (g) **and** 4.2 (g)	**2** (2 × AO2)	**Accept** any answer that rounds to 4.7, eg 4.72, 4.724, for 2 marks **Reject** 6.2 for 2 marks (ratio of total lipid)

Question	Marking guidance	Mark	Comments
04.3	1. Drug L inhibits lipase, so fewer ester bonds in triglycerides are hydrolysed OR less triglyceride is hydrolysed (to fatty acids); 2. Triglycerides are not absorbed (by epithelial cells) OR only the products of hydrolysis are absorbed, so triglycerides stay in the gut/are egested; 3. (So) most of the lipid in the faeces is triglyceride (79%) OR there is more lipid in the faeces (26 g compared with 5 g);	**2 max** (1 × AO2) (1 × AO3)	1. **Ignore** 'digested' or 'broken down' for hydrolysed 2. **Accept** triglycerides are too large to be absorbed **Reject** drug L denatures lipase

Question	Marking guidance	Mark	Comments
04.4	1. Bile salts emulsify lipids OR break large lipid droplets into smaller droplets; 2. (With less bile salt) a smaller surface area for lipase, so less/slower hydrolysis of triglycerides; 3. Explains the higher percentage/mass of triglycerides in the faeces (36% compared with 16% OR 11.2 g compared with 0.8 g); 4. But most of the lipid in the faeces is fatty acids (64%), so most triglyceride was hydrolysed, but the fatty acids were not absorbed; 5. Bile salts (combine with fatty acids to) form micelles; 6. Micelles make fatty acids more soluble in water OR carry fatty acids to the epithelial cells/lining of the ileum OR maintain a higher concentration of fatty acids at the cell surface; 7. Fatty acids (are released from micelles and) enter the epithelial cells by diffusion;	**5 max** (2 × AO1) (1 × AO2) (2 × AO3)	**Max 3** if Table 3 is not used (neither point 3 nor point 4) 1. **Accept** descriptions of emulsification 2. Must be linked to lipase/hydrolysis. Reject bile salts hydrolyse/digest lipids 5. **Accept** monoglycerides or glycerol with fatty acids. Ignore other correct components of micelles 6. **Accept** bring/transport/release fatty acids to the cells OR micelles break down close to the cells 6. and 7. Ignore lipid/fat/triglyceride for fatty acids 7. **Ignore** 'facilitated'. Ignore the absorption of micelles themselves 5. **Reject** micelles are formed by emulsification **Ignore** bile salts neutralise acid/change the pH **Ignore** re-formation of triglycerides, chylomicrons or transport in lymph: correct but not required

Question	Marking guidance	Mark	Comments
05.1	1. (In people without the condition) sodium ions are actively transported out of the epithelial cells into the blood; 2. Maintaining a sodium ion concentration gradient (from the lumen into the cell) OR keeping the sodium ion concentration in the cell low; 3. (Without the condition) sodium ions move into the cell through the functional co-transporter, bringing tryptophan with them OR tryptophan is co-transported with sodium ions (even against its concentration gradient); 4. Tryptophan moves out of the cells into the blood by facilitated diffusion; 5. (With the condition) the sodium ion gradient is still present, but the co-transporter cannot bind/transport tryptophan, so little tryptophan is co-transported into the cells/reaches the blood; 6. Uses Figure 3 to compare the groups: a much smaller rise in plasma tryptophan with the condition, eg about 20 compared with about 115 µmol dm^{-3} OR a peak of about 50 compared with about 165 µmol dm^{-3};	**4 max** (2 × AO1) (1 × AO2) (1 × AO3)	**Max 2** from points 1–4. Points 1, 2 and 4 happen in both groups; they explain how uptake works when the co-transporter functions Point 5 is the explanation; point 6 is the comparison from Figure 3. Each is credited on its own: point 5 does not need figures, and point 6 needs a comparison but not exact values 1. **Accept** pumped out using ATP / by the sodium–potassium pump 1. **Reject** sodium ions pumped into the lumen **Accept** Na^+ for sodium ions. Reject 'sodium' without reference to ions once, then accept 3. **Accept** co-transporter for co-transport. Reject tryptophan absorbed by active transport alone unless co-transport with sodium ions is described 4. **Reject** (simple) diffusion 5. **Accept** the co-transporter has a different shape/binding site, so tryptophan cannot bind 6. Plotted values: with the condition 30 rising to 50; without 50 rising to 165. Accept readings within ± 5 µmol dm^{-3}

Question	Marking guidance	Mark	Comments
05.2	Some tryptophan enters the epithelial cells by facilitated diffusion (through other carrier/channel proteins) when its concentration in the lumen is higher than in the cells;	**1** (1 × AO2)	**Accept** other carrier proteins/transport proteins absorb some tryptophan **Ignore** 'diffusion' unqualified **Ignore** absorption as dipeptides: the drink contains tryptophan, not dipeptides

Question	Marking guidance	Mark	Comments
05.3	So no amino acids/tryptophan from a recent meal were being absorbed OR so any rise in plasma tryptophan is due to the drink;	**1** (1 × AO3)	**Accept** so the starting concentrations are stable/comparable **Ignore** 'fair test' unqualified

Question	Marking guidance	Mark	Comments
06.1	Correct answer for 2 marks: 3.5;; Accept for 1 mark: surface areas of 0.953 **and** 0.275 (μm^2) **OR** 3.47/3.466 (not to two significant figures)	**2** (2 × AO2)	**Reject** 3.6 for 2 marks (ratio of lengths only) **Reject** 3.4 for 2 marks (diameter used as the radius) **Accept** answers using π from a calculator

Question	Marking guidance	Mark	Comments
06.2	1. Larger surface area (of cell-surface membrane) for absorption; 2. More co-transporter/carrier/channel proteins (for amino acids); 3. Amino acids enter (the cell) with sodium ions by co-transport OR proteins for a second, different type of transport, eg co-transport **and** facilitated diffusion; 4. More membrane-bound dipeptidases, so more amino acids produced at the cell surface;	**2 max** (2 × AO2)	1 and 2. Separate marks 1. **Ignore** 'SA' for surface area 2 and 3. Proteins for only one type of transport, without the sodium ions, gain only point 2 3. Carrier proteins for active transport and proteins for co-transport count as two types of transport 3. **Accept** Na^+ for sodium ions; accept symport for co-transport **Reject** villi for microvilli **Ignore** thin walls/one cell thick **Ignore** mitochondria/ATP (credited in 06.3)

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Question	Marking guidance	Mark	Comments
06.3	1. Surface area increased about 3.5 times, but the rate of absorption increased 7 times (5.6 ÷ 0.8); 2. (So) surface area cannot explain all of the increase OR the conclusion is not supported/another factor is involved; 3. A suitable other factor, eg more co-transporter/carrier proteins per μm^2 of membrane OR more mitochondria/ATP for active transport of sodium ions; 4. The number of epithelial cells/villi per cm of ileum was not measured, so the total membrane surface area per cm may have increased by more than 3.5 times (so surface area could still explain the increase);	**2 max** (2 × AO3)	1. **Accept** ECF from the student's answer to 06.1 3. **Accept** Na^+ for sodium ions **Credit** points that support or oppose the conclusion

Question	Marking guidance	Mark	Comments
06.4	Folds of the cell-surface membrane of an epithelial cell;	**1** (1 × AO1)	

Extended response: digestion of starch and protein 3.3.3

Question	Marking guidance	Mark	Comments
07	1. Amylase hydrolyses starch to maltose; 2. Hydrolysis of glycosidic bonds; 3. Disaccharidase hydrolyses maltose to glucose; 4. Disaccharidases/dipeptidases are bound to the cell-surface membranes of the epithelial cells; 5. Hydrolysis of peptide bonds (in protein); 6. Endopeptidases hydrolyse internal peptide bonds (within polypeptides); 7. Exopeptidases hydrolyse terminal peptide bonds (at the ends of polypeptides); 8. Endopeptidases produce more ends for exopeptidases; 9. Dipeptidases hydrolyse dipeptides to amino acids;	**6 max** (6 × AO1)	**Max 4** from starch points (1–3) or protein points (5–9) alone; point 4 can count with either **Max 5** if hydrolyse/hydrolysis is never used 1. **Reject** glucose as the product of amylase. Reject 'disaccharide' or 'sugar' for maltose 3. **Accept** maltase for disaccharidase 4. Either enzyme being membrane-bound is enough, eg 'maltase is bound to the membranes of the epithelial cells'. Accept membrane-bound OR on the microvilli/brush border 6. and 7. Accept bonds in the middle/within the chain; bonds at the ends/external bonds 5. to 9. Reject dipeptide bonds/polypeptide bonds for peptide bonds. Reject 'hydrolyses amino acids' Do not penalise incorrect sites of digestion or of enzyme production, except for point 4 **Ignore** stomach acid. Ignore descriptions of absorption: not asked

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