2. Biological Molecules

2.2 Carbohydrates and Lipids

Paper 2

Marking Scheme

Q1.

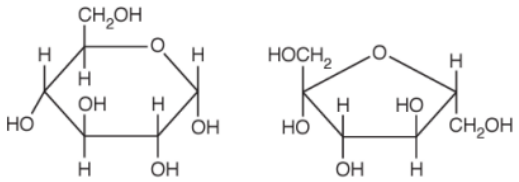
(a)	*allow points from correctly labelled diagram* (monomers of) beta-glucose / β-glucose ; **R** α-glucose / two β-glucoses *plus any **two** from:* *max 1 if no monomer stated* (joined by) 1, 4 glycosidic bonds ; **A** 1,4 glucosidic bonds **R** 1,4 and 1,6 bonds each (β–) glucose rotated by 180° compared to adjacent (β–)glucose ; AW linear / straight, chain / molecule; unbranched ;	**3**

Q2.

(a)(i)	*all correct for one mark* ; palmitic acid 0 linoleic acid 2 stearic acid 0 palmitoleic acid 1	**1**
(a)(ii)	circle drawn around palmitic acid and around stearic acid ;	**1**
(a)(iii)	COOH / carboxyl (group) / carboxylic acid (group) ; **A** carbonyl group and hydroxyl group **R** if response includes incorrect groups	**1**

(a)(iv)	*if no ref. to fatty acids, allow one mark for (some) triglycerides may, be saturated / have no double bonds (in hydrocarbon chain,) and (some) may, be unsaturated / have double bonds* **I** 'tails' *any* ***two*** *from:* **1** each triglyceride has three fatty acids ; **2** fatty acids can be, saturated / with no double bonds, and, unsaturated / with double bonds ; **A** unsaturated fatty acids can have a different number of double bonds **3** fatty acids can have different, (hydrocarbon chain) lengths / number of carbons ; **4** detail from Table 1.1 to support mp2 or 3 ; saturated = palmitic / stearic v unsaturated = oleic / linoleic / palmitoleic **or** 1 double bond = oleic / palmitoleic v 2 double bonds = linoleic **or** oleic / linoleic / stearic = 18C v palmitic / palmitoleic = 16C **5** *idea of* a particular fatty acid, can be located at a different position in a triglyceride / can form a bond with any one of the three (functional) hydroxyl groups ; **6** *ref. to* different environmental conditions of plants grown in different regions ; e.g. colder conditions and oils having (more triglycerides with) higher proportion of unsaturated fatty acids **7** *idea of* (shared triglycerides) have structures (most) suited as energy stores ; **A** example e.g. (have fatty acids with) longest hydrocarbon chains easiest to, hydrolyse / release hydrogen atoms have greater energy value than others **8** ref. to ease of, production / synthesis ; **9** *idea that* shared triglycerides composed of the fatty acids (present) in highest proportions ; e.g. *using Table 1.1 to determine the most common 2 or 3 fatty acids* 'could all have the same fatty acid combination from oleic acid and / or palmitic acid and/or linoleic acid' (any two)	**2**

Q3.

(a)(i)	glycosidic ;	1
(a)(ii)	 *any **three** from:* label one monomer correctly ; α-glucose with a hydroxyl group on C1 ; fructose drawn with a hydroxyl group on C2 ; water used in the reaction ;	3

Q4.

(d)(i)	more than two / three or more / many / large number of / polymer of, monosaccharides / sugar monomers / sugar units / simple sugars / carbohydrate subunits / AW ; **A** macromolecule *for large number of* **R** if includes incorrect example of a polysaccharide, e.g. sucrose *plus one from:* joined by / AW, glycosidic bonds ; *idea of* repeating, subunits / units / monomers / AW ;	2

Q5.

(a)	*if only one molecule described, statement of difference must be in context of glycogen* *any **three** from:* *glycogen* branched (v cellulose unbranched) ; monomer is / made of, alpha- / α-, glucose (v cellulose monomer is β-glucose) ; (1,4- and) 1, 6-. glycosidic bond(s) (v cellulose 1,4-glycosidic bond(s)) ; alternate, monomers / glucose residues / 1,4-(glycosidic) bonds, are not, rotated 180° / inverted / flipped / AW ; **ora**	**3**
(b)	*any **three** from:* **1** glycogen is a store of, energy / glucose ; **R** produces energy **2** *idea that* many, branching points / 'ends' / terminals, for easy / faster, addition / release, of glucose ; **3** compact so stores much, glucose / energy (in cells / small space) ; **4** insoluble ; **5** does not, lower / change, water potential (of cell) ; **A** no osmotic effect **6** AVP ; e.g. prevents loss of glucose from cell (chemically) inactive so does not take part in cell metabolism / AW	**3**

(c)	*any **three** from:* **1** unbranched (polymer) / straight chain / linear ; **2** cellulose molecules are arranged in parallel ; **3** *idea that* large number of -OH groups (projecting in all directions) ; **4** allows, hydrogen bonds / H-bonds, to form with water **or** makes molecule hydrophilic ; **5** many hydrogen bonds between cellulose molecules / AW ; **6** cellulose molecules form microfibrils ; **I** 'fibrils' / fibres **7** hydrogen bonds give high tensile strength to microfibrils **A** cellulose fibres / cell wall **or** hydrogen bonds help cell walls to resist, turgor pressure / AW ;	**3**

Q6.

(b) **4**

feature of polysaccharide	callose molecule	cellulose molecule
monosaccharide used to synthesise the polysaccharide		beta / β, glucose ; **R** B glucose
bond connecting the monomers	1, 3 glycosidic bond ;	
shape of molecule		straight / linear ;
orientation of monosaccharides in the molecule	adjacent glucose molecules same way up / AW ;	

Q7.

(a) — **2**

*any **two** from:*
I *ref. to* two units v one unit **or** bigger v smaller (neutral points)

sucrose		***fructose***
disaccharide **R** if incorrect monosaccharides stated	v	monosaccharide ;
non-reducing sugar ora	**or**	reducing sugar ; ora
A described in terms of reaction with Benedict's reagent		
glycosidic bond present **R** glucosidic	**or**	no glycosidic bond present ;
AVP ; e.g. always ring structure(s) hydrolysed / broken down before used as, a respiratory substrate / an energy source	v v	ring structure or straight chain form can be used immediately as, a respiratory substrate / an energy source

(b)(i) — **3**

I three fatty acids
A fatty acid residue *for fatty acid*

*any **three** from:*
1 glycerol ;

2 ester, bond / linkage, qualified ; e.g. labelled on Fig. 3.2 / three ester bonds / ester bond between (O of) glycerol and (C of carboxyl of) fatty acid

3 palmitate is saturated **or** oleate(s) are, unsaturated / monounsaturated **or** two fatty acid(s) are, unsaturated / monounsaturated, and one is saturated ;

4 (each fatty acid has a) hydrocarbon chain ;

5 AVP ; extra detail e.g.
hydrocarbon chain palmitate 15C and oleate 17C
palmitate, $CH_3(CH_2)_{14}$ and oleate, $CH_3(CH_2)_7CH{=}CH(CH_2)_7$

palmitate 16C and oleate 18C

unsaturated fatty acid tail(s) / oleate
ref. to, presence of one, C=C / (carbon-carbon) double bond
not the maximum number of, hydrogen atoms / hydrogens

saturated fatty acid tail(s) / palmitate
ref. to no, C=C / (carbon-carbon) double bond
maximum number of hydrogen atoms / hydrogens

(b)(ii) — **1**

*any **one** from:*
idea that provides greater energy per unit volume ;
A higher calorific value / greater energy density
R produces more energy

less mass needed to provide same energy / low(er) mass to energy ratio ;
ora higher energy to mass ratio

low(er) mass to volume ratio ;

AVP ; e.g. glycogen can only be stored in liver and muscles
glycogen is hydrated / uses water for storage, so mass increases
suggestion that more, areas / adipocytes / adipose tissue, in body to store triglycerides
(proportionately) more C-H bonds (to supply H for respiration)

suggestion that triglycerides provides insulation during flight (at heights)
more compact

Q8.

(a)(i)	ester ;	1
(a)(ii)	condensation ;	1
(a)(iii)	1 (hydrocarbon chains of) different lengths / **Y** is longest / **Z** is shortest ; **A** correct numbers of carbon atoms in each fatty acid (**X** 18, **Y** 20 and **Z** 16) *if no ref. to different lengths* 2 **Z** saturated, **X** and **Y** unsaturated ; **A** only Z is saturated 3 **X** polyunsaturated, **Y** monounsaturated ; 4 **X** 3, **Y** 1, **Z** 0 double (C=C) bonds ; **only Z** only has single / C-C) bonds **or** (for whole molecule) **X** 4 double bonds , **Y** 2 double bonds, **Z** 1 double bond ;	3
(b)(i)	*any **two** from:* 1 (hydrocarbon / fatty acid tails, are) non-polar / have no polar groups / not charged ; **A** equal sharing of electrons in molecule 2 not soluble / insoluble, (in water) ; 3 cannot form hydrogen bonds with water ; **I** repel water	2

Q9.

(b)(ii)	*any **four** from:* *similarities to max 3* polymers / polysaccharides / described ; composed of α-glucose ; (monomers joined by) glycosidic bonds ; contain 1–4 (glycosidic) bonds / linkages ; **A** glucosidic *differences to max 3* amylose molecules are unbranched / amylopectin molecules are branched ; amylopectin molecules contain 1–6 (glycosidic) bonds ; amylose helical ; amylose is a smaller molecule ; amylopectin is more compact ;	4

Q10.

(b)(i)	glycosidic ;	1

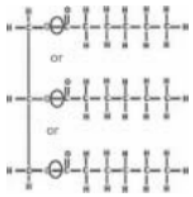
(c)	α-glucose ; **A** glucose **R** β-glucose α, 1-4 ; α, 1-6 ; *bond types either way round* glycogen ;	4

Q11.

(a)	glycosidic ;	1
(b)	*any one from:* no double, bond / bonds, in hydrocarbon chain ; each carbon (atom) in the hydrocarbon chain is bonded to two hydrogen atoms ; there is, a full complement / maximum number, of hydrogen atoms on the hydrocarbon chain ; **A** aliphatic chain *for hydrocarbon chain* **A** hydrogens *for hydrogen atoms*	1
(c)	β-glucose / beta-glucose ; **R** B-glucose	1

(e)	**E** ;	1

Q12.

(a)(i)	circle around any one correct bond ; **R** if circle includes the double bond O 	1
(a)(ii)	condensation ; **A** dehydration (synthesis) **A** esterification three ;	2

Q13.

(a)	fructose ; **I** α or β	1

Q14.

(a)		**4**

polymer	constituent monomer	type of bond between monomers
amylose	glucose	glycosidic glycosidic ; **A** glucosidic **I** details of bond
cellulose	glucose	
collagen	amino acid ; **R** protein (amino acid)	peptide
DNA	DNA nucleotide	phosphodiester ;
glycogen	(α-)glucose ; **R** β-glucose	glycosidic

(b)	*two from* **1** amylose composed of α-glucose (monomers) and cellulose composed of β-glucose (monomers) ; **2** (amylose) α-1,4 v. (cellulose) β-1,4 (glycosidic) bonds ; **R** if amylose stated to have α-1,6 bonds **I** *ref. to* cellulose also has hydrogen bonds *If mp 1 and 2 not stated allow one mark for amylose has α-glycosidic bond and cellulose has β-glycosidic bond* **3** (cellulose) adjacent, monomers / glucose(s), rotated through 180° ; AW **R** *ref. to* heads / tails **4** amylose has an (energy) storage function v. cellulose has structural function / description relating to cell wall ;	**2**

Q15.

(b)(i)	*idea that triglycerides and phospholipids* are not composed of, monomers / repeating (sub-)units ;	**1**
(b)(ii)	*any two from:* *phospholipids have* two fatty acids (residues / tails) not three ; **A** hydrocarbon chains / aliphatic chains **A** one less fatty acid (residue / tail) **A** ora two ester bonds rather than three ; a phosphate (group / head) ; **A** ora **R** 'phosphate not glycerol' AVP ; e.g. may have a (named) additional group, such as choline / AW e.g. triglycerides do not have nitrogen / phospholipids may have nitrogen	**2**

Q16.

(a)	glycine in monomer column <u>only</u> ; **monomer**: thymine (nucleotide), α-glucose, β-glucose ; / **I** glycine **polymer**: cellulose, messenger RNA, glycogen, α-globin ; / **I** glycine **monosaccharide**: β-glucose, α-glucose ; / **I** glycine **polysaccharide**: cellulose, glycogen ; / **I** glycine **I** incorrect spellings *if α-globin appears once and is in monomer column instead of polymer column, and the monomer and polymer columns are otherwise correct, allow one mark (ecf)*	**5**

Q17.

(c)(i)	(composed of) many / chain of / polymer of / AW, monosaccharides / sugar monomers / sugar units ; **A** glucose, molecules / residues **A** more than two / many sugars further detail ; e.g. carbohydrate may be, branched / unbranched *in context of polysaccharide* macromolecule *in context of polysaccharide* glycosidic bonds *in context of between sugar monomers* (sugar monomers) joined by condensation reactions	**2**

Q18.

(a)(i)	**A** – (α-) glucose ; **R** any qualification of glucose other than α, e.g. β-glucose **B** – fructose ; **I** hexose sugar **I** any qualification of fructose, e.g. α	**2**
(a)(ii)	glycosidic ; **R** glucosidic **I** any qualification of glycosidic, e.g. 1–2, 1–6	**1**
(a)(iii)	hydrolysis ; **A** acid hydrolysis	**1**

(b)	*two from:* sucrose is, a non-reducing sugar / non-reducing / not a reducing sugar ; **A** no reducing sugars present no (hydrochloric) acid used (to break down sucrose to reducing sugars) ; **A** sucrose not hydrolysed (to monomers / monosaccharides / reducing sugars) AVP ; (sucrose will not reduce) (blue) copper II ions to (red) copper I ions cannot donate electrons *idea that* reactive groups are not available (to react with Benedict's solution / copper ions) no (free), aldehyde / ketone, group	**2**

Q19.

(a)	*polymer – context of a chain / strand* (similar) repeating, smaller molecules / subunits **or** repeating / many, monomers / (RNA) nucleotides **; R** branching **A** *idea of* nucleotides joined together to form a chain **A** made of nucleotides to form polynucleotide *'made of nucleotides' 'made of monomers' not enough* *macromolecule (in context of RNA)* large (biological) molecules / 1000 or more atoms / high molecular mass ; **A** giant / huge, structure **I** long	**2**

Q20.

(a)	glycosidic ; **I** any qualification of glycosidic, e.g. β,1–4	**1**
(b)(i)	hydrolysis ;	**1**

Q21.

(a)(i)	*any three from* (polymer / polysaccharide of) β-glucose ; glycosidic, bonds / linkages ; **A** glucosidic (β) 1–4 (glycosidic) bonds ; **R** if 1–6 also given *ref.* to (β) glucose units, linked at 180° to each other / alternately orientated / AW ; unbranched (polymer) / straight chain / linear ; able to form hydrogen bonds with parallel chains / AW ;	**3**