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# Examiners' Report
# June 2018

## GCE Biology 9BI0 02

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# Introduction

This was the second series of the new 9BI0 specification. Candidates generally found the paper more accessible than last year indicating that the majority of centres have come to terms with the style and demands of the new specification. The examiners commented on the excellent factual knowledge demonstrated by many candidates and the much improved understanding of all the command words. The new specification has more emphasis on analysis of data and candidates are gradually becoming accustomed to this change of emphasis. Mathematical skills were good although some candidates found the application of statistical testing challenging. It was also pleasing to see that most candidates have adapted to the terminal examination system whereby topics 1 - 4 along are examined alongside topics 8 - 10. Time pressure is still an issue for many candidates and it is important that candidates look carefully at the mark allocation of each question and do not spend too long on some questions.

Successful candidates:

- Showed excellent, detailed knowledge of all areas of the specification
- Understood what each of the command words required
- Were able to apply the chi-squared test
- Were able to analyse data and draw appropriate conclusions
- Worked at a good pace and wrote answers that reflected the mark allocations

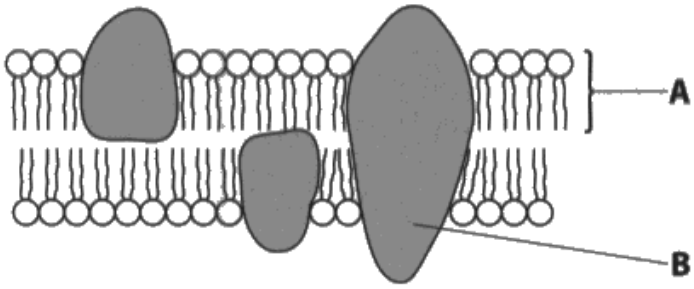
Less successful candidates:

- Tended to use GCSE level detail in their answers
- Did not appreciate the meanings of the different command words
- Tended to work at an uneven pace and so spent too long on some questions leaving little time to complete the paper
- Did not analyse data correctly

## *Question 1 (a)*

The majority of candidates were able to correctly state that structure A was a phospholipid and B was a protein. A range of correct suggestions for structure B, such as channel protein or carrier protein, were accepted. Some candidates did not score as they did not indicate which structure was the phospholipid and the protein. A minority of candidates got the structures the wrong way round and a few thought that B represented cholesterol.

**1** The diagram shows the structure of a cell membrane.




(a) Name the parts labelled **A** and **B**.

**(1)**

A = phospholipid

B = intrinsic protein.

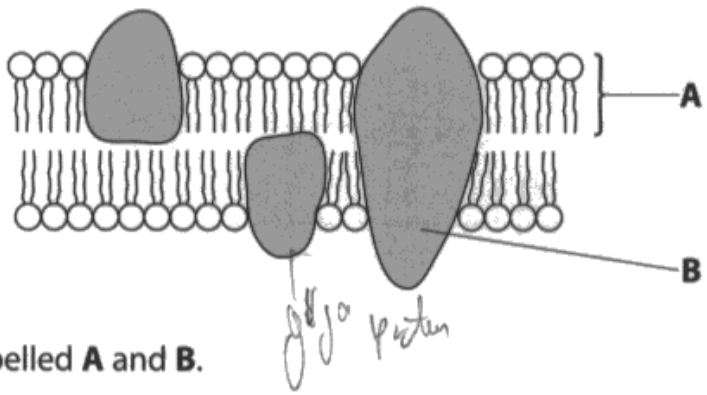
**ResultsPlus**
**Examiner Comments**

This is an example of a response that correctly identifies the structures. It gained one mark.

**ResultsPlus**
**Examiner Tip**

Make sure you give clear answers. In this question, it was important to state which part was A and which part was B.

**1** The diagram shows the structure of a cell membrane.




(a) Name the parts labelled **A** and **B**.

**(1)**

phospholipid

Protien

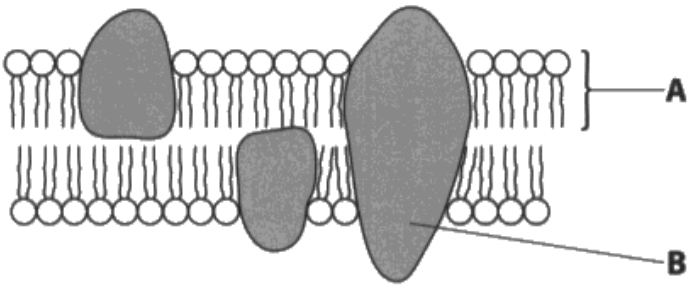
**ResultsPlus**
**Examiner Comments**

This response gained no marks as it was not clear which of the parts was A or B.

**ResultsPlus**
**Examiner Tip**

Make sure that your answers are clear so that an examiner knows what you are referring to.

**1** The diagram shows the structure of a cell membrane.




(a) Name the parts labelled **A** and **B**.

**(1)**

A - Phospholipid

B - channel protein ~~extrinsic~~ (intrinsic).

**ResultsPlus**
**Examiner Comments**

This was a correct answer that gained one mark. Both intrinsic and channel protein were acceptable answers.

## *Question 1 (b)*

This question tested candidates' knowledge of membrane structure and how it affects the transport of polar molecules. The question asked candidates to give an explanation rather than just a description of the membrane. Successful candidates demonstrated an excellent, detailed knowledge of the structure of the membrane and correctly referred to the hydrophilic nature of phosphate groups and hydrophobic nature of the fatty acid tails. A few candidates confused the terms hydrophobic and hydrophilic. Many excellent answers were seen that explained how charged polar molecules are unable to pass the fatty acid tails. Less successful answers often failed to give detail, other than the need for the carrier proteins, and rarely considered how the phospholipid bilayer would affect transport.

(b) Explain how the structure of the membrane controls the transport of polar molecules.

**(4)**

The lipid bilayer contains a hydrophobic tail which doesn't allow polar molecules to go through. Therefore, either via facilitated diffusion or active transport (ATP), the carrier proteins allows the polar molecule to pass through via the pores. Water is able to diffuse through the hydrophilic head thereby acting as a polar solvent, & allowing the polar molecules to pass through via osmosis.

ResultsPlus
Examiner Comments

This is a good answer that explains the hydrophobic nature of the fatty acid tails and how this prevents the passage of polar molecules. A correct reference to the role of carrier proteins is made. It gains three marks in total.

**ResultsPlus**
**Examiner Tip**

Make sure that you use scientific terms precisely in your answers. Terms like hydrophilic and hydrophobic are easily confused and you should be secure in your understanding of them.

(b) Explain how the structure of the membrane controls the transport of polar molecules.
**(4)**

- phospholipid bilayer (hydrophilic heads, hydrophobic tail(s)) allows movement of small polar molecules eg. water through membrane but not large polar molecules (by osmosis)
- channel proteins can allow facilitated diffusion of larger polar molecules
- extrinsic/surface proteins can be receptors to polar molecules trying to move through membrane → facilitated diffusion
- can be moved in via active transport = requires ATP

**ResultsPlus**
**Examiner Comments**

This is a good answer that gained two marks. Correct references to the hydrophilic head groups and role of carrier proteins are made but the candidate does not expand any further on these points.

**ResultsPlus**
**Examiner Tip**

Make sure that you explore all aspects of a topic rather than just one or two. Both breadth and depth are important in answers.

(b) Explain how the structure of the membrane controls the transport of polar molecules.

**(4)**

Cell membrane is composed of phospholipids, which is made up of a hydrophobic tail (Hydrogen carbon chain) and hydrophilic phosphate ion head. Many such phospholipids form a bilayer with hydrophilic head pointing out, hydrophobic tail pointing in. The phospholipid bilayer encloses cell content, giving cell content a unique compartment with unique conditions. Cell content are mostly not polar. For polar molecules to enter the cell they can diffuse passively via protein channels (extrinsic proteins) on the cell membrane. Only small charged ions, eg. potassium ions can do so. For larger polar molecules, they may also enter via passive diffusion through carrier proteins. For larger polar molecules, they have to be actively transported into molecule using energy from ATP at one of the carrier proteins / intrinsic protein. One example is voltage gated ions such as sodium.

**(Total for Question 1 = 5 marks)**

**ResultsPlus**
**Examiner Comments**

This is a strong answer that gains four marks. The idea of charge is linked with polar molecules and the candidate explains how hydrophilic head groups are found on the outside of the membrane. A correct explanation of the roles of carrier proteins is also included.

(b) Explain how the structure of the membrane controls the transport of polar molecules.

(4)

The phospholipid bilayer has a layer of phospholipids on either side, ~~each side is surrounded by water~~, with water in the middle. The head of the phospholipid is hydrophobic and the tail is hydrophillic. So the head stays away from the water and the tail is attracted to it. The tails face inwards towards the water and the heads face out from the water. There are large proteins that act as pumps, on the surface or the whole way across the membrane, these transport molecules across to where they're needed up the concentration gradient.

**ResultsPlus**
**Examiner Comments**

This answer gained no credit. The candidate has misunderstood the terms hydrophilic and hydrophobic and does not explain that the carrier proteins transport the polar molecules.

**ResultsPlus**
**Examiner Tip**

Use scientific terms accurately.

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

This question required candidates to demonstrate their knowledge of disaccharides. The diagram showed the structure of sucrose - candidates had to then state the two monomers (fructose and glucose) that it is composed of. Despite most candidates gaining credit, a surprising number suggested that the sucrose molecule was composed of two glucose monomers or glucose and galactose.

(ii) Name the monosaccharides produced from the breakdown of sucrose.

**(1)**

a glucose , a fructose

**ResultsPlus**
**Examiner Comments**

This answer gained one mark and the candidate correctly named glucose and fructose.

**ResultsPlus**
**Examiner Tip**

Make sure that you learn the factual content for all topics that may be tested on a particular examination.

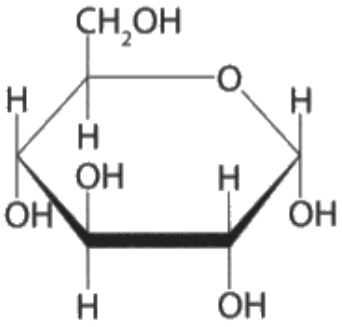
## *Question 2 (a) (iii)*

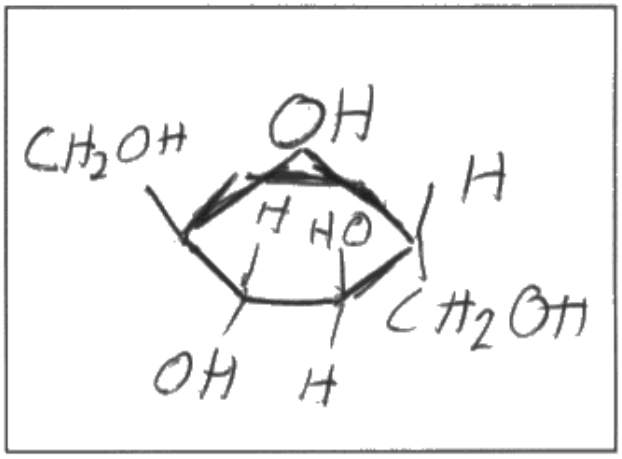
Many candidates found this question surprisingly challenging. It tested candidates' knowledge of hydrolysis reactions. Although it is not expected that candidates can reproduce the structure of fructose, it was given to them in the diagram of sucrose (and candidates are expected to know the structure of glucose). Successful candidates drew correct diagrams. Less successful candidates drew a range of incorrect structures including glucose and an attempt at fructose but with an H group instead of an OH group.

(iii) The diagram shows one of these monosaccharides.

Draw the structure of the other monosaccharide.

**(1)**




**ResultsPlus**
**Examiner Comments**

This answer gained zero marks. The candidate has drawn an incorrect structure and has also not added an OH group to the ring.

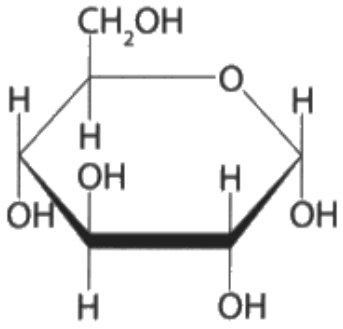
**ResultsPlus**
**Examiner Tip**

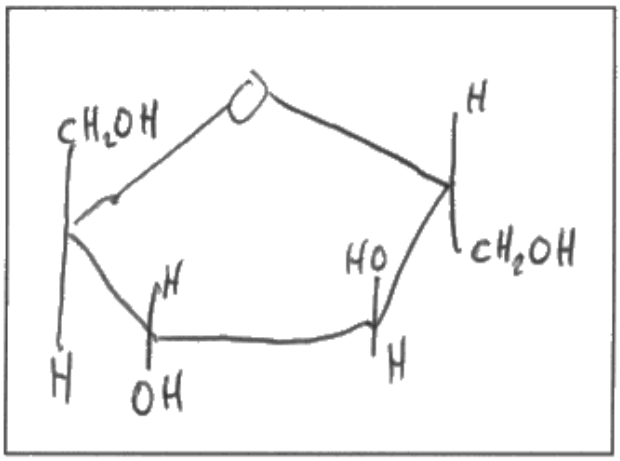
Take care with accuracy when drawing chemical structures.

(iii) The diagram shows one of these monosaccharides.

Draw the structure of the other monosaccharide.

**(1)**



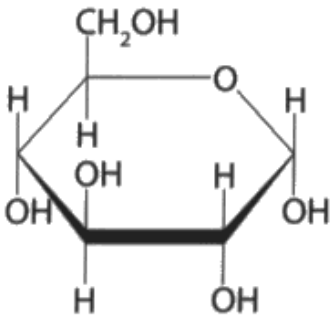

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**Examiner Comments**

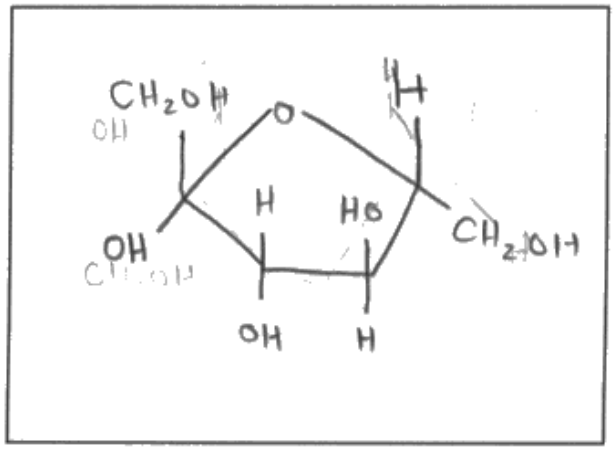
This answer gained zero marks as the candidate has added an H group instead of an OH group

(iii) The diagram shows one of these monosaccharides.

Draw the structure of the other monosaccharide.

**(1)**



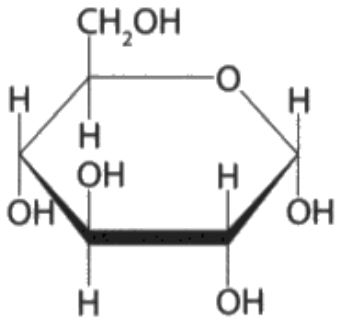
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**Examiner Comments**

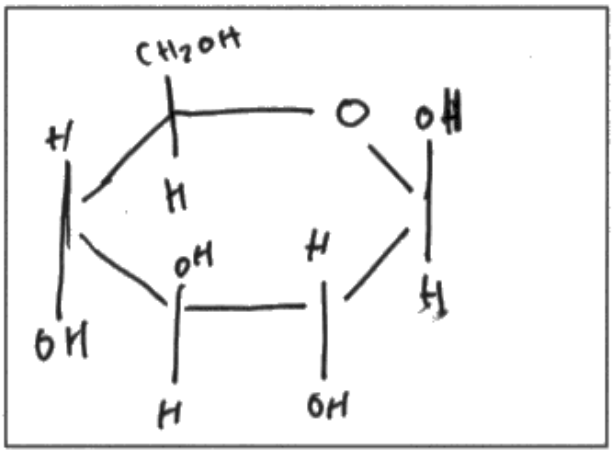
This is a correct structure and gained one mark.

(iii) The diagram shows one of these monosaccharides.

Draw the structure of the other monosaccharide.

**(1)**




**ResultsPlus**
**Examiner Comments**

This is an example of where a candidate drew the structure of glucose and gained zero marks.

**ResultsPlus**
**Examiner Tip**

Make sure that you know the composition of all the disaccharides.

## *Question 2 (c) (i)*

This question required candidates to compare and contrast the effect of two inhibitors on the activity of amylase enzyme. Pleasingly, most candidates now understand that the command, 'compare and contrast', requires both similarities and differences. Many candidates gained at least one mark. Where candidates did not gain both mark points, it was typically for not giving figures in their answer for mark point one - the effects of both inhibitors were similar up to approximately 32 md $dm^{-3}$. It is important at A-level to use figures in answers when giving a description. Most candidates appreciated the idea that the rate continued to rise with inhibitor A when amylose concentration was increased, but levelled off with inhibitor B.

(i) Compare and contrast the effects of these two inhibitors on amylase activity.

**(2)**

Inhibitor A causes a slower rate of maltose production whereas inhibitor B causes a slower rate and half the quantity of maltose.

**ResultsPlus**
**Examiner Comments**

This answer gained zero marks. There are no quantitative references and the contrasting of the effects of the two inhibitors is very vague. The candidate is not clear at which period the rate is slower. They have also only 'contrasted' the two inhibitor effects.

**ResultsPlus**
**Examiner Tip**

When describing data and graphs, you should be very precise and give a clear description of patterns and use data points. It is useful to use the labels on graph axes in your answers.

(i) Compare and contrast the effects of these two inhibitors on amylase activity.

**(2)**

As you can see inhibator B has a greater effect on than inhibator A. they both slow down the rate of maltose production for a period of time but inhibator A does reach the same leves of maltose production while B never gets above 16 $ag^{5-1}$.

**ResultsPlus**
**Examiner Comments**

This answer gained one mark for the idea that the rate with inhibitor A continues to rise but B levels off. No similarity is given so the candidate has only answered the 'contrast' part of the question.

(i) Compare and contrast the effects of these two inhibitors on amylase activity.

**(2)**

Both the inhibitors caused maltose to be produced however slowed ~~it~~ down the rate of reaction. Inhibitor A ~~took 38~~ required stopped the production of maltose at 78 $mg/dm^3$ whereas inhibitor B ~~stop the pr~~ caused the rate to plateau at 38 $mgdm^{-3}$

**ResultsPlus**
**Examiner Comments**

This answer gained one mark for the contrasting of the effects of the two inhibitors. There is no indication that the effects are similar up to an amylose concentration of approximately 32 mg $dm^{-3}$.

(i) Compare and contrast the effects of these two inhibitors on amylase activity.

**(2)**

inhibitor A and B have the same effect for 32 ~~seconds~~ mg dm-3 of amylose. However, inhibitor A does not prevent amylase from reaching its maximum activity. ~~and~~ Meanwhile B reduces the maximum rate and is not affect by greater amylose concentrations. ~~thus~~

**ResultsPlus**
**Examiner Comments**

This answer gained two marks. The candidate gives both a similarity and a difference and gives the correct range over which the effects of the two inhibitors are similar.

**ResultsPlus**
**Examiner Tip**

If a question is 'compare and contrast', you will have to refer to both similarities and differences to gain full credit.

## *Question 2 (c) (ii)*

This question required candidates to use their own knowledge to identify which of the two inhibitors was non-competitive and explain how it would have its effect. Successful candidates demonstrated an excellent knowledge of how non-competitive inhibitors bind to enzymes (not at the active site) and alter the shape of the active site and were then able to apply this to the explain the graph. Less successful candidates often suggested that inhibitor A was non-competitive and/or confused the description of a non-competitiive inhibitor with a competitive one. The effects of non-competitive inhibitors can rarely be overcome by increasing the concentration of substrate. Some candidates did not read the command word and simply described the data.

(ii) Explain which of the two inhibitors is non-competitive.

(3)

inhibitor B as it constantly inhibits the production of maltose regardless of the concentration of amylose. it reduces the production of maltose by approximately half after 40 ~~mg dm$^{-3}$~~ $\mu g s^{-1}$ which is lower than 31 $\mu g s^{-1}$ produced without any inhibitors. The rate of production of maltose never reaches max rate of production shown by amylase wimout an inhibitor or with inhibitor A.

**ResultsPlus**
**Examiner Comments**

This answer gained one mark. The candidate correctly identifies inhibitor B and correctly refers to how the graph demonstrates that the inhibitor is non-competitive but does not go on to explain how competitive inhibitors act.

**ResultsPlus**
**Examiner Tip**

If an answer asks for an explanation, always try to add the words like 'because' and 'so that' in your answer. For example, 'Inhibitor B is non-competitive because it binds to the enzyme (away from the active site), changing the shape of the active site so that increasing the concentration of substrate will not increase the rate of reaction any further.'

a constant effect until it equals when no inhibitor added at concentration 76 μg/dm³

**(ii) Explain which of the two inhibitors is non-competitive.**

**(3)**

Inhibitor B is non competitive, Inhibitor A must be competitive as increase in enzyme concentration reduces effect of inhibitor, however not known for B as rate of control (no inhibitor) and of enzyme and inhibitor B are never equal, rate for B addition is always lower. Hence inhibitor B must bind to another site (allosteric) that is not active ~~present~~ changes shape of active site previously enzyme / substrate complex forming.

**ResultsPlus**
**Examiner Comments**

This answer gained all three marks. The candidate explains how the inhibitor binds to an allosteric site and this changes the active site. They also gain mark point one for explaining how competitive inhibitors would affect the rate of reaction.

(ii) Explain which of the two inhibitors is non-competitive.

**(3)**

B. A non competative inhibitor does not bind to the active site of an enzyme but to elsewhere, ~~preventing~~ changing the shape of the enzyme and hence of the active site. This means the substrate is no longer a complementary shape to the enzyme and hence cannot catalyse a reaction. It is not competing with the substrate to bind to the active site which is less effective. Therefore, B is the non competative inhibitor

**ResultsPlus**
**Examiner Comments**

This answer gained two marks. It contains a very good description of how non-competitive inhibitors work but does not refer to the graph to explain how this can be inferred.

## *Question 3 (a)*

This question required candidates to relate the function of mitochondria in generating ATP to the activity of rod cells. Most candidates were able to gain at least one mark, typically for the idea of energy release or ATP production. Some candidates then gave very vague answers regarding the function of the ATP in rod cells, often simply referring to active transport or to enable the rod cell to function. A few candidates thought that ATP was important for the breakdown of rhodopsin.

**3** The retina contains rod cells and bipolar neurones.

Rod cells contain large numbers of mitochondria.

(a) Explain the role of mitochondria in the functioning of rod cells.

**(2)**

The mitochondria provide ATP which is needed when rod cells are activated by.

**ResultsPlus**
**Examiner Comments**

This answer gained one mark for the idea of ATP production. The candidate did not go on to explain why rod cells require ATP.

**ResultsPlus**
**Examiner Tip**

Always explore all parts of a question. This question considered both mitochondria and rod cells.

**3** The retina contains rod cells and bipolar neurones.

Rod cells contain large numbers of mitochondria.

(a) Explain the role of mitochondria in the functioning of rod cells.

**(2)**

Mitochondria are the ~~source of~~ powerhouse of the cell, where respiration takes place. Rod cells process the light that reaches the cell and so has a high rate of activity, so it's needs mitochondria to power the many reactions in rod cells.

**ResultsPlus**
**Examiner Comments**

This answer gained zero marks. There is no reference to ATP or energy and the candidate has given a GCSE level answer by referring to the 'powerhouse' of the cell. No specific role of energy is suggested.

**ResultsPlus**
**Examiner Tip**

Make sure that your answer is not a GCSE level one. Always think whether you could have written the same answer during your GCSEs - if you could, you may need a bit more detail.

**3** The retina contains rod cells and bipolar neurones.

Rod cells contain large numbers of mitochondria.

(a) Explain the role of mitochondria in the functioning of rod cells.

**(2)**

In order for rod cells to stimulate a generator potential, rhodopsin needs to be resynthesised before it can be broken down into retinal and opsin. In order for the retinal to be transformed from trans → cis and bond with opsin, energy is needed from ATP from respiration. Mitochondria is the [illegible] respiration

**ResultsPlus**
**Examiner Comments**

This answer gained two marks and correctly refers to the production of ATP and then goes on to give a function of this in rod cells.

## *Question 3 (b)*

This question required candidates to have a detailed understanding of how rod cells react to light. Successful candidates often demonstrated an excellent understanding of the role of rhodopsin, how rhodopsin breakdown affects sodium ion channels, and how changes in sodium ion permeability lead to reduced glutamate release. The examiners remarked that many candidates had clearly prepared very thoroughly. Less successful candidates, however, often had little knowledge of how rod cells function and gave little more than vague references to the role of rhodopsin. Amongst the less successful candidates, there was often a great deal of confusion over the movement of sodium ions with many thinking that light induces an action potential and that glutamate release increases. A hint as to the role of glutamate was given in the question which stated that glutamate is an inhibitory transmitter. Some candidates also discussed the effects of light on the post synaptic bipolar neurone - the question only asked for the events leading up to a change in glutamate release.

(b) Rod cells release glutamate, an inhibitory neurotransmitter.

Describe how light causes a change in the release of glutamate from rod cells.

**(4)**

rod cells contain rhodopsin which is one of the reasons why they are good in low light conditions and pick up movement very well, the increased light intensity can cause a change the release of glutamate because of bleaching caused by the light.

**ResultsPlus**
**Examiner Comments**

This answer only gained one mark for the reference to rhodopsin. The candidate gives no further detail and does not state whether glutamate release increases or decreases.

**ResultsPlus**
**Examiner Tip**

Make sure that you state the direction of any changes, e.g. increase or decrease. Try to avoid vague references such as 'affect'.

(b) Rod cells release glutamate, an inhibitory neurotransmitter.

Describe how light causes a change in the release of glutamate from rod cells.

(4)

When light falls on the retina, this stops the release of glutamate from rod cells. This causes the bipolar cell to become depolarised and hence an action potential is created which is sent down the optic nerve to the occipital lobe. Rod cells contain Rhodopsin and when light falls on the rhina this causes Rhodopsin to break down and form retinal and opsin. These compounds inhibit the release of glutamate.

ResultsPlus
Examiner Comments

This answer gained three marks. A correct description of reduced release of glutamate is given and the candidate explains that rhodopsin is broken down into retinal and opsin but does not explain how this leads to the change in glutamate release.

(b) Rod cells release glutamate, an inhibitory neurotransmitter.

Describe how light causes a change in the release of glutamate from rod cells.

(4)

When a photon of light hits the rod cells, the pigment rhodopsin which contains cis retinal and opsin will be affected. The cis retinal is converted to trans retinal which strains the bond between the retinal and opsin, causing it to break. Eventually, this would mean that the release of glutamate would increase since the sodium ion channels (that are permeable to sodium) will open due to high levels of light, allowing sodium to diffuse in, creating an action potential. Glutamate is therefore released more.

**ResultsPlus**
**Examiner Comments**

This answer gained two marks for a correct reference to rhodopsin and the conversion of retinal. The candidate has then confused the effects of this breakdown and suggested that sodium channels open leading to increased glutamate release.

(b) Rod cells release glutamate, an inhibitory neurotransmitter.

Describe how light causes a change in the release of glutamate from rod cells.

**(4)**

- The light converts cis retinal into trans retinal, breaking rhodopsin apart into trans retinal and opsin.
- this stimulates a cascade of reactions that reduces the permeability of the rod cells to $Na^+$ ions so the inside of the rod cell becomes more negative relative to the outside (hyperpolarisation)
- this stops an action potential in the rod cell so stops the release of the inhibitory neurotransmitter across the synaptic cleft so it cannot bind to receptors on the bipolar neurones

**(Total for Question 3 = 6 marks)**

**ResultsPlus**
**Examiner Comments**

This answer gained four marks. The candidate correctly refers to the breakdown of rhodopsin and explains that this leads to the closure of sodium channels and hyperpolarisation of the membrane. The candidate also goes on to state that the effect of this is the reduction of glutamate release.

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

This question tested the understanding of candidates' knowledge of electron microscopy and its resolving power. Many candidates were able to state that the resolving power of electron microscopes is much higher than light microscopes but only a handful explained that this is due to the short wavelength of the electrons. Some less successful candidates referred only to improved magnification - candidates do need to be clear about the difference between magnification and resolution.

(iii) Explain why an electron microscope, rather than a light microscope, was used to produce this photograph.

**(2)**

An electron microscope has a higher magnification and resolution allowing a larger and more detailed image of the bacterial cell to be produced.

**ResultsPlus**
**Examiner Comments**

This answer gained one mark for the correct reference to resolution. The candidate does not go on to explain why the resolution is better so does not gain the second mark point.

(iii) Explain why an electron microscope, rather than a light microscope, was used to produce this photograph.

**(2)**

Because it produces much clearer images and has higher magnifications than a light microscope. This is necessary as the viruses are very small particles and may not easily be seen under a light microscope.

ResultsPlus
Examiner Comments

This answer gained zero marks. There is no mention of resolution and the candidate has simply given a very vague answer about the size of viruses.

ResultsPlus
Examiner Tip

Use correct terminology where appropriate.

(iii) Explain why an electron microscope, rather than a light microscope, was used to produce this photograph.

**(2)**

The ~~stru~~ wavelength of ~~lig~~ visible light is too long for the structures in the photograph to be seen as viruses are very small. An electron microscope can have a much shorter wavelength and therefore a much higher resolution than the light microscope.

ResultsPlus
Examiner Comments

This is an excellent answer that gains two marks. The candidate clearly refers to improved resolution and links this to the wavelength of light/electrons.

(iii) Explain why an electron microscope, rather than a light microscope, was used to produce this photograph.

**(2)**

Tha is because electron microscope provides a ~~better~~ high resolution and magnification because electrons have smaller wavelength than the light in light microscope. so can identify between the ~~pa~~ viruses.

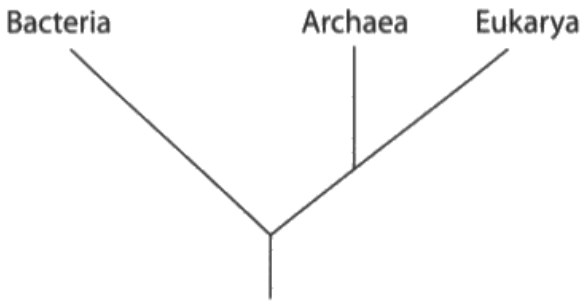
**ResultsPlus**
**Examiner Comments**

This is an excellent answer that gains two marks for the idea of better resolution due to smaller wavelength.

## *Question 4 (b) (i)*

This question required candidates to evaluate evidence for the three-domain theory. Different features of the groups were presented to candidates and this had to be analysed to explain the proposed phylogenetic model. Successful candidates explained that Eukarya and Archaea have more common characteristics (or stated the characteristics) and that this suggests that they have a more recent common ancestor. Some then went on to explain that the differences in Eukarya and Archaea were probably features that had evolved after they had separated. Many candidates also explained that each domain possessed unique characteristics that support the existence of separate domains. Less successful candidates did not directly compare the groups and simply described the features that each group possessed.

(b) The diagram shows the three-domain model of classification as suggested by Carl Woese.




This model was based on the comparison of many different characteristics.

Some of the characteristics used by Woese are shown in the table.

| Characteristic | Archaea | Bacteria | Eukarya |
|---|---|---|---|
| Membrane lipids | branched carbon chains attached to glycerol by **ether** linkage | straight carbon chains attached to glycerol by **ester** linkage | straight carbon chains attached to glycerol by **ester** linkage |
| First amino acid in protein synthesis | methionine | formylmethionine | methionine |
| Antibiotic sensitivity | no | yes | no |
| rRNA loop sequence | absent | present | absent |
| Ribosome size | 70 S | 70 S | 80 S |

(i) Analyse the information to explain the evidence for the three-domain model of classification.

**(3)**

Diagram shows Archea and Eukarya were closely related were recent common ancestor than Bacteria - Supported by shared characteristics which are not shared by Bacteria : First Amino Acid is Methionine, they are not sensitive to Antibiotics and do not have rRNA loop sequence. All three domains have distinct characteristics : - Ether linkage and branched chains in Archea, Presence of rRNA loop - Antibiotic sensitivity and Formyl Methionine use in Bacteria and 80s ribosomes in Eukaryan. - Three domains have different distinct characteristics so must be assigned differently

**ResultsPlus**
**Examiner Comments**

This is a strong answer that gained three marks. The candidate clearly states that the Eukarya and Archaea are the most closely related and supports this with evidence. They also explain that there are three separate domains, each with different characteristics.

**ResultsPlus**
**Examiner Tip**

Always try to support your arguments with evidence.

(i) Analyse the information to explain the evidence for the three-domain model of classification.

**(3)**

The three model domain has archaea being shown more closely related to eukarya than bacteria. Archaea and eukarya have the same first amino acid in protein synthesis, methionine, and bacteria has a different one. Archaea and eukarya also lack an rRNA loop sequence, and have no antibiotic sensitivity. They are more likely to share a common ancestor late than a common ancestor with bacteria. There are 3 domains as each has a unique characteristic. Eukarya have 80s ribosomes, archaea have branched chains in membrane lipids, and bacteria have a rRNA loop sequence. The unique characteristics show the need for seperate domains.

**ResultsPlus**
**Examiner Comments**

This is a strong answer that gained three marks. The candidate clearly states that there are three separate domains, each with unique features and that the Eukarya and Archaea are most closely related. They also explain the evidence to support that close relationship between the Eukarya and Archaea.

(i) Analyse the information to explain the evidence for the three-domain model of classification.

**(3)**

All 3 domains differ from one another. Archaea, the extremophile bacteria, cannot belong to bacteria as it has ether linkage, not an ester one, as well as its first amino acid in protein synthesis is methionine but bacteria's is formylmethionine. Similarly, Eukarya, the eukaryotes, can't be classified with other domains as it has 80S ribosome (other 2 have 70S) and it differs mostly with bacteria in general. This means that all 3 domains classify very different organisms, of different biochemical structures, niches and behaviours.

**ResultsPlus**
**Examiner Comments**

This answer gained one mark. The candidate explains that there is evidence to support three separate domains (i.e. they all have unique features) but does not recognise that Eukarya and Archaea are most closely related. Most of the answer is purely description of different characteristics.

**ResultsPlus**
**Examiner Tip**

If you are asked to analyse and explain, don't just describe the data.

(i) Analyse the information to explain the evidence for the three-domain model of classification.

**(3)**

Archaea and Eukarya both have methionine as the first amino acid in protein synthesis, and the rRNA loop sequence is absent for both domains. This would suggest that Archaea and Eukarya are more closely related to eachother than [illegible] are to bacteria. They [illegible] Archaea and Eukarya are also not sensitive to antibiotics, whereas bacteria is.

**ResultsPlus**
**Examiner Comments**

This is a good answer that gains two marks. The candidate recognises that Eukarya and Archaea are most closely related and supports this with evidence.

(i) Analyse the information to explain the evidence for the three-domain model of classification.

**(3)**

This is because there are characteristics of both bacteria and Eukaryo found in Archea, while Eukaryo and bacteria have no characteristics in common except ester linkages. Also archaea have ether linkages which none of the others have. Since Archaea and Eukarya have more characteristics in common it means they evolved from the same ancestor before speciating. These are the smallest units hence 3 separate ~~kingdo~~ domains

**ResultsPlus**
**Examiner Comments**

This answer gained two marks for clearly explaining that Archaea and Eukarya are most closely related and supports this with evidence from the table.

**ResultsPlus**
**Examiner Tip**

Always look at the mark allocation. If three marks are allocated to a question, you will need to identify at least three points in your answer.

## *Question 4 (b) (ii)*

This question was found to be accessible by most candidates who correctly recognised that scientists share findings by publishing results, peer review or presenting them at conferences. A few candidates misread the question and instead discussed alternative methods, such as DNA sequencing, that could be used to establish the phylogeny.

(ii) Many scientists agree with this three-domain model.

State how these scientists would have reached agreement about this model.

**(1)**

Previous research shows these three domains have some similar but some different.

ResultsPlus
Examiner Comments

This answer gained zero marks. The candidate has given a vague answer about previous research but does not refer to a method by which scientists share findings.

(ii) Many scientists agree with this three-domain model.

State how these scientists would have reached agreement about this model.

**(1)**

Peer review ; publishing in journals or scientific conference

ResultsPlus
Examiner Comments

This answer gained one mark for correctly stating that scientists use peer review, publishing and conferences.

(ii) Many scientists agree with this three-domain model.

State how these scientists would have reached agreement about this model.

**(1)**

The scientists would have compared the DNA makeup of each to find similarites.

**ResultsPlus**
**Examiner Comments**

This answer gained zero marks. The candidate has misread the question and considered how to find alternative evidence rather than how scientists reach agreement.

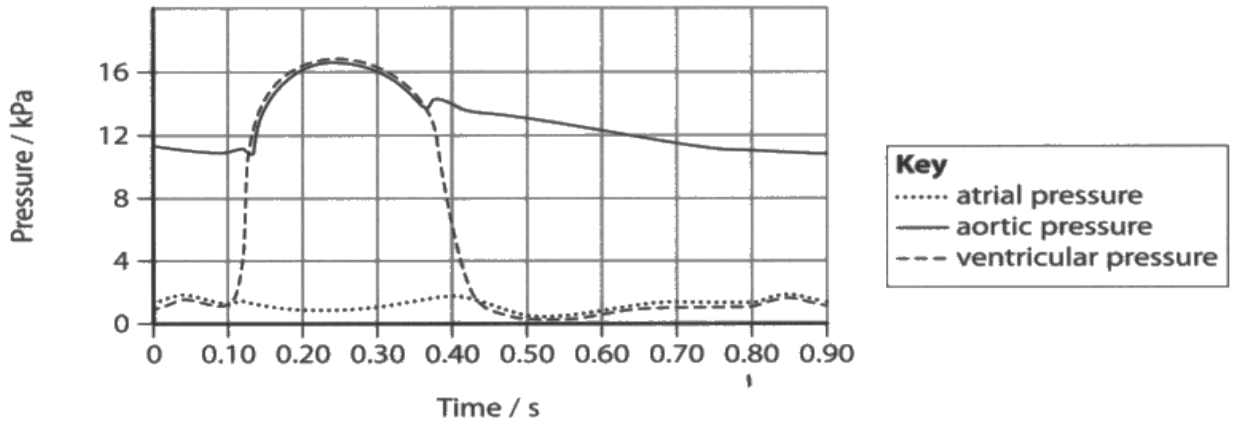
**ResultsPlus**
**Examiner Tip**

Always be careful that your answers match the questions posed.

## *Question 5 (a) (i)*

Many candidates found this question surprisingly challenging and a very diverse range of answers were seen. The question required candidates to use the graph to determine that one heart contraction took 0.8 seconds and so the heart rate would be 75 seconds. Some candidates thought that the heart rate was 0.8 or 0.9 beats per minute. Other candidates misread the graph and thought that the duration of one heart beat was 0.9 seconds. Candidates should consider whether their answers are, in fact, sensible answers as a heart rate of 0.8 beats per minute is unrealistic.

**5** The graph shows the pressure changes in the left side of the heart during one cardiac cycle.




(a) (i) Calculate the heart rate.

(1)

60 ÷ 0·8 = 75 bpm

Answer 75

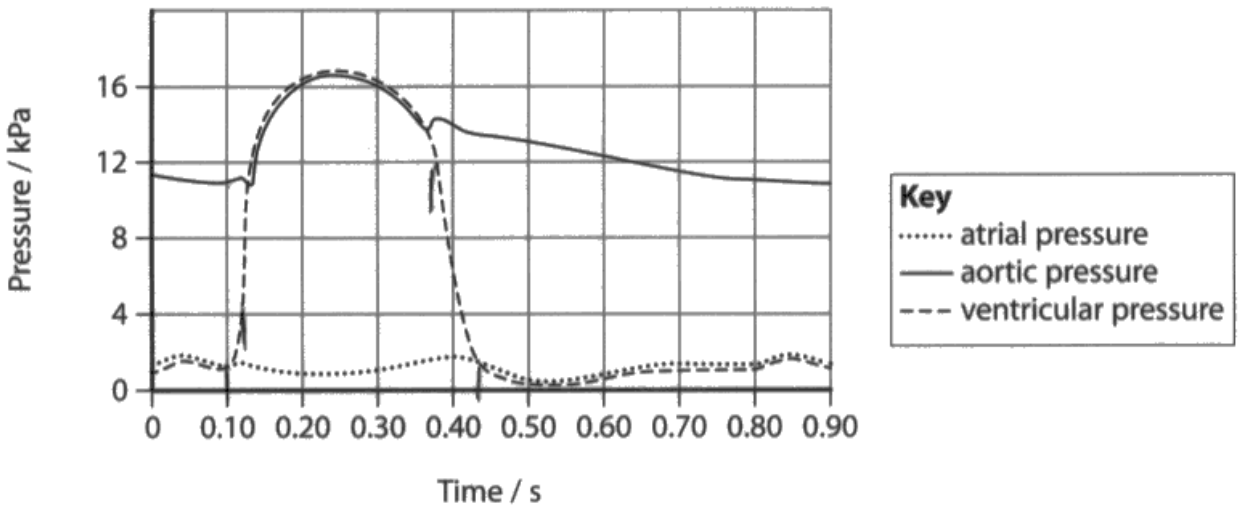
**ResultsPlus**
**Examiner Comments**

This candidate has correctly calculated the heart rate and gained one mark.

**ResultsPlus**
**Examiner Tip**

Always consider if your answers are sensible.

**5** The graph shows the pressure changes in the left side of the heart during one cardiac cycle.




(a) (i) Calculate the heart rate.

**(1)**

17

Answer 56 BPM

ResultsPlus
Examiner Comments

This answer gained zero marks. The calculated heart rate is incorrect and there is no working. It is good practice to always show working.

ResultsPlus
Examiner Tip

Always show your working in maths questions.

## *Question 5 (b)*

This question generated a wide range of responses. Successful candidates gave well-structured answers that described the process of myogenic heart contraction in detail and in the correct chronological order. Some excellent answers were seen and many, well-prepared candidates demonstrated their excellent understanding of the topic with impressive use of key vocabulary. Less successful candidates often confused the roles of the SA and AV nodes, wrote answers that confused the order of events and/or thought that the heart rhythm was due to nervous activity. A few candidates misread the question and gave descriptions of the heart cycle rather than the myogenic control.

(b) Describe how myogenic stimulation brings about contraction of the atria and the ventricles.

**(5)**

Increase in the PH of the blood due to the increased concentration of $CO_2$ gas is detected by chemo receptors in ~~the~~ blood stream results in the secretion of noradrenaline (neurotransmitter) which increases the frequency of SAN depolarisation, which results in atrial systole and SAN's a signal to the AVN which results in an electrical signal being passed through the septum via the pickenjie fibres causing ventricular systole.

**ResultsPlus**
**Examiner Comments**

This is a good answer that gained three marks. The candidate gives a correct reference to the SA node, the wave of depolarisation that leads to atrial contraction and the role of the Purkinje fibres. Ventricle systole is mentioned but there is no reference to the contraction of the heart muscles from the base upwards.

**ResultsPlus**
**Examiner Tip**

When asked for detailed descriptions of a process always structure your answers in the correct sequence.

(b) Describe how myogenic stimulation brings about contraction of the atria and the ventricles.
**(5)**

Myogenic stimulation contracts the atria and ventricles by sending a electrical message from the SAN to the ~~bundle of~~ nerve tissues. It then travels to the bundle of His where it causes the nerve tissue to be stimulated and causes a contraction.

**ResultsPlus**
**Examiner Comments**

This answer just gained two marks. There is a correct reference to the SA node. The atrial depolarisation is not, however, linked to contraction of the atria. Credit was given for the role of the bundle of His.

(b) Describe how myogenic stimulation brings about contraction of the atria and the ventricles.

**(5)**

The ~~heart beat~~ cardiac muscle is myogenic which means that ~~it gives~~ the heart pumps with no external stimulus. Myogenic stimulation gives rise to intrinsic rhythmicity ~~with~~ which is maintained by a wave of electrical excitation. Sinoatrial node (SAN) cells in the right atria acts as a natural pacemaker they start depolarisation so atria contract. The annulous fibrosis is a region of non-conducting tissue that stops excitation from reaching the ventricles ^The SAN cells trigger the atrioventricular ~~nol~~ node to ~~depolar~~ depolarise ^After a slight delay the Bundle of His and then Purkyne tissue. Depolarisation starts the apex of the ventricles contracting, forcing blood out.

**ResultsPlus**
**Examiner Comments**

This is an excellent answer that gained all five marks. The candidate explains that myogenic stimulation requires no external stimulus and then gives a detailed account of the process in the correct order. There are correct references to the role of the SA node, depolarisation and atrial contraction, the role of the Purkinje fibres and the ventricular contraction from the base upwards.

(b) Describe how myogenic stimulation brings about contraction of the atria and the ventricles.

(5)

in right atrium

SAN produces a wave of excitation (stimulated by autonomic nervous system if needs to increase/decrease); causing atria to contract wave of excitation travels to annulus fibrous (non-conducting tissue/ prevents excitation from travelling straight to ventricle, the wave of excitation travels to atrioventricular node in right atrium which produces a delay before passing the wave of excitation ~~fro~~ down the septum using the Purkyne tissue which penetrate to the bottom of the ventricle wall : the ventricle contract from the apex upwards

ResultsPlus
Examiner Comments

This is a very strong answer that gained five marks. The answer is detailed and is a good example of how to organise an answer in the correct sequence.

## *Question 5 (c)*

This question required candidates to analyse and explain the effects of a beta blocker drug. The question presented candidates with ECG traces with and without the beta blocker drug, and the structures of the beta blocker drug and noradrenaline. The majority of candidates were able to correctly recognise that the drug slowed down the heart rate, but only more successful candidates recognised that the structure of the beta blocker was similar to noradrenaline and so would bind to noradrenaline receptors preventing noradrenaline binding. Less successful candidates tended to focus exclusively on the ECG trace and kept repeating the idea that the trace showed fewer heart beats.

Analyse the information to explain the results of this investigation.

(3)

The beta blocker causes the ~~person's~~ post exercise person's heart rate to fall by about a third. During exercise, the increased rate of aerobic respiration causes $CO_2$ to be produced, which is detected by chemoreceptors in the aorta, which send impulses to the accelerator centre in the medulla, which in turn sends impulses to the SAN, via the sympathetic nervous system, ~~as~~ which uses noraddenaline as a neurotransmitter and increases heart rate. Therefore, it is likely that the beta blocker, as it is vaguely similar in structure to noradrenaline binds to the SAN instead of noradrenaline, or prevents noradrenaline binding in some other way, thus preventing the noradrenaline from increasing heart rate.

**(Total for Question 5 = 11 marks)**

**ResultsPlus**
**Examiner Comments**

This excellent answer gained three marks. The candidate explains that the beta blocker has slowed down the heart rate and gives a correct explanation describing the drugs' similarity to noradrenaline and how this would lead to receptors being blocked.

**ResultsPlus**
**Examiner Tip**

This question has two parts of evidence - the ECG and the structure of the beta blocker. Always explore all aspects of a question rather than focusing on only one.

Analyse the information to explain the results of this investigation.

**(3)**

When exercising with no beta blocker, the heart rate of the patient was almost twice as fast in comparison to the person with the beta blocker. This is due to the beta blocker being of similar structure to noradrenaline. The beta blocker attaches to noradrenaline receptors, inhibiting them, and therefore inhibiting the speed up of heart rate. When the patient had no beta blocker, noradrenaline was able to bind to its receptors to speed up heart rate.

**(Total for Question 5 = 11 marks)**

**ResultsPlus**
**Examiner Comments**

This is a well organised answer that gained all three marks. The candidate has identified that the heart rate has slowed and goes on to explain that the structure is similar to noradrenaline and so binds to the same receptors.

Analyse the information to explain the results of this investigation.

(3)

Exercise with a beta blocker has a lower heart rate than exercise without a beta blocker. This is due to the beta blocker acting ~~on~~ on the parasympathetic nervous system which stimulates the heart, in lowering the heart rate. nodes (SAN & AVN)

**ResultsPlus**
**Examiner Comments**

This answer gained one mark. The candidate has recognised that the beta blocker has resulted in a slower heart rate but has not focused on the structures of the beta blocker and noradrenaline.

**ResultsPlus**
**Examiner Tip**

Always look at all the data in a question, it is usually there to help you reach an appropriate conclusion.

Analyse the information to explain the results of this investigation.

**(3)**

Beta blockers slow down the heart rate. This is shown through the comparison of the gaps between each heart beat. As shown, there is a bigger gap when exercising with beta blocker compared to with no beta blocker. Therefore beta blockers slow down the heart rate. However, it does not affect the voltage of the heart which has remained the same in both exercise with and with no ~~without~~ a beta blocker

**(Total for Question 5 = 11 marks)**

**ResultsPlus**
**Examiner Comments**

This answer gained one mark. The candidate has correctly described the reduced heart rate but then continues to repeat the same point. There is no explanation as to how the beta blocker exerts its effect.

**ResultsPlus**
**Examiner Tip**

Try to focus on more than one aspect of a question, don't restrict your answer to one thing.

## *Question 6 (b)*

This question required candidates to use data to calculate the number of babies that would be expected to be born with Down's syndrome. Most candidates found the question very accessible and gained at least one mark, with many gaining both. Where candidates did not gain credit, it was often due to being unable to use the probability of having a baby with Down's syndrome to predict the number of affected babies.

(b) Down's syndrome in humans is caused by non-disjunction.

The chance of having a baby with Down's syndrome increases as the age of the mother increases.

At age 40, the probability of having a baby with Down's syndrome is 0.018.

In 2016 the number of women aged 40 in the UK was estimated to be 500 000.

The pregnancy rate for women in the UK aged 40 is 14 pregnancies per 1000 women per year.

Calculate the number of babies with Down's syndrome that were expected in 2016 in the UK.

$14 \times 500 = 7000$ women pregnant per year 40 years old. (2)

$7000 \times 0.018 = 126$

Answer 126

ResultsPlus
Examiner Comments

This is a correct answer that gained both marks. The candidate has correctly determined the number of babies born to women over 40 and then used this value to determine the number of babies with Down's syndrome. This answer shows good practice in that all working is shown clearly.

ResultsPlus
Examiner Tip

Always show all working - you may gain some credit for correct methods.

(b) Down's syndrome in humans is caused by non-disjunction.

The chance of having a baby with Down's syndrome increases as the age of the mother increases.

At age 40, the probability of having a baby with Down's syndrome is 0.018.

In 2016 the number of women aged 40 in the UK was estimated to be 500 000.

The pregnancy rate for women in the UK aged 40 is 14 pregnancies per 1000 women per year.

Calculate the number of babies with Down's syndrome that were expected in 2016 in the UK.

**(2)**

0.018

500,000 : 14 per 1000

14 per 1000
28 2000
42 3000
56 4000
70 5000

500,000 women

Answer 7000 babies

1000 x 500 000 ÷ 500 = 7000

14 : 1000
x 500 : 500000 x 500
7000

70 per 5000
140 per 10000
210 per 15000
280 20000
350 25
420 30000
490 35
560 40
630 45
700 50

700 in 50,000
1400 in 100,000
2100 in 200000
2800 in 300 000
3500 in 400 000
4200 in 500 000

ResultsPlus
Examiner Comments

This answer gained one mark. The candidate has correctly determined the number of babies born to women over 40 but has not gone on to calculate how many of these would be likely to have Down's syndrome.

## *Question 6 (c)*

This question presented candidates with data for two different methods of genetically screening embryos - polar body biopsy and preimplantation genetic diagnosis. Data on the effectiveness on both techniques on embryo survival, and success in leading to live births, was presented to candidates along with a comparison of IVF with no screening. Candidates were asked to comment on the effectiveness of both techniques. The majority of candidates were able to gain at least one mark and most found the question very accessible. Most candidates had a good understanding of the command word, 'comment' and explored many aspects of the data. Successful candidates identified that polar body biopsy had a higher rate of embryo survival, whilst PGD was more effective in terms of leading to live births, and both techniques were more effective than no screening. Stronger candidates calculated the overall effect of the techniques and identified that, overall, PGD was the most effective. Some candidates recognised that a reason for the higher effectiveness of PGD was that this technique screens the genotypes of both parents whilst polar body biopsy only screens maternal genes. Less successful candidates tended to only comment on one or two aspects of the data and not explore it fully.

Analyse the data to comment on the effectiveness of the two techniques.

(4)

The polar body biopsy has a higher percentage of embryos that survive screening ~~cont~~ compared to PGD, however the percentage of embryos transferred to the uterus that lead to the birth of a baby is higher in PGD, this means that PGD has more success than the polar body biopsy technique ~~as the aim~~ because although less embryos survive screening, more from those embryos lead to the birth of a baby. The control shows IVF with no screening which results in 16 % leading to birth of a baby, meaning that screening not being carried out would ~~result in a high decent~~ still affect cause the embryos ~~and~~ to not survive.

**ResultsPlus**
**Examiner Comments**

This answer gained two marks. There are clear references to the increased survival rates with polar body biopsy and higher birth rate with PGD. The candidate almost states that both techniques are more effective than IVF alone and quotes the data but does not actually evaluate it.

**ResultsPlus**
**Examiner Tip**

Make sure that you don't just quote data but also state if there are increases or decreases.

Analyse the data to comment on the effectiveness of the two techniques.

**(4)**

The data shows that a greater percentage of embryos survive screening with the polar body biopsy technique than the PGD technique. However, using PGD, a greater percentage of embryos lead to the birth of a baby compared to the polar body technique. This means that PGD is more effective because ~~there's an 8% increase~~ although less embryos survive screening, ~~not~~ a greater percentage of these lead to the birth of a baby compared to the other technique. However, both techniques are more effective than IVF which results in 16% of embryos leading to the birth of a baby.

**ResultsPlus**
**Examiner Comments**

This answer gained three marks. The candidate correctly states that both techniques are more effective than IVF alone, polar body biopsy leads to a higher survival rate and PGD leads to a higher birth rate.

Analyse the data to comment on the effectiveness of the two techniques.

(4)

Polar body biopsy has a higher % of embryos that survive screening (87%) than PGD (74%) however it has a smaller % of ~~ba~~ embryos that lead to the birth of a baby (21%) while PGD leads to the birth of a baby 29% of the time.
Both techniques are more effective than ~~no~~ doing IVF with no screening as they have a higher rate of successful birth.
PGD is more effective than polar body biopsy has it has a higher successful birth rate and still has a ~~rela~~ **(Total for Question 6 = 8 marks)**
relatively high % of embryos that survive screening. From a sample of 100 PGD would produce 21 babies while PBB would produce 18.

$74 \times \frac{29}{100} = 21.46$ ✓

$87 \times \frac{21}{100} = 18.27$.

**ResultsPlus**
**Examiner Comments**

This excellent answer gained all four marks. The candidate correctly states the higher survival rate of embryos with polar body biopsy, the higher birth rate with PGD, the higher effectiveness of both techniques compared to IVF alone and then goes on to calculate the overall effectiveness (21.46 % and 18.27 %).

Analyse the data to comment on the effectiveness of the two techniques.

**(4)**

Both techniques are effective as the percentage of embryos that lead to birth of baby are both higher than the control. Polar body biopsy has a higher rate of embryo survival after screening is because the polar bodies are not actively involved in the embryos' development. Later they degenerate anyway. However removing one of the cells during PGD is more likely to interfere with the normal development as each cell may already have a designated specialisation and removing one could cause damage. Hence PGD has a lower embryo survival rate. However PGD has a higher birth rate because when screening the polar bodies, they only contain maternal chromosomes, so only abnormalities from the mother's half of the genetic material is found. With the cells in the embryo, they are diploid, so both paternal and maternal chromosomes are screened for. This leads to a higher percentage of birth of baby.

**ResultsPlus**
**Examiner Comments**

This excellent answer gained four marks. There is a full evaluation of both techniques and the candidates also explains that PGD screens both paternal and maternal chromosomes.

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

This question required candidates to state what is meant by biodiversity. Most candidates had a good understanding of the term; successful candidates either described the number of different alleles in a population or the number of different species in an area. Less successful candidates tended to use incorrect terminology such as number of different genes or number of different species within a population. Candidates should take care to use terminology precisely and accurately.

(i) State what is meant by the term **biodiversity**.

**(1)**

The number of different species in an area.

ResultsPlus
Examiner Comments

This answer gained one mark for correctly recognising that diversity can be a measure of the number of different species within an area.

(i) State what is meant by the term **biodiversity**.

**(1)**

The ratio of different allele presents in a ecosystem.

ResultsPlus
Examiner Comments

This answer is a good example of inaccurate use of terminology. The candidate clearly understands that allele frequency is linked to diversity but uses this in the wrong context.

## *Question 7 (b) (ii)*

This question required candidates to read the information given to them in the question and to recognise that the lynx that had been reintroduced had undergone a genetic bottleneck (due to the few individuals bred from) and so resulted in few different alleles in the population. Successful candidates identified both these points or often gave correct converse answers when referring to the lynx that had been protected in the natural area. Less successful candidates misread the question and often discussed the fact that the lynx may have been outcompeted when released or that they were poorly adapted to the environment.

(ii) Explain why, in 2016, the genetic biodiversity of the lynx population in the area where they had been reintroduced was much lower than in the protected area.

**(2)**

~~The lynx were extinct in the area so there was less genetic biodiversity~~ no There were only ten lynxs in the reintroduced area, so only they could interbreed, which meant they had a smaller gene pool.

**ResultsPlus**
**Examiner Comments**

This good quality answer identifies that the number of lynx used was very small (only 10) and that this had led to a small gene pool. It gained two marks.

(ii) Explain why, in 2016, the genetic biodiversity of the lynx population in the area where they had been reintroduced was much lower than in the protected area.

**(2)**

This may of been because the lynx was unable to survive on it's own.

**ResultsPlus**
**Examiner Comments**

This answer gained zero marks. The candidate has not referred to the small gene pool or low number of lynx used for breeding.

**ResultsPlus**
**Examiner Tip**

Always ensure that you read questions carefully and identify what they are asking before rushing pen to paper.

(ii) Explain why, in 2016, the genetic biodiversity of the lynx population in the area where they had been reintroduced was much lower than in the protected area.

**(2)**

The lynx bred in 2003 had more similar traits and likely had been inbred which reduces biodiversity.

**ResultsPlus**
**Examiner Comments**

This candidate gained one mark for the idea of inbreeding.

**ResultsPlus**
**Examiner Tip**

Always be careful with terms that can be easily confused. Inbreeding and interbreeding are often confused by candidates and mean very different things.

## *Question 7 (c)*

This question required candidates to explain the principles and issues associated with ex-situ conservation. Most candidates were able to gain at least one mark although fewer went on to gain all four. The question asked for explanations and many candidates simply gave descriptions of ex-situ conservation or descriptions of its consequence. Successful candidates gave good explanations that often considered the purposes of this method of conservation such as using breeding programmes to increase populations and/or using named methods to prevent inbreeding depression. Less successful candidates did not give explanations and tended to focus their answers around one point such as changes in behaviour patterns.

(c) Explain the principles and issues associated with *ex-situ* conservation methods. **(4)**

Ex-situ conservation is when animals close to extinction are brought to zoos so that they can increase their genetic biodiversity and prevent extinction. They do this by using stud books and breeding the animals between zoos so that the gene pool is larger and they can be reintroduced back into the area. However can however lead to habituation where the animals start to behave adapted to the zoo so when they are reintroduced into the world they do not know how to survive.

**ResultsPlus**
**Examiner Comments**

This is a good answer that gained three marks. The candidate has explained one of the principles of ex-situ conservation by explaining how extinctions are prevented and has then gone on to discuss the use of breeding between zoos and problems with behavioural adaptations.

**ResultsPlus**
**Examiner Tip**

Always consider all aspects of questions. This question had two aspects: the principles and the issues associated with ex-situ conservation.

of alleles, therefore genetic [illegible]

(c) Explain the principles and issues associated with *ex-situ* conservation methods.

**(4)**

Ex situ takes the organism out of its natural habitat. The organisms normally take part in a breeding programme to increase population number. The issues are that the organism may not be living in its natural climate or eating its usual food sources. When the organisms are reintroduced they may not have the behavioural adaptations to survive. Removing an organism from its natural habitat could disrupt the food ~~chain~~ chain of the area.

**ResultsPlus**
**Examiner Comments**

This answer gained two marks. The candidate has clearly explained the role of breeding programmes and the problems associated with behavioural changes.

(c) Explain the principles and issues associated with *ex-situ* conservation methods.

**(4)**

There is an ethical issue about whether it is morally to cage animals because it can change their behaviour or not in natural environment. The principles are that the animals are protected from both predators and poachers. Ex-situ Conservation methods aim to increase genetic diversity in species by cut breeding very short species. Also aim to increase population size. Also to educate people on the animals & raise money for wild conservation. Another issue is that it can be hard to reintroduce the animals back into the wild. And also it is more expensive than in-situ conservation.

**ResultsPlus**
**Examiner Comments**

This is a very strong answer that gained all four marks. The candidate considers and explains the ethical issues, the use of study books, the role of breeding programmes to increase populations and how education is linked to conservation.

(c) Explain the principles and issues associated with *ex-situ* conservation methods.

**(4)**

Harder to control. Cant chose ~~who mates with~~ which animals mate in order to increase alleles. Animals need to remain within area.

**ResultsPlus**
**Examiner Comments**

This answer gained zero marks. The candidate has mentioned the need to increase the frequency of different alleles but has not explained how to do so.

## *Question 8 (b)*

This question required candidates to analyse data concerning the effect of the molecular mass of different substances on ultrafiltration in the kidney. A ratio of filtrate concentration: blood concentration was given along with the mass of each substance. Most candidates gained at least one mark and were able to recognise that larger particles are unable to be passed out of the glomerulus, fewer went on to explain what the ratio showed and/or refer to the size of the pores in the glomerulus/basement membrane. Some excellent answers were seen with candidates using impressive scientific vocabulary and demonstrating a strong understanding of the anatomy of the kidney.

Analyse the data to explain the ratios of these substances.

**(3)**

In general, the greater the molecular mass of the substance, the lower its concentration in the filtrate in comparison to its concentration in the blood. This is since, when blood enters the glomerulus, it is under high pressure as it is undergoing the process of ultrafiltration. So, molecules such as myoglobin and plasma proteins with a high molecular mass tend to also be large molecules. So, these substances are unable to pass through the small pores of the glomerulus capillaries and the basement membrane to pass into the filtrate, unlike ions and water, urea and glucose which are all so small that they are completely removed from the blood to be present in the filtrate. So, as the molecular mass of myoglobin is 16940 greater than that of urea, 1·3 times more urea is present in the filtrate than myoglobin.

**ResultsPlus**
**Examiner Comments**

This excellent answer gained all three marks. The candidate explains what the data shows and goes on to explain that only smaller particles are able to pass through the pores.

**ResultsPlus**
**Examiner Tip**

If a question asks for data analysis, show the examiners the analysis that you have carried out.

Analyse the data to explain the ratios of these substances.

**(3)**

Sodium ions, water, urea and glucose are all pumped out put then are pumped in. For myoglobin, a vast majority of ~~it~~ it is pumped out, but not all. For plasma proteins, they are not really pumped out as they are too big to be pumed out so the concentration is very small.

**ResultsPlus**
**Examiner Comments**

This answer gained one mark for the idea of size linked to filtration. There is no mention of the pores or correct explanation of the ratios.

Analyse the data to explain the ratios of these substances.

(3)

The data shows that substances with a higher relative molecular mass such as Myoglobin and plasma proteins have a lower ratio of concentration in the filtrate. This is due to very large proteins remaining in the blood along with blood cells. There are much higher ratios of substances with lower masses as these can easily fit through the filtering tissues. So there will be higher concentrations of sodium, water, urea and glucose in the filtrate.

**ResultsPlus**
**Examiner Comments**

This answer gained two marks. The candidate has identified the effect of size on filtration and has explained the ratios. No mention is made of the pores.

## *Question 8 (c)*

This question drew a very broad range of responses and discriminated well. To gain a level 3 mark, candidates were required to consider all parts of the nephron and give an account that did not contain any major errors. Major errors were considered to be comments such as indicating extra urea being pumped into the filtrate, and the ornithine cycle taking place in the kidney. Many candidates produced excellent quality answers that fully explained the selective uptake of glucose in the proximal convoluted tubule, the roles and actions of the ascending and descending limbs of Henle, and how the absorption of water caused the increase in urea concentration. Some candidates even explained that the data indicated the presence of ADH and so aquaporin channels would be present in the collecting duct. Less successful candidates were often confused about the activity of the ascending and descending limbs of the loop of Henle and often thought that urea and salt concentrations increased due to the secretion of these substances in the collecting duct. A few candidates gave a pure description of the changes in concentrations of the substances and were thus restricted to one mark.

**Explain the changes in the concentration ratios of these solutes in the different parts of the nephron.**

**(6)**

Glucose's concentration ratio started from 1.0 as for glucose and sodium ions however ~~went~~ decreased ~~very~~ within the proximal convoluted tubule. The concentration ratio of urea increased ~~the~~ during every part of the nephron and the concentration of sodium ions increased during first part of loop of Henle as the $Na^+$ was diffusing in the loop of Henle and then diffused out, it's concentration ratio increased back to 1.0 during distal convoluted tubule and collecting duct.

**ResultsPlus**
**Examiner Comments**

This answer was considered to be a level 1 answer and was awarded one mark. There is only a basic description of how glucose and sodium change throughout nephron. There is little explanation so a maximum of one mark was awarded.

Explain the changes in the concentration ratios of these solutes in the different parts of the nephron.

**(6)**

The ~~sodio~~ sodium ions move out of the ascending limb by active transport due to the ascending limb being impermeable to water. ~~The water moves out of the~~ ~~co~~ This causes a lower water potential and therefore a higher concentration in the medulla. The water enters the collecting duct by osmosis this is due to the collecting duct being permeable to water, therefore the concentration of urea in the collecting duct is the highest. The glucose is only present in the proximal ~~coil~~ convoluted tubule because it leaves the nephron through it. The sodium ions will be the highest in the loop of Henle as they will be transported out of the ascending limb and into the descending limb until it reaches the distal convoluted tubule when some of the sodium ions will move out, and the few present will be found in the urine in the collecting duct which will then reach the Bowman's capsule and be released.

**ResultsPlus**
**Examiner Comments**

This was considered to be a level 1 answer and was awarded two marks. There is description of changes in substances at all areas but very little explanation other than in the collecting duct. Explanation of one other area would have made it a level 2 answer.

Explain the changes in the concentration ratios of these solutes in the different parts of the nephron.

**(6)**

There is a sudden drop in the level of Glucose in the proximal convoluted tubule as the glucose is reabsorbed ~~from~~ into the blood, due to their being a lower concentration outside than inside, and because glucose is a source that the body cannot waste, as it is required for the production of ATP, so the body would reabsorb the glucose, and as a result, there is no glucose throughout the rest of the nephron as it has all been reabsorbed.

There is a dip in the amount of sodium ions as Sodium ions are transported out at the start of the loop of henle to increase water potential and ~~diffuse~~ cause it to come out of the loop of henle, so that the water can be used for other bodily functions.

The level of urea rises in concentration throughout the graph as all the other solutes are removed from the filtrate, such as water and glucose, as it is the main waste product and so must be removed by the body, through urine, as it cannot be retaken up.

**ResultsPlus**
**Examiner Comments**

This answer was considered to be a level 2 answer that was awarded three marks. Only two areas of the nephron are discussed, and the level of depth was not sufficient to award four marks.

Explain the changes in the concentration ratios of these solutes in the different parts of the nephron.

(6)

- Glucose is reabsorbed by selective reabsorbtion in the proximal convoluted tubule.
- The concentration of sodium ions increases in the descending limb of the loop of henle as they diffuse out down a concentration gradient into the medullary fluid. This increase in $Na^+$ cause water to leave the Bowman's capsule so it can be ~~reb~~ reabsorbed (this is ultrafiltration) as water leaves the relative concentration of urea in the loop of henle increases. More water can then be reabsorbed and taken out of the distal convoluted tubule therefore further increasing the concentration of urea. Antidiuretic hormone then controls the permeability of the collecting duct to water, allowing more $H_2O$ to leave and be reabsorbed, therefore, once again further increasing the concentration of urea and allowing for highly concentrated urine so important substances e.g. $H_2O$ can be retained.

ResultsPlus
Examiner Comments

This answer was considered level 2 and was awarded four marks. All three areas are discussed but there is a major error - the candidate has suggested that sodium causes water to leave the Bowman's capsule. The error means that the answer has a maximum of level 2 and was this awarded four marks.

Explain the changes in the concentration ratios of these solutes in the different parts of the nephron.

(6)

glucose concentration ratio decreases rapidly to 0.02 in the proximal convoluted tubule (PCT) as it is selectively reabsorbed from the PCT into the cortex and then back into the blood stream. Urea increases ~~through~~ concentration throughout all sections of the nephron as no urea is reabsorbed yet the total volume of the filtrate decreases as other molecules like water are reabsorbed, increasing the urea concentration. Sodium ion concentration increases at the descending limb of the loop of henlé, ~~shown first~~ as water is reabsorbed into medulla and into blood, yet sodium ions can't be reabsorbed as the descending limb is impermeable to $Na^+$ ions. ~~In~~ The concentration of $Na^+$ ions then decreases in the ascending loop of henlé, ~~this~~, ~~shown by the middle~~ the start of this shown by half way through the 5th square on the graph. The concentration decreases as the ascending limb is permeable to $Na^+$ ions, and at first they ~~are actively~~ diffuse out at the bottom of the ascending limb, and then the $Na^+$ ions are actively ~~pumped~~ pumped out of the filtrate. The concentration of $Na^+$ ions and urea then constantly increases through the distal convoluted tubule and the collecting duct because ADH causes water in the filtrate to diffuse out by osmosis through aquaporins ~~aquaporins~~ that are found in the distal convoluted tubule and collecting duct.

ResultsPlus
Examiner Comments

This answer was considered to be level 3 and was awarded 5 marks. There is some explanation of all parts of the nephron, but the level of detail was considered to not be sufficient to award 6 marks.

Explain the changes in the concentration ratios of these solutes in the different parts of the nephron.

**(6)**

Firstly glucose. During selective reabsorption in the proximal convoluted tubule, as glucose is actively transported from the filtrate back into the blood. It becomes attached to a sodium ion and is pumped back into the blood supply. As a result, at the beginning of the convoluted tubule the concentration is high, however before the end of the tubule, all glucose has been reabsorbed into the blood so the ratio is extremley small tending to 0.

Next, sodium ions. The concentration of sodium ions in the proximal convoluted tubule remains constant. During the loop of Henle it changes. In the ascending limb, sodium ions are pumped out of the limb into the medulla, and the limb is impermeable to their return. This is shown by the drop in concentration in the later part of the loop of Henle graph. These sodium ions diffuse back into the descending limb of the loop of Henle, increasing the concentration. The peak in ratio concentration at almost 2 comes at the bottom of the loop, where concentration is extremley high so $Na^+$ sodium ions diffuse out into the medulla. This process is to ~~This level of~~ ~~increase~~ decrease water ~~sodium ions increases~~ potential in the medulla. In the distal convoluted tubule, the Filtrate ion levels in the ~~blood~~ are altered to ensure that the blood pH is correct, thus why sodium ion concentration increases.

Finally urea, the concentration of urea increases as the filtrate passes along the nephron, because gradually more substances are reabsorbed into the blood. Concentration gradually increases in the proximal convoluted tubule as water (80%) and glucose are reabsorbed into the blood. Urea becomes more concentrated however further on, reaching over 50.0. This is because in the collecting duct, water is reabsorbed into the blood (it moves out of the filtrate by osmosis due to the medulla's low water potential), therefore urea becomes more concentrated, eventually forming urine.

**(Total for Question 8 = 10 marks)**




This answer was considered to be level 3 and gained 6 marks. All areas of the nephron are discussed in detail and there are no major errors. Excellent terminology and explanations are shown throughout.




Remember that on level-based questions, the mark scheme comments are indicative and not the only way in which you can gain credit.

Explain the changes in the concentration ratios of these solutes in the different parts of the nephron.

**(6)**

The ~~ratio~~ concentration ratio of glucose decreases at the proximal convoluted tubule from 1.0 to 0.02 as glucose is reabsorbed at the proximal convoluted tube and is reabsorbed back into the blood using $Na^+$ co transporter protein in the basal membrane. The concentration ratio sodium remains constant at 1.0 in the proximal convoluted tubule but then increases to 1.9 at the loop of Henle. because the loop of Henle acts as a counter current multiplier and so the ascending loop has a sodium potasium pump and is impermeable to water and pumps out $Na^+$ ions to ~~great~~ more create a negative water potential in the medulla. Water moves out of the distal convoluted tubule and collecting duct depending on the level of ADH present. The $Na^+$ would move out down the concentration gradient. The urea increases at the distal convoluted tubule and collecting duct due to ~~the~~ water moving out.

ResultsPlus
Examiner Comments

This answer is a level 3 answer that gained 6 marks. There is a full, detailed discussion of all parts of the nephron and no major errors.

## *Question 9 (a) (i)*

This was a straightforward question that required candidates to give a definition of net primary productivity. Most candidates were able to correctly state that the net primary productivity is equal to the gross primary productivity minus energy loss from respiration. A range of other correct alternatives such as the energy passed on to consumers were also accepted. Some candidates confused NPP with GPP and others thought that it was the total amount of energy fixed in photosynthesis.

(a) (i) State what is meant by the term **net primary productivity** (NPP).

**(1)**

Net primary productivity is the Gross primary productivity – Respiration.

ResultsPlus
Examiner Comments

This gained one mark for correctly stating that NPP is the GPP minus respiration.

(a) (i) State what is meant by the term **net primary productivity** (NPP).

**(1)**

The amount of energy used to create new plant growth

ResultsPlus
Examiner Comments

This answer gained zero marks as the definition is not correct.

(a) (i) State what is meant by the term **net primary productivity** (NPP).

**(1)**

NPP is how much energy is available to be passed to the next trophic level (from producer to primary consumer) after respiration and some energy for biological processes e.g. Respiration.

ResultsPlus
Examiner Comments

This answer gained one mark for correctly stating that the net primary productivity is the energy available to the next trophic level.

## *Question 9 (a) (ii)*

This question required candidates to examine data about ocean productivity linked to the time of year, duration of light and temperature. The data demonstrated that NPP varied throughout the year and was dependent upon both temperature and daylength. Successful candidates recognised that both temperature and daylength increased NPP and that when NPP was high, the rate of photosynthesis was greater than the rate of respiration. Only a few candidates recognised that a negative NPP suggested that respiration rate exceeded GPP or photosynthesis and that light was clearly acting as a limiting factor during some months. Less successful candidates tended to restrict their answers to repeatedly describing the data and generally only gained one mark for identifying the effect of daylength and temperature on NPP.

(ii) Analyse the data to explain the effect of daylight and temperature on NPP.

**(3)**

because • positive correlation between temperature and NPP
• positive correlation between daylight hours and NPP
• More daylight and temperature increases photosynthesis which increases the GPP as more products are stored as biomass
• less respiration when the days are longer which increase NPP.

ResultsPlus
Examiner Comments

This answer gained one mark for correctly identifying the effect of daylength and temperature on NPP. The reference to respiration is in the wrong context.

(ii) Analyse the data to explain the effect of daylight and temperature on NPP.

(3)

As mean hours of daylight increase and temperature increase, so does the NPP. This is because there is more light available for longer time so the photosynthesis can occur for a longer time within the plants. Therefore more biomass that has been produced is able to be fixed because some of rate of respiration is the same. Also high temperature means rate of water loss so rate of transpiration is high so plant rate of photosynthesis is higher because of LI + $H_2O$ are less limiting to rate. Also high temperature of photosynthetic enzymes.

ResultsPlus
Examiner Comments

This answer gained two marks. The candidate clearly describes the effects of daylength and temperature on NPP and goes on to explain that NPP is high when the rate of photosynthesis increases, and the rate of respiration remains low.

(ii) Analyse the data to explain the effect of daylight and temperature on NPP.

(3)

With more daylight hours and higher temperature, this increases the NPP. From January, with 9 hours daylight and 2.8°c the NPP was -1.0 a day. Then in June with is hours daylight and 20.6°c, NPP was +8.0. This is because less energy is lost to respiration and more being made by photosynthesis. With more energy being produced as conditions better for photosynthesis, so there can be more energy stored in the plant.

ResultsPlus
Examiner Comments

This answer gained two marks for correctly identifying the effects of daylength and temperature on NPP and then explaining that NPP is high when the rate of photosynthesis is high, and rate of respiration is low.

a given time period minus effect of respiration.

(ii) Analyse the data to explain the effect of daylight and temperature on NPP.

(3)

The general trend shows that increasing daylight increased temperature (more sunlight) and ~~more~~ had a positive value for NPP (∴ more photosynthesis occurs than respiration.) As you decrease the hours of daylight e.g. 9 hours, the temperatures tend to be coldest and NPP is negative (more respiration occurs than photosynthesis) January ~~February~~ had the lowest temp of ~~8°~~ 2.8° February & December March had most negative NPP value of -1.2

ResultsPlus
Examiner Comments

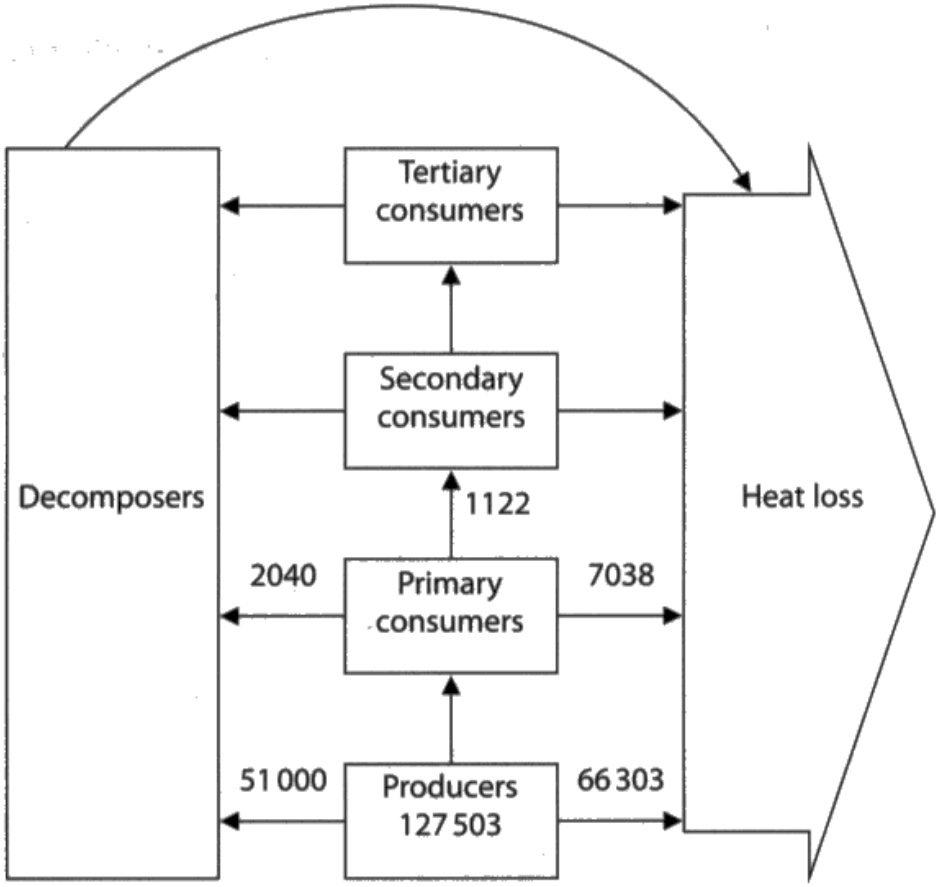
This strong answer gained three marks. The effects of daylength and temperature on NPP are stated correctly and the candidate then goes on to correctly explain how the rates of photosynthesis and respiration cause NPP to be positive and negative.

## *Question 9 (b) (i)*

This question required candidates to calculate the percentage energy efficiency of the energy transfer between producers and primary consumers. Most candidates were able to gain at least one mark by determining the quantity of energy passed on and many of these went on to calculate the percentage efficiency of this transfer. Less successful candidates were often unable to determine the quantity of energy transferred with many erroneously thinking that 127 503 kJ $m^{-2}$ $year^{-1}$ were transferred. A common error was incorrect rounding of numbers with a significant number of candidates giving 7.9 as a final answer.

(b) The diagram shows some of the energy transfers through a food chain from this area.

The figures show the energy transfer in kJ $m^{-2}$ $yr^{-1}$.




(i) Calculate the percentage efficiency of energy transfer from the producers to the primary consumers.

**(2)**

$127503 - 66303 - 51000$

$= 10200$

$\frac{10200}{127503} \times 100 = 7.998$

$\therefore 8.0\%$

Answer 8.0%

ResultsPlus
Examiner Comments

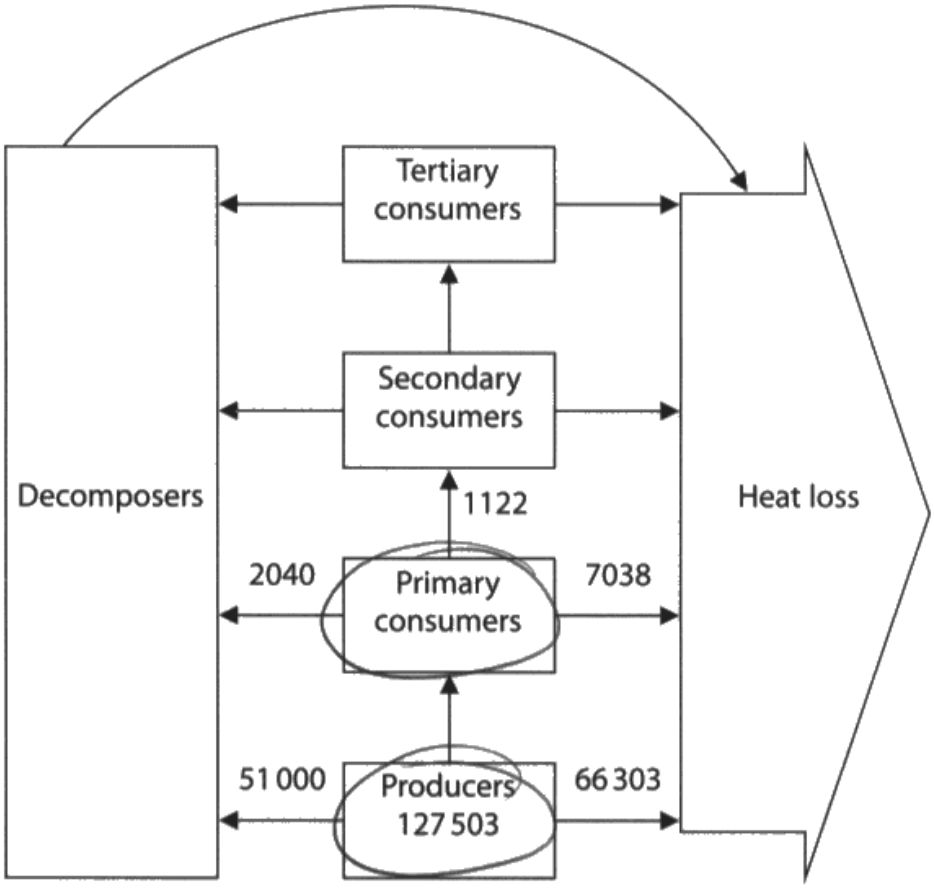
This answer gained two marks. The candidate has shown all the working and it is clear how they have determined their final answer.

ResultsPlus
Examiner Tip

Always show your working when answering maths questions.

(b) The diagram shows some of the energy transfers through a food chain from this area.

The figures show the energy transfer in kJ $m^{-2}$ $yr^{-1}$.




(i) Calculate the percentage efficiency of energy transfer from the producers to the primary consumers.

(2)

$127,503 - (51,000 + 66,303)$

$\Rightarrow 127,503 - 117303$

$= 10,200$

Answer 10,200 kJ $m^{-2}$ $yr^{-1}$

ResultsPlus
Examiner Comments

This answer gained one mark. The candidate has correctly calculated the quantity of energy transferred but has not used this to determine the percentage efficiency.

## *Question 9 (b) (ii)*

This question required candidates to explain why energy efficiency varies. Successful candidates gave answers that explained how different organisms have different energy losses and went on to give examples of this in terms of inedible food, losses from excretion, indigestible food and respiration linked with heat loss or movement. Less successful candidates tended to give GCSE level answers that simply listed mechanisms of energy loss without explaining how these would vary.

(ii) Explain why the efficiency of energy transfer differs between different trophic levels.
(3)

The energy transfer differs between trophic levels because as the trophic levels raise there are various external factors such as amount of food eaten, heat loss which limit the energy transfer for each ~~anim~~ level.

**ResultsPlus**
**Examiner Comments**

This answer gained zero marks. The candidate has restated the question stem and has not linked heat loss to the rate of respiration.

(ii) Explain why the efficiency of energy transfer differs between different trophic levels.
(3)

Firstly as you move up the trophic level, the amount of energy available decreases. Hence, higher trophic levels usually are smaller in number of and are more efficient. The efficiency from the primary to secondary consumes, for example, is 10%. The small ~~one~~ amount of energy available from producers is much less than the amount of energy available for producers. Also as you move to higher trophic levels, the amount of food that's undigested decreases, and so efficiency increases. Any heat is lost through metabolism etc through thermoregulation, as organisms become more complex

ResultsPlus
Examiner Comments

This answer gained two marks for the ideas that energy is lost via heat loss (and respiration) and indigestible food.

(ii) Explain why the efficiency of energy transfer differs between different trophic levels.

**(3)**

Because there are different organisms present at each trophic level. Some organisms have worse efficiency of energy transfer compared to others due to factors such as size, how active they are (movement) and amount they respire or excrete. For example, more active organisms who respire more will use up a lot of energy which means less and less energy is passed up the trophic levels.

ResultsPlus
Examiner Comments

This answer gained three marks. The candidate explains that organisms at different trophic levels have different energy losses and qualifies this by linking it to respiration and movement, and excretion.

## *Question 9 (c)*

This question required candidates to read information about Bluefin tuna farming and inspect a graph showing the possible impacts of the farming on wild tuna stocks and wild tuna catches. Information in the text explained to candidates that the method of farming required the removal of young, immature fish from the ocean along with captures of large amounts of prey species. Successful candidates recognised that the graph showed that farming may have led to a decrease in both catches and mass of wild tuna and linked this to the removal of young immature fish and prey species. Less successful candidates only referred to the graph and some thought that the farming of tuna had led to an increase in wild tuna mass rather than causing a further decrease.

**Comment on the impact of Bluefin tuna farming.**

**(4)**

Since a year after the Bluefin tuna ~~was farming~~ farming started, the mass of coild Bluefin tuna caught has started to decrease and ~~generally~~ steadily ~~in~~ decreasing. As the farming kept on increasing. However, total mass of bluefin tuna has steeply & decreased from 350 thousand tonnes in 2000 to 50 thousand tonnes by 2009.

**ResultsPlus**
**Examiner Comments**

This answer gained one mark for the idea that farming has led to a decrease in wild tuna. The candidate has not given a specific date at which the tuna catch began to decline and so gained no credit for recognising the decrease in catch.

Comment on the impact of Bluefin tuna farming.

(4)

Blue fin tuna farming has lead to a decrease in the total mass of blue fin in the wild. As the farming began in 2002 there has been a significant decrease in blue fin tuna in the wild from 300 thousand tonnes in 2002 to 50 thousand tonnes in 2009



This answer gained one mark for identifying the decline in wild tuna mass after the start of farming.

Comment on the impact of Bluefin tuna farming.

(4)

blue tuna farming has reduced drastically the mass of tuna, as the tuna are caught when they are yet sexually immature they have not bred new tuna so the numbers decrease consistantly through the years as tuna are not able to breed. on the other hand since 2002, the numbers of tuna produced by farming have increased to a level of being at the same masses as those wildly caught, so they are replacing this method which could be stopped so that tuna are allowed to bred and increase in masses.



This answer gained two marks for recognising that tuna farming has led to a reduction in wild tuna mass and linking this to the removal of young, immature fish.

Comment on the impact of Bluefin tuna farming.

**(4)**

Wild bluefin tuna masses have decreased dramatically. Farming of bluefin tuna has increased steadily since 2002. While slightly less wild bluefin tuna are being caught, the amount of wild individuals is decreasing. This is possibly because tuna farming has also lead to prey species being caught to feed the farmed tuna. This reduces the amount of food for the wild bluefin tuna, increasing competition and reducing their numbers that survive.

**ResultsPlus**
**Examiner Comments**

This answer gained three marks. The candidate has recognised that farming has led to a reduction in wild tuna mass and catch since 2002 and has explained how this may be due to the capture of prey species.

## *Question 10 (a) (i)*

This question required candidates to make a correct null hypothesis for the chi squared test. Only a minority of candidates gained this mark with many giving incorrect hypotheses rather than null hypotheses.

**10** In the fruit fly, *Drosophila*, the allele for normal wings (**N**) is dominant to the allele for vestigial (small) wings (**n**).

The allele for red eyes (**R**) is dominant to the allele for sepia eyes (**r**).

In an investigation, students crossed homozygous parent flies. Flies with normal wings and red eyes were crossed with flies with vestigial wings and sepia eyes.

All the $F_1$ offspring of this cross had normal wings and red eyes.

Flies from this $F_1$ generation were crossed and the phenotypes of their offspring ($F_2$ generation) were counted.

The results for the $F_2$ generation are shown in the table.

| *Drosophila* phenotype | Number of *Drosophila* with each phenotype |
|---|---|
| normal wings and red eyes | 885 |
| normal wings and sepia eyes | 322 |
| vestigial wings and red eyes | 286 |
| vestigial wings and sepia eyes | 107 |

The students thought that the genes for wing length and eye colour were on different chromosomes.

(a) (i) State a null hypothesis for this investigation.

**(1)**

Wing length and eye colour are on different chromosomes

**ResultsPlus**
**Examiner Comments**

This gained zero marks and is an example of a commonly written, incorrect answer.

(a) (i) State a null hypothesis for this investigation.

**(1)**

Genes for wing length and eyecolour are on the same chromosome

ResultsPlus
Examiner Comments

This answer gained zero marks and is an example of an incorrect answer that is not a null hypothesis.

(a) (i) State a null hypothesis for this investigation.

**(1)**

There is no significant difference between observed and expected results ~~the wing length and eye colour~~

ResultsPlus
Examiner Comments

This answer gained one mark for correctly stating the null hypothesis.

## *Question 10 (a) (ii) - (iv)*

These questions required candidates to carry out a chi squared test and use the critical values table to reach an appropriate conclusion. Successful candidates were able to carry out all the calculations correctly, select the correct critical value and then explain that this meant that the null hypothesis was not rejected and that the difference in the observed and expected values was not significant. Less successful candidates did not gain credit for a variety of reasons including:

- incorrect calculations in parts (i) and (ii), often writing 15 rather than -15
- not selecting the correct critical value. Many selected one or four degrees of freedom and/or used the critical value at the 0.5 level of significance
- incorrect interpretation of the chi squared value - many thought that if the value was less than the critical value this means that there is a significant difference

(ii) A Chi squared test was carried out to test this hypothesis.

Complete the table.

(1)

| Phenotype | Expected ratio | Observed results (O) | Expected results (E) | (O – E) | $(O - E)^2$ | $\frac{(O - E)^2}{E}$ |
|---|---|---|---|---|---|---|
| normal wings and red eyes | 9 | 885 | 900 | -15 | 225 | 0.25 |
| normal wings and sepia eyes | 3 | 322 | 300 | 22 | 484 | 1.61 |
| vestigial wings and red eyes | 3 | 286 | 300 | –14 | 196 | 0.65 |
| vestigial wings and sepia eyes | 1 | 107 | 100 | 7 | 49 | 0.49 |

(iii) Calculate the value of Chi squared using the formula

(1)

$$\chi^2 = \sum \frac{(O - E)^2}{E}$$

$\chi^2 = 0.25 + 1.61 + 0.65 + 0.49$

$= 3$

Answer 3

(iv) The table shows some critical values of Chi squared at different degrees of freedom.

| Degrees of freedom | *p* value | | | | |
|---|---|---|---|---|---|
| | 0.900 | 0.500 | 0.100 | 0.050 | 0.010 |
| 1 | 0.016 | 0.455 | 2.706 | 3.841 | 6.635 |
| 2 | 0.211 | 1.386 | 4.605 | 5.991 | 9.210 |
| 3 | 0.584 | 2.366 | 6.251 | 7.815 | 11.345 |
| 4 | 1.064 | 3.357 | 7.779 | 9.488 | 13.277 |

Use this table to comment on the results of the investigation.

(3)

As number of categories - 1 = 3, this is the number of degrees of freedom. At the probability of 0.05, the critical value is 7.815. As this value is greater than our calculated value of 3, we must conclude that the genes for wing length and eye colour are found on different chromosomes, and accept the null hypothesis. Therefore concluding that there is a greater than 0.05 probability that the results are due to chance.

**ResultsPlus**
**Examiner Comments**

This is a strong answer that gained full marks for all parts of the question. The candidate carries out all calculations correctly and goes on to use the calculated value correctly in part (iv).

(ii) A Chi squared test was carried out to test this hypothesis.

Complete the table.

**(1)**

| Phenotype | Expected ratio | Observed results (O) | Expected results (E) | (O – E) | $(O - E)^2$ | $\frac{(O - E)^2}{E}$ |
|---|---|---|---|---|---|---|
| normal wings and red eyes | 9 | 885 | 900 | – 15 | 225 | 0.25 |
| normal wings and sepia eyes | 3 | 322 | 300 | 22 | 484 | 1.61 |
| vestigial wings and red eyes | 3 | 286 | 300 | –14 | 196 | 0.65 |
| vestigial wings and sepia eyes | 1 | 107 | 100 | 7 | 49 | 0.49 |

(iii) Calculate the value of Chi squared using the formula

(1)

$$\chi^2 = \sum \frac{(O - E)^2}{E}$$

$\chi^2 = 0.25 + 1.61 + 0.65 + 0.89$

$= 3$

Answer 3

(iv) The table shows some critical values of Chi squared at different degrees of freedom.

| Degrees of freedom | *p* value | | | | |
|---|---|---|---|---|---|
| | 0.900 | 0.500 | 0.100 | 0.050 | 0.010 |
| 1 | 0.016 | 0.455 | 2.706 | 3.841 | 6.635 |
| 2 | 0.211 | 1.386 | 4.605 | 5.991 | 9.210 |
| 3 | 0.584 | 2.366 | 6.251 | 7.815 | 11.345 |
| 4 | 1.064 | 3.357 | 7.779 | 9.488 | 13.277 |

Use this table to comment on the results of the investigation.

(3)

At the 5% significance level the critical value is 2.366, because as there are 4 phenotypes being tested the degrees of freedom are $4 - 1 = 3$. $\chi^2$ is therefore greater than the critical value, and there is enough evidence to reject the null hypothesis and assume that the genes are linked

**ResultsPlus**
**Examiner Comments**

This answer gained 1 mark each for parts (ii) and (iii) but gained zero for part (iv). The calculations of chi-squared are correct but the candidate has chosen the wrong level of significance for part (iv).

(ii) A Chi squared test was carried out to test this hypothesis.

Complete the table.

**(1)**

| Phenotype | Expected ratio | Observed results (O) | Expected results (E) | (O – E) | $(O - E)^2$ | $\frac{(O - E)^2}{E}$ |
|---|---|---|---|---|---|---|
| normal wings and red eyes | 9 | 885 | 900 | −15 | 225 | 0.25 |
| normal wings and sepia eyes | 3 | 322 | 300 | 22 | 484 | 1.61 |
| vestigial wings and red eyes | 3 | 286 | 300 | −14 | 196 | 0.65 |
| vestigial wings and sepia eyes | 1 | 107 | 100 | 7 | 49 | 0.49 |

(iii) Calculate the value of Chi squared using the formula

(1)

$$\chi^2 = \sum \frac{(O - E)^2}{E}$$

5.25 + 1.61 + 0.65 + 0.49

= 3.

Answer 3.00

(iv) The table shows some critical values of Chi squared at different degrees of freedom.

| Degrees of freedom | *p* value | | | | |
|---|---|---|---|---|---|
| | 0.900 | 0.500 | 0.100 | 0.050 | 0.010 |
| 1 | 0.016 | 0.455 | 2.706 | 3.841 | 6.635 |
| 2 | 0.211 | 1.386 | 4.605 | 5.991 | 9.210 |
| 3 | 0.584 | 2.366 | 6.251 | 7.815 | 11.345 |
| 4 | 1.064 | 3.357 | 7.779 | 9.488 | 13.277 |

Use this table to comment on the results of the investigation.

(3)

DF = n-1 = 4-1 = 3 at the p = 0.05, the critical value was 7.815 which is greater than our chi squared value meaning we cannot reject our null hypothesis. Therefore, wing length and eye colour are on the same ~~gene~~ chromosome.

**ResultsPlus**
**Examiner Comments**

This answer gains one mark for both of parts (ii) and (iii) and two marks for part (iv). In part (iv), the correct level of significance is selected, and the candidate correctly states that the null hypothesis is not rejected but does not state that the difference is not significant.

(ii) A Chi squared test was carried out to test this hypothesis.

Complete the table.

**(1)**

| Phenotype | Expected ratio | Observed results (O) | Expected results (E) | (O – E) | $(O - E)^2$ | $\frac{(O - E)^2}{E}$ |
|---|---|---|---|---|---|---|
| normal wings and red eyes | 9 | 885 | 900 | −15 | 125 | 0.25 |
| normal wings and sepia eyes | 3 | 322 | 300 | 22 | 484 | 1.61 |
| vestigial wings and red eyes | 3 | 286 | 300 | −14 | 196 | 0.65 |
| vestigial wings and sepia eyes | 1 | 107 | 100 | 7 | 49 | 0.49 |

(iii) Calculate the value of Chi squared using the formula

**(1)**

$$\chi^2 = \sum \frac{(O - E)^2}{E}$$

$0.25 + 1.61 + 0.65 + 0.49$

$= 3$

Answer 3

(iv) The table shows some critical values of Chi squared at different degrees of freedom.

| Degrees of freedom | *p* value | | | | |
|---|---|---|---|---|---|
| | 0.900 | 0.500 | 0.100 | 0.050 | 0.010 |
| 1 | 0.016 | 0.455 | 2.706 | 3.841 | 6.635 |
| 2 | 0.211 | 1.386 | 4.605 | 5.991 | 9.210 |
| 3 | 0.584 | 2.366 | 6.251 | 7.815 | 11.345 |
| 4 | 1.064 | 3.357 | 7.779 | 9.488 | 13.277 |

Use this table to comment on the results of the investigation.

**(3)**

degrees of freedom are 4 and so at $p = 0.05$ our value does not exceed the critical value. Therefore we can accept the null hypothesis and state that there is no genes for wing length + genes for eye colour do not occur on different chromosomes and that they do BECAUSE this is due to chance is 5 %.

ResultsPlus
Examiner Comments

This answer gained one mark for each of parts (ii), (iii), and (iv). Chi-squared is calculated correctly in parts (ii) and (iii) but in part (iv), the candidate has selected the wrong critical value but gains credit for explaining that the null hypothesis is accepted.

## *Question 10 (b)*

This question tested candidates' knowledge of dihybrid crosses and genetic linkage. Candidates were presented with the results of a cross and asked to explain them. Credit was awarded for giving the parental and $F_1$ genotypes and stating what alleles the gametes would be expected to carry. Many candidates recognised that the products of the $F_1$ cross would be expected to be in a 9:3:3:1 ratio if the genes were on different chromosomes and several drew out the cross to help explain this. Credit was also given for explaining that as the results were not in the 9:3:3:1 ratio, the genes were linked on the same chromosome. Many candidates recognised that the genes were linked but did not explain how this would affect the inheritance pattern or that if recombination did not occur, a 3:1 ratio of phenotypes would be expected. Some very good explanations of how the recombinant phenotypes were produced were seen and many candidates are fully conversant with the nature of crossing over and chiasmata formation. A few very successful candidates drew out genetic diagrams to show how linked genes are inherited and explained that the few numbers of recombinants suggested that the genetic loci were close together. Where candidates were less successful, typical reasons for gaining few marks were:

- suggesting that the $F_2$ ratios were in a 9:3:3:1 ratio
- not explaining the genetic crosses
- suggesting that the genes were sex linked
- only focusing on one aspect of the question, either linkage or how a dihybrid cross occurs

*(b) In *Drosophila*, the allele for grey bodies (**G**) is dominant to the allele for black bodies (**g**).

In a second investigation, students crossed homozygous parent flies. Flies with normal wings and grey bodies were crossed with flies with vestigial wings and black bodies.

All the $F_1$ offspring had normal wings and grey bodies.

Flies from this $F_1$ generation were crossed and the phenotypes of their offspring ($F_2$ generation) were counted.

The results are shown in the table.

| *Drosophila* phenotype | Number of *Drosophila* with each phenotype |
|---|---|
| normal wings and grey body | 1105 |
| normal wings and black body | 85 |
| vestigial wings and grey body | 72 |
| vestigial wings and black body | 338 |

Explain the results of this second investigation.

**(6)**

The results of the investigation showed that the majority of Drosophilia (69%) had normal wings + a grey body due to the dominance of their alleles (N+G) Those with one dominant characteristic (normal wings/& grey body) and one recessive characteristic (vestigial wings + black body) were less common (~5%) due to the recessive alleles needing to be homozygous in an individual to be expressed.

**ResultsPlus**
**Examiner Comments**

This answer was considered to be level 1 as only one aspect is discussed and as there is very little relevant detail; one mark was awarded.

Explain the results of this second investigation.

**(6)**

• Grey bodies are dominant and so are normal wings so having only one allele ~~that~~ will show in the phenotype

The F, offsprings that were crossed were all heterozygous. When both heterozygous are crossed a 9:3:3:1 ratio shows. There are the most of normal wings and grey body because they are both dominant alleles, which means the heterozygous pair (of alleles) would appear Normal wings and grey body.

• The second investigation shows that body colour and type of wing are linked because the heterozygotes in F, were crossed and gave a 9:3:3:1 ratio

**ResultsPlus**
**Examiner Comments**

This answer was considered to be level 1 and was awarded 2 marks. There is some discussion of how the alleles are inherited and linkage is mentioned. It is not clear, however, that linkage is in the correct context so 2 marks were awarded.

Explain the results of this second investigation.

(6)

~~Carrying out the chi~~ These sets of results in the number of Drosophilia with each ~~pair~~ phenotype are different than the first investigation. ~~This is due~~ instead of to the phenotype ratio of 9:3:3:1 which is what we would expect in a ~~F1 cross where the two~~ dihybrid cross when the genes are linked. Instead we have a higher number of Drosophilia with normal wings and grey body and vestigial wings and black body. This means that the two genes for body colour and wing types are linked. ~~It~~ As a result of the linkage the genes are on the same chromosome so therefore during meiosis I and II during metaphase I and II they are unaffected by the independant assortment and are inherited like one gene. In metaphase I the genes ~~it~~ are linked so stay in the same bivalent and with metaphase II ~~the gene~~ since the genes are linked they stay together on ~~the~~ and are inherited on the same chromatid. ~~There~~ Therefore increasing the phenotype numbers of flies ~~that~~ which share the parental phenotype as the genes are inherited unchanged. However there is still some with ~~very~~ a different phenotype to the parents as some recombinant DNA can occur during ~~pla~~ prophase I as there is crossing over at chiasmata between two non-sister chromatids of the same bivalent. Depending on the loci of the gene depends on the likelihood of chiasmata occuring between the genes and seperating the linked genes however this results in a much lower ratio with this recombinant DNA

**ResultsPlus**
**Examiner Comments**

This answer was considered to be a level 2 answer and 3 marks were awarded. There is a consideration of the genetic cross and an explanation of linkage but there are only a few details regarding the inheritance of the alleles. Because two aspects were considered but the discussion was mainly about one of them, three marks were awarded.

Explain the results of this second investigation.

**(6)**

The first cross, NNGG × nngg, will have created offspring with the genotypes NnGg, and as normal wing and grey body alleles are dominant, all the $F_1$ offspring had normal wings and grey bodies. When $F_1$ offspring were then crossed, different results were produced. The majority had normal wings + grey body, some had vestigial wings + black body, and ~~there other~~ there was very little of the other 2 phenotypes. This ratio suggests that the genes for wing size and body colour are on the same chromosome. Normal wings/black body and vestigial wings/grey body flies were not very abundant as the only way these could be produced is by crossing over during meiosis, in prophase 1, ~~each the creation of~~ involving chiasmata. This would mean alleles from one chromosome would be ~~the~~ broken off by enzymes and rejoined to the other chromosome, transferring genetic material.

**ResultsPlus**
**Examiner Comments**

This answer was considered to be a level 2 answer and was awarded 4 marks. The genotypes of the parents and $F_1$ are given along with an explanation of linkage. There is not enough depth to reach level 3 so 4 marks were awarded.

Explain the results of this second investigation.

**(6)**

the results of the second investigation ~~are~~ show values which are very far from the typical 9:3:3:1 ratio you expect in dihybrid inheritance - for ~~me~~ the heterygous offspring, the numbers should be around 15-16, not 85 and 72. This is due to gene linkage - meaning the genes are inherited together on the same chromosome, however, in prophase 1, crossing over occurs ∴ if the genes are not close together on the chromosome and chiasmata form, they may end up on different homologous chromosomes and therefore may not be inherited together. The further away the ~~values~~ genes are the more likely crossing over will occur and so the more likely recombinant phenotypes have formed (differ from parents) the cross over value/ percentage in this investigation is $\frac{85+72+338}{1105+85+72+338} \times 100 = 30.9\%$.

If there are 30.9% of phenotypes that are recombinant, the genes are obviously not always inherited together, so ~~they are far away~~ the loci of these two genes are not close.

ResultsPlus
Examiner Comments

This answer was considered to be a level 3 answer and was awarded 5 marks. There is an explanation of the genetic cross and the idea of linkage is explained making it at least a level 2 answer. The extra detail explaining that the small number of recombinants suggested that the genes are close together makes it a level 3 answer but there is insufficient depth to award 6 marks.

Explain the results of this second investigation.

**(6)**

- The expected observations should would be expected to be in the ratios of 9:3:3:1 if assuming independent assortment occurs.
- This however is not the case, as the number of parental phenotypes is higher than the recombinant phenotypes.
- The difference is substancial and so it's unlikely to be due to chance or improper sampling techniques but instead are due to autosomal ~~lin~~ gene linkage.
- This means that the ~~alleles~~ genes for body colour and wings are found closely on the same chromosome.

- The F1 generation would have one chromosome containing the gn alleles and one containing the GN alleles, and so when the chromosomes segregate during meiosis most gametes will have either GN or gn allele combinations.
- Recombinant ~~allele~~ gametes do form however when the homologous chromosomes cross over during prophase 1 where parts of chromatids are exchanged at the chiasmata

**(Total for Question 10 = 12 marks)**

**TOTAL FOR PAPER = 90 MARKS**

- If the parts being exchanged contain one of the alleles then recombinant chromosomes form with allele combinations of Gn and ~~GG~~ Ng, ~~This is less~~ which forms gametes with these alleles. This event however is rare ~~as~~ however as the correct chromosome sections need to be swapped.
- A higher number of normal wing and grey body Drosphila are seen ~~as~~ than ~~the~~ vestigial wing and ~~black~~ black body variants as the GN alleles will overwride any ~~to~~ gn alleles.
- Since normal wings, black bodies and vestigial wings and grey body require 2 gamete ~~combinations of Gn and~~ recombinant gamets their frequency is much lower.

ResultsPlus
Examiner Comments

This answer was considered to be level 3 and was awarded 6 marks. There is a detailed discussion of how the genes area inherited, an explanation of linkage and detailed explanation of how the recombinant genotypes are produced.

## Paper Summary

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

- Use accurate scientific vocabulary
- Be familiar with how to use all the statistical tests listed in the specification
- Be familiar with all the command words listed in the specification
- Work at a steady even pace being guided by the mark allocation of each question
- Show all working for maths questions
- On data analysis questions, support your answers with the data.

# 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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