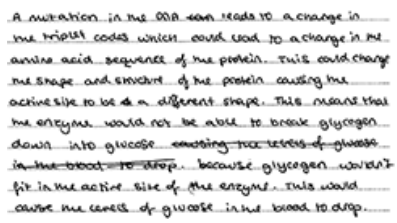
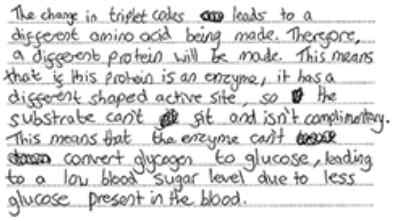
Mark scheme

Question			Answer/Indicative content	Marks	Guidance
1	a		(Increasing the temperature) will increase decay/decomposition ✓ (Increase in temperature) increases the kinetic energy ✓ (increase in temperature) more collisions ✓	3 (1 x AO 2.2) (1 x AO 3.1a) (1 x AO 3.1a)	**ALLOW** (increasing the temperature) will increase conversion of sugar into lactic acid **DO NOT ALLOW** decay stops at high temperatures **ALLOW** increase energy to move around / move faster **IGNORE** more energy **ALLOW** more enzyme substrate complexes **Examiner's Comments** This question assessed the candidate's ability to draw conclusions from the data and identify pattern/trends from experimental results. Over half of candidates were able to identify that increased temperature the rate of decomposition increased. Many candidates re-wrote this in many different forms such as the more the sugar converted into lactic acid. A few candidates did go onto state that the rate of decay stops at high temperatures which did not happen in the results provided in the experiment. Fewer candidates went on to explain this pattern by increased kinetic energy and increased collisions. Some candidates stopped short by stating higher temperatures were closer to optimum conditions for enzyme action without any further explanation.
	b		The milk would not decompose / pH would not fall /change✓ Bacteria would be killed / enzymes denatured / active site changes shape and substrate will not fit ✓	2 (2 x AO 3.3a)	**ALLOW** pH will be 6.5 / sugar can't convert into lactic acid **IGNORE** slows down decay/pH falls slower **Examiner's Comments**

					This question discriminated well between candidates at different grades, assessing the candidate's ability to analyse information relating to decomposition and bacteria above optimum temperatures. The most common scoring response identified that decay would stop, then half of those candidates were able to qualify this because enzymes had denatured / bacteria were killed.
			Total	**5**	
2		i	Non-coding DNA ✓ Transcription✓ Ribosomes ✓ Translation ✓	4 (4 x AO 1.1)	**Examiner's Comments** This gap fill question all candidates attempted and the majority scored either three or four marks. Only a small number were not given any marks here. The most common given marks were for transcription and translation identified correctly. The most common error candidates made was stating that genes can be switched on by coding DNA instead of non-coding DNA.
		ii	(Genetic engineering) introduce a gene from another organism ORA ✓	1 (AO 1.1)	**AW** adding/transfer/insert for introduce **IGNORE** change/replace genes/DNA from another organism **ALLOW** only uses gene from one organism **Examiner's Comments** This question proved the most challenging to the candidates assessing their knowledge and understanding of genetic engineering. Most candidates were not able to describe the process of genetic engineering. Vague references to vectors and various enzymes were answered. Where candidates did identify moving a gene, they did not clearly identify that the gene was from another species. Common responses included genetic engineering swaps/replaces a gene. **Misconception**

					There has been a knowledge gap identified and most candidates did not know that in genetic engineering genes are introduced from one organism to another. Misconceptions included, swapping genes / replacing genes and part of selective breeding. Revisiting key ideas throughout the GCSE course would help remove and eliminate these misconceptions.
			Total	**5**	
3			**A**	1 (AO 1.1)	
			Total	**1**	
4			**Level 3 (5–6 marks)** Describes how a change in triplet codes alters the formation of an enzyme **and** how this affects enzyme function. **AND** Describes the resulting impact on glucose levels in the blood. *There is a well-developed line of reasoning which is clear and logically structured. The information presented is relevant and substantiated.* **Level 2 (3–4 marks)** Describes how a change in triplet codes can alter the formation of an enzyme **and** explains how a change in enzyme structure can alter enzyme function. **OR** Describes how a change in triplet codes can alter the formation of an enzyme **and** identifies the resulting impact on glucose levels in the blood. **OR** Explains how a change in enzyme structure can alter enzyme function **and** identifies the resulting impact on glucose levels in the blood. *There is a line of reasoning presented with some structure. The information presented is relevant and supported by some evidence.*	6 (2 x AO 1.1) (4 x AO 2.1)	**AO1.1 Demonstrates knowledge and understanding of scientific ideas to describe how a change the triplet code alters protein formation**. • Different triplet codes will code for different (sequences of) amino acids. • Different (sequences of) amino acids result in a different protein/enzyme being formed. **AO2.1 Applies knowledge and understanding to explain why a change in enzyme structure alters enzyme function**. If the enzyme changes shape glycogen cannot be broken down into glucose because: • the active site is not complementary to the substrate/glycogen. • the substrate/glycogen cannot fit into/bind with the enzyme's active site. **AO2.1 Applies knowledge and understanding to explain why a failure of the enzyme affects blood glucose levels**

			Level 1 (1–2 marks) Describes how a change in triplet codes can alter the formation of an enzyme **OR** Describes how a change in enzyme structure can alter enzyme function. **OR** Identifies the resulting impact on glucose levels in the blood. *There is an attempt at a logical structure with a line of reasoning. The information is in the most part relevant*. **0 mark** *No response or no response worthy of credit.*		• Glucose will not be released into the blood. • If the person has low blood glucose levels, they cannot raise this level / blood glucose levels may be too low/decrease • Glucagon cannot function. If reference to different types of amino acids being formed/made, then limited to Level 2 **Examiner's Comments** This question was the 6-mark Level of Response question on this paper. Candidates were expected to focus on three main ideas in their responses: • the effect of a mutation on the amino acid sequence of a protein • the resulting change in the shape of the active site and ability to bind with the substrate • the failure to be able to elevate blood glucose levels. Some candidates produced concise, accurate Level 3 responses concentrating on each of these areas. Others gave long descriptions of the process of protein synthesis, without covering the implications of a mutation. There were also many examples of confusion between glucagon and glycogen in candidates' responses. Another misconception that was often seen was that DNA codes for the production of amino acids rather than the production of proteins. Some of these points are seen in the following two exemplars. Exemplar 1

					 A mutation in the DNA can leads to a change in the triplet codes which could lead to a change in the amino acid sequence of the protein. This could change the shape and structure of the protein causing the active site to be a different shape. This means that the enzyme would not be able to break glycogen down into glucose ~~causing the levels of glucose in the blood to drop~~. because glycogen wouldn't fit in the active site of the enzyme. This would cause the levels of glucose in the blood to drop. This response was awarded Level 3, 6 marks. It is a complete, concise response, highlighting the change to the amino acid sequence, leading to a possible change in the shape of the active site and the consequence for the blood sugar level. The response is clear and logically structured. Exemplar 2  The change in triplet codes ~~and~~ leads to a different amino acid being made. Therefore, a different protein will be made. This means that is this protein is an enzyme, it has a different shaped active site, so ~~if~~ the substrate can't ~~fit~~ sit and isn't complimentary. This means that the enzyme can't ~~break down~~ convert glycogen to glucose, leading to a low blood sugar level due to less glucose present in the blood. This response was awarded Level 2, 4 marks. It clearly outlines the possible effect of a mutation on the activity of the enzyme and the resulting failure to be able to raise blood sugar levels. However, the misconception of DNA producing amino acids, rather than coding for their order, is seen in the first sentence. This limits the response to Level 2.
			Total	**6**	
5			C	1 (AO 2.2)	
			Total	**1**	
6			D	1 (AO 1.1)	**<u>Examiner's Comments</u>** Although the majority of responses were correct, some candidates thought that DNA contained amino acids, rather than coding for them, and so chose option B as their response.

			Total	**1**	
7			Please refer to the marking instructions on page 4 of this mark scheme for guidance on how to mark this question. **Level 3 (5–6 marks)** Explains the impact the insertion has on the base sequence of the DNA, the mRNA produced **AND** explains how this produces a different protein. *There is a well-developed line of reasoning which is clear and logically structured. The information presented is relevant and substantiated.* **Level 2 (3–4 marks)** Explains how the impact of the insertion of the bases affects the structure of the DNA and therefore mRNA **OR** Explains how a change in mRNA causes a change in the protein produced. *There is a line of reasoning presented with some structure. The information presented is relevant and supported by some evidence.* **Level 1 (1–2 marks)** Explains the function of DNA and why a change in DNA can produce a different protein. *There is an attempt at a logical structure with a line of reasoning. The information is in the most part relevant***.** **0 mark** *No response or no response worthy of credit.*	6 (2 xAO 1.1) (4 xAO 2.1)	**AO1.1** Explains the function of DNA and why a change in DNA can produce a different protein • the order of the bases/nucleotides in DNA codes for the production of a protein • so a different order of bases means a different order of amino acids/different protein. **AO2.1** Explains how the impact of the insertion of the bases affects the structure of the DNA and therefore mRNA • idea that in transcription DNA is used as a template to produce mRNA • therefore, a change in the bases in DNA will cause a change in the bases in mRNA **AO2.1** Explains how a change in mRNA causes a change in the protein produced • the order of bases in mRNA determines the order of the amino acids joined together in translation • this is because different tRNA/carrier molecules will bind to the mRNA Any answer referring to the production of amino acids is limited to Level 2 **<u>Examiner's Comments</u>** This was the level of response question on this paper. To obtain Level 3, candidates had to explain the impact the insertion of bases has on the base sequence of DNA, how this effects the mRNA produced and how this produces a different protein via the action of tRNA. Some candidates

					described protein synthesis in detail but did not link this to any changes in base sequence. Level one candidates often concentrated on DNA with no reference to mRNA or tRNA. Level 2 responses included mRNA changes but usually omitted references to tRNA. Exemplar 3  * During protein synthesis DNA unzips and the complementary base pairs attach (no thymine so uracil binds to Adenine) (transcription) * Due to the mutation caused by Beta Thalassaemia the bases extra bases are inserted onto the mRNA * The mRNA detaches and the DNA zips back up * The mRNA leaves the nucleus through the cytoplasm to ribosome for translation * Ribosome reads the mRNA in codons/triplets each coding for another amino acid * However, the extra bases inserted on mRNA means that the ribosome will read it differently than normal person without Beta Thalassaemia. * As a result, an alternative haemoglobin protein is produced as the amino acids that chain together are different (due to extra bases) (sequence) Exemplar 3 shows an answer that was given Level 2, 4 marks. The response is well constructed and relevant, explaining how the change in DNA results in a change in mRNA and the protein produced. However, there is no reference to tRNA.
			Total	**6**	
8	a		*In method 1 / fresh pineapple:* The bromelain/enzyme will break down the gelatin/protein (so the jelly cannot set) ✓ *In method 2 / tinned pineapple:* The bromelain/enzymes have been denatured ✓ The active site of the bromelain/enzymes will change shape / the gelatin/protein will no longer fit into the active site ✓ The gelatin/protein has not been broken down (so the jelly can set) ✓	4 (4 xAO 2.1)	**Examiner's Comments** Responses to this question were rather polarised. Successful answers highlighted that heat treatment of the tinned pineapple would have denatured the enzymes, changing the shape of the active site, resulting in gelatin not being digested. Whereas gelatin is digested by the enzymes in the fresh pineapple. Other answers stated that the heat treatment gave the optimum temperature for the enzymes to work, even though this would not explain why the jelly sets.
	b		X placed at approximately half the maximum rate of reactions ✓	2 (AO 3.1a)	**Examiner's Comments** Candidates that realised that 50%

			Explanation: idea that this is half the maximum rate (so assume that half the active sites are occupied) ✓	(AO 3.1b)	occupation of the active sites would result in half of the maximum rate of reaction managed to put the X in the correct position. However, this question proved quite challenging.
			Total	**6**	
9			**D**	1 (AO 1.1)	
			Total	**1**	
10			The (amyloid) protein is not made ✓ The allele/gene is not having an effect/ the allele/gene is not expressed ✓	2 (AO 2 × 2.1)	**ALLOW** the gene/allele/mRNA is not translated **DO NOT ALLOW** the DNA/mRNA is not transcribed **DO NOT ALLOW** the allele/gene is destroyed **DO NOT ALLOW** prevents the gene coding for the amyloid protein **Examiner's Comments** Again, this AO2.1 question was challenging for all candidates and only a very small number scored full marks. Many candidates thought that the gene or DNA code had been destroyed. Few candidates appreciated that since the mRNA had been destroyed, transcription had already taken place and that it was translation or the production of the protein that could not take place. **Misconception** There was a misconception that if a gene is silenced, the gene is destroyed.
			Total	**2**	
11	a		CA(E) ✓ DB ✓	2 (2 × AO1.1)	**Examiner's Comments** Generally, correctly answered.
	b		**Any two from:** Each triplet/3 bases/codon codes for one amino acid ✓	2 (2 × AO1.1)	**DO NOT ALLOW** codes for the production of amino acids / forms different amino acids

			The order of the triplet codes determines the sequence of amino acids ✓ The sequence of amino acids determines protein structure/which protein is made ✓		**ALLOW** order of bases determines the sequence of amino acids **Examiner's Comments** Higher demand questions about the genetic code have appeared before in previous examinations and continue to be challenging. Candidates often confuse bases with amino acids in their answer or state that there are 20 amino acids in a protein. **Misconception** A common error that was seen in answers to this question and previous similar questions is the idea that that the triplet code is responsible for the production of amino acids.
	c	i	A different order of the amino acids would result ✓ Different proteins have different orders of amino acids / the protein would have a different shape/structure ✓	2 (2 × AO2.1)	**DO NOT ALLOW** idea that each section would now code for a different amino acid **DO NOT ALLOW** codes for the production of different amino acids **DO NOT ALLOW** the idea that amino acids code for proteins **Examiner's Comments** If candidates correctly understood the importance of the triplet code, they often went on to correctly explain the effects of changing the order of the sections. Incorrect answers often stated that different amino acids would be coded for rather than the order being changed.
		ii	6 ✓	1 (1 × AO1.2)	
			Total	**7**	
12			**Level 3 (5-6 marks)** Describes the general role of stem cells **AND** Describes the development of red	6 (2 × AO1.1) (3 × AO2.1)	**AO1 Demonstrate knowledge and understanding of scientific ideas of the general role of stem cells.**

			blood cells as specialised cells **AND** Explains the change in RNA concentration or the loss of the nucleus *There is a well-developed line of reasoning which is clear and logically structured. The information presented is relevant and substantiated.* **Level 2 (3-4 marks)** Describes the general role of stem cells **and** describes the development of red blood cells as specialised cells **OR** Describes the development of red blood cells as specialised cells **and** explains the change in RNA concentration **or** the loss of the nucleus **OR** Describes the general role of stem cells **and** explains the change in RNA concentration **or** the loss of the nucleus *There is a line of reasoning presented with some structure. The information presented is relevant and supported by some evidence.* **Level 1 (1-2 marks)** Describes the general role of stem cells **OR** Describes the development of red blood cells as specialised cells **OR** Explains the change in RNA concentration **or** the loss of the nucleus *There is an attempt at a logical structure with a line of reasoning. The information is in the most part relevant.* **0 marks** *No response or no response worthy of credit.*	(1 × AO3.2b)	• Stem cells are undifferentiated cells/are able to differentiate to form different cells • Stem cells become specialised for specific functions/become specialised cells **AO2 Apply knowledge and understanding of scientific ideas to the development of the red blood cell from a stem cell to a cell that contains the protein haemoglobin.** • Red blood cells (are specialised cells as they) - do not have a nucleus - contain haemoglobin • Haemoglobin is made by protein synthesis/by using RNA **AO3 Analyse information from the graph to explain changes that occur to RNA and the loss of the nucleus** • Amount of RNA falls due to the loss/decrease in size of the nucleus • The cell loses the nucleus to give room for large amounts of haemoglobin that have been produced **<u>Examiner's Comments</u>** This was the level of response question on this paper. To obtain Level 3, candidates had to discuss the importance of stem cells in forming specialised cells. They then had to explain how red blood cells become specialised by losing the nucleus in order to allow more room for haemoglobin. A common misconception in some

					answers was the idea that the fall in mRNA in the cell made more room for haemoglobin. Also, there was confusion concerning the loss of the nucleus. Many candidates correctly referred to the increase of space for haemoglobin but others said that this would increase the surface area to volume ratio of the cell.
			Total	**6**	
13			C ✓	1 (AO 2.1)	
			Total	**1**	
14			B ✓	1 (AO 2.2)	
			Total	**1**	