

1. (a) (i) Energy put in to get reaction started (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]

2. (a) (i) Less substrate (molecules) present;
 Due to them being used up in reaction;
OR
Product inhibits reaction;
 Allosteric / competitive / non-competitive inhibition; 2
 (ii) Double;
 Increase of 10°C doubles rate of reaction;
OR
 Increase;
 Increased KE/ increased energy of molecules / increased movement; 2
- (b) To show that enzyme was responsible for conversion, (no other factor); 1

[5]

3. (a) (i) Divide amount of product produced by time taken /
 calculate gradient / slope of graph;
 (**R** Numerical answer without supporting calculation) 1
- (ii) Higher temperatures means molecules have more (kinetic) energy;
 (Look for idea of molecules.)
 Move faster;
 Greater chance of collision (between enzyme and substrate);
 More chance of enzyme-substrate complex being formed; max. 3

- (b) At 65°C enzyme has been denatured / description of denaturing; 1
 (c) To maintain a constant pH; 1

[6]

4. (a) (i) More (kinetic) energy;
 (Molecules) moving faster;
R references to vibrating **I** activation energy
 Greater chance of collision
 More E-S complexes formed; max 3

- (ii) Bonds/specified bonds break; **R** peptide bond
 Tertiary structure disrupted / denatured / active site destroyed;
 Substrate no longer fits / binds with active site / ES complex
 not formed: 3

- (b) Lysosomes contain enzymes / lysozyme;
 Break down proteins;
 When they burst; max 2

[8]

5. (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 Shape no longer maintained / protein denatured; 2 max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]

6. (a) (Molecules) with little (kinetic) energy;
Move slowly;
Few collisions (between enzyme and substrate)/fewer enzyme-substrate complexes formed; 3
(Note: Question refers to slow rate at 5°C and answer must be in this context.)
- (b) Heating would cause bonds (maintaining tertiary structure)/named bonds to break:
Denaturing enzyme/ altering tertiary structure;
Altering shape of active site; max 2
(Note: if answers clearly relate to lactose, they are incorrect) [5]
7. (a) Mauve/ purple/ violet/ lilac;
It is a protein; 2
[Reject: blue or pink colour]
- (b) (i) Fell as it was used up/ broken down/ changed; 1
(ii) Substrate becomes limiting/ falls/ gets less;
Fewer collisions/ complexes formed; 2
(iii) Initial rate slower;
Levelling out at same value; 2
- (c) Enables a comparison to be made;
As the rate/concentration changes as reaction progresses;
Cells/ catalase may become damaged/affected by heat; max 2 [9]
8. (a) (i) Same general structure as all amino acids; = 1 mark
Same general structure as all amino acids and answer making specific reference to amino/ NH₂ group and carboxyl/ COOH group; 2
- (ii) Not normally found in proteins/ polypeptides; 1
[Note: Alternative answers must fit with information provided in passage]
- (b) (i) Protein will have different tertiary structure;
Affecting shape of active site;
Therefore unable to bind to substrate/substrate not able to fit/cannot form enzyme-substrate complex; 3
- (ii) tRNA does not bind with non protein amino acids/ACA;

tRNA will only bring proline / will not bring ACA
ribosome/mRNA;
Enzyme molecules will only contain proline /will not
contain ACA;

max 2

- (c) Competitive because toxin/ swainsonine has sugar-shaped molecules;
Which will fit into active site of enzyme / mannosidase;

2

- (d) Some species can make particular toxins harmless;
Therefore can feed on particular plants;
OR Toxins distributed in different quantities in different parts of plants;
Therefore different species can feed on different parts of plant/
can eat different part of plant at different time;

max 2

[12]

9. (a) (i) Curve rising and levelling out;

1

- (ii) Substrate becomes limiting/falls/gets less;
Fewer collisions/complexes formed;

2

- (b) To keep pH the same / optimum pH / so change in pH does not affect reaction;

1

- (c) (i) For temperature up to 40 – 50°C has no effect;
Over temperature (of 40 – 50°C) reduces rate of reaction;

2

*Note. Award one mark for general statement about the longer the
incubation time, the slower the rate of reaction.*

- (ii) Bonds (holding tertiary structure) broken;
More enzyme denatured / tertiary structure destroyed;
Active sites lose shape/no longer fit;
Fewer enzyme-substrate complexes formed;

max 3

*Note. Award marks if clearly in the context of more denaturation.
Allow credit here for converse relating to exposure for 5 minutes.*

- (d) 1 Statement about two types, competitive and non-competitive;

Note. Award points 2 –5 only in context of competitive and non-competitive inhibition

Competitive

2 Similarity of shape of inhibitor and substrate;

3 Inhibitor can enter/bind with active site (of enzyme);

Non-competitive

4 Affect/bind to enzyme other than at active site;

5 Distorts shape of active site;

Inhibitors

6 Prevent entry of/binding of substrate to active site;

7 Therefore fewer/no enzyme-substrate complexes formed;

max 6

[15]

10. (a) diagram showing molecule **A** fitting in inhibition site; distortion of active site; 2

- (b) molecules moving less/slower; reduces chance of collision (between enzyme and substrate)/of enzyme-substrate complexes being formed;
(*reject converse*) 2

- (c) these bonds hold/maintain tertiary/globular structure (of enzyme); enzyme denatured/tertiary structures destroyed; (shape of) active site distorted/changes;
substrate no longer fits/enzyme-substrate complex not formed; 3 max

[7]

11. (a) Shape drawn that resembles the active site;
drawn in the active site / clearly going to the active site; 2

- (b) Substrate concentration not limiting / enzyme concentration limiting;
all active sites of enzyme full / enzyme at maximum turnover rate; 2

- (c) (More substrate than inhibitor so) more likely to form enzyme-substrate complex;
more likely for substrate to enter the active site: 1

- (d) Correctly named bonds broken / water removed;
tertiary / globular shape of enzyme changed;
shape of active site affected; 3

[8]

12. (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]**
13. (a) (i) maltose. 1
- (ii) Activation energy reduced;
starch attached to active site / formation of enzyme-substrate complex;
less energy required to bring (substrate) molecules together
/ to break bonds;
reaction occurs in small(er) steps;
change in shape of enzyme molecule (induced fit) brings molecules
together / allows bonds to break / causes overlapping of electron
orbits of substrates. max 3
- (b) Enzyme (molecules) denatured at 60°C / high temperature, or description
of denaturing (e.g. vibration disrupts enzymes);
change (in shape) of active site;
change in tertiary/'3D' structure / hydrogen bonds broken;
substrates no longer fit;
loss of activity of enzyme in water bath due to slow denaturing. max 4
- [8]**
14. (a) Cyanide binds to enzyme molecule away from active site;
shape of active site changed.
OR: cyanide attaches permanently to active site;
active site blocked. 2
- (b) (i) Protein (receptors) / antigen / glycoprotein / glycocalyx. 1
- (ii) Enzyme + antibody attaches (to membrane);
of cancer cells only;
Enzyme breaks down (injected) linamarin;
Cyanide released disrupts respiration/metabolism of cancer cells. max 3
- [6]**
15. (a) Active site; 1

- (b) Substrate enters active site;
Complimentary shapes / Lock and Key;
(Binding) to form enzyme-substrate complex;
Lowering of activation energy;
Conformational / shape change;
Breaking of bonds in substrate;
Products no longer fit active site and so are released; 4
- (c) **Molecule A** binds at site away from active site / allosteric site;
Causes enzyme / active site to change shape;
Molecule B can enter / competes for active site;
Prevents substrate from entering / no enzyme-substrate complex formed / active site blocked; 4
- (d) (i) Optimum pH is 7 / neutral / between 6 and 8 / between 7 and 8; 1
- (ii) $\text{Max rate} = \frac{\text{Distance}}{\text{Time}} / \frac{11}{4} / \frac{11}{4 \times 60}$; 2
[Correct answer = 2 marks (*IGNORE units*)
e.g. 2.75 mm / hour, 0.046 mm/min, 4.6×10^{-3} mm/min
1 mm/ 21.8 mins, 23.76mm²/hour]

[12]

16. (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]

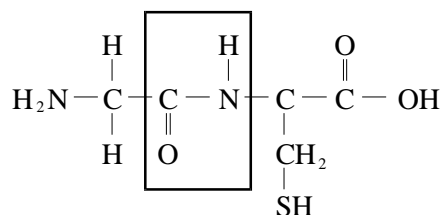
17. (a) (i) The receptor / glucagon will have a particular shape / tertiary structure;
 The other will fit / bind because of its shape; 2
- (ii) Cells in other parts of the body do not have these receptors /
 Liver cells have these receptors; 1
- (b) Side chains / R-groups are different; 1
- (c) Tertiary 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]

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) Several/more than one polypeptide chain in molecule; 1
Evidence must only relate to 4^o 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]**
- 20.** (a) Biuret reagent / Add NaOH and CuSO₄; (*ignore heated*)
Positive result = violet/mauve/lilac/purple coloration; (*NOT blue*) 2

- (b) (i) Nitrogen / N; (*NOT* N₂) 1
(ii) Condensation; 1
(iii) *Must have box correct (allow HN / NH, but must have C=O correct)*



1

[5]

21. (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]

22. 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) C₁₂ ;
H₂₂O₁₁ ; 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 <u>membrane-bound</u> 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]**

23. (a) glucose; 1
(reject alpha glucose)

(b) hydrolysis; 1
(accept catabolic)

(c) (long) straight/unbranched chains;
 (idea of more than 1) chains lie side by side / form (micro)fibrils;
 idea of H bonds holding chains together; 3

[5]