Q1.

5 (a) **(i)** haem; R. incorrect spelling
combines/binds with/carries/holds/takes up/transports oxygen; **2**

(ii) soluble/polar/hydrophilic (on outside)/compact/spherical/curled/coiled/folded (into a ball)/metabolically active;
4 polypeptides; **2**

(b) iron needed for haem/haem contains iron;
less haemoglobin (made); R. less RBCs
less oxygen transported/supplied/delivered (to cells/tissues);
less respiration/respiration rate decreased;
R.respiration less efficient/effective **max 3**

Q2.

Question **Expected Answers** **Marks**

3 (a)

roles of water	physical properties of water			
	high specific heat capacity	strong cohesive forces between water molecules	high heat of vaporisation	solvent for polar molecules and ions
transport medium in blood plasma and phloem				/
surface for small insects to walk on		/		
major component of sweat used in heat loss			/	
transpiration pull in xylem		/		
prevents wide variation in temperature	/			

Q3.

(d) condensation (reaction) / described as elimination of water;
glycosidic, bond / link;
1:4 in, amylose / amylopectin / both;
amylose, helix / unbranched; **A** curved chain **R** straight chain
amylopectin, branched;
1:6 links (to give branches); **[max 4]**

(e) (raw material) for photosynthesis; **A** for photolysis
maintains turgidity / provides support;
pushes chloroplasts to edge of cell;
used in hydrolysis reactions;
solvent for, ions / named ion / pigment / named pigment; **[max 3]**

Q4.

3 (a)

Statement	Letter
an amino acid that is a major constituent of collagen	**J**
a component of RNA	**G** ;
a molecule polymerised to form glycogen	**D** ;
a molecule with a peptide bond	**H** ;
an important store of energy, insoluble in water	**K** ;
a molecule with hydrophilic and hydrophobic regions	**F** ;
an amino acid that forms disulfide (disulphide) bonds in proteins	**E** ;

[6]

(b) *Assume the answer is about DNA unless indicated otherwise. A comparison is not required. Information given below is for either DNA or collagen features.* ***A*** *ideas from either column. Do not penalise if points are not corresponding on one line / sentence as long as biologically correct. Only reject if biologically incorrect. If no attempt at 2 can* ***A*** *both marks from 1 if biologically correct.*

DNA	Collagen
4 (different) monomers ;	more than four (different) monomers
(monomers =) nucleotides / polynucleotides ;	(monomers =) amino acids / polypeptides
double helix ; **A** two strands	triple helix **A** three stands
right handed helix ;	left handed helix
loose helix ;	tightly coiled
sugar ;	no sugar
phosphate / phosphorus ;	no phosphate / phosphorus **A** sulfur (sulphur) present
base(s) ;	no base(s)
phosphodiester bonds ;	peptide bonds
antiparallel strands ;	strands not antiparallel

A sugar phosphate backbone for 2 marks if nothing written by 2. [2]

Q5.

1 **(a)** **(i)** glycosidic ; [1]

(ii) hydrolysis / hydrolytic ; [1]

(iii) *assume that the answer refers to within the cell unless told otherwise*
accept any two relevant examples, e.g.
solvent / medium for reactions ;
transport medium ;
maintaining turgidity / keeping firm / prevents flaccidity / AW ;
(raw material / reactant for) photosynthesis / photolysis ;
expansion / elongation / growth ;
maintains, hydrostatic pressure / pressure potential ;
maintains water potential (gradient) ;
A maintains osmotic gradient / prevents plasmolysis
stomatal opening ;
hydrophilic interactions of membranes ;
(in vacuole) pushes chloroplast to edge of cell ;
R hydrogen bonding unqualified by ref. to membranes [2 max]

(b) spherical / ball-shaped / AW ;
has a tertiary structure ; **ignore** quaternary
hydrophilic / polar, groups on outside ;
water soluble ;
ignore 'more than one polypeptide' [2 max]

Q6.

4 (a) (i) (describes the) sequence of amino acids (in a polypeptide chain) ; **A** order/arrangement [1]

(ii) H_2O/water, released ;
(correct) bond formation between (lysine) carboxyl group and (valine) amino group ;
dipeptide (of lysine and valine) and formed with correct structural formula ; [3]

(b) (i) *secondary*
1 regular order/pattern, based on H-bonds ;
2 between CO– group of one amino acid and NH– group of another ;
3 alpha-helix and β-pleated sheet ;

tertiary to max 4
1 folding coiling ;
2 interactions between, R groups side chains ;
3 two correctly named bonds ; e.g. hydrogen bonds, disulfide, bonds/bridges, ionic bonds, hydrophobic interactions
4 further description of bonds ; e.g. *disulfide* between cysteine (S–H) groups
hydrogen between polar groups (NH– and CO–)
ionic between ionised amine and carboxylic acid groups
hydrophobic interactions between non-polar side chains
5 ref. active site, specific/precise, shape ;
6 ref. globular/AW, shape ; **A** spherical/ball
7 ref. amino acids with, hydrophilic/polar, R groups facing to outside ; ora [5 max]

(ii) enables (protein to) function/AW ; **A** enables antimicrobial action/AW
A biological catalyst, qualified
provides active site ;
qualified ref. to specificity ; [1 max]

(c) altered, (mRNA) codon(s)/triplet(s) ; **A** named type of mutation
changed/AW, amino acid(s) ;
ref. to effects of stop codon ; e.g. shortened polypeptide chain
different, primary structure/described ;
A ref. to differences in, transcription/translation
ref. to different properties of, R group/side chain (of normal v replaced amino acid) ;
altered tertiary structure/AW ; **A** different R group interactions
A change/loss of, active site
idea of globular to fibrous change/hydrophilic R groups no longer to outside ; [3 max]

[Total: 13]

Q7.

3 **(a)** **(i)** primary ; **A** first
quarternary ; **A** fourth [2]

(ii) disulfide (bonds/bridges) ; [1]

(b) peptide bond broken ;
correct involvement of water ;
free –COOH/–COO^- and free –NH_2/–NH_3^+ shown ; [3]

[Total: 6]

Q8.

5 **(a)** *put ticks and crosses against the boxes*
1 – 4 and 7 – one letter only – if more than one letter mark as wrong
allow two or three correct letters for 5
allow two correct letters for 6

	statement	letter
1	contains peptide bonds	**H**
2	part of the molecule forms the hydrophobic part of cell membranes	**L**
3	contains 1-4 and 1-6 glycosidic bonds	**K**
4	forms the primary structure of a protein	**H**
5	used for energy storage in plants	**K / M / H**
6	forms a helical structure	**M / H**
7	the sub-unit molecule is β-glucose	**J**

[Total: 7]

Q9.

5 **(a)** **A** = glycerol ;
B = ester bond ; **I** covalent
C = fatty acid *or* hydrocarbon, chain / tail ; [3]

(b) **(i)** 2, fatty acid / hydrocarbon, chain / tails ;
(third fatty acid replaced by a) phosphate group ;
AVP ; (most) contain, nitrogen / choline (attached to phosphate in, head / polar portion) ;
[max 2]

(ii) can form a bilayer ;
link between, hydrophobic core / AW, and barrier to water-soluble substances ; **A** polar / ionic
idea of, hydrophilic / phosphate, head, forming H bonds with water ;
A facing, water / watery environment / aqueous environment / cytoplasm / cytosol

ref. contribution to fluid nature of membrane ;
further detail ; e.g. mainly saturated fatty acids, less fluid e.g. mainly unsaturated fatty acids, more fluid
ref. to control over membrane protein orientation ; e.g. hydrophobic – hydrophobic interaction for 'floating' proteins [max 3]

Q10.

(b) *shown to max 2*

secondary structure ;
α / alpha, helix ; **R** 'helix' / helical structure unqualified by alpha
β pleated sheet ;
tertiary structure / folding ; **ignore** 3D shape or structure
globular ;

not shown to max 2

amino acids / primary structure / sequence of amino acids ;
(types of) R groups ;
bonds / named bonds ; **A** peptide
quaternary structure ;
prosthetic group ; [max 3]

Q11.

3 **(a)** **(i)** quarternary (structure) ; [1]

(ii) alpha / α, helix ; [1]

Q12.

4 **(a)** glycosidic ; **A** glucosidic [1]

(b) **A** = trehalose ;
B = maltose ;
C = cellobiose ;
D = sucrose ; [max 3]

Q13.

Question			Expected Answers	Marks
2	(a)	(i)	**A** glycerol; **B** fatty acid;	**2**
		(ii)	condensation / esterification / ester bond formation;	**1**
	(b)		more energy released / stored per gram / unit / given mass; R. per mole 37 kJ v 17 kJ; A. (37-40 kJ) v (15-17 kJ) A. equivalent calorific values if calculated fats are highly reduced; more hydrogens / fewer oxygens / higher carbon to hydrogen ratio / more CH bonds; release / yield more energy when respired / oxidised;	**2 max**
	(c)		20% or more above the recommended weight / mass for height / BMI / Body Mass Index / $\frac{\text{mass kg}}{(\text{height in m})^2}$ greater than 30; A. within range (30-40)	**1**
	(d)		diabetes; coronary heart disease / atherosclerosis / cardiovascular disease / stroke / AW; hypertension / high blood pressure; cancer; arthritis / joint problems; hernia; varicose veins; gallstones; increased risk during surgical operations;	**2 max**

[Total : 8]

Q14.

Question **Expected Answers** **Marks**

4 (a) *one mark per row*

statement	starch	glycogen	cellulose
glycosidic bonds between monomers	✓	✓	✓
monomer is β glucose	✗	✗	✓
stored within chloroplasts	✓	✗	✗
stored in muscle cells	✗	✓	✗
exists in two forms - branched and unbranched chain	✓	✗	✗

Do not penalise where all ✗ or ✓ s are omitted
Do penalise each row if a mixture of ✗ , ✓ , and blanks

5

5

(b) take samples at timed intervals e.g. every minute;
test with iodine solution / potassium iodide soln / **or** Benedicts ;
determine the end point, eg continue until no blue / black (colour) / yellow / brown appears **or** continue until brick red / colourless ;
time taken to reach end point e.g. record the time;
ref to use of colorimeter (for precise results) (for both experiments) **or** standards / green -> yellow -> orange -> red;
plot amount of starch remaining **or** glucose / maltose / reducing sugar produced / transmission / absorption against time / sketch graph with labelled axes;
ref to initial rate / rate calculation (e.g. $^1/_t$ or gradient from graph);

max 4

[Total 9]

Q15.

2 **(a)** -OH is below/AW (-H) on carbon (atom) 1;

A from sketch with C1 labelled **1**

(b) **(i)** (1-4) glycosidic; **R** 1, 6 glycosidic **R** oxygen bridge **1**

(ii) **1** -OH on free molecule and end of chain indicated;

2 water eliminated/removed/condensation reaction;

3 oxygen bridge/glycosidic bond drawn in correct position relative to chain;

4 between C1 and C4, must be labelled either side of glycosidic bond; **3**

M.P.2 and **M.P.4** can be taken from written account if no diagram

(iii) cellulose; **1**

(c) amylase breaks down/hydrolyses/acts on, starch to give maltose/reducing sugar;

R glucose

maltase/amylase, denatured/active sites disrupted/tertiary structure changed, when boiled/at high temperature;

maltase does not, break down/act on/digest/hydrolyse, starch;

reference to specificity/shape and fit/lock and key explained;

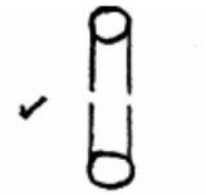
R no e-s formed

tube F is a control;

to show that there is no breakdown of starch without an enzyme **4 max**

[Total 10]

Q16.

Question		Expected Answers	Marks
2	(a)	Bilayer/two layers; Hydrophilic part/polar head/phosphate/choline, faces, water/outside cell/tissue fluid/cytoplasm; Hydrophobic part/fatty acid chains, face each other/AW. *Accept annotated diagram*  ✓ Ref to outside/cytoplasm/ Water/tissue fluid etc.	[2]
	(b)	*Phospholipid has* Phosphate/phosphorus; Two fatty acid chains; Fatty acids of different lengths; (different numbers of carbon atoms in each chain); Different fatty acids/one is unsaturated/one has a double bond; Choline/nitrogen/base.	max [2]
	(c)	Long hydrocarbon chain/mostly CH_2 units repeated/many C-H bonds; **A** many C-H bonds Higher proportion of hydrogen/more highly reduced/few oxygen/AW; Generates much energy (when respired)/twice as much energy as carbohydrate; **A** 15-17 kJ v 37-40 kJ Compact; Can be stored in anhydrous form; Higher calorific value/more energy per unit mass/smaller mass per unit energy.	max [2]

Q17.

Question			Expected Answers	Marks
6	(a)		*Assume answers are about globular proteins* Soluble; Ref hydrophilic groups; Compact; Ref tertiary structure; AVP.	max [2]
	(b)		*2 marks if all correct, 1 mark if one wrong, no marks if two or more wrong* leu thr pro glu lys ser	[2]
	(c)	1 & 2	Names of four bonds; *award one mark for three named bonds.*	
		3	(Hydrogen bond) between polar groups;	
		4	(Ionic bond) between amines and carboxylic acid groups;	
		5	(Disulphide bond) between cysteines;	
		6	(Hydrophobic interactions) between non-polar side chains;	
		7	AVP; e.g. folding sites in 1° structures.	max [4]
				[Total: 8]

Q18.

2 **(a)** **(i)** haem / prosthetic group ; **A** porphyrin

site of attachment of / binds with / carries / combines with / joins with / takes up / transports, oxygen ;
R absorbs / reacts with / stores
(oxygen binds to) iron ion / Fe^{2+} / FeII (in haem) ;
A atom, of iron / ferum [3]

(ii) *tertiary*
(each) polypeptide / protein, with complex 3D shape ;
folding of secondary structure / folded alpha helices ;
polypeptide / protein, coiled / folded / curled up / compact ;
1 max

quaternary
more than one polypeptide / AW ; [2]

Q19.

5 **(a)** *one mark for each row*

statement	haemoglobin	DNA	phospholipids	antibodies	
contains iron	✓	x	x	x	;
contains phosphate	x	✓	✓	x	;
able to self-replicate	x	✓	x	x	;
hydrogen bonds stabilise the molecule	✓	✓	x	✓	;
contains nitrogen	✓	✓	✓	✓	;

[5]

(b) *AVP answers must be in context to a watery external environment*
ref to molecules held together / strong attraction / AW ;
A cohesion between water molecules
detail of hydrogen bonding, e.g. slight –ve charge on O, slight +ve charge on H ;
A water molecules are polar
high boiling point / boils at 100°C ;
high latent heat of vaporisation ;
so water is liquid over wide range of temperatures ;
(liquid so) provides, support / buoyancy ;
high (specific) heat capacity ;
stable temperature / temperature of water does not change quickly ;
large amount of energy needed to be transferred from water for it to freeze / high latent heat of fusion ;
maximum density at 4°C / less dense at 0°C ;
provides surface tension ;
ref solvent ;
AVP ;
AVP ;
e.g. ref to surface dwellers, less need for support tissue,
stable habitat qualified, ref upwelling currents
ice floats / insulates [5 max]

[Total: 10]

Q20.

2 **(a)** **(i)** *assume answer is about glycogen*

branched ;
1–6 , glycosidic, links / bonds ;
not, coiled / helical ; [2 max]

(ii) compact so large quantity can be stored ;
insoluble so no osmotic effect ;
glucose would lower water potential ; **A** decrease, more negative
(so) water would enter and cell volume would increase ;
(so) plant cells would need thicker cell walls / animal cells might burst ;
glucose reactive molecule ; [3 max]

(b) *use annotations to help award these points*

1 oxygen bridge / glycosidic bond, broken ;
2 at left hand end of chain ;
3 water shown to be involved ; **A** hydrolysis
4 free glucose molecule with –OH drawn on C1 ;
5 chain now ends with –OH on C4 ; [3 max]

[Total: 8]

Q21.

5 (a) (i) β glucose ; [1]

(ii) glycosidic ; [1]

(b) many hydrogen bonds within the molecule ;
idea of parallel chains / AW ;
hydrogen bonds between cellulose molecules ;
to form microfibrils ;
held together by more hydrogen bonds to form fibres ; [2 max]

Q22.

3 (a) *primary*
sequence / arrangement / order / AW, of amino acids ;

secondary
α, helix / helices ; **A** description *ignore any ref to β / pleated, sheet*

tertiary
folding of, one / each, polypeptide / globin ; **A** coiling
(shape) held in place by interactions between, R-groups / side chains ;
A three or more named interactions

quaternary
(arrangement / interaction, of) four polypeptides / four globins / two α and two β globins ; **A** chains **A** ref. to more than one polypeptide if specific ref. to α and β chains
haem / prosthetic group ; **A** porphyrin [max 4]

(b) six / first five and seventh, amino acids are the same ; ora amino acid at position 6 is different
both are 1. val-2.his-3.leu-4.thr-5.pro….7.glu ; *take from diagram*
variant 1 is, glutamic acid / glu (whereas), variant 2 is, valine / val ; [3]

(c) **(i)** withstands pressure ;
prevents, overstretching / AW ;
prevents, bursting / rupture / AW ; [max 1]

(ii) *assume answer is about collagen unless told otherwise*
1 polypeptides are not identical (v. 2 identical, α / β, polypeptides) ;
2 triple helix *or* three, polypeptides / helices (v. 4 polypeptides) ;
3 only composed of amino acids *or* no, prosthetic group / haem / iron ;
4 (fibrous so) not globular ;
5 no complex folding / AW (v. complex folding) ; **A** no tertiary structure
6 glycine is repeated every 3rd position / more glycine ;
7 repeating triplets of amino acids / large number repeating amino acid sequences (v. greater variety) ;
8 AVP ; e.g. different primary structure / AW
variation in amino acid sequences (v specific sequences)
all polypeptides, helical / AW (v. α different to β, polypeptides)
hydrogen bonds between polypeptides (v. Van der Waals)
covalent bonds between molecules (to form fibrils) (v. none)
300nm long polypeptides (v 5–10nm)
each polypeptide over 1000 amino acids (each 141 / 146 amino acids) [max 1]

[Total: 9]

Q23.

4 **(a)** *allow points on annotated diagram*
if only diagram drawn, max 1 mark if not annotated
if written response given, only use diagram (if correct) to confirm mark points

1 6 carbons ; (v. 5 carbons) **A** 1 more
2 6 oxygens ; (v 4) **A** 2 more
3 12 hydrogens ; (v10) **A** 2 more
4 5 OH groups v 3 OH groups ;
A more *if correct diagram drawn*
5 6-membered ring / pyranose ; (v. 5-membered ring / furanose)
6 carbon 2, OH (pointing down) / has O ; (v. H pointing down / no O) AW
7 H and OH other way round on carbon 1 ; AW
8 H and OH other way round on carbon 3 ; AW [max 3]

(b)

type of bond(s)	biological macromolecule
β,1-4 glycosidic	cellulose ;
α,1-4 and α,1-6 glycosidic	amylopectin ;
phosphodiester	mRNA ;
peptide	protein ;

R if more than one molecule in box [4]

Q24.

(b) *max 3 if only structure or only explanations given*

polysaccharide ;

chains of α-glucose (residues) ; *only need α once*
α1–4 glycosidic bonds / links ;

branches ;
(because of) α 1–6 glycosidic bonds ; *only need glycosidic once*

idea that many 'ends' to easily, add / remove, glucose ;
compact / AW ;
insoluble ;
will not affect, water potential / ψ ; AW
AVP ; [max 4]

Q25.

(d) (i) 1 amylopectin branched / AW; **ora**
2 amylose, spiral /spiralled / helix / helical; **ora**
R α – helix
R coiled
allow ecf from mps 1 and 2 to award mp 3
3 amylose (α) 1 – 4 linkages but 1 – 4 and 1 – 6 linkages in amylopectin / amylose has 1 – 4 linkages only;
accept from clearly labelled diagram(s) [max 2]

(ii) *any one valid; e.g.*
1 for chlorophyll, structure / synthesis / formation / AW
2 for ATP functioning **A** required for energy transfers
3 for enzyme, functioning / cofactor
4 signalling ion / regulates carbon fixation
5 for, DNA / RNA, synthesis
6 stabilises, DNA / RNA, structure
7 required in, translation / joining, small and large subunits (of ribosomes) [1]

Q26.

2 (a) (i) **G ;** [1]

(ii) **B / C ;** [1]

(iii) **A / F ;** [1]

(iv) **B ;** [1]

(v) **D ;** [1]

Q27.

2 (a)

Keratin and chitin have structural functions cellulose ; collagen ; *allow only one incorrect molecule to be listed for max 1*	*Keratin is a fibrous protein* collagen ; *no marks if other molecules given*
The monomers of chitin have β-1,4 linkages between them cellulose ; *no marks if other molecules given*	*Keratin and chitin contain nitrogen* collagen / haemoglobin ; *1st mark* mRNA ; *2nd mark* *allow only one incorrect molecule to be listed for max 1*

[max 5]

Q28.

5 (a) *mark both parts together to a maximum of four marks*

1 (polymer / polysaccharide of) β-glucose ; *allow glucose if β given for bond*
2 (1-4, β) glycosidic, bonds / linkages ; **A** glucosidic
R if 1-6 also given
3 ref. to (β) glucose units, linked at 180° to each other / alternately orientated / AW ;
4 many –OH groups projecting out (in different directions) ;
5 unbranched (polymer) / straight chain / linear ;
6 many hydrogen bonds between molecules ;
7 (straight chain allows) molecules lie parallel to each other ;
8 (form) microfibrils ;
9 many microfibrils form (cellulose) fibres ;
10 ref. to fibres at angles / criss-cross / AW ;
11 (cellulose) cell wall is permeable ;
A *idea* of many gaps, in wall / between fibres, allowing passage of water / (named) substances
12 ref. to strength to, prevent cell bursting / withstanding (turgor) pressure / AW ; [max 4]

Q29.

(c) *accept points from a diagram*

1 loss of a water molecule / condensation reaction ;

2 OH / O^-, from, carboxyl / -COOH / COO^- (group) of one amino acid ;
3 H / H^+, from, amine / NH_2 / NH_3^+ (group) of other amino acid ;
2/3 *allow one mark for ref. to involvement of carboxyl and amine group*

4 (peptide bond) links C–N ; [3]