HELICATE · AS AND A-LEVEL BIOLOGY · TOPIC BANK

3.1.3 Lipids

Mark scheme

TOTAL MARKS	QUESTIONS
46	8

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.

Triglycerides 3.1.3

Question	Marking guidance	Mark	Comments
01.1	1. One glycerol and three fatty acids; 2. Condensation (reactions) OR water is removed/released; 3. Three molecules of water are removed/released OR one water molecule is removed for each fatty acid; 4. H from an OH/hydroxyl group of glycerol and OH from the carboxyl/COOH group of a fatty acid (form water) OR OH from glycerol and H from the carboxyl/COOH group; 5. Ester bond(s) form (between glycerol and each fatty acid);	**4 max** (4 × AO1)	**Accept** a correctly labelled diagram or a balanced equation for any point 3. Water removed must be linked to three fatty acids/three bonds; 'water removed' alone gains point 2 only 4. **Reject** H removed from a C–H group of glycerol; reject OH removed from both molecules 4. **Accept** carboxylic acid (group) for carboxyl 5. **Reject** glycosidic, peptide or phosphodiester bond **Reject** hydrolysis for condensation

Question	Marking guidance	Mark	Comments
01.2	Bond broken: Ester Number of water molecules used: 3 Products: Glycerol and three fatty acids;	**1** (1 × AO1)	One water molecule is used to break each of the three ester bonds

Question	Marking guidance	Mark	Comments
01.3	Correct answer for 2 marks: $C_{51}H_{98}O_6$;; Accept for 1 mark: $C_{51}H_{104}O_9$ (total of the reactants) **OR** three water molecules (H_6O_3) subtracted from the total, with one arithmetic error	**2** (2 × AO2)	**Accept** atoms in any order $C_{51}H_{102}O_8$ ($C_{51}H_{104}O_9 - H_2O$: only **one** water molecule removed instead of three) is not worth 2 marks; award 1 mark only if $C_{51}H_{104}O_9$ is shown

Question	Marking guidance	Mark	Comments
02.1	Correct answer for 2 marks: 73 (g);; Accept for 1 mark: 18.35 OR 18.4 OR 18 (g of glycogen) **OR** (8.0 × 39) ÷ 17 × 4, with an arithmetic error	**2** (2 × AO2)	**Accept** 73.4 or 73.6 (g) for 2 marks 55 (g) (water only, glycogen not added) gains 1 mark Energy = 312 kJ

Question	Marking guidance	Mark	Comments
02.2	1. Triglyceride releases more (than twice as much) energy per gram than glycogen (39 compared with 17 kJ); 2. Less/(almost) no water is stored with triglyceride, but 3.0 g of water is stored with each gram of glycogen, so a much smaller mass is carried for the same energy (8 g compared with 73 g) OR so the bird is lighter and needs less energy for flight/can fly further; 3. Triglyceride is non-polar/hydrophobic OR has no OH/hydroxyl groups, so it does not bind water, whereas glycogen has many OH groups that form hydrogen bonds with water OR triglyceride has more C–H bonds per gram/a higher proportion of hydrogen/less oxygen (than glycogen), so it releases more energy per gram;	**3** (1 × AO1) (1 × AO2) (1 × AO3)	1. **Accept** more energy per unit mass 2. Less water must be linked to a smaller mass/lighter bird; 'less water' alone does not gain point 2 2. **Accept** 'lighter' for smaller mass 3. Must be a structural difference between triglyceride and glycogen; accept 'triglyceride is hydrophobic/non-polar, so no water is stored with it' without reference to glycogen **Ignore** 'insoluble' alone, or 'does not affect water potential': glycogen is also insoluble and does not affect water potential **Ignore** 'more energy' without reference to mass/per gram

Saturated and unsaturated fatty acids 3.1.3

Question	Marking guidance	Mark	Comments
03.1	$C_{10}H_{18}O_2$;	**1** (1 × AO2)	**Accept** atoms in any order **Reject** $C_{10}H_{20}O_2$ (the formula of X)

Question	Marking guidance	Mark	Comments
03.2	1. X: no double bonds between carbon atoms (in the R group) OR all carbon–carbon bonds are single; 2. Y: (one) double bond between two carbon atoms (in the R group) OR has a C=C bond;	**2** (1 × AO1) (1 × AO2)	1. **Reject** 'no double bonds' unqualified, because the carboxyl group contains a C=O double bond 1. **Accept** each carbon (in the R group) is bonded to the maximum number of hydrogen atoms 2. **Accept** two (adjacent) carbon atoms each bonded to only one hydrogen atom 2. **Reject** 'double bond' unqualified

Question	Marking guidance	Mark	Comments
04.1	$C_{22}H_{42}O_2$;	**1** (1 × AO2)	Two more carbon atoms (CH_2 groups) than arachidic acid gives $C_{22}H_{44}O_2$; one C=C double bond means two fewer hydrogen atoms

Question	Marking guidance	Mark	Comments
04.2	1. Above 34 °C, because nervonic acid has more carbon atoms/a longer chain than erucic acid (and melting point increases with the number of carbon atoms for fatty acids with one C=C); 2. (Much) below 84 °C, because nervonic acid has a C=C double bond/is unsaturated and lignoceric acid, with the same number of carbon atoms, is saturated OR because a C=C double bond lowers the melting point (by about 46–52 °C at each chain length);	**2** (2 × AO3)	Each point needs a suggested value of 35–50 °C; no marks for a value outside this range 1. **Accept** melting point increases with chain length for saturated fatty acids as well 2. **Accept**, as an alternative for point 2, any value in the range supported by a stated, valid calculation from Table 2, eg: • about 45 °C: with one C=C, two more carbon atoms raise the melting point by 11 °C (23 to 34 °C), so 34 + 11 • about 38 °C: saturated fatty acids rise by 4 °C from 22 to 24 carbon atoms (80 to 84 °C), so 34 + 4 • about 38 °C: a C=C lowers the melting point by 46 °C at 22 carbon atoms, so 84 − 46 • about 44 °C: the effect of a C=C falls from 52 to 46 °C, so about 40 °C at 24 carbon atoms, so 84 − 40 1. A calculation that adds an increase for the longer chain to erucic acid (34 °C) also gains point 1 The measured melting point of nervonic acid is about 42 °C (for information only) **Reject** references to boiling point

Question	Marking guidance	Mark	Comments
04.3	$C_{69}H_{134}O_6$;	**1** (1 × AO2)	**Accept** atoms in any order 3 C=C double bonds, one in each fatty acid; each gains two hydrogen atoms, so 6 hydrogen atoms are added **Reject** $C_{69}H_{131}O_6$ (one hydrogen atom added per double bond)

Question	Marking guidance	Mark	Comments
04.4	1. All the fatty acids become saturated/have no C=C double bonds OR gondoic, erucic and nervonic acids become arachidic, behenic and lignoceric acids; 2. Saturated fatty acids have (much) higher melting points than unsaturated fatty acids with the same number of carbon atoms, eg erucic acid 34 °C but behenic acid 80 °C;	**2** (2 × AO2)	2. Must use a pair of values from Table 2 with the same number of carbon atoms, eg gondoic acid 23 °C and arachidic acid 75 °C **Reject** the chain becomes longer/gains carbon atoms **Reject** hydrogen molecules for hydrogen atoms in the fatty acids **Reject** boiling point

Phospholipids and the properties of lipids 3.1.3

Question	Marking guidance	Mark	Comments
05.1	1. Phosphate (heads) in/facing the water because they are hydrophilic/polar/charged OR attracted to water; 2. Fatty acid (tails) point up into the air/away from the water because they are hydrophobic/non-polar OR repelled by water;	**2** (2 × AO2)	Each point needs the position **and** the reason **Reject** phosphate heads hydrophobic or fatty acid tails hydrophilic **Ignore** references to a bilayer

Question	Marking guidance	Mark	Comments
05.2	Correct answer for 2 marks: 1.9 (: 1);; Accept for 1 mark: total surface area of 7.0×10^{-2} OR 0.070 (m^2)	**2** (2 × AO2)	**Accept** 1.857 OR 1.86 (: 1) OR any other correct unrounded ratio (not to two significant figures) for 1 mark only 0.54 (inverted ratio) gains 1 mark if the total surface area of 7.0×10^{-2} OR 0.070 (m^2) is shown; otherwise 0 marks

Question	Marking guidance	Mark	Comments
05.3	1. Area of the monolayer is (about) twice the (total) surface area of the cells; 2. So there is enough lipid to form two layers (each one molecule thick) around each cell;	**2** (2 × AO3)	1. **Accept** ratio is close to 2 (: 1) 2. **Accept** so the membrane is two molecules thick

Question	Marking guidance	Mark	Comments
05.4	Not all of the lipid was extracted (from the membranes) OR some lipid was lost;	**1** (1 × AO3)	**Accept** the membrane also contains proteins/other molecules that take up some of its area, so the lipids cover less than the whole cell surface **Accept** the surface area of the cells was overestimated **Accept** lipids in the monolayer were more tightly packed than in the membrane **Ignore** ‘human error’ or ‘only one sample’ unqualified

Question	Marking guidance	Mark	Comments
06.1	**Q** only;	**1** (1 × AO2)	Q is the hydrophobic region formed by the fatty acid tails

Question	Marking guidance	Mark	Comments
06.2	1. Phospholipid has two fatty acids and a phosphate(-containing) group (joined to glycerol), but a triglyceride has three fatty acids (and no phosphate); 2. Phosphate (head) is hydrophilic/polar/charged, so it is attracted to water; 3. Fatty acid (tails) are hydrophobic/non-polar, so they are repelled by water/point away from water; 4. Phospholipids form a bilayer, with the tails pointing towards each other/inwards (away from the water); 5. The bilayer closes into a sphere, so no tails are exposed to water at its edges OR heads face the water both inside (P) and outside (R) the liposome; 6. So water, and a water-soluble drug, is enclosed/held in the centre/region P (and cannot pass through the hydrophobic region/Q); 7. Triglyceride is hydrophobic/non-polar only OR has no hydrophilic part, so it is not attracted to water/cannot form a bilayer; 8. So triglycerides group together as droplets that do not enclose water OR a water-soluble drug would not dissolve in the triglyceride;	**5 max** (3 × AO1) (2 × AO2)	**Max 3** unless point 5 or 6 is given (the answer must apply the structures to the liposome) **Max 3** if only phospholipids or only triglycerides are described **Max 4** unless point 7 or 8 is given 1. **Accept** converse; accept one fatty acid replaced by a phosphate(-containing) group 2. **Ignore** 'fatty acids repel water' as the reason for point 2 3. Never credit as a difference from triglycerides, because triglyceride fatty acid tails are hydrophobic too; credit it only as part of the phospholipid arrangement **Reject** phosphate hydrophobic or fatty acid tails hydrophilic (cancels the point) **Ignore** heads 'protect' the tails **Reject** phosphodiester bonds or 'phosphorus group'

Question	Marking guidance	Mark	Comments
06.3	Ester bonds;	**1** (1 × AO1)	

The emulsion test 3.1.3 (AT b, AT f)

Question	Marking guidance	Mark	Comments
07.1	1. Mix/shake with ethanol, then add (the liquid) to water (and shake); 2. White/milky emulsion;	**2** (2 × AO1)	1. Ethanol must be added before water. Accept shake with ethanol then pour into water 1. **Reject** heating 2. **Reject** precipitate; ignore cloudy **Accept** the Sudan III test: add Sudan III (to the sample in water) for 1 mark; red(-stained) (oil) layer (on the surface) for 1 mark

Question	Marking guidance	Mark	Comments
07.2	1. Lipid is insoluble in water/non-polar/hydrophobic, so when the ethanol (solution) is added to water the lipid forms (tiny) droplets/an emulsion (that scatter light); 2. Glycerol is soluble in water/polar/hydrophilic, so it stays dissolved OR no droplets form (so light is not scattered and the mixture stays clear);	**2** (1 × AO1) (1 × AO2)	1. 'Lipid dissolves in ethanol' alone is not enough 2. **Accept** glycerol has (three) OH/hydroxyl groups that form hydrogen bonds with water 2. Must go beyond 'glycerol is not a lipid' **Reject** lipid/glycerol forms a precipitate **Ignore** 'lipid reacts with ethanol/water'

Question	Marking guidance	Mark	Comments
07.3	Juice was (already) cloudy, so the cloudiness may be due to (suspended) particles in the juice rather than an emulsion of lipid;	**1** (1 × AO3)	**Accept** no control (of juice in water without ethanol) to compare with **Accept** result was not described as white/milky

Question	Marking guidance	Mark	Comments
08	1. Crush/grind the seeds and use the same mass of each type (weighed on a balance); 2. Add the same volume of ethanol and shake for the same time (to dissolve the lipid); 3. Filter OR allow to settle/centrifuge, and use the same volume of the ethanol (solution) each time, so that seed pieces do not add to the cloudiness; 4. Add to the same volume of (distilled) water and shake (for the same time); 5. Measure the absorbance with a colorimeter after the same time, zeroed with ethanol and water/a blank; 6. Repeat (at least three times) for each type of seed and calculate a mean; 7. Use known masses/concentrations of oil (in ethanol) to make a calibration curve, and use it to read the lipid content (of each type of seed) from its absorbance;	**6 max** (1 × AO1) (5 × AO3)	**Max 4** unless at least two variables are controlled (points 1, 2, 4 or 'same time' in 5) 1. **Reject** 'same number of seeds' for same mass 4. **Reject** heating 5. **Accept** same (colour) filter/wavelength **Ignore** 'higher absorbance means more lipid' (given in the question) **Ignore** 'fair test' unqualified