

# Proteins and enzymes 2

Level: CIE A Level 9700

Subject: Biology

Exam Board: Suitable for all boards

Topic: Proteins and enzymes 2

Type: Mark Scheme

To be used by all students preparing for CIE Biology A Level 9700 foundation or higher tier but also suitable for students of other boards.

## Mark schemes

- 1** (a) Ribosome/rough endoplasmic reticulum;  
*Ignore RER or endoplasmic reticulum unqualified* 1
- (b) 1. Does not digest protein inside cells;  
*Accept named examples*  
2. So (pancreatic) cell/tissue/function not destroyed/damaged; 2
- (c) (i) Peptide (bond); 1
- (ii) 1. Inhibitor is a similar shape to the substrate;  
2. (Inhibitor) blocks active site/is complementary to the active site/binds to the active site (of trypsin);  
3. Substrate can't bind to active site / no/fewer ES complexes formed; 3
- [7]
- 2** (a) Quaternary (structure);  
*Accept phonetic spelling eg quarternary/quarternery /4°*  
*Award no mark for quaternary as part of a list* 1
- (b) 423; 1
- (c) 1. Oxyhaemoglobin formed/ haemoglobin is loaded/  
uptakes/associates/binds with oxygen in area of higher  $ppO_2$  /  
in gas exchange surface/lungs/gills;  
*Reference to "react with" = max 1*  
*Accept: reversible interaction with oxygen*  
*Ignore: haemoglobin is carried / contained in red blood cells*  
2. (oxygen) unloaded/dissociates from/released (in area of lower  
 $ppO_2$  / in capillaries/to cells/tissues); 2
- (d) (i) 56(%)  
*Accept responses in the range 54-58(%)* 1
- (ii) 1. (Anaemia curve shifted to right) haemoglobin has lower  
affinity for oxygen / binds less tightly;  
*Assume reference is to haemoglobin of anaemia unless stated*  
2. releases more oxygen / oxygen is released quicker / oxygen  
dissociates/ unloads more readily to muscles/tissues/cells;  
3. (For) respiration;  
*Accept: even with a lower haemoglobin concentration / meet  
demand for ATP/energy;* 3



- 3** (a) C.  
*Ignore name of organ* 1
- (b) E.  
*Ignore name of organ* 1
- (c) 1. Active site (of enzyme) has (specific) shape / tertiary structure / active site complementary to substrate / maltose;  
*Reject active site on substrate.*  
*Must have idea of shape*  
*Assume "it" = maltase*  
*Accept (specific) 3D active site*  
*Reject has same shape*
2. (Only) maltose can bind / fit;  
*Accept "substrate" for "malt ose"*
3. To form enzyme substrate complex.  
*Accept E-S complex* 3

[5]



4

- (a) Lactose intolerance in babies/babies don't make/have lactase;  
Lactose (in milk) causes colic/crying/discomfort;  
Lactase breaks down lactose/milk sugar;

2 max

- (b) To avoid prejudice/bias from mother (when recording crying);

*Accept for mother she/they/their*

*Accept to avoid mothers being concerned that their child has lactose intolerance.*

*Q - Reject vague ref. to fair test/avoid bias with no ref. to mothers.*

1

- (c) **One** variable; with explanation;

Example,

Type of milk used;

So same concentration of lactose;

Same age of children;

Change in enzyme production with age;

Same age of children;

Change in milk consumption with age;

Same volume of milk (per kg baby);

So same dosage (of lactose);

*Accept ref. to controlling other factors in diet*

*Reject time in the context of duration of investigation, given in stem*

*Accept e.g. time of feeding each day*

*Accept temperature of milk, related to action of lactase enzyme*

2 max



- (d) There is a decrease in crying;  
Could be other causes/symptoms of colic;  
Babies might cry for reasons besides colic/might have colic and not cry/can't be sure they have colic, they can't talk;  
Don't know number of babies in trial/need a larger study;  
So don't know how reliable mean is;  
Standard deviation not given/spread of data;  
So don't know whether difference is significant;  
Babies still crying (for 1.43 hours);  
Recording by mothers might not be reliable;  
Longer running study to make sure effect (of lactase) lasts;

3 max

[8]

5

- (a) Concentration of substrate solution / of enzyme solution / pH.

1

- (b) 1. 2.5 / 0.04;

*1 mark for correct value*

2.  $\text{g dm}^{-3} \text{ minute}^{-1}$  /  $\text{g dm}^{-3} \text{ s}^{-1}$ ;

*1 mark for related unit*

2

- (c) 1. Initial rate of reaction faster at 37 °C;  
2. Because more kinetic energy;  
3. So more E-S collisions / more E-S complexes formed;  
4. Graph reaches plateau at 37 °C;  
5. Because all substrate used up.

*Allow converse for correct descriptions and explanations for curve at 25 °C*

5

[8]



- 6 (a) 1. Helicase;  
2. Breaks hydrogen bonds;  
3. Only one DNA strand acts as template;  
4. RNA nucleotides attracted to exposed bases;  
5. (Attraction) according to base pairing rule;  
6. RNA polymerase joins (RNA) nucleotides together;  
7. Pre-mRNA spliced to remove introns.

6 max

- (b) 1. Polymer of amino acids;  
2. Joined by peptide bonds;  
3. Formed by condensation;  
4. Primary structure is order of amino acids;  
5. Secondary structure is folding of polypeptide chain due to hydrogen bonding;  
*Accept alpha helix / pleated sheet*  
6. Tertiary structure is 3-D folding due to hydrogen bonding and ionic / disulfide bonds;  
7. Quaternary structure is two or more polypeptide chains.

5 max

- (c) 1. Hydrolysis of peptide bonds;  
2. Endopeptidases break polypeptides into smaller peptide chains;  
3. Exopeptidases remove terminal amino acids;  
4. Dipeptidases hydrolyse / break down dipeptides into amino acids.

4

[15]

- 7 (a) 1. Tertiary structure / 3D shape of enzyme (means);  
*Accept references to active site*  
2. Active site complementary to maltose / substrate / maltose fits into active site / active site and substrate fit like a lock and key;  
*Idea of shapes fitting together*  
3. Description of induced fit;  
4. Enzyme is a catalyst / lowers activation energy / energy required for reaction;  
*Accept "provides alternative pathway for the reaction at a lower energy level"*  
5. By forming enzyme-substrate complex;  
*Accept idea that binding stresses the bonds so more easily broken*  
**Do not award point 5 simply for any reference to E-S complex**

5



- (b) 1. Inhibitors reduce binding of enzyme to substrate / prevent formation of ES complex;

*Max 3 if only one type of inhibition dealt with. Accept maltase and maltose as examples of enzyme and substrate (and others)*

*Only once, for either inhibitor*

**(Competitive inhibition),**

2. Inhibitor similar shape (idea) to substrate;

3. (Binds) in to active site (of enzyme);

*Accept allows max rate of reaction to be reached / max product will eventually be formed*

*Accept complementary to active site*

4. (Inhibition) can be overcome by more substrate;

**(Non-competitive inhibition),**

5. Inhibitor binds to site on enzyme other than active site;

6. Prevents formation of active site / changes (shape of) active site;

*Accept does not allow max rate of reaction to be reached / max product will not be formed*

7. Cannot be overcome by adding more substrate;

5 max

[10]

8

- (a) Amylase;

(Starch) to maltose:

Maltase;

Maltose to glucose;

Hydrolysis;

(Of) glycosidic bond;

**Q** *Do not penalise incorrect site for digestion or incorrect site of enzyme production.*

5 max



- (b) Glucose moves in with sodium (into epithelial cell);  
Via (carrier / channel) protein / symport;  
Sodium removed (from epithelial cell) by active transport / sodium- potassium pump;  
Into blood;  
Maintaining low concentration of sodium (in epithelial cell) / maintaining sodium concentration gradient (between lumen and epithelial cell);  
Glucose moves into blood;  
By (facilitated) diffusion;  
**Q** Only allow diffusion mark in context of movement of glucose into the blood.

5 max

[10]

9

- (a) (i) Hydrolysis; 1  
(ii) Water enters fungus (by osmosis) which increases pressure inside fungus;  
Cell wall no longer strong enough / present so cannot withstand this; 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;  
*Do not credit unqualified reference to three-dimensional shape.  
Reject third level / third sort.* 1
- (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]





- 10 (a)
1. Sodium ions actively transported from ileum cell to blood;
  2. Maintains / forms diffusion gradient for sodium to enter cells from gut (and with it, glucose);
  3. Glucose enters by facilitated diffusion with sodium ions;

3

(b)

Biochemical test	Liquid from beaker	Liquid inside Visking tubing
Biuret reagent		✓
I <sub>2</sub> /KI		✓ or blank
Benedict's	✓	✓

1 mark for each correct row

3

- (c)
1. Biuret: protein molecules too large to pass through tubing;  
*Neutral: enzyme molecules*
  2. Iodine in potassium iodide solution: starch molecules too large to pass through tubing;  
*If no tick in 04.2, allow no starch hydrolysed*
  3. Benedict's: starch hydrolysed to maltose, which is able to pass through tubing.  
*Reject: glucose*

3

[9]

- 11 (a)
1. IV on x axis and DV on y axis **and** both axes on linear scales;
  2. Axes labelled clearly and with correct units separated from variable by solidus or in brackets;
  3. All rates calculated correctly;
  4. Points plotted correctly **and** joined by ruled lines and no extrapolation;

4



(b) Yes:

1. Expect optimum temperature of enzyme to be same

**OR**

Similar to temperature where bacterium lives;

2. Optimum temperature for enzyme (appears to be around) 15 °C;

No:

3. Need data from more temperatures (between 10 °C and 20 °C);

4. Data for only isolated enzyme

**OR**

Isolation may affect activity;

4

(c) 1. Initial / starting substrate concentration

2. Enzyme concentration

3. pH.

*Any 2 for 1 mark*

1 max

[9]

12

(a) 1. (before reaction) active site not complementary to/does not fit substrate;

2. Shape of active site changes as substrate binds/as enzyme-substrate complex forms;

*Note. Points 1 and 2 may be made in one statement and 'complementary' introduced at any point.*

*Points 1&2 – active site mentioned once applies for both points*

*Point 2 – Ignore references to how shape change is caused*

3. Stressing/distorting/bending bonds (in substrate leading to reaction);

2 max

(b) 1. Tangent to curve drawn;

*Tangent drawn at about 10 minutes*

2. Value in range of 8 to 11;

*1 mark only for correct answer*

2



- (c) 1. (Rate of) increase in concentration of maltose slows as substrate/starch is used up  
**OR**  
High initial rate as plenty of starch/substrate/more E-S complexes;  
*Reject ref. to amylase being used up*
2. No increase after 25 minutes/at end/levels off because no substrate/starch left;  
*Accept 'little'*  
*Ignore references to substrate a limiting factor*

2

- (d) 1. Make/use maltose solutions of known/different concentrations (and carry out quantitative Benedict's test on each);
2. (Use colorimeter to) measure colour/colorimeter value of each solution and plot calibration curve/graph described;  
*Axes must be correct if axes mentioned, concentration on x-axis and colorimeter reading on y-axis*
3. Find concentration of sample from calibration curve;

3

[9]

13

- (a) Any **one** from:
1. Numerical readings / not subjective / colour change subjective / gives quantitative data / not qualitative / gives continuous data;
2. Greater accuracy;  
*Accept greater precision*

1 max

- (b) Fatty acids produced;

1

- (c) 1. No more (fatty) acids produced;
2. All triglycerides/fat//lipids/substrate used up / enzyme denatured;

2

- (d) 1. Line starting at same point and falling above original line;
2. Levels off at same pH, but later;

*Accept the line still falling at 4 minutes*

*Do not credit if levels off at higher pH*

2

[6]

14

- (a) 1. Add Benedict's;  
*Hydrolyse with acid negates mp1*
2. Heat;  
*Accept warm, but not an unqualified reference to water bath*
3. Red / orange / yellow / green (shows reducing sugar present);  
*Accept brown*

3



- (b) (i) 1. Starch hydrolysed / broken down / glucose / maltose produced;  
*Neutral: Sugar produced*
2. Lower water potential;
3. Water enters by osmosis;

3

- (ii) Only 2 pHs studied / more pHs need to be tested;  
*Accept: different amylase may have a different optimum pH*

1

[7]

15

- (a) **EITHER**

*Answer either based on*

1. Molecules move at slower speeds;  
*2 diffusion or*
2. Decreases rate of diffusion;  
*4 enzymes.*

**OR**

3. Molecules move at slower speed;
4. Fewer collisions between enzymes and substrates / fewer enzyme-substrate complexes formed;

*Accept converse answers if clearly in context of "If it stayed at 30 °C".*

2 max

- (b) (i) 1. Allows comparison;
2. Different amounts of fungus added / fungus is different size at start;

2

- (ii) Two marks for correct answer in range 1.7 : 1 to 1.3 : 1;;  
*Answer must be expressed this way round and must give the diameter of the fungus as 1.*

One mark for unsimplified answer in range 29 : 19 to 27 : 21;

*Calculations are based on tolerance limits for measurements of  $\pm 1$  mm. If the actual measurements are other than 28 and 20, marking guidelines should be adjusted accordingly.*

2

- (c) 1. Colourless zone around fungus / colourless zone outside fungus;
2. No fungus growing here / must be enzyme here;  
*Accept any alternative wording clearly relating to colourless zone.*

2

[8]



- 16** (a) (Most of) bromelain is digested / not absorbed / broken down in blood; 1
- (b) Total volume of blood; 1
- 17** (a) (i) Increase to 30 °C / 31 °C and then decreases / optimum or max rate at 30 °C / 31 °C; 1  
*Accept: peak at 30 °C / 31 °C*
- (ii) 1. Enzyme denatured / hydrogen bonds / bonds holding tertiary structure broken / tertiary structure changed;
2. Change in shape of active site (of enzymes);
3. Substrate / protein no longer fits / binds (into active site) / few or no ES complexes;
- 1. Reject: Peptide bonds broken*  
*Denatures active site = 2 marks for mp 1 and 2*  
*2. Q Only allow second point if active site is used correctly*  
*Accept: active site no longer complementary*  
*3. Accept: Substrate cannot bind to enzyme* 3
- (b) (i) Use buffer / test pH (at end / at intervals); 1  
*Accept a method of measuring pH.*  
*Reject litmus.*
- (ii) (30 °C / 31 °C) Maximum rate / optimum temperature; 1  
*Accept other valid answers e.g. temp below 30 °C as enzyme not denatured.*
- (iii) Works best at pH 6 / at higher pH activity decreases; 1  
*Accept converse*  
*Insufficient: pH 6 had largest clear area*
- 18** (a) (i) (Grinding) breaks open cells / increases surface area (of liver); 2  
Releases catalase / enzyme / more catalase / allows more hydrogen peroxide into liver;
- (ii) Heating causes bonds (maintaining tertiary structure) to break; 3  
Denatures / changes tertiary structure so active site changed;  
Substrate no longer fits / ES complex not formed;

[2]

[7]



(b) (Control) to show that sand did not affect reaction (with ground liver); 1

(c) (i) Lower activation energy / less energy required to bring about reaction; 1

(ii) Energy in products / water and oxygen less than energy in substrate / reactants / hydrogen peroxide;  
(Difference) given out as heat / exothermic; 2

[9]

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

(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;  
*Do not allow blue or pink.* 1

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

[7]

**20** (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;  
*Note. Award one mark for general statement about the longer the incubation time, the slower the rate of reaction.*

2

- (ii) Bonds (holding tertiary structure) broken;  
More enzyme denatured / tertiary structure destroyed / active sites lose shape / no longer fit;  
Fewer enzyme-substrate complexes formed;  
*Note. Award marks if clearly in the context of more denaturation. Allow credit here for converse relating to exposure for 5 minutes.*

3

- (d) 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;

6

[15]

- 21** (a) urea diffused into / entered the tubing and was hydrolysed / broken down (inside tubing);  
ammonia increases pH / makes (solution) more alkaline and indicator turns blue as pH above 8 / due to alkalinity / due to ammonia;  
idea that outside stays yellow because urease does not pass out;

3

- (b) (i) add biuret solution / add sodium hydroxide + copper sulphate (solution);

*(disqualify heat / boil, but accept warm)*

violet / lilac / purple colour;

2

- (ii) inside: protein present, as enzyme is protein;  
outside: no protein, as urease / enzyme / protein unable to pass through membrane / out;

*(accept correct result of biuret test as indicator of protein)*

2



- (c) method to maintain range of temperatures, e.g. water baths;  
method to measure rate of activity - e.g. time taken to turn indicator blue;  
*(principle - measure rate of activity over range of temperatures = 1 mark, if neither point)*

other conditions kept constant / named examples,  
e.g. volumes of solutions,  
starting pH, sample time;  
method of refining optimum, e.g. repeats at narrower range;

3 max

[10]

22

- (a) colour results from starch-iodine reaction;  
decrease due to breakdown of starch by carbohydrase / enzyme;

2

- (b) (i) curve drawn below curve on graph and starting at same point;

1

- (ii) curve drawn above curve on graph and starting at same point but finishing above;

*(allow curve or horizontal line)*

*(allow alternative curve for pH if explanation in (ii) is consistent)*

1

- (c) (i) 1. increase in temperature increases kinetic energy;  
2. increases collisions (between enzyme / active site and substrate) / increases formation of enzyme / substrate complexes;  
3. increases rate of breakdown of starch / rate of reaction / carbohydrase activity;

- (ii) 4. (decrease in pH) increases H<sup>+</sup> ions / protons which attach / attracted to amino acids;  
5. hydrogen / ionic bonds disrupted / broken which denatures enzyme / changes tertiary structure;  
6. changes shape / charge of active site so active site / enzyme unable to combine / fit with starch / enzyme-substrate complex no longer able to form;  
7. decreases rate of breakdown of starch / rate of reaction / carbohydrase activity;

*(allow alternative explanation for pH if consistent with line drawn in (ii))*

7

[11]





- 23** (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]
- 24** (a) Hydrolysis;  
*Accept breaking of peptide bonds* 1
- (b) Adding fluorine changes shape/different shape from other proteins;  
Do not fit active site (of protease);  
Induced fit not produced; 2 max
- (c) (i) Suitable example;  
e.g. Flaming spreader/ use lid of Petri dish as umbrella/ clean bench with disinfectant/ sterilise agar in autoclave;  
*Ignore references to wearing gloves, unless suitably qualified and unqualified references to 'clean'* 1
- (ii) All the AMPs killed/inhibited the bacteria/AMPs with fluorine more effective than frog AMP;  
Not All fluorine AMPs are equally effective;  
Diameter/area of clear zone indicates effectiveness;  
Only used one kind of bacterium/need to repeat using other bacteria;  
Need to repeat the investigation/only one plate used;  
Credit suitable measurements or calculations; 3 max
- [7]
- 25** (a) Lactase hydrolyses lactose in to glucose (and galactose); 1
- (b) No lactase in the milk  
**OR**  
Enzyme can be reused. 1
- (c)  $100 \text{ cm}^3 \text{ minute}^{-1}$  is too fast to bind to active site / converse for  $50 \text{ cm}^3 \text{ minute}^{-1}$ ; 1
- (d) 14.1(4); 1



- (e) 1. Galactose is a competitive inhibitor / attaches to the active site (of lactase);  
2. Fewer enzyme substrate complexes formed.

2

[6]

26

(a) Deoxyribose.

1

- (b) 1. Thymine 18 (%);  
2. Guanine 32 (%).

2

(c) DNA polymerase.

1

- (d) 1. (**Figure 1** shows) DNA has antiparallel strands / described;  
2. (**Figure 1** shows) shape of the nucleotides is different / nucleotides aligned differently;  
3. Enzymes have active sites with specific shape;  
4. Only substrates with complementary shape / only the 3' end can bind with active site of enzyme / active site of DNA polymerase.

4

[8]

27

(a) Translation.

1

(b) Transfer RNA / tRNA.

1

(c) TAC;

UAC.

2

(d) Have different R group.

*Accept in diagram*

1

- (e) 1. Substitution would result in CCA / CCC / CCU;  
2. (All) code for same amino acid / proline;  
3. Deletion would cause frame shift / change in all following codons / change next codon from UAC to ACC.

3

[8]

28

(a) Box around single nucleotide.

1



(b)

DNA strand	Percentage of each base			
	A	C	G	T
Strand 1	(16)	34	21	29
Strand 2	29	(21)	(34)	16

2 rows correct = 2 marks;

1 row correct = 1 mark.

2

- (c)
1. Reference to DNA polymerase;
  2. (Which is) specific;
  3. Only complementary with / binds to 5' end (of strand);  
*Reject hydrogen bonds / base pairing*
  4. Shapes of 5' end and 3' end are different / description of how different.

4

[7]

29

- (a)
1. In phospholipid, one fatty acid replaced by a phosphate;  
*Ignore references to saturated and unsaturated*  
*Accept  $Pi/PO_4^{3-}$  / (P)*  
*Reject P/Phosphorus*  
*Accept annotated diagrams*

1

- (b)
1. Add ethanol, then add water;  
*Reject ethanal/ethonal*  
*Accept 'Alcohol/named alcohol'*
  2. White (emulsion shows lipid);  
*Accept milky – Ignore 'cloudy'*  
*Sequence must be correct*  
*If heated then DQ point 1*  
*Reject precipitate*

2

- (c) Saturated single/no double bonds (between carbons)

**OR**

Unsaturated has (at least one) double bond (between carbons);

*Accept hydrocarbon chain/R group for 'between carbons' for either*

*Accept Sat = max number of H atoms bound*

*'It' refers to saturated*

1



- (d) 1. (Fat substitute) is a different/wrong shape/not complementary;  
**OR**  
Bond between glycerol/fatty acid and propylene glycol different  
(to that between glycerol and fatty acid)/no ester bond;
2. Unable to fit/bind to (active site of) lipase/no ES complex formed;  
*If wrong bond name given (e.g. peptide/glycosidic), then penalise once*

2

- (e) It is hydrophilic/is polar/is too large/is too big;  
*Ignore 'Is not lipid soluble'*

1

[7]

30

- (a) 1. Change in DNA base/nucleotide (sequence);  
*Accept: mutation in DNA base (sequence).*  
*Accept: deletion/substitution/addition of a DNA base/nucleotide.*
2. Change in amino acid (sequence)/primary structure;  
*Reject: different amino acid formed.*  
*Ignore: change in code for amino acid.*
3. Alters (position of) hydrogen/ionic/disulfide bonds;
4. Change in tertiary structure (of receptor);  
*Reject: any reference to active site.*  
*Ignore: 3°.*

4

- (b) 1. (Receptor) is not complementary  
**OR**  
(HIV) cannot bind/attach and enter/infect (helper) T cell;  
*Accept: 'complimentary'.*  
*Accept: invade as alternative to infect.*
2. No replication (of virus)  
**OR**  
No destruction of (helper) T cell;  
*Accept: reproduction (of virus).*

2

- (c) 1. Low/lower exposure to HIV (in Europe)  
**OR**  
Low/lower number of HIV/AIDS (infections/cases);  
*Accept: converse.*
2. (HIV) has only been present for a short time period  
**OR**  
(HIV relatively) recently evolved;
3. Mutation/CCR5 has been around for many years;  
*Accept: frequency of mutation has always been high.*
4. Mutation/CCR5 is advantageous (for something else);

2 max

[8]



31

- (a) maximum rate at which enzyme can combine with substrate / form enzyme-substrate complexes / substrate no longer limiting / enzyme is a limiting factor;  
(active site of) enzyme saturated with substrate (*disqualify active sites / enzymes 'used up'*); 2
- (b) inhibitor attaches to enzyme away from the active site;  
changes shape of active site and prevents formation of enzyme-substrate complex; 2
- (c)  $\frac{7.6 - 5.6}{7.6} \times 100$ ;  
= 26.32%; (*accept 26% or 26.3%*)  
(*correct answer = 2 marks*)  
  
(*principle –  $\frac{\text{decrease in rate}}{\text{maxrate}} \times 100 = 1 \text{ mark}$* ) 2
- (d) curve below top curve (without inhibitor) joining to top curve / continues to increase to end of x-axis  
(*must not exceed or level out below 'without inhibitor curve' and must start from origin*); 1

[7]

32

- (a) (i) fall in deaths due to rise in number of people with immunity / better care / targeting vaccination at vulnerable; 1
- (ii) mutation of virus / new strain;  
mutant form not recognised by memory cells (*allow antibodies*); 2 max
- (b) (i) T lymphocyte receptors recognise shape of haemagglutinin / neuraminidase / viral antigen;  
clone (*once only*);  
destroy virus; 2 max
- (ii) clone (*once only*);  
produce antibodies;  
effect of antibody e.g. stimulation of phagocytosis / precipitation of toxins; 2
- (c) alter shape of active site of neuraminidase / block active site;  
virus unable to leave host cells; 2

[9]



33

- (a) To keep concentrations of gelatine constant;  
*Accept 'to keep concentration constant' for /  
mark if points 1 and 2 not made*

To keep concentration of pineapple extract constant;  
Tube 2 had HCl added / to give same volume as B;

2 max

- (b) Tube A

Enzyme (in pineapple) has digested gelatine;  
*Allow enzyme 'breaks down' gelatine*

So no gelatine / protein to form a jelly;

Tube B

Enzyme denatured / inhibited / reference to hydrogen bonds /  
change of tertiary structure;  
By HCl / change of pH;

4

- (c) For comparison / as a control;  
To show that it is an enzyme in pineapple that digested gelatine /  
stopped gelatine setting in tube 1;  
Boiling denatures enzyme / Can be described but must be  
permanent change;  
Other components of pineapple still present;

3 max

[9]