



EXAM PAPERS PRACTICE

# Proteins and enzymes 1

Level: AQA A Level 7402

Subject: Biology

Exam Board: Suitable for all boards

Topic: Proteins and enzymes 1

Type: Mark Scheme

To be used by all students preparing for AQA A Level Biology 7402 foundation or higher tier but also suitable for students of other boards.

## Mark schemes

- 1** (i) active sites contain substrate / ethylene glycol;  
all active sites occupied / enzyme is limiting;  
*(reject idea of active sites used up)* 2
- (ii) Ethanol is a similar shape to the substrate (ethylene glycol) /  
complementary to active site;  
*(reject "same shape")*
- ethanol is a competitive inhibitor / reduces enzyme-substrate complexes /  
prevents substrate (ethylene glycol) entering the active site;  
*(reject "decreases rate of reaction")* 2
- [4]**
- 2** (a) lower enzyme activity;  
decrease in rate of photosynthesis so less carbohydrate formed / named  
carbohydrate / lower translocation of sucrose / to growing point;  
lower respiration;  
lower rate of nutrient uptake / protein synthesis / cell division; 4
- (b) (i) differ in height when plants from different altitudes grown  
in same environment; 1
- (ii) plants from 1500 / 3000m differ in height when grown at different  
altitudes; 1
- [6]**
- 3** (a) (i) absorbed by diffusion;  
no energy / ATP available / active transport requires energy / ATP;  
*(disqualify energy made)*  
*(allow energy reference in either (i) or (ii))* 2 max
- (ii) absorbed by active transport; 1
- (b) (absorption by) diffusion no longer occurs / diffusion / movement  
of ions equal in both directions;  
because no concentration / diffusion gradient / reached equilibrium; 2
- (c) malonate fits into / blocks active site of enzyme / complementary to active site;  
(prevents fitting neutral)  
competes with substrate / is a competitive inhibitor / prevents substrate  
forming enzyme-substrate complex; 2
- [7]**



4

- (a) (i) Antibiotics kill other bacteria / *Clostridium* is resistant;  
Less / no competition so (*Clostridium*)  
reproduces / replicates / multiplies / increases in number;  
*Reference to bacteria being 'immune' negates first marking point.*  
*Reference to mitosis negates second marking point.* 2
- (ii) Immune system less effective / more likely to have other  
infections / been in hospital; 1  
*Accept: 'Weak / lower' immune system'.*
- (b) Attaches to active site (of enzyme);  
(Methicillin) is a competitive inhibitor / prevents monomers / substrate  
attaching (to enzyme);  
*'Competes for active site' = 2 marks.*  
*Neutral: 'Prevents monomers joining / attaching to each other'.*  
*Allow one mark max for answers relating to non-competitive  
inhibitor changing active site / preventing substrate attaching.*  
*Do not penalise Methicillin forms an enzyme / substrate complex.* 2
- (c) (i) Have other illness / medical condition / 'weak' immune system / disease /  
infection;  
*Reject: Due to 'other factors', 'are smokers', 'are obese' unless  
related to disease or illness.* 1
- (ii) Increase up to 2006 / 20 (per 100 000) then decreases; 1
- (iii) Correct answer in range of 52 – 59.1% = two marks;  
Incorrect answer but shows change as between 4.8 – 5.2 / shows  
correct subtraction giving this change e.g. 14 – 9 = one mark. 2

[9]

5

- (a) Several / more than one polypeptide chain in molecule;  
*Evidence must only relate to 4<sup>o</sup> structure* 1
- (b) Chemical bonds formed between sulphur-containing groups /  
R-groups / form stronger disulphide bonds;  
Bind chain(s) to each other; 2
- (c) Different number / sequences of amino acids;  
Bonds in different places which gives different shape; 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; 3

(e) Advantages:

- 1 Small objects can be seen;
- 2 TEM has high resolution as wavelength of electrons shorter;  
*Accept better*

Limitations:

- 3 Cannot look at living cells as cells must be in a vacuum;
- 4 must cut section / thin specimen;
- 5 Preparation may create artefact
- 6 Does not produce colour image;

6  
[14]

6

- (a) add antibodies / enzyme;  
wash to remove unbound antibodies;  
add (colourless) solution;

*(mark correct responses sequentially)*

3

- (b) antibodies specific / shape only fits one antigen;  
other antigens different shape and would not bind to antibodies;

2

[5]

7

- (a) Rate of movement / diffusion proportional to concentration gradient /  
difference in concentration;  
High concentration of potassium ions inside cell compared to outside;  
*Must mention high concentration. Ignore reference to other factors if  
reasoning is appropriate.*

2

- (b) (i) 
$$\begin{array}{c} \text{O} \\ || \\ \text{C} - \text{N} \\ | \\ \text{H}; \end{array}$$

1

- (ii) 10;

1

- (c) Action of vanilomycin depends on fluidity of membrane;  
Fluidity reduced / not fluid at low temperatures;  
Pore formed by gramicidin A remains in place / permanent;

3



- (d) Pore between sterol molecules lined with polyene antibiotic;  
Hydrophobic region next to sterol;

2

[9]

8

**General Principles for marking the Essay:**

Four skill areas will be marked: scientific content, breadth of knowledge, relevance and quality of language. The following descriptors will form a basis for marking.

**Scientific Content** (maximum 16 marks)

Category	Mark	Descriptor
<b>Good</b>	16	Most of the material reflects a comprehensive understanding of the principles involved and a knowledge of factual detail fully in keeping with a programme of A-level study. Some material, however, may be a little superficial. Material is accurate and free from fundamental errors but there may be minor errors which detract from the overall accuracy.
	14	
	12	
<b>Average</b>	10	Some of the content is of an appropriate depth, reflecting the depth of treatment expected from a programme of A-level study. Generally accurate with few, if any, fundamental errors. Shows a sound understanding of the key principles involved.
	8	
	6	
<b>Poor</b>	4	Material presented is largely superficial and fails to reflect the depth of treatment expected from a programme of A-level study. If greater depth of knowledge is demonstrated, then there are many fundamental errors.
	2	
	0	

**Breadth of Knowledge** (maximum 3 marks)

Mark	Descriptor
3	A balanced account making reference to most areas that might realistically be covered on an A-level course of study.
2	A number of aspects covered but a lack of balance. Some topics essential to an understanding at this level not covered.
1	Unbalanced account with all or almost all material based on a single aspect.
0	Material entirely irrelevant or too limited in quantity to judge.

**Relevance** (maximum 3 marks)

Mark	Descriptor
3	All material presented is clearly relevant to the title. Allowance should be made for judicious use of introductory material.
2	Material generally selected in support of title but some of the main content of the essay is of only marginal relevance.
1	Some attempt made to relate material to the title but considerable amounts largely irrelevant.
0	Material entirely irrelevant or too limited in quantity to judge.

**Quality of language** (maximum 3 marks)

Mark	Descriptor
3	Material is logically presented in clear, scientific English. Technical terminology has been used effectively and accurately throughout.
2	Account is logical and generally presented in clear, scientific English. Technical terminology has been used effectively and is usually accurate.
1	The essay is generally poorly constructed and often fails to use an appropriate scientific style and terminology to express ideas.
0	Material entirely irrelevant or too limited in quantity to judge.

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**Guidelines for marking the essay**

**Introduction**

The essay is intended for the assessment of AO4 (Synthesis of knowledge, understanding and skills) and Quality of Written Communication (Sections 6.4 and 6.5 in the specification).

Examiners are looking for

- evidence of knowledge and understanding at a depth appropriate to A level
- selection of relevant knowledge and understanding from different areas of the specification
- coverage of the main concepts and principles that might be reasonably expected in relation to the essay title
- connection of concepts, principles and other information from different areas in response to the essay title
- construction of an account that forms a coherent response
- clear and logical expression, using accurate specialist vocabulary appropriate to A level

**Assessing Scientific Content**

Maximum 16 marks.

Descriptors are divided into 3 categories: Good (16, 14, 12), Average (10, 8, 6) and Poor (4, 2, 0). Only even scores can be awarded, i.e. not 15, 13, etc.

Examiners need first to decide into which category an essay comes.

### A good essay

- includes a level of detail that could be expected from a comprehensive knowledge and understanding of relevant parts of the specification
- maintains appropriate depth and accuracy throughout
- avoids fundamental errors
- covers a majority of the main areas that might be expected from the essay title (These areas will be indicated in the mark scheme). (Occasionally a candidate may tackle an essay in an original or unconventional way. Such essays may be biased in a particular way, but where a high level of understanding is shown a high mark may be justified.)
- demonstrates clearly the links between principles and concepts from different areas.

Note that it is not expected that an essay must be 'perfect' or exceptionally long in order to gain maximum marks, bearing in mind the limitations on time and the pressure arising from exam conditions.

### An average essay

- should include material that might be expected of C / D / E grade candidates
- is likely to have less detail and be more patchy in the depth to which areas are covered, and to omit several relevant areas
- is likely to include some errors and misunderstandings, but should have few fundamental errors
- is likely to include mainly more superficial and less explicit connections

### A poor essay

- is largely below the standard expected of a grade E candidate
- shows limited knowledge and understanding of the topic
- is likely to cover only a limited number of relevant areas and may be relatively short
- is likely to provide superficial treatment of connections
- includes several errors, including some major ones

Having decided on the basic category, examiners may award the median mark, or the ones above or below the median according to whether the candidate exceeds the requirements or does not quite meet them.

### Marking the essay

In marking scientific content, letters in the margin show each key area covered; these are used to assess the breadth of criteria. A single tick is used to indicate accurate coverage of each significant area, and a double tick to emphasise 'good depth of content.' Errors are indicated with a cross. A squiggly line in the margin is used to highlight irrelevance and 'Q' to highlight poor use of terminology, unclear grammar and inappropriate style.



## Specific guidance for assessing Scientific Content and Breadth of Knowledge in Essays

The following provides guidance about topics which might be included in the essays. It is not an exclusive list; the assessment of scientific content does not place restrictions on topics that candidates might refer to, provided they are

- relevant;
- at an appropriate depth for A level and
- accurate.

It is not expected that candidates would refer to all, or even most, of the topics to gain a top mark; the list represents the variety of approaches commonly encountered in the assessment to the essays. In both essays, topics either from the option modules or beyond the scope of the specification should also given credit where appropriate.

### Enzymes and their importance in plants and animals

- (1) principles of enzyme action (A)  
e.g. catalysis, protein structure, active site, activation energy, enzyme-substrate complex, specificity.

good candidates relate protein structure to specificity / active site, catalysis to activation energy.

- (2) factors affecting enzyme action (F)  
e.g. temperature, pH, enzyme / substrate concentration, inhibition.

good candidates – relate changes in activity to denaturing / tertiary structure; effects of concentration to active site availability, distinguish competitive / non-competitive inhibition.

- (3) enzyme synthesis (S)  
reference to protein synthesis; link to genes, gene expression, effects of mutation.

good candidates – appreciation of connection between genes and enzyme production, e.g. 'one gene, one enzyme'.

roles and functions of enzymes in different processes. In each case good candidates should specify enzyme and its function.

- (4) digestion (D)  
enzymes involved in mammalian digestive system, breakdown of polymers in other circumstances, e.g. saprophytic digestion / mobilisation of storage compounds.

good candidates – range of enzymes giving source and action in sequence in mammalian digestion; reference to other breakdown.

- (5) metabolic pathways - photosynthesis (Ps) and respiration (R)  
e.g. light independent reaction, Krebs cycle, ATP formation.

good candidates - reference to specific roles e.g. in l.i.r., distribution in mitochondria / chloroplasts.





- (6) other specific examples  
e.g. in nervous system (N), such as role of acetylcholinesterase in synapses,  
in homeostasis (H), such as in glycogenesis,  
in muscle action (M), such as role of ATPase,  
in fertilisation (Sp), such as enzymes in acrosome,  
in transcription / translation (T), such as role of polymerases.

**Breadth of Knowledge**

- 3 marks      significant coverage of areas 1 and 2, + 3 others,  
                 or brief references to 5 others  
2 marks      areas 1 or 2 + 2 other areas, or brief reference to 5 + areas in total  
1 mark        any 3 areas

**9****General Principles for marking the Essay:**

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**Scientific Content** (maximum 16 marks)

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<b>Good</b>	16	Most of the material reflects a comprehensive understanding of the principles involved and a knowledge of factual detail fully in keeping with a programme of A-level study. Some material, however, may be a little superficial. Material is accurate and free from fundamental errors but there may be minor errors which detract from the overall accuracy.
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	12	
<b>Average</b>	10	Some of the content is of an appropriate depth, reflecting the depth of treatment expected from a programme of A-level study. Generally accurate with few, if any, fundamental errors. Shows a sound understanding of the key principles involved.
	8	
	6	
<b>Poor</b>	4	Material presented is largely superficial and fails to reflect the depth of treatment expected from a programme of A-level study. If greater depth of knowledge is demonstrated, then there are many fundamental errors.
	2	
	0	

**Breadth of Knowledge** (maximum 3 marks)

Mark	Descriptor
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**Quality of language** (maximum 3 marks)

Mark	Descriptor
3	Material is logically presented in clear, scientific English. Technical terminology has been used effectively and accurately throughout.
2	Account is logical and generally presented in clear, scientific English. Technical terminology has been used effectively and is usually accurate.
1	The essay is generally poorly constructed and often fails to use an appropriate scientific style and terminology to express ideas.
0	Material entirely irrelevant or too limited in quantity to judge.

[25]

**Additional guidance for assessing Scientific Content and Breadth of Knowledge in Essays**

The following provides guidance about topics which might be included in the essays. It is not an exclusive list; the assessment of scientific content does not place restrictions on topics that candidates might refer to, provided they are

- relevant;
- at an appropriate depth for A level and
- accurate.

It is not expected that candidates would refer to all, or even most, of the topics to gain a top mark; the list represents the variety of approaches commonly encountered in the assessment to the essays.

In both essays, topics either from the option modules or beyond the scope of the specification were also given credit where appropriate.

**How the structure of proteins in relation to their functions.**

1. Structure (S)  
 primary structure – peptide bond  
 secondary structure  
 tertiary structure. Globular - bonds between R groups give spherical shape – shape determines function – active sites and receptor sites  
*(allow quaternary structure – haemoglobin incorporates ions for oxygen transport)*



2. Structural proteins (ST)  
fibrous – regular pattern of hydrogen bonds – coiling,  
(e.g. *keratin coils twist together to form rope-like structures – flexible and strong*)  
(e.g. *collagen – coils more tightly bound – more rigid*)
3. Transport (T)  
channel – complementary shape – charges – gated  
carrier – complementary shape – can change shape  
active transport – phosphate group attached by energy from  
ATP – can change shape
4. Enzymes (E)  
active site, enzyme-substrate complex  
activation energy reduction - explanation e.g. brings molecules closer
5. Receptors (R)  
synapse  
insulin / glucagon  
ADH  
rhodopsin
6. Muscle (M)  
actin thin – binding site  
myosin thick - cross bridges  
tropomyosin – block binding sites

**Breadth of knowledge**

- 3 marks Four or more of the above 6 areas  
2 marks Three of the above 6 areas  
1 mark Two of the above 6 areas

10

- (a) Student was measuring change in pH  
**OR**  
Buffer would maintain a constant pH.

1 max

- (b) 1. Volume of suspension of lipids;  
2. Concentration of suspension of lipids;  
3. Volume of lipase solution;  
4. Temperature;

2 max

- (c) Boiled lipase solution;

1

- (d)  $-0.34 = 2$  marks

$0.34 = 1$  mark

2



- (e) 1. Fatty acids produced;  
2. Curve levels off as all substrate used up.  
*accept the lower pH inactivates / denatures the enzyme*

2

- (f) 1. Faster fall in pH **and** levels off at same point;  
2. More enzyme = substrate complexes formed;  
3. Same amount of fatty acids produced / product

3

[11]

- 11** (a) **Two** suitable suggestions;  
E.g.  
1. (Are mammals so) likely to have same physiology / reactions as humans;  
2. Small enough to keep in laboratory / produce enough milk to extract;  
3. (Can use a) large number.

*Ignore references to ethical issues*

2 max

- (b) 1. Hydrolysis of lipids produces fatty acids;  
2. Which lower pH of mixture.

2

- (c) 1. (Bile-activated lipase / it) increases growth rate (of kittens);  
2. Results for formula with lipase not (significantly) different from breast milk / are (significantly) different from formula milk alone;  
3. Showing addition of (bile-activated) lipase is the likely cause (of increased growth);  
4. Lipase increases rate of digestion of lipids / absorption of fatty acids.

3 max

[7]

- 12** (a) Any **two** of the following:  
Concentration of enzyme  
Volume of substrate solution  
pH.

*Allow same concentration of substrate*

1

- (b) Ratio between 5.18:1 and 5.2:1  
Initial rates incorrect but correctly used = 1 mark.

*Allow 1 mark if rate at:*

$$60^{\circ}\text{C} = 0.83\text{g dm}^{-3} \text{ s}^{-1} / 49.8\text{g dm}^{-3} \text{ minute}^{-1}$$

**OR**

$$37^{\circ}\text{C} = 0.16\text{g dm}^{-3} \text{ s}^{-1} / 9.6\text{g dm}^{-3} \text{ minute}^{-1}$$

2



- (c) At 60 °C:  
1. More kinetic energy;  
2. More E–S complexes formed.  
*Allow converse for 37 °C*

2

- (d) Different times:  
1. Higher temperature / 60 °C causes denaturation of all of enzyme;  
*Accept converse for 37 °C*  
2. Reaction stops (sooner) because shape of active site changed;  
*Reject if active site on substrate*

Different concentrations of product (at 60 °C)

3. Substrate still available (when enzyme denatured);  
4. But not converted to product.

4

[9]

13

- (a) 1. Maltose;  
2. Salivary amylase breaks down starch.

2

- (b) Maltase.

1

- (c) (Mimics / reproduces) effect of stomach.

1

- (d) 1. Add boiled saliva;  
2. Everything same as experiment but salivary amylase denatured.

2

- (e) 1. Some starch already digested when chewing / in mouth;  
2. Faster digestion of chewed starch;  
3. Same amount of digestion without chewing at end.

*Accept use of values from graph*

3

[9]

14

- (a) 1. Large / dense / heavy cells;  
2. Form pellet / move to bottom of tube (when centrifuged);  
3. Liquid / supernatant can be removed.

*Must refer to whole cells.*

3

- (b) Break down cells / cell parts / toxins.

*Idea of 'break down / digestion' needed, not just damage*

1



(c) 1. To stop / reduce them being damaged / destroyed / killed;  
*Reject (to stop) bacteria being denatured.*

2. By stomach acid.  
*Must be in context of stomach.*

2

(d) 1. More cell damage when both present / A;

2. Some cell damage when either there on their own / some cell damage in B and C;

*MP1 and MP2 – figures given from the graph are insufficient.*

3. Standard deviation does not overlap for A with B and C so difference is real;

*MP3 and MP4 **both** aspects needed to gain mark.*

4. Standard deviations do overlap between B and C so no real difference.

*MP3 and MP4 accept reference to significance / chance for 'real difference'*

3 max

(e) 1. Enzyme (a protein) is broken down (so no enzyme activity);  
*Accept hydrolyse / digested for 'broken down'.*

2. No toxin (as a result of protein-digesting enzyme activity);  
*Must be in the correct context.*

3. (So) toxin is protein.

*This must be stated, not inferred from use of 'protein-digesting enzyme'.*

3

[12]

15

(a) 1. Inhibition;

*Accept either competitive or non-competitive inhibition or a description of either.*

2. Changes tertiary structure (of enzyme);

3. Changes shape of / blocks active site (of enzyme);

*The active site must be in the context of the enzyme / cytochrome oxidase.*

4. Enzyme cannot bind to its substrate / no enzyme-substrate complex formed.

*Accept 'ES'. Accept 'substrate cannot attach to enzyme'.*

3 max



- (b) (Antidote reacts with / binds to cyanide) so cyanide cannot bind to enzyme / cytochrome oxidase  
OR  
(Antidote reacts with / binds to cyanide) so causing cyanide to be released from the enzyme / cytochrome oxidase.

*Key idea is how the antidote affects the cyanide.*

1

- (c) (i) 1. **A + C + E** / all liver (trials)  
2. **B + D + F** / all kidney (trials)  
3. **D + E** / all rat (trials);;  
*Accept a description of any trial letter.*  
*All 3 groups correct = 2 marks.*  
*Any 2 groups correct = 1 mark.*  
*1 group / no groups correct = 0 mark.*

2 max

- (ii) 1. Cyanide reduces oxygen use / rate of respiration in **A** and **B**  
/ in both  
OR  
as concentration of cyanide increases, the use of oxygen decreases in both;  
*Accept use of letters or description of the animal **and** organ*  
*Reference to 'both', in some way, is required.*
2. Greater effect of cyanide (on oxygen use) on sheep kidney / **B** than on sheep liver / **A**;  
*Comparison required in the statement. The statement should not be inferred from MP3.*
3. Appropriate calculations of mean oxygen use from the data  
E.g. 1 liver falls by 74% whereas kidney falls by 87%  
OR  
liver falls to 0.26 / to 26% whereas kidney falls to 0.13 / to 13%  
E.g. 2 liver falls by 2.0(au) whereas kidney falls by 12.2(au);  
*Check correct calculations using the data but a comparison must be shown. Accept other calculations using the data.*

3

- (iii) 81(%)  
*Correct answer = 2 marks.*  
*Allow 1 mark for either:*  
*Showing 8.1 divided by 10 or answer of 19(%)*  
*Ignore '+' or '-' in showing the difference.*

2

[11]



16

- (a) 1. No effect at 25°C  
*The question only refers to plants with GB*  
*1. Reject same mass*
2. Keeps growing at 30°C and 35°C / up to 35°C (more than without GB);
3. Above 35°C, falls but grows more than plant without GB;  
*3. Accept at all temperatures above 25°C more growth than without GB*

2 max

- (b) (i) Significantly different / SEs do not overlap ;  
*Accept converse without GB*

1

- (ii) (As temperature increases,)

1. Enzyme activity reduced / (some) enzymes denatured;
2. Less photosynthesis, so fewer sugars formed;
3. Less respiration / less energy / ATP for growth;
4. Less energy for named function associated with growth  
*4. Eg mitosis, uptake of mineral ions*

4

- (c) 1. (Rubisco activase attaches to thylakoid and) this changes shape / tertiary structure (of enzyme) / blocks active site / changes active site;  
*Note - question states enzyme stops working when it attaches to thylakoid, not before*  
*1. Accept rubisco in this context*

2. (This) prevents substrate / RuBP entering active site / binding;  
*2. Accept prevents ES complex forming*  
*2. Accept no longer complementary to substrate / RuBP*

2

- (d) 1. GB prevents / reduces binding of rubiscoactivase to (thylakoid membrane);  
*1. Accept enzyme instead of rubiscoactivase. Accept rubisco*
2. (Prevents it) up to 35°C;
3. (So) rubiscoactivase / enzyme remains active;
4. (So) photosynthesis / light-independent stage still happens;  
*4. Accept descriptions of light-independent stage*
5. Above 35°C, some binding still occurs but less than without GB, so less reduction in growth;

4 max





- (e) 1. Looked for information / journals, on crop plants that grow at high temperatures;  
*1. "other research" is minimum accepted*  
*1. Accept previous experiments research with temperature resistant crops*  
*Ignore simple references to looking at previous studies / other plants - need to relate to this context*
2. (Crop plants cited in this research) contain / make GB;
3. So assumed making plants produce GB makes them resistant to high temperatures;

2 max

[15]

17

- (a) 1. Enzyme hydrolyses / breaks down protein to amino acids;
2. Products are soluble / can be washed away;

2

(b) **Arguments for biological washing powder:**

*3 max if only arguments against biological washing powder are referred to*

1. More effective with all stains;  
*Accept different ways of expressing 'effective' e.g. higher % of stain removed*
2. Greater improvement with salad dressing / chocolate milkshake / chocolate pudding;

**Arguments against biological washing powder:**

3. Little / less improvement with raspberry sorbet / raspberry smoothie;
4. Only tested 5 / a small number of stains;
5. Only chose stains that would work / didn't select stains that wouldn't work;
6. Only included results that did work / didn't show results that didn't work;
7. Only one set of results / not repeated;
8. Only compared against one washing powder / may not be true for other washing powders;

*Ignore references to unknown masses of powder, temperature of washes or other aspects of technique or different fabrics*

4 max



- (c) 1. Enzyme **S** effective across a wider range of temperatures;  
2. Enzyme **S** more active above 50 °C / active up to 80 °C / active above 60 °C;  
3. Enzyme **S** more active below (about) 37 °C temperature;  
4. (Although) Enzyme **P** has higher rate of reaction at optimum / 40 – 50 °C;  
5. Enzyme **P** denatured above 50 °C;

*Answers should be in the context of choosing enzyme **S** but, if **P** is chosen, points 4 and 5 may still be awarded, if described*

*In points 2 and 3, a temperature must be stated. Allow  $\pm 5$  degrees of values shown*

3 max

- (d) 1. Stains caused by different substances;  
2. Enzymes are specific;  
3. Active site specific to substrate / other substrates cannot fit active site;  
*This could be expressed in other ways e.g. 'other substrates are not complementary to the active site'*

3

[12]

18

- (a) (i) 1. Water potential same (inside and outside) / no water potential gradient;  
*Accept symbol  $\Psi$  or abbreviation WP as alternatives to water potential.*  
2. Water does not enter / leave spores;  
3. By osmosis / prevents osmotic damage;  
*Answer must refer to osmosis.*

2 max

- (ii) Prevents growth (before ready) / stops growth of (other) microorganisms / slows enzyme action / prevents enzymes being denatured;

1

- (b) 1. Nitrogen / N / sulfur / S;  
2. Catalase is a protein / catalase is made up of amino acids / enzymes are proteins / enzymes are made up of amino acids;  
*Specific reference needed to proteins or amino acids.*

2

- (c) 1. Prevents contamination by (other) microorganisms;  
*Accept alternatives such as microbes, bacteria, other fungi.*  
2. Which also produce the enzyme / catalase / which would produce substances that affect catalase;

2



(d) (i) 90 hours;  
*Hours must be specified in answer to (c)* 1

(ii) 70 – 80 (hours);  
*Allow with no reference to units.*  
*Incorrect units negates answer.* 1

(e) 1. Extra steps (with intracellular enzymes);  
2. Cells have to be broken open;  
3. Cell walls / bits of cells have to be removed / separated from enzyme;  
4. Needs to be separated from all the other enzymes in the cell; 2 max

[11]

**19** (a) 1. Hydrolysis breaks proteins / hydrolyses proteins / produces amino acids (from proteins);

2. Protein synthesis involves condensation; 2

(b) Amino acids (from calliphorin) can be joined in different sequences / rearranged; 1

(c) 1. Fall, rise and fall;  
2. Rise after 40 and fall after 80;  
*Ignore concentration values.* 2

(d) (i) Fall / increase then fall;  
Lysosomes associated with tissue breakdown; 2

(ii) 1. Tissues / cells are being broken down;  
2. RNA is digested / hydrolysed / broken down;  
3. By enzymes from lysosomes;  
4. New proteins not made / no new RNA made; 2 max

(e) 1. (RNA) associated with making protein;  
2. New / adult tissues are forming; 2



- (f) 1. In the first 6 days no / little oxygen supplied / with breakdown of tracheae, no / little oxygen supplied;
2. (Without tracheae) respire anaerobically;
3. Anaerobic respiration involves reactions catalysed by enzyme **B** / conversion of pyruvate to lactate / involves lactate production;
4. Enzyme **A** / Krebs cycle is part of aerobic respiration;
- Or, with emphasis on aerobic respiration:*
1. *Tracheae supply oxygen / after 6 days oxygen supplied;*
2. *(With tracheae) tissues can respire aerobically.*

4

[15]

20

- (a) (Rennet) has less / variable amount of chymosin;
- Limited supply (of rennet) available;
- Pepsin may digest curd / protein / has another protein- digesting enzyme;
- (Animal) rennet unacceptable by vegetarians / vegans / against religious beliefs / harms animals;
- Accept use of figures e.g. 80-90% for first mark point.*

2 max

- (b) Both contain chymosin / both derived from animal gene;

1

- (c) (i) (Coagulation time) is reduced / is more active;

1

- (ii) 2 marks for correct answer of 27% / 27.3%;;

1 mark for incorrect answer in which candidate has shown fall in coagulation time as 3 (minutes) or 11 -8;

2 max

- (d) 1. (Enzyme) denatured / loss of tertiary structure / hydrogen bonds broken;
2. Shape of active site changes / no longer complementary;
3. Less / no substrate binds / fewer / no enzyme-substrate complexes formed;

3

[9]

21

- (a) Shows mass of wheat seedlings when grown on their own;
- Allows percentage to be calculated / allows comparison / allows effect of competition to be seen;

2



- (b) 1. Interspecific competition / ryegrass reduces growth of wheat;  
2. Justification by using values;  
*100% with wheat but less when grown with ryegrass*  
3. Competition between shoots had a greater effect than competition between roots;  
4. Justification by use of values;  
*46% when shoots complete / in Y / 76% when roots compete / X*  
*When marking please number marking points*  
*E.g. 4 means a mark awarded for point 4.*

4

- (c) Growth involves enzymes / enzyme-controlled reactions;

Lower temperature means less kinetic energy / fewer collisions / fewer E–S complexes formed;

Wheat and ryegrass affected to a different extent;

*Accept other valid physiological processes such as growth involves diffusion / lower temperature means less kinetic energy / molecules move slower.*

2 max

[8]

22

- (a) (i) To show whether immune response occurred / because cats are (genetically) related to cheetahs;  
*Ignore reference to control.*

1

- (ii) To show that rejection did not normally occur / skin could (successfully) be grafted;

1

- (b) (i) Rapid rejection between unrelated (domestic) cats / cats are **not genetically** similar;  
Rapid rejection between (domestic) cat and cheetah / cats and cheetahs are not **genetically** similar;  
Slow / no rejection in cheetahs / cheetahs are **genetically** similar;

3

- (ii) Sample size small;  
Time observed was short;

1 max

- (iii) Similar (antigens on all cheetahs);  
*Accept same / not very different*

1



(iv) Protein / antigen production determined by alleles / genes / base sequence on DNA;

The more similar the proteins the more similar their alleles / genes / base sequence on DNA / the more they are genetically similar;

2

[9]

**23** (a) Increased soaking temperature decreases germination in seeds (germinated) at 35°C / soaking and germinating at 35°C results in failure (to germinate);

Soaking at 20°C and 25°C has no effect on seeds germinated at 20°C;

(Soaking above 30°C) may denature enzymes / proteins;

*In 3rd marking point:*

*Accept description of denaturation*

*Reject breakage of peptide bonds*

3 max

(b) So that they could compare different numbers of seedlings;

1

[4]

**24** (a) (i) 14 / 15 – 58 / 59 or 43 – 45 (mg per 100cm<sup>3</sup>);

*Wrong calculation does not disqualify*

1

(ii) The larger the person the more blood they would have so have a lower concentration of blood glucose;

as same amount of glucose absorbed / all / 50g absorbed;

2

(b) 1. Any reference to overlap between all 3 groups;

2. One lactase deficient subject had high blood glucose / similar to control;

3. Some control / Group A subjects had the similar blood glucose to LD / Group B subjects / some IBS subjects had similar results to lactase deficient subjects;

3

[6]

**25** (a) Increase in the first 3 – 4 hours and then decrease;

1

(b) Little / no difference (at 8 hours);

Between all groups;

2

(c) Respiration ( produce CO<sub>2</sub>);

By cells / tissues;

2



- (d) Clear differences between the lactose deficient and IBS / control group;

No overlap in SD;

*Accept between all groups*

2

[7]

26

- (a) High sucrose / starch diet leads to increase in lactase activity;

1

- (b) Not valid / cannot be certain because overlap in SD between high sucrose and high starch;

Study based on rats (not human) so may not apply to human;

2

[3]

27

- (a) Measure with eyepiece graticule / scale;  
Calibrate with stage micrometer / scale on slide / object of known size;  
Repeats and calculate the mean;

**OR**

Use a ruler to estimate the field diameter under microscope;

How many droplets go across the field;

Repeats and calculate mean;

*Accept references to radius*

3

- (b) (i) Two mark for correct answer of 4 : 1;;  
One mark for incorrect answer but working shows that candidate has clearly attempted to compare values of  $r^2 / 6^2$  and  $3^2 / 36$  and 9;

*Idea of comparing ratios*

*A ratio of 1 : 4 should gain 1 mark*

2

- (ii) Small droplets have a larger surface area to volume ratio;  
More surface for lipase (to act), leading to faster digestion of triglycerides;  
Fatty acids are produced more quickly so pH will drop more quickly in curve Y / with bile salts / less fatty acids in curve Z / without bile salts so pH drop more slowly;

3

[8]

28

- (a) (i) Increases then plateaus / constant / steady / rate does not change;

*Neutral: 'peaks' / 'reaches a maximum' / 'stops increasing' / 'no effect' instead of 'plateaus'*

*Reject: rate decreases / reaction stops*

Correct reference. to 27 / 28 units;

e.g. increases up to / plateaus at 27 / 28

2



- (ii) Substrate concentration / amount of substrate;

As substrate concentration increases, rate increases / positive correlation  
(between rate and substrate concentration);

2

- (iii) All active sites occupied / saturated / enzyme limiting (rate of reaction) /  
maximum number of E-S complexes;

*Reject: enzymes used up*

*Reject: substrate limits rate of reaction*

*Neutral: substrate no longer limits the reaction*

*Neutral: reference to temperature*

1

- (b) Curve is lower and plateaus at a higher substrate concentration  
(it must also start at zero);

*Accept: curve lower and joins existing curve at final point (with no  
plateau)*

*Reject: if curve plateaus before original*

*Reject: if curve plateaus lower than original*

1

- (c) (i) Methotrexate / drug is a similar shape / structure to substrate so binds to / fits /  
is complementary to active site;

**Q** *Reject: same structure / shape*

**Q** *Reject: reacts with active site*

Less substrate binds / less enzyme-substrate complexes formed;

*Accept: substrate cannot bind / enzyme-substrate complex not  
formed*

2

- (ii) Methotrexate / drug is only similar shape to specific substrate / only fits this  
active site;

*Assume that 'it' refers to the drug*

**OR**

Methotrexate / drug is a different shape to other substrates / will not fit other  
active sites;

1

[9]

29

- (a) any two named polymers [subsets = 1 max. (e.g. protein / haemoglobin)]

2

- (b) (i) hydrostatic pressure / description of pressure;  
causes ultrafiltration at Bowman's capsule / glomeruli / renal capsule;  
through basement membrane;  
enabled by small size of urea molecule;

max 2





- (ii) reabsorption of water; [water out]  
by osmosis;  
at the PCT / descending LoH;  
at the DCT / CD;  
active transport of ions / glucose creates gradient (in context);

max 4

- (c) (i) by (simple) diffusion;  
*[reject facilitated]*

1

- (ii) to maintain concentration gradients / stop reaching equilibrium;  
[idea of maintaining concentration gradients]

1

- (iii) ions, glucose and amino acids would diffuse into the dialysate;  
because of their concentration gradients;  
Causing deficiency in these substances;

**OR**

the WP of the dialysate would be higher / less negative than the WP of the surrounding tissues;  
therefore osmosis would take place into the cells surrounding the abdominal cavity;  
causing these cells to burst / damaging these cells / cannot be excreted;

max 2

[12]

30

- (a) Tapes / string / axes laid out at right angles / grid area;  
Method of obtaining random co-ordinates;  
*Do not allow "Use random number generator"*

2

- (b) (i) Decrease then remain constant;  
From 200 cm / over 150 cm;

2

- (ii) Oxygen decreasing because soil becomes more compacted / not replaced;  
Decrease in oxygen leads to fewer aerobes surviving;

2

- (c) Anaerobic bacteria replace aerobic as oxygen decreased by aerobic bacteria;  
Remove competition;  
Aerobic bacteria no longer able to survive in these conditions;

3



- (d) (i) Near the surface / in top 50 cm;  
Table shows decrease with time at greater depths; 2
- (ii) Decrease;  
Fewer aerobic bacteria with depth;  
Oxygen concentration decreases / less oxygen at depth; 3
- (e) Probability greater than 95% / 0.95;  
Results are not due to chance / results are significant;  
Because bars do not overlap; 3
- (f) Plot as graph;  
Draw line of best fit;  
Read off appropriate value; 3

[20]

31

- (a) (i) **D** plasmid / ribosome(s) / cytoplasm / storage granules;  
*(accept any sensible structure)*
- E** (slime / mucous) capsule
- OR
- slime / mucous layer; 2
- (ii) protection / maintain shape / prevent lysis / strength / support; 1
- (b) two of the following:  
nucleus;
- OR
- nuclear envelope / mitochondria / chloroplasts / sER / rER /  
golgi apparatus / 80s ribosomes
- linear DNA / chromosomes / lysosomes / vacuole / vesicles /  
cellulose cell wall;

2 max



- (c) (i) starch digested / broken down;  
by amylase / carbohydrase; 2
- (ii) any sensible suggestion e.g. no secretion of amylase /  
functional amylase /  
piece of fungus might have died;  
*(accept carbohydrase / enzyme for amylase)*  
*(reject "no digestion" without qualification)* 1

[8]

32

- (a) 1. Different parts/areas/amino acid sequences (of amyloid-precursor) protein;  
*Accept APP*  
2. Each enzyme is specific/fits/binds/complementary to a different part of the APP;  
*Point 2 subsumes point 1 and is worth 2 marks total.*

2

- (b) 1. Peptide bond broken;  
2. Using water;  
*Hydrolysis in stem*

2

- (c) 1. Mutations prevent production of enzyme(s)/functional enzyme;  
2. (Increase in  $\beta$ -secretase) leads to faster/more  $\beta$ -amyloid production  
**OR**  
(Decrease in  $\alpha$ -secretase) leads to more substrate for  $\beta$ -secretase;  
*'This' must refer to  $\alpha$ -secretase*  
3. (Leads to) more/greater plaque formation;

3

- (d) 1. (Inhibitor) binds to/blocks active site of  $\beta$ -secretase/enzyme;  
2. Stops/reduces production of  $\beta$ -amyloid/plaque;

2

- (e) 1. Some  $\beta$ -amyloid required/needed (to prevent side effects)  
**OR**  
(Some)  $\beta$ -secretase needed;  
*Accept 'Both enzymes needed'*  
2. Leads to build-up of amyloid-precursor protein (that causes harm)  
**OR**  
Too much product of  $\alpha$ -secretase (causes harm);  
*Accept build-up of substrate (leads to harm)*

1 max

[10]



- 33** (a) Hydrolysis (reaction);  
*Accept phonetic spelling* 1
- (b) 1. Too big / wrong shape;  
*Wrong charge - neutral*  
*Accept insoluble*
2. To fit / bind / pass through (membrane / into cell / through carrier / channel protein);
3. Carrier / channel protein;  
*Accept carrier / channel protein not present* 3
- (c) Foreign / (act as) antigen / non-self;  
*Reject foreign cells* 1
- (d) 1. Dose to be given;  
*Accept: interaction with other drugs*
2. No (serious) side effects;
3. How effective;
4. Cost of drug;
- 2 max**
- [7]**
- 
- 34** (a) Amino acid / amino acids ;  
*If anything else is given as well do not award mark.* 1
- (b) (i) 1. Affects one monomer / amino acid;  
*i.e. What is affected*
2. Not found in all active sites;  
*i.e. Where it is found.*  
*2. Must relate to active site. Enzyme is insufficient.* 2



(ii) 1. **X**;

2. Enzyme in both pathways;

*2. Award independently*

2

(c) 1. Occupies / blocks / binds to active site;

*i.e. What it does in terms of the active site.*

2. Substrate will not fit / does not bind / no longer complementary to / enzyme-substrate complex not formed;

*1. Ignore references to change in shape and shape of aspirin molecule.*

*Ignore reference to competitive inhibitor i.e. Consequence required*

2

[7]