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# Examiners' Report
# June 2018

## GCE Biology SNAB 9BN0 02

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# Introduction

This is the second year of the new A level specification.

Due to the linear nature of the course, approximately half of the available marks in this paper are to be allocated to the assessment of topics from Year 1 of the course. The paper is now 2 hours in length, with more questions on the last 2 topics of the specification, 7 and 8, as well as more questions testing knowledge of any of the first 4 topics of the specification, 1 to 4.

It is clear that candidates are still adjusting to the demands of the new specification. The types of question in this new specification have a greater requirement to apply knowledge and understanding in the context of qualitative and quantitative data provided. There are also two 6-mark questions requiring candidates to write at length to convey their ability to produce sustained arguments or linkages between data and biological knowledge. The successful candidates considered all of the data and referred to it in their analysis. However, there were many examples of candidates only referring to one aspect of the data they were given.

There were some very good entries, with candidates displaying a depth and breadth of knowledge on the learning objectives tested on this paper, particularly concerning the structure of biological molecules and transport across a cell membrane. However, a number of topics appeared on the paper this year that have rarely been examined. These included the role of dendrites, the development of the visual cortex in the critical period and the use of fMRI. Students' knowledge in these areas was often limited. Where candidates were given information to analyse in order to answer a question, they often did not make full use of all the information.

Successful candidates:

- had revised all of the topics, including those in topics 7 and 8 which are not frequently tested
- answered the questions in the context set
- had learnt how to interpret the new command words, and to distinguish the difference between describe and explain
- had read through the introduction to each question and made use of all the information given when constructing their answer
- worked through calculations in a logical sequence, having given careful consideration to the calculation required
- demonstrated the ability to convert units and orders of magnitude

Less successful candidates:

- had gaps in revision
- did not answer questions in context, writing all they knew about a topic rather than using their knowledge to answer the question they were asked
- did not understand the command words and therefore misinterpreted the question
- did not attempt some of the questions, or ran out of time at the end

- left out vital details or wrote vague answers lacking relevant facts
- made errors in calculations or failed to convert to the correct units

Implications for future teaching and learning and exam preparation - revisiting the key concepts taught in year 1 as year 2 topics are taught, to help provide a thorough understanding of the more applied topics. Exam preparation should include a reinforcement of the new command words and an emphasis on the need to use all of the data or information given when analysis is required, especially in the 6-mark questions. As actual past papers become available for revision and exam preparation, less emphasis should be given to the sample and specimen materials produced as these have not been reviewed in the light of student responses.

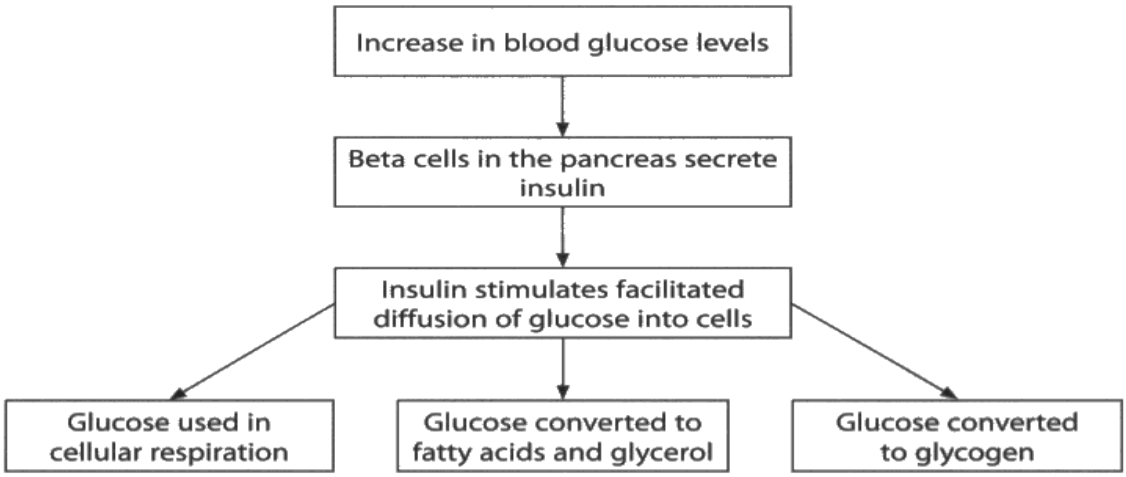
When completing the exam papers, we would ask students to continue with their answers in the blank spaces below the answer lines where possible, rather than using additional sheets. The lines do not take up the whole page as this would mislead candidates as to the length of response required, but if an answer is changed or more space is required, the response can be written under the answer lines and will be seen most easily by examiners.

## *Question 1 (a) (i)*

This question asked about the movement of glucose, a large molecule, across the cell membrane. Glucose is non polar, so the question was looking for a reference to carrier proteins in the cell membrane. Candidates generally responded well to this question. Most candidates understood that the movement is from a high concentration to a lower concentration, but there was confusion between channel proteins and carrier proteins.

**1** The internal conditions within the body are maintained by homeostatic mechanisms. The regulation of blood glucose involves homeostatic mechanisms.

(a) The diagram shows part of the sequence of events when there is an increase in blood glucose levels.




(i) Describe how glucose moves into cells by facilitated diffusion.

**(2)**

Glucose diffuses into the cell with the aid of channel proteins. Since glucose is a large molecule, cannot diffuse through phospholipid bi-layer so travels down its concentration gradient through a channel protein embedded in the phospholipid bi-layer of cell surface membrane. (passive transport).

**ResultsPlus**
**Examiner Comments**

This answer gained 1 mark for movement down the concentration gradient. A mark cannot be awarded for the protein in the membrane because it is a channel protein.

Glucose binds to proteins specifically channel proteins & carrier proteins, channel protein allow the glucose onto the other side of the membrane. When binding to carrier protein the protein changes shape allowing the passage of glucose on the other side.

ResultsPlus
Examiner Comments

This answer was awarded 2 marks. There is a clear reference to carrier proteins, so in this case channel protein can be ignored, and an explanation of the carrier protein changing shape.

## *Question 1 (a) (ii)*

This question asks about the role of glycogen as an energy store. The command word is explain, so links must be made between the structure of glycogen and how this contributes to its role as an energy store. A description of the structure of glycogen did not gain marks. Most students gained at least the first mark point, but many referred to easy hydrolysis rather than faster so did not gain the third mark point.

(ii) Explain how the structure of glycogen allows it to be an energy store.

**(3)**

Glycogen is energy storage molecule in animals. Glycogen is a polysaccharide that has loads of side branches that can be hydrolysed quickly by enzymes when body needs glucose. A lot of energy will be given to cell by hydrolyses of 1,4-glycosidic bonds of glycogen. Also it is an insoluble molecule so it won't allow water to enter cells by osmosis, hence it's good for storage. Finally it is a compact molecule hence a lot of it can be stored in a small place

**ResultsPlus**
**Examiner Comments**

This is a clear answer that gained full marks, for glycogen as a polysaccharide, with branches that allow it to be hydrolysed quickly, and insoluble so there is no osmotic effect.

(ii) Explain how the structure of glycogen allows it to be an energy store.

**(3)**

glycogen is made up of many glucose molecules formed together by glycosidic bonds. glycogen is a branched chain so has 1,4 and 1,6 glycosidic bonds so can easily be hydrolysed to release glucose for respiration. it is also a compact structure and forms coils due to hydrogen interactions so it is more compact. as it is made of many glucose it also has little osmotic effect so ~~[illegible]~~ won't move out of the cell.

**ResultsPlus**
**Examiner Comments**

This answer gained 2 marks, for glycogen made of many glucose molecules and glucose used in respiration.

It did not gain the mark for the effect of the branches on hydrolysis because easily is not the same as rapidly.

It did not gain the mark for no osmotic effect as there is no link with insoluble.

## *Question 1 (b)*

This question asks for an explanation as to how transcription factors activate the gene. There were many good responses, although some candidates showed confusion with repressor molecules or operons. Quite a number failed to mention the promoter region. There was some confusion here with answers relating to methylation and epigenetics.

(b) Beta cells in the pancreas produce insulin when there is an increase in glucose levels in the blood.

Transcription factors are involved in the activation of the insulin gene.

Explain how transcription factors could activate insulin gene expression in beta cells.

**(3)**

Transcription factors may bind to the promotor site so RNA polymerase can transcribe and translate ~~into~~ the ~~gene~~ gene to a protein so ~~beta~~ insulin is released.

**ResultsPlus**
**Examiner Comments**

This response gains 2 marks, for stating that the transcription factor binds to the promoter site and transcription takes place. It does not gain the 3rd mark because although there is a reference to RNA polymerase, it does not state that it binds to the promoter region.

(b) Beta cells in the pancreas produce insulin when there is an increase in glucose levels in the blood.

Transcription factors are involved in the activation of the insulin gene.

Explain how transcription factors could activate insulin gene expression in beta cells.

**(3)**

Insulin is a peptide hormone. Insulin binds to complementary receptors located on the target cell, which are beta cells. ~~Peptide hormones can not~~. This causes the activation of a secondary messenger that can activate transcription factors or which can act as a transcription factor. This will then bind on to the promoter region of the gene, inside the beta cell nucleus, and RNA polymerase to form a transcription initiation complex. This can activate the expression of the insulin gene by synthesising mRNA to allow transcription and hence form the protein by translation.

**ResultsPlus**
**Examiner Comments**

This is a clear answer that gains all 3 marks.

## *Question 2 (a) (ii)*

This question was a comparison question between saturated and unsaturated fatty acids. More marks were gained for the differences than the similarities. Many candidates lost the mark for the double bond because they didn't state it was between carbon atoms, although there were also some good descriptions of the C-C and C=C bonds. Quite a number confused fatty acids with triglycerides in their answer.

(ii) Compare and contrast the structures of a saturated fatty acid and an unsaturated fatty acid.

(double bond) (3)

Saturated fatty acids have no C=C bonds compared to unsaturated fatty acids that do have a double bonded C=C bond. This C=C bond causes kinks in unsaturated fatty acids that saturated fatty acids do not have. Un-saturated fatty acids are there-fore easier to break down than saturated fatty acids.

They both have ester bonds.

**ResultsPlus**
**Examiner Comments**

This answer describes the differences clearly, gaining 2 marks , but there are no similarities given. 2/3

**ResultsPlus**
**Examiner Tip**

Always read the command words carefully. If the question is compare and contrast, it is not possible to gain full marks without at least one similarity and one difference.

(ii) Compare and contrast the structures of a saturated fatty acid and an unsaturated fatty acid.

**(3)**

A saturated fatty acid has a long straight chain with only single bonds between its carbon atoms on its tails.
An unsaturated fatty acid can have double bonds ~~joins~~ between its carbon atoms on its tail and ∴ 'kinks' are created.
Unsaturated fatty acids can be broken down more easily and ∴ are less harmful.

**ResultsPlus**
**Examiner Comments**

Again, a clear description of the differences but no similarities.

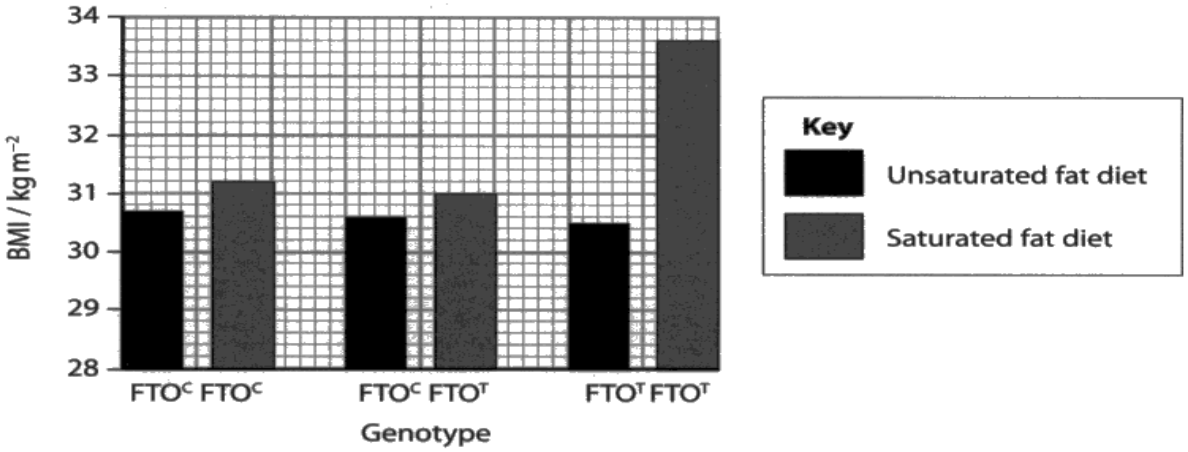
The 2 marks can be awarded here because the differences are clearly stated even though they are both put together in one sentence.

## *Question 2 (b)*

This question asks candidates to analyse data about diet and genotype, the link between genetic effects and environmental effects. The command word "deduce" requires them to draw conclusions.

Most candidates gained 1 mark for recognising the link between a saturated fat diet and BMI. Many candidates then recognised that there was some link between genotype and BMI, but didn't gain a mark because they failed to say that it was only the homozygous that had an effect. Very few candidates stated that the allele was recessive.

(b) The effects of saturated fats in the diet on the BMI in individuals with different FTO genotypes are shown in the graph.




Deduce the effect of environmental and genetic factors on BMI.

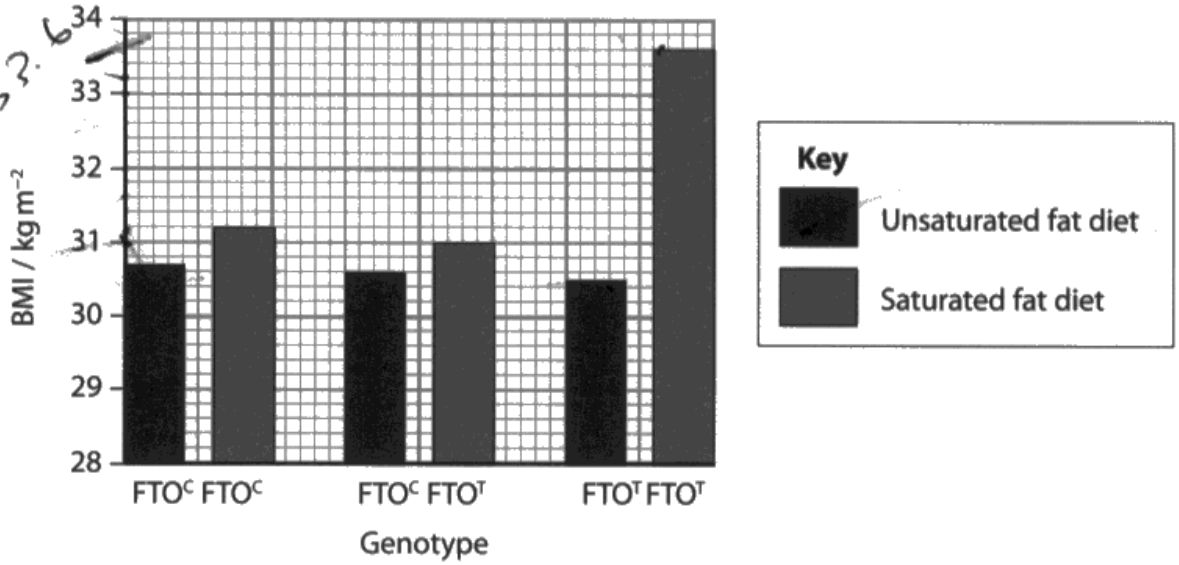
(3)

The graph shows how ~~eating~~ having a diet high in saturated fats increases individuals BMI to some extent with all genotypes. However, ~~those with two FTO^T alleles~~ who ~~can~~ consume a diet ~~&~~ high in ~~&~~ saturated fat, who have two FTO^T alleles, have a much higher BMI than those with two FTO^C, or an FTO^C and a FTO^T allele. This suggests that environmental ~~genetic~~ factors ~~have a greater effect than~~ play ~~effect~~ people's BMI have a greater effect on BMI when certain genetic factors are in place, thus implying that they can both ~~have an effect on~~ cause an increase in BMI.

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Examiner Comments

This answer shows good analysis of the data, stating that BMI is affected by a saturated fat diet but the effect is greater if the individual has the homozygous genotype. However, there is no recognition that this shows the allele is recessive, so gains 2/3 marks.

(b) The effects of saturated fats in the diet on the BMI in individuals with different FTO genotypes are shown in the graph.




Deduce the effect of environmental and genetic factors on BMI.

(3)

~~all gen~~ FTO genotypes | ~~An unsaturated fat diet~~ For genotypes $FTO^cFTO^c$ and $FTO^cFTO^T$ ~~an~~ a saturated fat diet shows to ~~them~~ have similar effects on both their BMI with only a 0.2 increase in BMI of $FTO^cFTO^c$ compared to $FTO^cFTO^T$, however a saturated fat diet on $FTO^TFTO^T$ genotype ~~sho~~ shows that their genetic factors ~~effect~~ are effected by saturated fats than the other 2 genotypes this is because the graph shows this genotype to have a very high increase in BMI when taking saturated fats compared to the others (8.39% increase). unsaturated fat diet shows that genotype to not have any affect as all their BMIs are ~~a~~ very similar

**ResultsPlus**
**Examiner Comments**

Again, this response gains 2/3 marks for analysing the data but not making the link between the data and a recessive allele.

**ResultsPlus**
**Examiner Tip**

Many candidates are quoting the data or carrying out some manipulation but no marks are awarded for this in the new specification unless specifically asked for.

## *Question 3 (a)*

This explain question requires links to be made between the conditions in the blood stream and their effect on bacteria. Many candidates only gained 1 mark for stating that the bloodstream gives warm conditions, but did not go on to explain the link with enzyme activity, or make any link between glucose and respiration. Several went into descriptions of the immune system.

**3** Sepsis is a bacterial infection in the bloodstream. Sepsis can cause tissue death in limbs. This may require parts of a limb to be removed (amputation).

(a) Open wounds can become infected by bacteria, leading to sepsis.

Explain why bacteria are able to multiply in the bloodstream when they enter the body.

**(3)**

bacteria multiply through nuclear fission / splitting. In the blood stream, there are optimum conditions for bacteria for example there is glucose in the blood that the bacteria is able to use for energy. Blood is also oxygen rich and the bacteria can use this for respiration.

**ResultsPlus**
**Examiner Comments**

This response gains 2/3 marks for glucose in the blood and the use of glucose for energy.

References to oxygen in the blood and a link with respiration cannot be credited because most of the oxygen is combined with haemoglobin and not available to the bacteria, also these bacteria are anaerobic.

**3** Sepsis is a bacterial infection in the bloodstream. Sepsis can cause tissue death in limbs. This may require parts of a limb to be removed (amputation).

(a) Open wounds can become infected by bacteria, leading to sepsis.

Explain why bacteria are able to multiply in the bloodstream when they enter the body.

**(3)**

~~Bleed~~ Bacteria have easy access to bloodstreams due to open wounds. The temperature in the body is optimum for bacteria enzymes, allowing them to carry out metabolic activity and divide. The blood contains oxygen and glucose that allow bacteria to carry out respiration to produce energy for them to multiply. Bacteria exist in very large number. ~~Bact~~ The body contains optimum conditions for bacteria to multiply

ResultsPlus
Examiner Comments

A clear answer that gains all 3 marks. 3/3.

## *Question 3 (b)*

This question asked for a link to be made between blood clots in the capillaries and tissue death. Many candidates gained full marks, although few stated that it was the lumen of the capillary that was blocked.

(b) Sepsis can cause blood clots to form and block the supply of blood to tissues in the limbs.

Explain why blood clot formation in capillaries could cause tissues to die.

**(2)**

Blood clots in the capilliaries ~~causes~~ stops the transport of blood to these areas. As a result the tissues are not getting ~~the oxygen~~ sufficient oxygen for the tissue cells to respire aerobically. Therefore the tissue cells will eventually die due to oxygen starvation.

**ResultsPlus**
**Examiner Comments**

A clear answer that gains 2/2 marks.

Although this answer states aerobic respiration, respiration alone is sufficient here as it could also be due to a lack of glucose.

(b) Sepsis can cause blood clots to form and block the supply of blood to tissues in the limbs.

Explain why blood clot formation in capillaries could cause tissues to die. (2)

Capillaries have a narrow lumen so a blood clot formed in the capillary could block it. This stops the blood flow to all tissues the capillary normally supplies. These tissues will not gain oxygen, glucose and other essential minerals from the blood. Without oxygen they will respire anaerobically for a short period of time then die from lack of essential resources. Dead cells cannot be replaced as no oxygen for respiration means not cell replication. Thus tissues die.

**ResultsPlus**
**Examiner Comments**

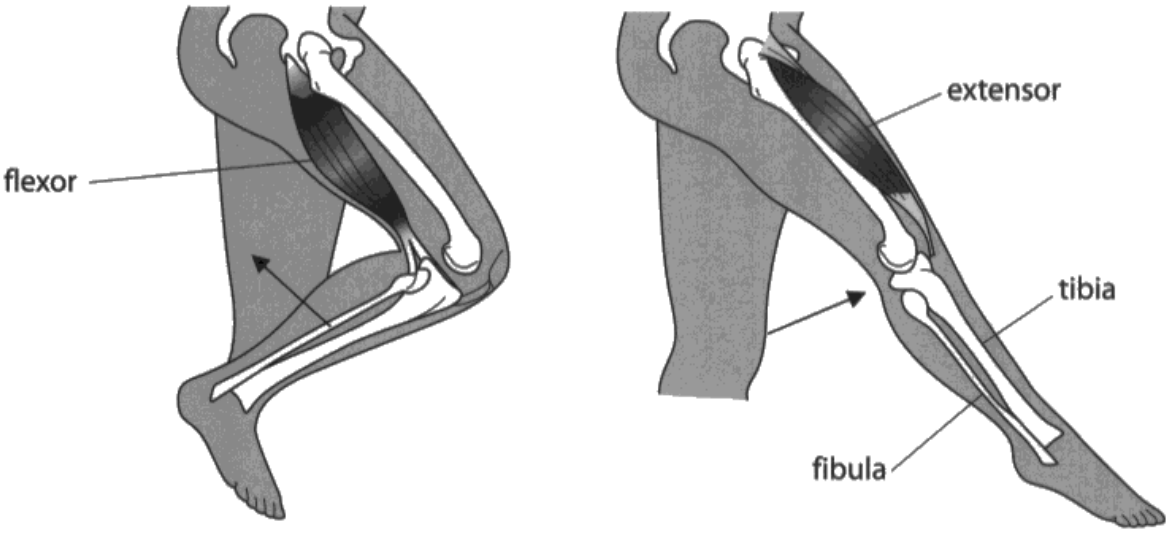
This is a detailed answer that covers all 3 marks available.

The mark for lack of respiration would be awarded in the last sentence, it could not be awarded for the reference to anaerobic respiration as there is no mention of lactic acid build up. It gains 2/2.

## *Question 3 (c) (i)*

This question asks how muscles bring about movement in the context of the lower leg. Most candidates gained 1 mark for stating that the muscles act as an antagonistic pair. Few explained the role of tendons and very few went onto to use the information in the diagram to answer the question fully, failing to link the correct muscle to the correct bone and movement.

(c) Extensor and flexor muscles are involved in the movement of the lower leg as shown in the diagrams.




(i) Explain how the extensor and flexor muscles bring about movement of the lower leg.

**(2)**

leg muscles work in antagonistic pairs. muscles can only pull therefore when one contracts the other relaxes so if the flexor contracts the extensor will relax causing leg to move to right and would move to left if opposite occured.

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**Examiner Comments**

This response gains 1/2 for stating that the muscles work as an antagonistic pair.

The 2 muscles are antagonistic. When the extensor muscle contracts it shortens, pulling the tibia bone which is connected via the tendons & pulling the lower leg outside. When the flexor muscle contracts it is attached to the fibula bone thus pulls it closer causing the lower leg towards the inside

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**Examiner Comments**

This is a clear answer that states that the muscles act antagonistically, then goes on to use the information in the diagram to explain how each of the named muscles moves each part of the leg. It also states that tendons attach muscle to bone. It gains 2/2.

## *Question 3 (c) (ii)*

This deduce question asks candidates to use the information they are given to explain how prosthetic limbs can be moved. This was not answered well; many candidates had the right idea but failed to give both parts of the explanation. A few candidates thought that muscle or nerve connections could be made with the prosthesis.

(ii) Individuals who have had limbs amputated can use prostheses to compete in athletic events.

A transtibial amputation involves the removal of part of the lower leg below the knee. Extensor and flexor muscles are still attached to the parts of the lower leg bones (the tibia and fibula) that remain.

The photograph shows Paralympic athletes competing in the 100m final in London 2012. The three athletes shown have all had transtibial amputations.




www.sciencephoto.com

Deduce how athletes with transtibial amputations are able to move their prosthetic limbs during a race.

(1)

The leg still has flexor and extenser muscles that are still attached to the fibra and fibula.

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**Examiner Comments**

This candidate clearly had the correct idea, but the mark could not be awarded because it doesn't state that the prosthesis is attached to the lower limb. 0 marks.

The extensor and flexsor are still attatched to the the tibia e fibula which are attatchedl to the prosthetic limb so these muscles are essentially causing the prosthetic to move as well since it's all connected.

**ResultsPlus**
**Examiner Comments**

This answer clearly explains how the muscles are still attached and can bring about movement, and the prosthesis is attached to the bone. 1/1.

## *Question 4 (a) (iii)*

This question asks for an explanation of how fMRI works, in the context of the visual cortex. There were some good answers which indicated a detailed understanding of the process. However, many candidates made generalised comments that failed to achieve the marks. Many answers included details of how the scan is done, and many missed marks for small mistakes in language such as describing the part of the brain that was being used, rather than active. Some referred to oxygenated blood rather than oxyhaemoglobin.

(iii) Explain how fMRI can be used to identify the part of the brain involved in interpreting information from the visual cortex.

**(3)**

FMRI works by detecting ~~to~~ the level of blood flow (and therefore the level of oxygen) in the brain. When an area in the brain is more active, more blood is redirected to that area so that enough oxygen is transported to be used for energy. This level of oxygen is picked up by the scanner to highlight the areas of the brain that are the most active such as when interpreting the information from the visual cortex the cerebellum of the brain becomes more active.

**ResultsPlus**
**Examiner Comments**

This is a clear answer that gains 2/3 marks for explaining that fMRI detects blood flow in the brain, and makes the link with active areas of the brain requiring more oxygen. Although it states that the oxygen level is picked up by the scanner, there is no mention of oxyhaemoglobin so the 3rd mark cannot be awarded.

(iii) Explain how fMRI can be used to identify the part of the brain involved in interpreting information from the visual cortex.

**(3)**

fMRI looks at brain functions by following the uptake of oxygen in the blood. The patient could be asked to look at a picture or something visual. This means the part of the brain responsible for vision (occipital lobe) will be activated so as neural activity increases at that part of brain, increased blood flow and so increased oxygen levels at that site will follow. Since oxyhaemoglobin doesn't absorb radio waves but deoxyhaemoglobin does, these radio waves / signals will be detected and the signals will create an image on the computer as brightly coloured spots corresponding to the location of activity of brain. The brightly coloured areas will be seen as in occipital

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Examiner Comments

A clear answer that gains 3/3 marks.

## *Question 4 (b)*

This question asked about the role of visual stimulation in the development of the visual cortex. It is a describe question and on the specification, but many candidates showed a lack of knowledge, giving a very general account and failing to realise the importance of the synapses and connections that are made during the critical period. Many candidates failed to score on this question, but the majority of those that did gained 1 mark for describing ocular dominance columns.

(b) Describe the role of visual stimulation on the development of the visual cortex during the critical period.

Stimulation is required to trigger cell signalling, that results in the transcription and translation of proteins that will trigger the development of ocular dominance columns in the visual cortex. This will only occur if the stimulation is provided during a critical window of development (3)

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**Examiner Comments**

This answer gained 1/3 for the development of ocular dominance columns.

(b) Describe the role of visual stimulation on the development of the visual cortex during the critical period.

**(3)**

There are already existing ocular dominance columns in the visual cortex that have overlaping axons but are still not refined (from genes - nature). When visual stimulation occurs the neurones are stimulated and are able to strengthen their synapses when axons are fired. This allows refinement of the columns (L, R, LR) as information from the retina reaches the visual cortex through the thalamus. If these synapses are not used and axons are not fired because of absence of stimulation there will be no development during the critical period and there will be permanent impairment of vision.

**ResultsPlus**
**Examiner Comments**

This is a clear answer that gains 2/3 marks for describing the ocular dominance columns and indicating that the neurones synapse with these cells. It doesn't quite gain the 3rd mark because it is not clear that the connections are strengthened, or that there are more synapses.

## *Question 5 (a)*

This question asks how thermoregulatory mechanisms are controlled in marathon runners. Many candidates lost marks because they simply described the thermoregulatory mechanisms rather than saying how they are controlled. They often made mention of vasodilation, but no link was made to an increase in blood flow, or to sweating without the link with impulses to the sweat glands. Most candidates understood that the hypothalamus controls thermoregulation, but many failed to link it to the heat loss centre.

**5** Athletic competitions often take place during the summer months when ambient temperatures are high.

High ambient temperatures affect marathon runners.

Heat stress occurs when the core body temperature rises above 40 °C.

(a) Describe how thermoregulatory mechanisms are controlled to help marathon runners avoid heat stress.

**(4)**

If the Skin receptors send impulses to the thermoregulatory Centre in the hypothalamus, this sends ~~information~~ impulses to the effectors, for example if impulses are sent to smooth muscle cells so vasodilation occurs this means more heat ~~radiated~~ radiated at the surface of the skin. Sweat glands are stimulated so sweats is evaporated to have a cooling effect on body. ~~As~~ Hair Adrenal glands and ~~hair~~ hair on the skin aren't stimulated and remain erected. This means the norm levels can be reached.

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Examiner Comments

This answer gains 2/3, for the thermoregulatory centre in the hypothalamus and stimulation of the sweat glands. Although there is a reference to vasodilation, there is no explanation that this increases blood flow to the skin, so the marks cannot be given.

when the temperature is too high, the following occurs:

1. to norm value
↓temperature increases

2. the increase in temperature is detected by thermo receptors.

3. thermoreceptors generate and send an impulse to the hypothalamus

4. the impulses are then sent to the effectors (muscle or glands) to counter act that change. The sweat glands are stimulated in to produce sweat which would cool the body by evaporation. Vasodilation occurs where the shunt vessels cause the arteriole walls to relax, the blood flowing through the arterioles causes them to dilate. This means that more blood is ~~can~~ transported to the skin surface and thermal energy is lost/transferred. The erector muscles relax ~~to~~ causing the hairs to lie flat which would then prevent convection from occuring.

5. the temperature returns to the norm value.

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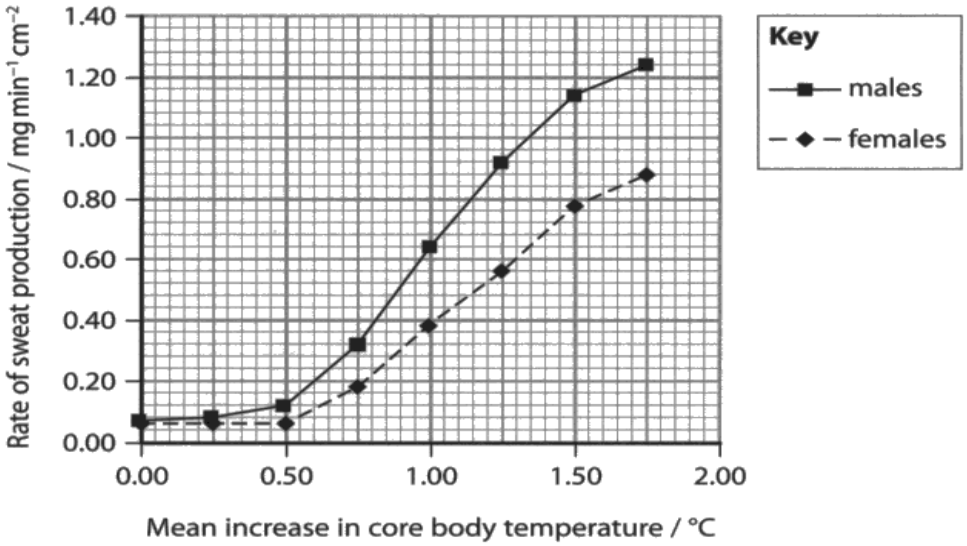
This answer gains 3/3 marks. It states that thermoreceptors detect the rise in temperature, sweat glands are stimulated and vasodilation directs blood towards the surface of the skin.

# *Question 5 (b)*

This question asked candidates to comment on how gender could affect thermoregulation, based on three pieces of information they were given. One piece of information was in the form of a graph, and many candidates focused only on this data. Others tried to link all the information to the graph. Many candidates scored only 1 mark, for stating that sweat production is higher in men than women. Marks were also lost because there was a reference to cooling, rather than heat loss, or to more rather than faster heat loss.

(b) Physical and physiological differences between males and females affect thermoregulation.

The graph shows the effect of a mean increase in body temperature on the rate of sweat production by males and females.




Female marathon runners have smaller bodies, with a larger ratio of skin surface to body mass than males.

Male marathon runners have less body fat than females: 5–11% compared with 10–15%.

Comment on how gender could affect thermoregulation in marathon runners.

**(4)**

Females have a lower rate of sweat production than men as core body temperature increases. Females have larger ratio of skin surface to body mass meaning that ~~sweat~~ production ~~is~~ distributed all over the body so evaporation occurs faster. whereas for men there's is vice versa. Male marathon runners have less body fat so this means during excersise (running) more proteins will be broken down rather than fat, to provide energy for respiring cells so more sweat is produced whereas in females they have more fat so rate of sweat production is less as more effort is spent breaking down the fats. So thermoregulation is more effective in men. But overall increase in both genders.

**ResultsPlus**
**Examiner Comments**

This answer gains 1/3 for stating that females have a lower rate of sweat production than males. Although there is a comment about both females having a larger ratio of skin surface to body mass and females having more body fat, this is linked to sweat production rather than rate of heat loss.

Femdle marathon runners have a higher ratio of skin surface to body mass therefore they can be able to release heat faster. Also female have a higher body fat percentage therefore they have more insulation during colder temperatures. Females produce less sweat than males because they have other ways to lose heat to surroundings. When blood vessels dilate, females would lose more energy to surrounding because they have higher skin surface to body mass ratio.

**ResultsPlus**
**Examiner Comments**

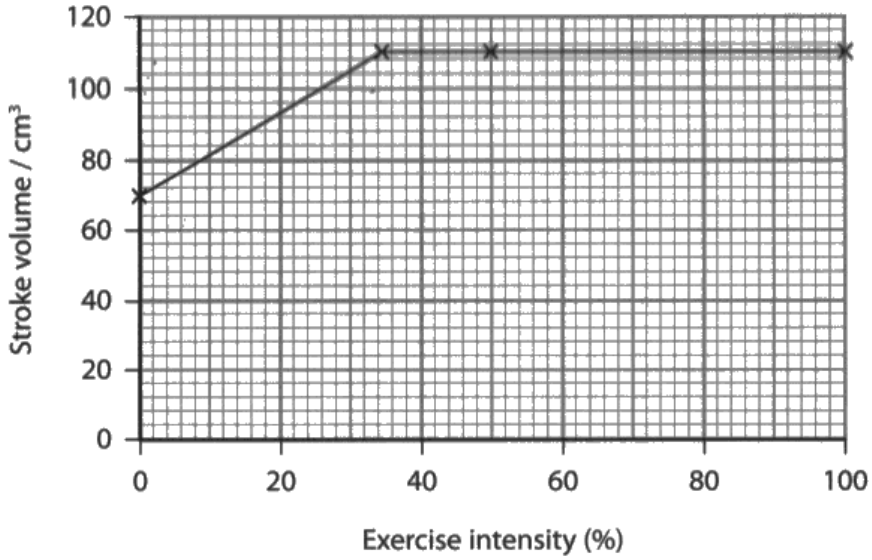
This is a clear answer that gains 2/3 marks for linking the skin surface to body mass ratio to rate of heat loss, and stating that females produce less sweat. The statement that more body fat gives more insulation in colder temperatures is not in the correct context, as the question is about preventing heat stress in marathon runners.

# *Question 5 (c) (i)*

This is a calculation question requiring candidates to take two sets of figures and manipulate them, then convert the answer into different units. The most common mark was 1 for 13750, as the units were not converted correctly.

(c) When running a marathon, both heart rate and stroke volume increase.

The graph shows the effect of exercise intensity on stroke volume for marathon runners.




(i) Cardiac output is the product of stroke volume and heart rate.

During a race, a marathon runner's exercise intensity increased from 0 to 100%. The table shows the effect on the runner's heart rate.

| Exercise intensity (%) | Heart rate / bpm |
|---|---|
| 0 | 55 |
| 100 | 160 |

Calculate the increase in cardiac output for a marathon runner during a race.

Give your answer in $dm^3 min^{-1}$.

**(2)**

110 x 160 = 17600 $dm^3 min^{-1}$

70 x 55 = 3850

17600 - 3850 = 13750 $dm^3 min^{-1}$

~~17600~~

..... $dm^3 min^{-1}$

**ResultsPlus**
**Examiner Comments**

The first stage of the calculation is carried out, with the workings clearly shown, but the conversion is not made. It scores1/2.

Cardiac output = heart rate (bpm) x stroke volume ($cm^3$)

$3850\ cm^3\ min^{-1} = 55 \times 70$

$17600 - 3850 = 13750\ cm^3\ min^{-1}$

13.75 $dm^3\ min^{-1}$

$1\ dm^3 = 1000\ cm^3$

$17600\ cm^3\ min^{-1} = 160 \times 110$

**ResultsPlus**
**Examiner Comments**

A correct answer with the working shown. 2/2.

**ResultsPlus**
**Examiner Tip**

Always show your working in a calculation question. The correct answer will always gain full marks, but if you have made a mistake in your workings, you may be given some credit if you have shown the stages you have taken.

## *Question 5 (c) (ii)*

This question asks candidates to explain why the cardiac output needs to increase during a marathon. Most candidates understood this, with many gaining full marks. A few missed the idea of more oxygen.

(ii) Explain why it is necessary for the cardiac output of marathon runners to increase during a race.

**(2)**

During race muscles are contracting energy is being used up, cells are respiring more quickly. Cardiac output must increase for demand of oxygen and energy to be met.

**ResultsPlus**
**Examiner Comments**

This response gains 1/2 for the increased demand for energy. It does not state that **more** oxygen is required, so that mark cannot be given.

(ii) Explain why it is necessary for the cardiac output of marathon runners to increase during a race.

**(2)**

because their muscles require excess oxygen so they can keep respiring aerobically, so they need increased blood flow

**ResultsPlus**
**Examiner Comments**

This answer gains 2/2, for more oxygen for aerobic respiration.

# *Question 6 (a) (i)*

This question asked candidates to deduce the effect of testosterone on muscle size, based on the information given. Most candidates gained 1 mark for stating that testosterone increased the size of the muscle but only the better candidates went on to state clearly that the greatest increase was with testosterone and exercise. Many candidates recognised that there was a link between the SD and significance of the results, but very few correctly stated that the results for testosterone and exercise showed a significant difference because the SDs don't overlap.

**6** Anabolic steroids and testosterone have been used as performance-enhancing drugs by some athletes. These drugs can increase muscle mass and strength.

(a) An investigation was carried out to assess the effect of doses of testosterone on muscle size.

A group of men was randomised into four groups: A, B, C and D. Groups A and B were given a placebo. Groups C and D were both given doses of testosterone. Groups A and C had no exercise training. Groups B and D were given exercise training.

The cross-sectional area of the triceps muscle of each individual was measured at the start of the investigation and after 10 weeks.

The results are shown in the table.

| Muscle | Mean cross-sectional area of muscle / $mm^2$ ± SD | | | |
|---|---|---|---|---|
| | Group A Placebo without exercise | Group B Placebo with exercise | Group C Testosterone without exercise | Group D Testosterone with exercise |
| Triceps – at the start | 3621 ± 213 | 4052 ± 262 | 3579 ± 260 | 3483 ± 217 |
| Triceps after 10 weeks | 3539 ± 226 | 4109 ± 230 | 4003 ± 229 | 3984 ± 239 |

57 424 501

(i) Deduce the effect of testosterone on the size of the triceps muscle.

**(2)**

Testosterone caused for ~~se~~ size of triceps to increase with or without exercise. The Group D increased cross-sectional area by 501 $mm^2$ ± 510, while group B whom were given a placebo and same amount of exercise ~~the~~ only increased by 57 $mm^2$ ± 492. Hence showing that testosterone greatly affects size of muscle growth.

**ResultsPlus**
**Examiner Comments**

This response gains 1/2 for stating that testosterone increases muscle size. Although there is an attempt to compare the figures, this is not linked to the SD so no mark is awarded.

Group C and D with testosterone caused a much greater increase in tricep muscle size than those using the placebo. However the group that had both testerone and exercise saw the largest increase on tricep muscle size.

**ResultsPlus**
**Examiner Comments**

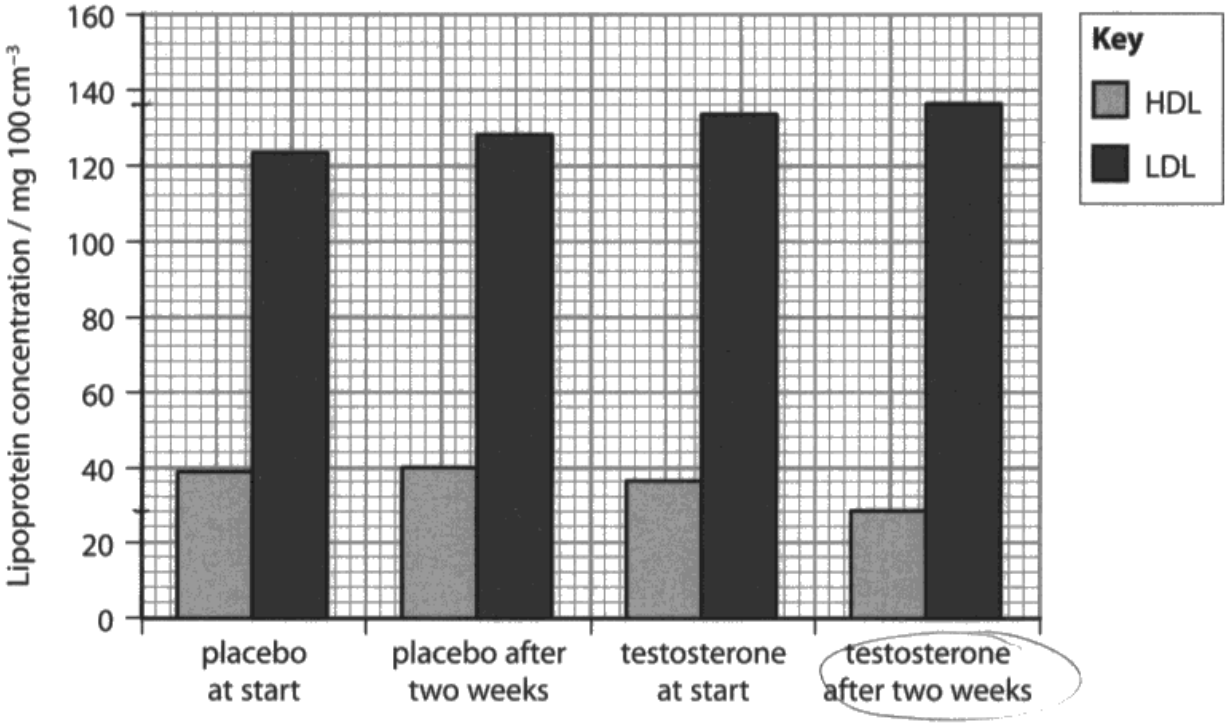
There is a clear statement that testosterone increases muscle size, and the greatest increase is in combination with exercise, so this response gains 2/2.

# *Question 6 (b) (i)*

This is a fairly straightforward calculation that requires candidates to read 2 figures off a graph, add them together and calculate a ratio. Many candidates gained full marks, however marks were lost when candidates failed to add the figures together before calculating the ratio.

(b) In another investigation, groups of men were given either a placebo or 300 mg of testosterone per week for two weeks. The concentrations of different lipoproteins (HDL and LDL) in the blood were measured at the start of the investigation and after two weeks.

The results of the investigation are shown in the graph.




(i) The ratio of total cholesterol to HDL is used as an indicator of the risk of cardiovascular disease. The higher the ratio of total cholesterol to HDL, the greater the risk.

In this investigation, the men given the placebo had a total cholesterol to HDL ratio of 4.2:1 after two weeks.

Calculate the ratio of total cholesterol to HDL for those taking testosterone after two weeks.

(2)

HDL ⇒ 28 mg
LDL ⇒ 136
total ⇒ 164

∴ ratio ⇒ 164 : 28
⇒ 5.9 : 1
(2 s.f.)

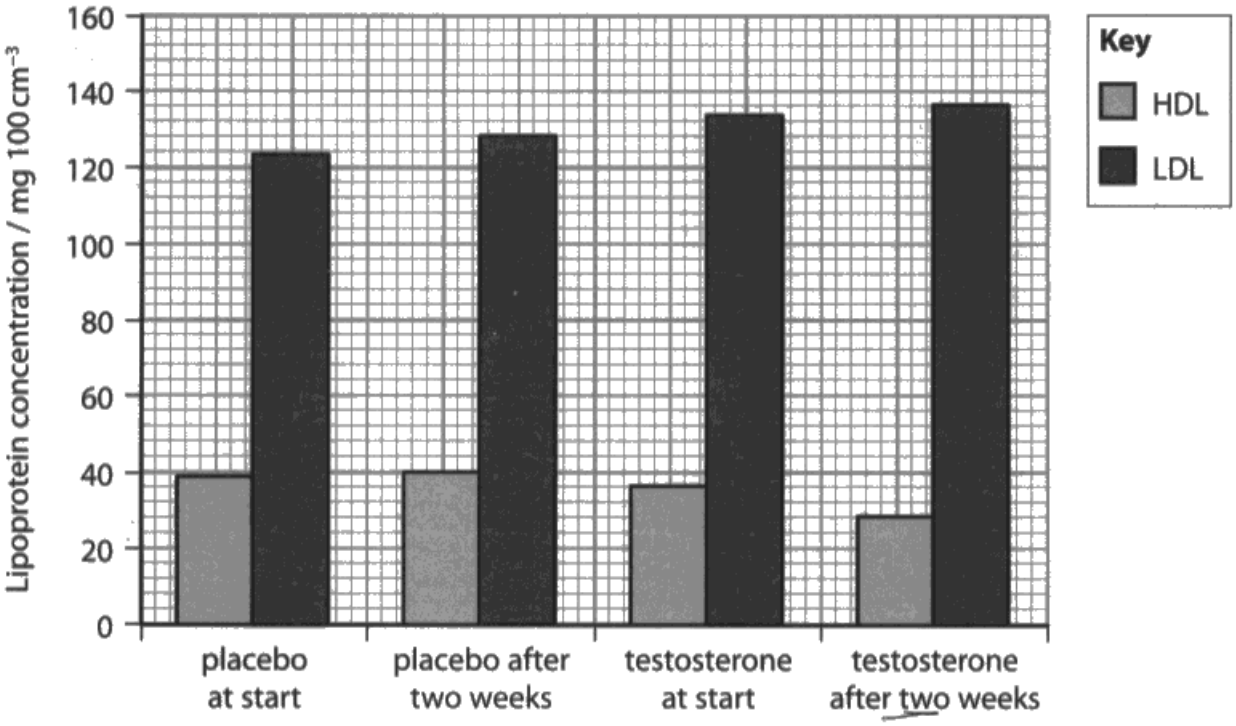
Ratio of total cholesterol to HDL 5.9 : 1

**ResultsPlus**
**Examiner Comments**

A correct answer, clearly set out to show the working. 2/2.

(b) In another investigation, groups of men were given either a placebo or 300 mg of testosterone per week for two weeks. The concentrations of different lipoproteins (HDL and LDL) in the blood were measured at the start of the investigation and after two weeks.

The results of the investigation are shown in the graph.




(i) The ratio of total cholesterol to HDL is used as an indicator of the risk of cardiovascular disease. The higher the ratio of total cholesterol to HDL, the greater the risk.

In this investigation, the men given the placebo had a total cholesterol to HDL ratio of 4.2:1 after two weeks.

Calculate the ratio of total cholesterol to HDL for those taking testosterone after two weeks.

41 : 7 28+136 : 28 164 : 28

**(2)**

Ratio of total cholesterol to HDL 41 : 7

ResultsPlus
Examiner Comments

This candidate correctly carried out the first stage, but 41:7 is not the correct way to express a ratio. 1/2.

## *Question 6 (b) (ii)*

This is the first of the extended writing questions on this paper. These level based questions, which were introduced for the first time last year, require students to make use of several pieces of information, in this case to explain why the use of testosterone as a performance enhancing drug poses a risk to health.

Students are required to analyse the scientific information and link it to their knowledge and understanding. Level 2 can only be achieved if more than one piece of information is analysed, with a greater degree of structure to the scientific reasoning. Candidates who develop a sustained argument, considering all of the information, reach level 3.

Many candidates reached level 2 by considering at least 2 of the effects of testosterone and explaining why this could increase the risk of CVD. Some candidates were able to develop these arguments to show sustained reasoning, making use of all the information they were given and achieving level 3. However, some candidates restricted themselves to a low level 2 at best because they focused on only one piece of information and developed that in detail. Several candidates addressed all of the content but did not say the use was unacceptable so missed out on maximum marks.

*(ii) Doses of testosterone are used to enhance performance in sports by increasing muscle mass and therefore strength.

- Testosterone increases the activity of an enzyme in the liver that breaks down HDL.
- The production of cholesterol is catalysed by the enzyme HMG CoA reductase (HMGCR).
- Testosterone increases levels of mRNA for HMGCR.

Explain why using testosterone as a performance-enhancing drug is unacceptable in terms of risks to health.

**(6)**

Testosterone is a steroid hormone. It reduces HDL levels in blood meaning so less cholesterol removed from blood LDL: HDL increases so more LDL cholesterol in the blood this ~~meat~~ is dangerous as if the wall of artery becomes damaged there is a higher risk of LDL cholesterol depositing on the wall of the damaged artery and so leading to atherosclerosis or thrombosis. So higher risk of developing CHD / CVD. Since testosterone increases levels of mRNA for HMGCR this means that once translated ~~more~~ lots there will be higher levels of this enzyme protein ~~so~~ which will catalyse a higher production of cholesterol. Once again ~~too~~ too much cholesterol in the blood can reduce sensitivity of cells to insulin and so increased risk of developing type II diabetes. Also increased risk of becoming obese and developing CHD since increased depositions of ~~cholesterol~~ cholesterol on damaged artery so more atheroma forming and ~~leading~~ leading to increased blood pressure.

**ResultsPlus**
**Examiner Comments**

This answer describes the effects of cholesterol, such as reduction in HDL levels and an increase in cholesterol, which can lead to CVD. It goes on to link the role of HDL in removing cholesterol and the effect of this on atherosclerosis, also the effect of the enzyme HMCGR. This is a good level 2 answer gaining 4/6.

As HDL is broken down less cholesterol is removed from the blood stream and taken into the liver to be broken down. As mRNA for HMGCR levels increase more HMGCR will be made and more cholesterol will be produced. This will lead to more cholesterol in the blood stream of the athlete. As LDL bind to cholesterol LDL receptors on the cells will become saturated and no more cholesterol will be taken into the cells. This will increase the chance of atherosclerosis as if an arteries endothelium is damaged an inflammatory response will occur leading to the accumulation of cholesterol forming an atheroma. This will lead to calcium salts and fibrous tissue to accumulate forming a plaque increasing blood pressure as the artery is narrowed and is less flexible. This will begin a dangerous positive feedback response as the higher pressure will lead to more damage and atherosclerosis this may occur in the coronary arteries or the carotid artery leading to a heart attack or a stroke if a blood clot forms.

ResultsPlus
Examiner Comments

This level 3 answer makes use of all the information given. It describes the effects of testosterone, then goes on to make linkages between the lack of HDL to remove cholesterol to the liver, the increase in LDL and its role in atherosclerosis. Sustained scientific reasoning can be seen in the detailed explanation of the harm to health.

This is given 5/6

## *Question 7 (b) (i)*

Few candidates gained full marks on this calculation question. Errors included careless mistakes such as incorrectly reading from the table. There was some confusion on whether to multiply by 850 or divide.

(b) During hibernation, the core body temperature of an arctic ground squirrel can fall from 37 °C to −3 °C.

The table shows the effect of air temperature on the metabolic rate in the arctic ground squirrel.

| Air temperature / °C | Metabolic rate / $cm^3$ oxygen $g^{-1}$ $hour^{-1}$ |
|---|---|
| −16 | 0.18 |
| −8 | 0.08 |
| −4 | 0.04 |
| 0 | 0.02 |
| 4 | 0.02 |
| 8 | 0.02 |
| 12 | 0.02 |

(i) Calculate the change in metabolic rate for an arctic ground squirrel, with a body mass of 850g, as the air temperature increases from −16 °C to 4 °C.

Give your answer in $dm^3$ oxygen $day^{-1}$.

**(3)**

0·18 − 0·02 = 0·16 $cm^3$ /1g /1 ~~g/hour~~

$\frac{0.16}{1000}$ /850g/24 hrs

$1.6 \times 10^{-4}$ ~~×~~ 850 g

0.136$dm^3$ ×24

= 3.264 3.264 $dm^3$ oxygen $day^{-1}$

**ResultsPlus**
**Examiner Comments**

A clearly set out correct answer. 3/3.

(850 x 0.18
= 153 x 24
= 3672 for -16
= 408 for 4

3672 - 408

3264 dm³ oxygen day⁻¹

**ResultsPlus**
**Examiner Comments**

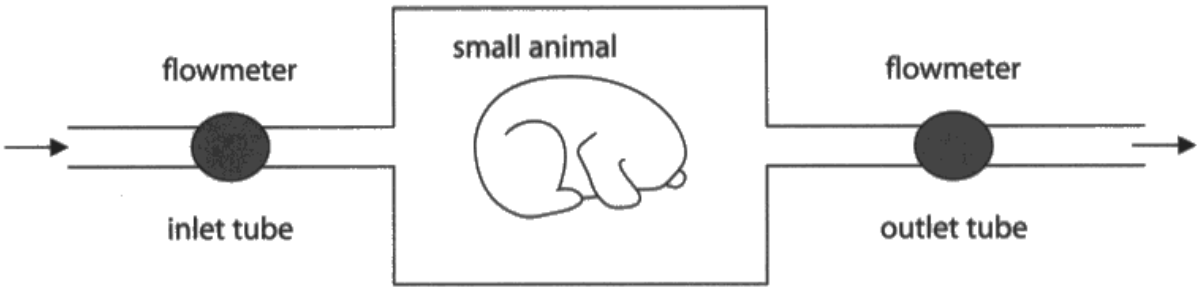
This answer gains 2/3 for correctly calculating the difference but failing to convert it to the correct units.

## *Question 7 (b) (iii)*

This question required candidates to devise a procedure using a continuous flow respirometer and an arctic squirrel. Students are expected to have used a respirometer to measure the rate of respiration and they had to apply this knowledge to a new situation. This was not answered well, with very few candidates gaining more than 2 marks, for the use of a suitable substance to absorb the carbon dioxide and controlling a variable. In most cases, candidates merely repeated the information, stating that they would measure the rate of flow rather than using this to measure the volume of air.

(iii) The data for calculating metabolic rate are collected using a respirometer.

The rate of respiration for small mammals can be measured using a continuous flow respirometer. A continuous flow respirometer circulates air through a chamber containing the animal. The rate of air flow can be measured using flowmeters on the inlet and outlet tubes.




Devise a procedure using a continuous flow respirometer to collect the data required to calculate the metabolic rate of an arctic ground squirrel.

(4)

Take 5 different squirrels that are of same BMI, same mass, from same species to have valid results. Use the flowmeter to find the rate of air flow every 30 minutes for 5 hours. Then take a mean to get more accurate results. Use a statistical test to compare them. Keep the temperature the same. Repeat the experiment. High rate of oxygen flow means low respiration happening as respiration uses oxygen.

ResultsPlus
Examiner Comments

This response gains 1/4 for controlling the temperature/using a stated period of time. Measuring the rate of flow is not the same as measuring the volume of air.

Place small animal in chamber and ~~open~~ place in a cold environment of -10°C. ~~Open tube~~ Connect the continuous flow respirometer to a manometer and outlet tube. Open the inlet tube to allow air in a measure for a set time (3 minutes) to movement of liquid as animal respires. ~~KO~~ KOH will be present to absorb any $CO_2$ (g) produced. Repeat in a warmer ~~climate~~ environment (10°C) and repeat both experiments twice. As oxygen uptake increases rate of metabolic increases too. Plot a line graph to calculate metabolic rate. Keep size of ~~animal~~ animal, time, temperature all constant.

ResultsPlus
Examiner Comments

This response gains 2/4 for the use of KOH to absorb the carbon dioxide, and giving a stated period of time. Although it says at the end to use a constant temperature, it has already said that it should be carried out at different temperatures so this mark couldn't be awarded here.

## *Question 8 (a) (iii)*

This is a describe question, asking students to describe the role of dendrites in a neurone. Considering this is taken from the specification, candidates generally had very poor knowledge, with general answers that scored very few marks. Many candidates could not identify the direction of transmission on a dendrite or state that an action potential is initiated.

(iii) Describe the role of the dendrites in a neurone.

**(3)**

Dendrites reciere the electrical impulses from other neurones (during synapses) and conducts the impulse either straight to the cell body or along a dendron to a cell body. Dendrites are part of the post-synaptic membrane and are involved when two neurones synapse with each other. Many dendrites allow efficient conduction of impulses and help to ~~integrate~~ carry information.

**ResultsPlus**
**Examiner Comments**

This response gains 1/3 for stating that dendrites receive impulses from other neurones. Although there are references to synapses, there is not a clear statement that dendrites synapse with other neurones. It is not enough to say that impulses are conducted to the cell body, it must be clear that the dendrites are involved in propagation.

(iii) Describe the role of the dendrites in a neurone.

**(3)**

Dendrites form a synapse with other neurons and they are what gain action potentials as when they are stimulated by neurotransmitters it creates an action potential however they initiate the impulse. In addition they are also responsible for releasing neurotransmitter into synaptic cleft so they are responsible for passing on the impulse.

**ResultsPlus**
**Examiner Comments**

This response gains 1/3 for stating that dendrites form a synapse with other neurones.

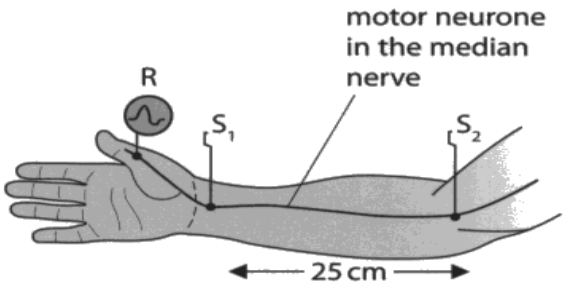
# *Question 8 (b)*

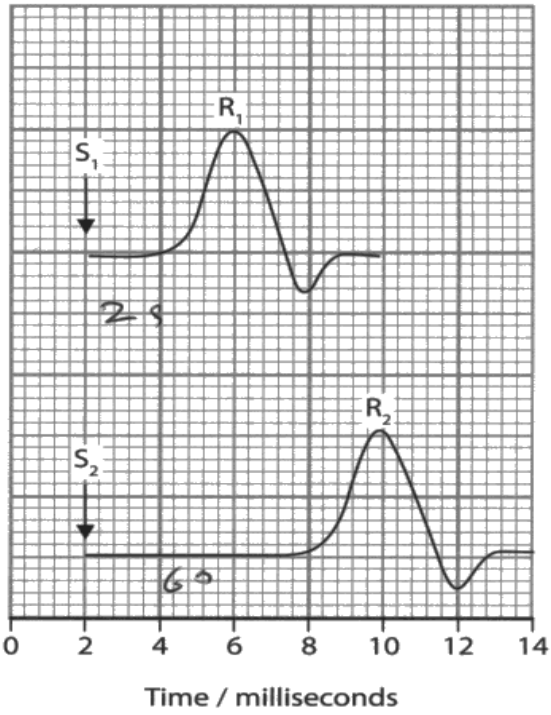
This is a straightforward calculation with an unfamiliar presentation of the data, and candidates struggled to correctly extract the correct information for the calculation. Many candidates failed to score. Again, the conversion to different units was often incorrect.

(b) The speed of conduction along a motor neurone can be calculated.

The time taken for a stimulus (S) to produce a response (R) further along the neurone is recorded.

Using two stimuli, a known distance apart, allows the speed of conduction to be calculated.




Calculate the speed of conduction for the neurone shown.

(2)

s D t

$\frac{25\text{ cm}}{4 \times 10^{-3}}$

6250

..... cm s$^{-1}$

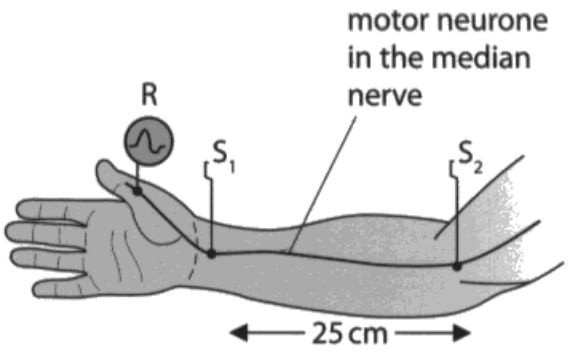
ResultsPlus
Examiner Comments

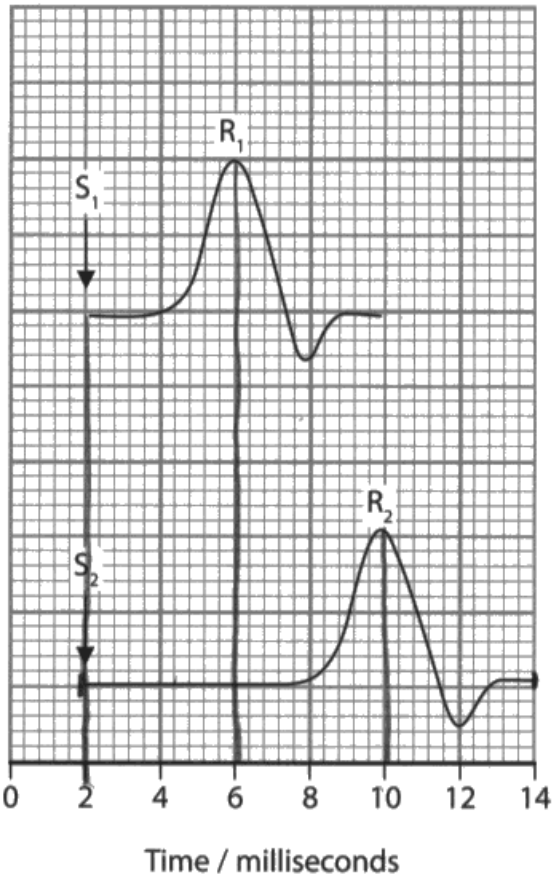
A correct answer gaining 2/2 marks.

(b) The speed of conduction along a motor neurone can be calculated.

The time taken for a stimulus (S) to produce a response (R) further along the neurone is recorded.

Using two stimuli, a known distance apart, allows the speed of conduction to be calculated.




Calculate the speed of conduction for the neurone shown.

(2)

$S_1$ : 6 − 2 = 4 ms

$S_2$ : 10 − 2 = 8 ms

$\frac{25}{8-4} = \frac{25}{4} = 6.25$

6.25 ..... $cm\ s^{-1}$

ResultsPlus
Examiner Comments

This candidate used the correct data to carry out the calculation but failed to convert to the units given. 1/2.

ResultsPlus
Examiner Tip

In a calculation, always check which units you are asked to give your answer in.

## *Question 8 (c)*

In this question, candidates were given information about a condition that effects the neurones, data showing the effect on the speed of conduction and asked to explain why this caused muscle weakness. It required an application of knowledge about the role of myelin in the transmission of nerve impulses. There were some good answers, with candidates applying their knowledge correctly. Most candidates gained at least 1 mark for stating that the speed of conduction is reduced in the motor neurone. Fewer candidates stated that there was no difference in the action potential. Some candidates have carried out manipulation of the figures. This is no longer awarded a mark in the new specification. Many candidates simply repeated information given in the stem of the question, without saying where the myelin is.

(c) In individuals with GBS, the immune system attacks and destroys the myelin sheath surrounding some neurones.

Neurone conduction was studied in an individual with GBS and in an individual without GBS. The results are shown in the table.

| Individual | Sensory neurone | | Motor neurone | |
|---|---|---|---|---|
| | Speed of conduction / metres per second | Size of action potential / mV | Speed of conduction / metres per second | Size of action potential / mV |
| With GBS | 54 | 35 | 39 | 10 |
| Without GBS | 58 | 33 | 63 | 10 |

Explain why GBS caused muscle weakness in this individual.

(4)

with GBS the speed of conduction in sensory and especially motor neurone is slower, ~~the~~ si compared to without GBS. This leads to muscle weakness as muscle are getting impulses too slowly ~~quickly~~ ~~and~~ For example at there's a 24 $ms^{-1}$ be difference between with GBS and without GBS in motor neurons. This is because ~~a~~ saltatory conduction can't happen if there's no myelinated sheath therefore it takes longer for impulses ~~to~~ to go to muscle to bring out movement. muscle aren't being stimulated quickly enough to

**ResultsPlus**
**Examiner Comments**

This response correctly states the speed of conduction in the motor neurone is slower, saltatory conduction can't happen, because there is no myelin sheath. 3/4

because speed of conduction in sensory neurone is less (4 m per second) compared to without GBS.

Also, in motor neurone the speed of conduction is 24 mps low than without GBS. So, the size of the action potential is same.

**ResultsPlus**
**Examiner Comments**

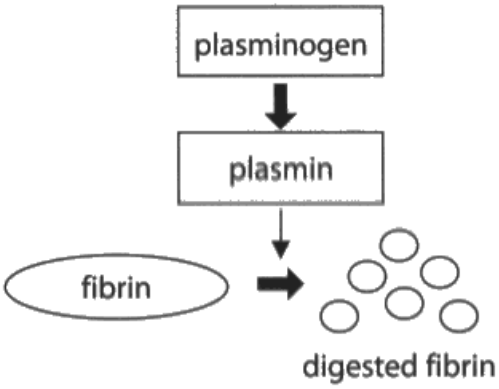
This candidate states that the speed of conduction in the motor neurone is less, but the action potential remains the same.

## *Question 9 (a)*

This question asked candidates to use the information they were given about blood clotting and the development of a drug to inhibit an enzyme in the clotting process, to explain the reduction of blood loss in surgery. Many candidates could describe the role of fibrin in blood clotting and the effect of the drug on the breakdown of fibrin, but very few recognised that this would cause blood clots to stay in place for longer.

**9** Plasmin is an enzyme that digests fibrin.

Plasmin is produced, in the blood, from an inactive form of the enzyme called plasminogen.




Pharmaceutical companies have developed drugs that inhibit the activity of plasmin.

One of these drugs, tranexamic acid, is used in surgery to reduce blood loss.

(a) Explain why tranexamic acid will result in reduced blood loss during surgery.

**(3)**

Fibrin is an insoluble molecule but is usal to create blood clots by allowing a mesh to be created. Tranexamic acid stops the insoluble fibrin from breaking down allowing for blood clots to form which results in less blood during surgery.

Incisions made during surgery increase blood loss but platelets and the fibrin stop the loss of blood.

**ResultsPlus**
**Examiner Comments**

This response gains 2/3 for stating that fibrin is involved in blood clotting and tranexamic acid prevents the breakdown of fibrin. Allowing blood clots to form during surgery is not the same as allowing clots to remain in place so this mark cannot be awarded.

tranexamic acid inhibits the activity of plasmin which means that it will not be able to digest fibrin. This means that during the surgery the ~~fibrin with~~ blood clotting process will occur and ~~fibrinogen will be converted thrombin~~ fibrin will be produced. #The fibrin will form an insoluble mesh which traps red blood cells and a blood clot will form. The blood clot will reduce the blood lost in the surgery through the insoluble fibrin mesh.

**ResultsPlus**
**Examiner Comments**

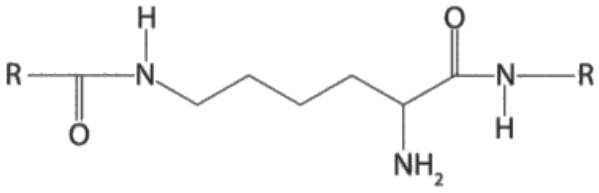
This response gains 2/3 for preventing the digestion of fibrin and the role of fibrin in blood clotting.

## *Question 9 (b)*

This question asks candidates to deduce why tranexamic acid prevents plasmin breaking down fibrin, based on information about the structure of lysine in fibrin and the structure of tranexamic acid. Students are expected to recognise the similarities and deduce that tranexamic acid acts as a competitive inhibitor. Not all candidates commented on the similar shape, even though they went on to explain that that the enzyme is inhibited. Some candidates thought the shape of the enzyme was changed, and in some cases marks were lost because candidates stated that tranexamic acid bound with the enzyme without mentioning the active site.

(b) The active site of the plasmin enzyme binds to the amino acid lysine on the fibrin protein molecule.

Plasmin binds to part of the fibrin molecule in order to break down the fibrin. The diagrams show the structure of lysine in the fibrin polypeptide and the structure of tranexamic acid.




Lysine in the fibrin polypeptide




tranexamic acid

Deduce why tranexamic acid prevents plasmin breaking down fibrin.

**(3)**

Tranexamic ~~be~~ acid has a similar structure to lysine and so will bind to the active site of the enzyme, preventing it from forming enzyme–substrate complexes with lysine. Through the induced fit-theory this is possible.

**ResultsPlus**
**Examiner Comments**

A clear answer that gains full marks. 3/3.

· Tranexamic acid will bind to the lysine molecule at the same active site that plasmin would use to bind to the lysine to break down the fibrin.
· Therefore tranexamic acid acts as a competitive inhibitor and prevents plasmin from binding to the fibrin, rendering plasmin inactive.

ResultsPlus
Examiner Comments

This response gains 2/3 for stating that tranexamic acid acts as a competitive inhibitor and prevents plasmin binding to the fibrin.

## *Question 9 (c) (ii)*

This was the second extended writing question on this paper, in which the marking was based on levels. It led on from the question about tranexamic acid as an inhibitor of plasmin. Candidates were given information about an investigation into the activity of plasmin in digestion of fibrin and asked to devise an investigation to compare the effectiveness of a new inhibitor with tranexamic acid. They had to apply their experience of using agar plates for microbiology to a completely new situation.

A level 1 answer gave details of methodology, such as cutting the wells, carrying out repeats and observing the size of the clear zones. Evidence of the linkages required to move to level 2 included the use of both inhibitors, mixing the plasmin with the inhibitors and comparing the 2 inhibitors. The sustained reasoning needed to reach level 3 could include details of how the comparison could be made, demonstrating an understanding of the effect of the inhibitors and the impact on the fibrin plate, and a suggestion that statistical tests could be used.

Many students limited their marks by failing to add plasmin. Most students managed to achieve level 1 by controlling the temperature and carrying out repeats.

*(ii) Scientists are developing new plasmin inhibitors.

Devise an investigation, using fibrin plates, to compare the effectiveness of a new inhibitor with tranexamic acid.

(6)

Pour fibrinogen and fibrin in agar plate. Make wells in the fibrin plate. ~~and also~~ Add ~~new~~ plasmin in the ~~so~~ wells with ~~the~~ different concentrations ~~of~~ of the new inhibitor, keep Concentration of plasmin the same and the concentration and volume of thrombin and fibrinogen. ~~Because~~ Have a Control with no ~~a~~ new inhibitor in the well. Then measure the length of ~~zone~~ the zone of of inhibition.

Do the same with tranexamic acid, make sure to use different concentration e.g. 0.5, 0.4, 0.3 etc, And ~~then~~ measure the length of ~~zone~~ clear zone.

~~Compare~~ Repeat experiments 3 times, and calculate a mean. using ~~a~~ ~~Student~~ T-test a statistical test calculate ~~the~~ significance. of

ResultsPlus
Examiner Comments

This answer gives details of the basic method for level 1, such as cutting wells in the plates and carrying out repeats. Linkages are demonstrated by using both inhibitors, mixing them with plasmin, comparing the size of the clear zones. It is a good level 2 answer.

It does not achieve level 3 because there is no sustained reasoning or sufficient development of the methodology.

It scores 4/6.

*(ii) Scientists are developing new plasmin inhibitors.

Devise an investigation, using fibrin plates, to compare the effectiveness of a new inhibitor with tranexamic acid.

**(6)**

Take a petri dish contain agar gel that contains fibrin and plasmin. Then at each well add increasing concentrations of tranexamic acid at: 0, 0.1, 0.2, 0.3, 0.4, 0.5. Leave it for 24 hours and examine the size of zone of inhibition. Do the same same but using different inhibitors. Repeat the experiment for each concentration and calculate the mean. Now find the area of the zone of inhibition and compare them. If the new inhibitor decreases the zone of inhibition more than the tranexamic acid, the new drug is more effective as it can inhibit more plasmin. To make the experiment valid, use same volume of tranexamic acid for all wells, keep same temperature throughout the experiment. Use same source of fibrin. Also use student's t test to compare the mean of the data from the 3 different types of inhibitor.

ResultsPlus
Examiner Comments

This is a detailed answer which makes full use of the information given and applies it to show sustained reasoning. It is a level 3 answer.

There are details of the methodology, controlling the temperature, carrying out repeats (L1)

Linkages are demonstrated by adding plasmin to the fibrin plate, using the same volume of both inhibitors, comparing the zones of inhibition (L2)

This answer then goes on to explain that the smaller the clear zone is the more effective the inhibitor, demonstrating sustained reasoning. It suggests the use of a statistical test.

It was given 5/6.

## *Question 10 (b)*

This is a straightforward question that asks candidates to describe what happens to lysosomes when their contents have been digested. Many were able to say that they left the cell by exocytosis, fewer went on to say this was by fusing with the cell membrane.

(b) Describe what happens to lysosomes once their contents have been digested.

**(2)**

The ~~enzymes~~ lysosome releases the byproducts from the cell by exocytosis

**ResultsPlus**
**Examiner Comments**

This answer is given 1/2 for exocytosis.

(b) Describe what happens to lysosomes once their contents have been digested.

**(2)**

They ~~fuse~~ fuse with a membrane, either the cell membrane to remove digested products by exocytosis or the cell and cause the exist.

**ResultsPlus**
**Examiner Comments**

This answer gets 2/2 for stating that the lysosome fuses with the cell membrane and removes the products by exocytosis.

Although there is some suggestion it is not always the cell membrane, no other membrane is mentioned so the mark can be given.

## *Question 10 (c) (i)*

This question asked students to explain how a single base mutation could alter the primary structure of an enzyme. Many candidates gained only 1 mark, for the altered sequence of amino acids, and then went on to explain how this changed aspects of the folding etc, which is not what this question asks for. There were references to changes in the mRNA, but not in the codon.

(c) More than 50 different mutations in the gene for enzyme G have been found to result in MPS I. Most of these mutations involve changing a single base in the gene.

(i) Explain how a single base mutation can lead to an altered primary structure of enzyme G.

**(3)**

The triplets changes, this changes the resulting amino acid. The poly peptide chain will contain a new amino acid, hence a changed primary structure. The gene has a mutation, the MRNA produced from it will have a different codon. The tRNA will transport an different amino acid corresponding to the new anticodon. The resulting aminoacid will be diffent as triplets (codon) are specific for a particular amino acid.

**ResultsPlus**
**Examiner Comments**

This answer is given 2/3 for stating that there will be a different amino acid in the primary structure because the mRNA will have a different codon. Although there is a reference to a change in the triplet, this mark cannot be given because it doesn't say triplet **code**.

(c) More than 50 different mutations in the gene for enzyme G have been found to result in MPS I. Most of these mutations involve changing a single base in the gene.

(i) Explain how a single base mutation can lead to an altered primary structure of enzyme G.

**(3)**

A single base mutation can lead to the insertion of a base that can create the stop codon. This means a short protein chain is going to be produced. It can also cause the amino acid produced to be different which means a different primary structure of enzyme G is produced.

**ResultsPlus**
**Examiner Comments**

This answer is given 3/3 for insertion of a base, creation of a stop codon ( both suitable alternatives from the additional guidance) and a different amino acid.

## *Question 10 (c) (ii)*

This question asked how a mutation associated with a genetic condition could be identified using human genome sequencing. Students were expected to base their answer on a comparison of people with and without the condition. This question was poorly answered, with the majority of students thinking that this could be achieved by use of the human genome project. Several referred to gel electrophoresis or PCR.

(ii) Explain how human genome sequencing can be used to identify the mutations associated with MPS I.

**(3)**

HGS can be used to see all the genes present in human DNA. Hence a ~~sequence~~ sequencing can be done from a healthy individual and it can be compared to a person with MPSI. The differences can be compared to find the gene responsible for the condition and also identify the type of mutations that are causing the disease. Human genome sequence allows to see all the gene in human DNA and to store in data base that can be used.

**ResultsPlus**
**Examiner Comments**

This answer is given 1/3 for the sequencing of a person with MPS1. The mark is not given for sequencing people without MPS1 because it must be more than 1 person, and the comparison must be of **base sequences**.

(ii) Explain how human genome sequencing can be used to identify the mutations associated with MPS I.

**(3)**

A human without MPS 1 can have their genome sequenced ~~an~~ along with a person with MPS1. This means that all the base pairs on both humans can be identified and their base sequence can be compared and we can identify the change in base sequence which caused ~~the~~ MPS 1.

**ResultsPlus**
**Examiner Comments**

This answer is given 2/3, for sequencing someone with MPS1 and comparing the base sequence with someone who doesn't have it. Unfortunately they only state that one person without the condition should be sequenced, so this mark cannot be given.

## *Question 10 (d) (i)*

This question asks students how a short sequence of RNA could be produced to treat someone with MPS1. The answer required is transcription, using RNA nucleotides or RNA polymerase. However, many students went in completely the wrong direction, talking about PCR, genetic modification of bacteria and inserting DNA without the mutation.

(d) A biotechnology company is developing a method of repairing the mutations in the gene for enzyme G.

The method being developed is called CRISPR-Cas9.

In this method, a short sequence of RNA binds to the DNA containing the mutation responsible for MPS I.

This RNA acts as a guide to enable the Cas9 enzyme to bind to DNA.

This enzyme can then cut and repair the DNA, removing the mutation.

(i) Describe how scientists could produce this short sequence of RNA needed to treat someone with MPS I.

**(2)**

They can produce it using genetic modification by isolating the MPS I cutting it out with restriction enzymes and then repair the DNA with the RNA.
Short sequence RNA can be produced by isolating the fragment using gel electrophoresis and DNA fragmentation.

**ResultsPlus**
**Examiner Comments**

This is typical of many of the responses seen. It gains 0 marks.

Transcription can be used to make RNA. The RNA will be a complementary copy of the mutated DNA sequence, hence by complementary base pairing, it will bind to DNA and the CRISPR-Cas9 will follow it.

ResultsPlus
Examiner Comments

This student understood the question and gains 1/2 for stating that RNA will be transcribed from the mutated DNA sequence. Unfortunately it does not go on to say how this will be done.

## *Question 10 (d) (ii)*

This question asks students to explain why this treatment is an example of personalised medicine. Very few students gained the 2nd mark because they did not make the link with all the different possible mutations.

(ii) Explain why the use of CRISPR-Cas9 technology can be described as personalised medicine.

**(2)**

The treatment can only affect those with the specific Mutation of MPS I making it personalised to one mutation only.

**ResultsPlus**
**Examiner Comments**

This answer is given 1/2 for the specific mutation.

(ii) Explain why the use of CRISPR-Cas9 technology can be described as personalised medicine.

**(2)**

Different people will have different mutations for the condition, hence specific CRISPR-Cas9 will be produced ~~to~~ to repair specific mutations. Hence it will work only on one person, not for all people. ✓

**ResultsPlus**
**Examiner Comments**

This answer is given 1/2 for the specific mutation.

## Paper Summary

Based on their performance on this paper, candidates are offered the following advice:

- make sure that all aspects of all the topics are revised thoroughly
- read all the information provided, and make full use of it to answer the question
- analyse the data and use it in the correct context, don't just quote figures
- learn the command words and the types of answers expected
- read the whole question, identify the command word and the question
- give careful thought to calculations and the steps you need to take, then set out all your working carefully
- attempt every question - a gap will always score you 0
- make sure you add sufficient detail

# Grade Boundaries

Grade boundaries for this, and all other papers, can be found on the website on this link:

http://www.edexcel.com/iwantto/Pages/grade-boundaries.aspx

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