1. (a) (i) Carbon + hydrogen and oxygen in 2: 1 ratio/same proportions as in water; 1

(ii) Needs to be hydrolysed/glycosidic bond broken;
Product is a reducing sugar/glucose/fructose/monosaccharide;
Frees aldehyde/carbonyl/ketone group; max 2

(b) (i) Many different sorts of proteins;
Different primary structures/sequences of amino acids;
Tertiary structure;
Shape; allowing formation of receptor/binding site/site into which substance/substrate fits; max 3

(ii) Glucose and maltose soluble/starch insoluble; 1

(iii) Have similar molecular shape/structure / similarly positioned chemical groups;
so bind to/fit receptors; 2

(c) (i) Doesn't contaminate product/stays in reactor at finish/re-use/allows continuous reaction; 1

(ii) At low temperatures/9°C;
Relatively little kinetic energy/molecules only moving slowly;
Fewer collisions with enzyme;
Slower rate of reaction/takes longer for lactose to be reduced/some substrate goes through unchanged;

or

Enzyme concentration limiting;
Substrate in excess;
Saturation of active sites/all occupied;
Some substrate goes through unchanged; max 3

(d) (i) Fewer substrate/lactose molecules/lactose concentration falls;
Therefore less chance of collision with enzyme/forming enzyme substrate complex; 2

(ii) Economic reason such as

low levels of lactose not harmful/would take too much time/
high cost involved in removing all lactose; 1

[16]

2. (a) (i) Energy put in to <u>get</u> reaction <u>started</u> (Look for idea of getting started); 1

(ii) Curve showing energy levels at start and finish the same;
and lowered activation energy; 2

(b) Benedict‟s / Fehling‟s reagent and heat;
orange / red / brown / yellow / green; 2

(c) (i) Acid hydrolyses starch / breaks glycosidic bond; 1

(ii) Not specific / forms by–products / alters pH / corrosive; 1

(d) (i) Molecules would have less (kinetic) energy;
move slower;
fewer collisions / fewer E–S complexes form; max 2

(ii) Change in pH alters charge / shape;
distorts active site / tertiary structure of enzyme / denatures enzyme;
substrate will no longer fit active site; 3

[12]

3. (a) Add (Benedict‟s) reagent (to urine sample) and heat / heat the mixture;
red/ brown/ orange/ green/ yellow; 2

(b) Gives quantitative result/level of glucose/concentration of glucose;

specific (to glucose) / Benedicts not specific;

more sensitive / accurate / precise; max. 2

[4]

4. (a) Glycerol / glyceride; 1

(b) (i) Phospholipid has (one) phosphate / Phosphoric acid; 2
replacing fatty acid;

(ii) Saturated – all valencies of C filled / saturated with hydrogen / all (C–C) single bonds / no double bonds;
fatty acid 1 is saturated/fatty acids 2 and 3 are unsaturated; 2

[5]

>**5.** (a) Coiled shape / compact / branched allows large amount to be packed in small space;
Insoluble so not “washed away” / does not affect water potential / osmosis;
Made of glucose / readily broken down for respiration / energy release / ATP production **OR** many free ends / branched so readily broken down; max. 2
A single mark is awarded for the feature and its explanation.

(b) (i) Benedict's reagent / test and heat;
Green / yellow / orange / red colour,

(ii) Standardise specific feature / carry out tests the same;
e.g. amounts used / time heated / temperature
Compare colour / amount of precipitate / time taken to get colour; 4

(c) Glucose is a monomer / all (the glycosidic) bonds will be hydrolysed / broken down; 1

[7]

6. (a) (i) Carbon, hydrogen, oxygen, nitrogen / CHON; 1

(ii) Proteins made up of many monomers / amino acids;
Tryglyceride made of glycerol and fatty acids / few smaller molecules /not joined in chain; 2

(iii) Different sorts of amino acids;
Only one sort of glucose; 2

(b) They are proteins;
Can be used again / not "used up";
Bind to other molecules; max 2

(c) (i) Protein has primary structure / amino acid sequence;
Therefore bonds always form in same position; 2

(ii)
1 Active site (of enzyme) has particular shape;
2 (Into which) substrate molecule fits / binds;
3 Appropriate reference linking induced fit and shape;
4 (Competitive inhibitor) has similar shape to substrate;
5 Also fits active sites;
6 Prevents substrate access;
7 (Non-competitive inhibitor) fits at site other than active site;
8 Distorting shape of active site / enzyme;
6 Prevents substrate access; (award once only)
9 Two types identified as competitive and non-competitive; max 6

[15]

7. (a) (Crush in) ethanol / alcohol;
Add (to) water (*Order of adding is critical for this point*);
Emulsion / white colour; 3

(b) (i) Glycerol / glyceride; 1

(ii) Phospholipid has phosphate / phospholipid only has two fatty acids; 1

(iii) Phosphorus / P; 1

(c) (i) Both membranes contain phospholipid / lipid (bilayer); 1

(ii) Glucose unable to pass through artificial membrane as not lipid soluble;
Glucose transported by proteins;
(Proteins) found in plasma membrane /
not found in artificial membrane; max 2

[9]

8. (i) NH_2 ; 1

(ii) Two peptide bonds / reference to specific feature such as C=O / R groups appearing three times; 1

[2]

9. Quality of written communication should be considered in crediting points in the marking scheme. In order to gain credit, answers must be expressed logically in clear, scientific terms.

(a) (i) Made up of two sugar units / monosaccharides; **R** Two glucose units 1

(ii) Correct bond circled; 1

(iii) C_{12} ;
$H_{22}O_{11}$; 2

(b) A.T. involves carriers / proteins;
Molecules will have a different shape;
(Only those absorbed) will fit; 2

(c) Lactose produces a lower / more negative water potential;
So water moves into the intestine / less water absorbed;
By osmosis / diffusion / down concentration gradient;
Note: concentration gradient must be defined. 3

(d) 1 Prokaryotic cells do not have a nucleus / have genetic material in cytoplasm;
2 DNA in loop / ring;
3 Not associated with proteins / do not have chromosomes / chromatin / do not divide by mitosis;
4 Smaller ribosomes;
5 No membrane-bound organelles;
6 Such as mitochondria / lysosomes / endoplasmic reticulum / Golgi / chloroplasts;
7 Prokaryotic cells may have mesosomes;
8 Prokaryotic cells smaller;
9 May be enclosed by capsule; max 6

[15]

10. (a) C_{12};
$H_{22}O_{11}$; 2

(b) (i) Would turn lilac / purple / mauve;
Do not credit either pink or blue 1

(ii) Sucrase / enzymes are proteins / have peptide bonds; 1

(c) Benedict"s and heat;
Green / yellow / orange / red / brown
Do not credit unqualified references to water baths 2

[6]

11. (a) (i) The receptor / glucagon will have a particular shape / tertiary structure;
The other will fit / bind because of its shape; 2

(ii) Cells in other parts of the body do not have these receptors /
Liver cells have these receptors; 1

(b) Side chains / R-groups are different; 1

(c) Tertiary structure changes / enzyme denatured / bonds broken;
Will affect active site (of enzyme);
Starch cannot bind / fit / form enzyme-substrate complex; 3

(d) Keeps pH constant;
So proteins / enzymes in mitochondria not denatured / affected; 2

(e) 1 Some proteins pass right through membrane;
2 Some proteins associated with one layer;
3 Involved in facilitated diffusion;
4 Involved in active transport;
5 Proteins act as carriers;
6 Carrier changes shape / position;
7 Proteins form channels / pores;
8 Protein allows passage of water soluble molecules / charged particles / correct named example; 6 max

[15]

12. (a) (i) (Polypeptide is) coiled / folded; 1

(ii) Way in which whole molecule is folded / globular shape / folding of secondary structure / further folding /
Do not accept 3D shape if not further explained.
Structure held by ionic / disulphide bonds; *reject hydrogen bonds / peptide bonds only*. 1

(iii) Causes bonds which hold the tertiary structure / named bond;
To break;
Shape no longer maintained / protein denatured; 2 max

(b) (i) 5; 1

(ii) Substrates / active sites with shapes;
Active site / substrate with complementary (shape);
Fitting / binding / forming E-S complex; 3

[8]

13. (a) Bilayer / two molecules thick;
"Heads" / hydrophilic parts outwards / "Tails" / hydrophobic parts inward;
Credit information provided in a diagram, labelling essential for second marking point.
Reject „water loving"/ „water hating". 2

(b) Only parts of membrane with receptors / molecules into which surface proteins will fit / recognition / binding sites; 1

(c) Endocytosis / phagocytosis / pinocytosis;
Reject „cytosis". 1

(d) (i) Lysosome; 1

(ii) Enzymes;
Digests / breaks down / hydrolyses (other molecules);
Reject „cholesterol". 2

[7]

14. (a) (i) Atoms / named atoms arranged differently / isomers; 1

(ii) C_{12}; H_{22} O_{11}: 2

(b) (i) Facilitated diffusion is movement from high to low concentration / down concentration gradient; reject *„across"/ „along"*
Facilitated diffusion does not require energy / ATP / is passive; 2

(ii) Produces greater water potential gradient / lower / more negative water potential in cells / less negative / higher water potential in intestine;
Water moves (into cells) by osmosis / diffusion; 2

(c) Based on central carbon atom / α-carbon;
COOH group;
NH_2 / amino group;
H; 2 max

Allow information on diagram. Do not accept „both have an R-group".

[9]

15. (a) (i) 4; 1

(ii) Not made of identical units/ monomers/ made of fatty acids and glycerol; 1

(b) (i) A O(xygen);
B C(arbon); 2

(ii) No double bonds/ every carbon joined to two hydrogens/ four-other atoms; 1

(c) (i) 2 marks - Correct answer of 0.0000025/ 2.5×10^{-6} ;;

1 mark - Incorrect answer but clearly derived from volume divided by surface area; 2

[*Note: Assume units are mm unless otherwise stated*]

(ii) Head hydrophilic/ attracted to water/ polar;
Tail hydrophobic/ avoids/ shuns water/ non-polar; 2
[Allow: only one mark for limited references to "loving" and "hating" water]

[9]

16. (a) (Banana + Benedict"s solution) and heat;
More reducing sugar produces redder colour/more precipitate/ description of relative colour change/turns red quicker;
Standardise test/Same amount of banana and Benedict"s solution; 3

(b) More sugar/solute/soluble substances present;
So concentration of water lower/less free water molecules; 2
[*Accept: decreases solute potential*]

(c) (i) Process controlled by enzymes;
Low temperature/cold means less (kinetic) energy;
Fewer collisions/enzyme-substrate complexes formed; 3

(ii) Chilling caused by time and temperature so if time long, temperature must be higher; 1

[9]

17. (a) (i) 31/31.2; 1

(ii) Ratio would be less/smaller;
Cell is thin / has large surface area / (adapted) for diffusion; 2

Accept converse. Must relate to concept of ratio.

(b) (i) 6; 1

(ii) 11; 1

(c) Water potential inside vesicle more negative/lower;
Water moves into vesicle by osmosis/diffusion; 2

(d) Mitochondria supply energy/ATP;
For active transport / absorption against concentration gradient / synthesis / anabolism / exocytosis / pinocytosis; 2
Do not credit references to making, creating or producing energy.

(e) 1 Phospholipids forming bilayer/two layers;
2 Details of arrangement with "heads" on the outside;
3 Two types of protein specified;
e.g. passing right through or confined to one layer /
extrinsic or intrinsic /
channel proteins and carrier proteins /
two functional types
4 Reference to other molecule e.g. cholesterol or glycoprotein;
5 Substances move down concentration gradient/from high to low concentration;
Reject references to across or along a gradient
6 Water/ions through channel proteins/pores;
7 Small/lipid soluble molecules/examples pass between phospholipids/through phospholipid layer;
8 Carrier proteins involved with facilitated diffusion;
Ignore references to active transport.
Credit information in diagrams. max 6

[15]

18. (a) (i) Biuret / alkali + copper sulphate;
Lilac/purple/mauve/violet; 2

Do not give credit for blue or pink. Ignore references to heating.

(b) R group of phenylalanine copied accurately; 1

(c) (i) Bond shown linking carbon and nitrogen;
OH and H removed, =O and –H remaining; 2

(ii) Peptide bond; 1

(d) Addition of hydroxyl/OH group; 1

Candidate must distinguish clearly between hydroxylation and hydrolysis

[7]

19. (a) (i) Hydrolysis; 1

(ii) Water enters fungus (by osmosis);
Increases pressure inside fungus;
Cell wall no longer strong enough/present so cannot withstand this; max 2

(iii) Cell wall (of plant) not made of chitin/made of cellulose;
Enzyme is specific to chitin / will not break down cellulose; 1

(b) Way in which the whole protein/polypeptide is folded / shape adopted by whole protein molecule / further folding of 2° structure; 1

Do not credit unqualified reference to three-dimensional shape.
Reject third level /third sort.

(c) (i) More (kinetic) energy;
Bonds/specified bonds (holding tertiary structure) break; 2

(ii) Change amino acids;
Allowing formation of more hydrogen bonds/disulphide bridges; 2

(d) 1 Sequence of amino acids gives shape;
2 This is tertiary structure;
3 Has similar shape to substrate;
4 Fits / competes for active site;
5 Fits at site other than active site;
6 Distorting active site;
7 Therefore substrate will not fit (active site); max 6

[15]

20. (a) (i) (Molecule) made up of many identical/similar molecules/monomers/ subunits; 1
Not necessary to refer to similarity with monomers.

(ii) Cellulose / glycogen / nucleic acid / DNA / RNA; 1

(b) (i) To keep pH constant;
A change in pH will slow the rate of the reaction / denature the amylase / optimum for reaction; 2

(ii) Purple/lilac/mauve/violet; 1
Do not allow blue or pink.

(iii) Protein present;
The enzyme/amylase is a protein;
Not used up in the reaction / still present at the end of the reaction; max 2

[7]

21. (a) Several/more than one polypeptide chain in molecule; 1

Evidence must only relate to 4° structure

(b) Chemical bonds formed between sulphur-containing groups/ R-groups/form disulphide bonds; Stronger bonds; Bind chain(s) to each other; max 2

(c) Different number of amino acids; Different sequence of amino acids; Bonds in different places; Gives different shape; max 2

(d) Outer layer of skin cells are dead; Do not respire/Do not contain mitochondria; Do not produce ATP/release energy; Cells do not have required proteins/carriers; max 3

(e) 1 TEM uses (beam of) electrons;
2 These have short wavelength;
3 Allow high resolution/greater resolution/Allow more detail to be seen/greater useful magnification;
4 Electrons scattered (by molecules in air);
5 Vacuum established;
6 Cannot examine living cells;
7 Lots of preparation/procedures used in preparing specimens / fixing/staining/sectioning;
8 May alter appearance/result in artefacts; max 6

[14]

22. (a) (i) 150; 1

(ii) 27; 1

(b) 100;
number of peptide bond hydrolysed = total number present / all peptide bonds have been hydrolysed; 2

accept calculation showing same number top and bottom.

(c) curve rising to peak at pH 2 and falling to zero by pH 6; 1

(d) (change in pH) leads to breaking of bonds holding tertiary structure / changes charge on amino acids;
enzyme/protein/active site loses shape/denatured;
substrate will not bind with/fit active site;
fewer/no ES complexes formed; 3 max

(e) more resistant to changes in pH and washing conditions variable/ works in alkaline pH and washing powders alkaline; 1
mark awarded for indicating aspect of effect of pH and advantage of this in terms of washing powder and conditions in wash.

(f) *maximum of three marks for specificity, points 1 - 4.*
Can only be given credit in context of specificity
1 each enzyme/protein has specific primary structure / amino acid sequence;
2 folds in a particular way/ has particular tertiary structure;
3 active site with unique structure;
4 shape of active site complementary to/ will only fit that of substrate;
maximum of three marks for inhibition, points 5 – 8
5 inhibitor fits at site on the enzyme other than active site;
6 determined by shape;
7 distorts active site;
8 so substrate will no longer fit / form enzyme-substrate complex; 6 max

[15]

23. (a) amino acid; 1

(b) violet/purple/mauve/lilac; 1

(c) Amino acid/substrate shape/structure changed;
Active site of enzyme;
No longer fits/ no longer complementary /
enzyme: substrate complex not formed; 3

[5]

24. (a) (i) Amino acid; 1

(ii) Possession of CH_3 group/different R group; 1

(b) Glycogen consists of glucose/one type of monomer;
Many different amino acids (combined to form proteins); 2

[4]

25. (a) All have same primary structure/sequence of amino acids;
Therefore bonds holding tertiary structure form in same place; 2

(b) (i) Active site;
Loses shape;
As enzyme is denatured/tertiary structure lost;
Substrate no longer fits/no enzyme-substrate complex formed; max 3

(ii) Many different ways of forming bonds;
Some bonds reformed;
(Enzymes with these) will be active/regain shape; 2

[7]

26. (a) (i) NH_2: 1

(ii) Peptide bond indicated with a circle; 1

(iii) Serine and asparagine; 1

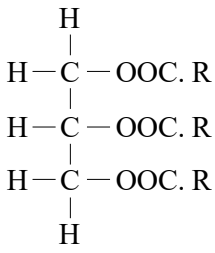
(b) (i) 363/364or434/435; 1

(ii) The amino acids may be combined in different orders/different amino acids involved; 1

[5]

27. (a) Cells all the same/similar structure/function. 1

(b) (i)



2 marks if fully correct;1 mark if glycerol attached to 3 fatty acids 2

(ii) Condensation / esterification. 1

(c) (i) (Unsaturated fatty acids) lower the melting point. 1

(ii) Triglycerides are oils / melting point below body temperature;
Explanation of advantage, e.g. prevents hard layer of fat forming under skin / mobility of lipid / deposition in arteries. 2

[7]

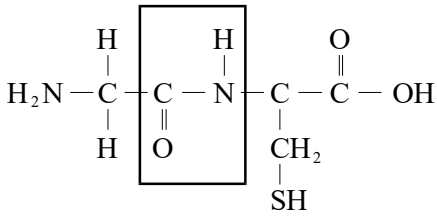
28. (a) Biuret reagent / Add NaOH and $CuSO_4$; (*ignore heated*)

Positive result = violet/mauve/lilac/purple coloration; (*NOT blue*) 2

(b) (i) Nitrogen / N; (*NOT N_2*) 1

(ii) Condensation; 1

(iii) *Must have box correct* (*allow HN / NH, but must have C=O correct*)



1

[5]

29. Long chains of aa;
Folding of chain into a coil / folds / helix / pleated sheet;

Association of several polypeptide chains together;
Formation of fibres / sheets <u>explained</u>; 2

H bonds / Disulphide bonding (*In context*);
<u>Fibres</u> provide strength (and flexibility);
<u>Sheets</u> provide flexibility;
Example e.g. keratin in hair, collagen in bone; (*MUST be in context*)
Insoluble because external R-groups are non-polar; 3

[5]

30. (a) (i) Initial mass of cylinders not identiical;
To be able to directly compare the results; 2

(ii) From 0.3 mol dm^{-3} to 0.1 mol dm^{-3} water moves into potato cells;
By osmosis;
So mass increases;
More water has entered potato cells 0.1 mol dm^{-3} / converse; 4

(iii) 0.35;
No mass change/no <u>net</u> osmosis/
volume of water in = volume of water out; 2

(b) <u>Range</u> from –511 to –549 kPa;
<u>Reason</u> e.g. Water moves from A to B, so must be lower than –510 <u>and</u>
Water moves from B to C, so must be higher than –550; 2

[10]

31. (a) (i) Increasing concentration of sugar in water (from A to C) / most sugar in C;
Cutting damages cells / releases sugar;
Increasing surface area from which sugar is released
(*ignore release by diffusion*) 2 max

(ii) No sugar because cells intact / not enough sugar released because of small surface area / excess washed off. 1

(b) Sugar solutions of known / specific concentrations;
Test each concentration with Benedict"s solution;
use equal volumes of solutions / variables controlled;
Method of comparison, e.g. compare colours, mass of precipitate.
(*accept: use of colorimeter / depth of precipitate*) 3

(c) (Brick) red / orange;
Cell membrane damaged (by heat);(walls" disqualifies).
(*Accept: hydrolysis of polysaccharide by boiling*) 2

(d) Polysaccharide broken down;
to allow transport of sugar to new shoots / to provide respiratory substrate for growth. 2

[10]

32. (a) **D;** 1

(b) **A;** 1

(c) **B;** 1

(d) **E;** 1

[4]

33. (a) lowers activation energy;
relevant mechanism *e. g. brings molecules close together / reaction in smaller steps / change in charge distribution / proton donation or acceptance / induced fit ensuring substrates brought in correct sequence;*
including relevant reference to active site; 3

(b) (i) add iodine (solution);
blue / black colour; 2

(ii) heat with Benedict's (solution);
brick red / brown / orange / green / yellow colour;
(*max I mark if non-reducing sugar test described*) 2

(c) (i) 48 56-58 51-54 **(all** correct); 1

(ii) *description*
increase up to 48 / optimum *allow ECF from* (*i*)*;*
decrease above 48 / optimum *allow ECF from* (*i*)*;*
explanation of increase
increased KE / move faster;
therefore more collisions / more enzyme-substrate complexes formed;
with active site;

explanation of decrease
denaturation / 3D structure changed / tertiary structure changed;
detail e.g. breaking of hydrogen / sulphur bonds; (*reject peptide bonds*)
shape of active site changed;
substrate no longer fits; 6 max

[14]

34. (a) **A** protein; 1
B fat /oil / lipid / triglyceride; 1
C reducing sugar / named; 1

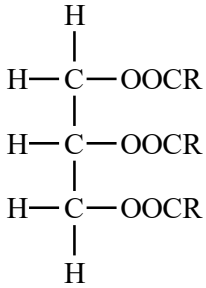
(b) heat with acid, then neutralise / hydrolyse using enzyme;
(heat) with Benedict's (solution); 2

(c) carbon, hydrogen, oxygen (ALL); *symbols neutral* 1

[6]

35. (a) 3 fatty acids attached;
ester bond correct;

(*H on glycerol component, O attached to carbon, R at other end*)



2

(b) not made of monomers/many repeating units; 1

(c) (many) mitochondria present in brown fat cells;
mitochondria release heat/energy; (*ignore ATP*)
white fat cells for fat storage / reduced fat storage in brown fat cells; 3

[6]

36. (a) C_{12} ; $H_{22}O_{11}$; 2

(b) (i) heat with Benedict's;
yellow/brown/orange/red; 2

(ii) (yes) (*may appear on second line*)
more precipitate in sample **B**;
both sugars are reducing sugars/ give a positive test; 2

[6]

37. (a) (i) condensation; 1

(b) (i) **D**; 1

(ii) **C**; 1

(iii) **A**; 1

(c) absence of a double bond;
in the (hydrocarbon) chain;
unable to accept more hydrogen / saturated with hydrogen; 2 max

[6]

38. (a) (i) fructose; 1

(ii) correctly drawn (OH group at bottom left); 1

(b) hydrolysis; 1

(c) (i) heat with Benedict's solution (*disqualify if HCl added*);
orange/brown/brick red/green/yellow colour or precipitate; 2

(ii) biuret test / NaOH + $CuSO_4$;
purple / violet / lilac / mauve; 2

[7]

39. (a) (i) box drawn around R group (i.e. CH_2OH group) 1

(allow circle if labelled R);

(ii) circle drawn around either of the Hs on NH_2 group and circle drawn around the OH; 1

(b) (i) (di)peptide and water; 1

(ii) peptide; 1

(c) sequence of amino acids changes;
tertiary structure changes/folds in a different way;
bonds form in different places;
(*Reject peptide bonds*) 3

[7]

40. (a) **A** and structure(of **A**) is complementary to that of the active site; 1

(b) idea that non-competitive inhibitor(**C**) binds at a site not the active site; binding causes a change in the shape of the active site;
substrate is no longer able to bind to the active site; 3

(c) peptide; 1

(d) idea that amino acid chain folds/tertiary structure;
named bond holding tertiary structure e.g. ionic disulphide hydrogen; 2

{reject peptide)

[7]