

## Examiners' Report June 2023

GCE Biology B 9BI0 03



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June 2023

Publications Code 9BI0\_03\_2306\_ER

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#### Introduction

There was a wide variety of questions on the paper covering large parts of the specification and overall candidates did well. Questions were set on six of the core practicals and many candidates were able to recall the methods followed as well as being able to explain the reasons behind them.

Several indirect practical skills were tested, including commenting on experimental design and evaluating methods, writing a null hypothesis, identifying variables to be controlled, plotting graphs, processing and analysing data and applying scientific knowledge to practical contexts. Overall these were done well.

There was a more mixed response to questions testing maths skills, and candidates would benefit from more practice in several areas including making up dilutions of stock solutions, calculation of the biodiversity index, carrying out and analysing the results of stats tests and use of the Hardy-Weinberg equation.

There were some excellent and thoughtful answers to extended writing questions including the nine-mark levels-based question and some five-mark questions, and candidates deserve credit for their ability to organise data, facts, and expressing themselves clearly. It was particularly pleasing to see candidates applying their scientific knowledge to real world data and situations.

It is clear that some of the advice given in the 2022 examiners report has been implemented and centres are to be commended for the way they have prepared candidates for this exam.

## Question 1 (a)

Almost all candidates were able to complete the diagram to show the structure of beta-glucose.

- 1 Glucose is a monosaccharide.
  - (a) Complete the diagram to show the structure of beta-glucose.





(1)

40 x 3

-V.

#### Question 1 (b)

This question asked for three differences between the structure of starch and cellulose. Generally it was well answered, with over half of the candidates gaining at least two marks.

Many candidates knew the properties of starch and cellulose, but not all could clearly give three differences. Candidates who lost marks usually did not give matching pairs of statements or gave only one half of the information.

Some candidates included information about the functions of starch and cellulose, eg that cellulose is found in cell walls and starch is a storage molecule. These gained no marks.

A few candidates confused the properties of starch and cellulose completely.

- Starth contains × glucose only and is made of B glucose only. Connose



stoch is moot of on beel on poed cellubre is made of B gwore that NOTCHE 180° & STOCH IS WOOL OF Celulate has 1,6 bonds & store both 1,4 & 1,6 20000 celulore is linea.



This candidate knew a lot of relevant information but did not make clear and matching points.

In their first bullet point, they commented only on starch, not cellulose.

In their second bullet point, they gained marking point 1, but gave only half of marking point 4.

Their third bullet point did not get credit because they did not refer to **glycosidic** bonds, and the information given about cellulose was incorrect.

A starch has a-glucose as a monomer
cellulose has B-glywse as a monomer-
- storch have both 1,6-glycosidic bond (amylopectin)
and 1, 4 - glycosidic band ( amy lose) join its nonemer to gether
cellulose only have 1,4 - gly cosidie land join it nono mer
tra ether.
· When joining, monomer (B-alycon) of cellulose is
inverted ( + Ctron + Linde starch management don't
h o CH20H

This is a very well organised answer making three clear points. A diagram can be a simple way to show something that is hard to explain.

Cellulose Starcv alpha beta - glucose (not se) (noi bea) - contains - contains & allucose glucose is -no inversion o moleculo inverted Cupside der contains (-4) and 1-6) rosolic 13 oma bar -no bran pranch



This is another way to make sure you make clear and matching points. This candidate made four relevant points and gained the full three marks.



Setting out your answer as a table of differences helps to keep you organised.

### Question 1 (c)

This question required a matched pair of answers explaining how a property of starch makes it suitable for energy storage in cells. The command word was **explain**, so the property had to be linked to a relevant comment about energy storage for full credit.

There were three creditworthy pairs:

- insoluble, so has no osmotic effect.
- compact, so a lot can be stored in a small space.
- branched, so hydrolysed quickly.

Almost half of the candidates scored two marks in this question, choosing a relevant property and explaining how this makes it suitable for energy storage. The most common errors were to give one or more properties, but not link them to energy storage or to give explanations that lacked detail.

starch is insoluble in water so does not affect the water potential of the cells.

starch form	ns a coiled	shape	so ii oz	mpacy	IF SO	a lot of energy can
be stored in	the cells	s in a r	elatively	sm 011	volume.	1.6-glycosidic bonds
that forms 1	prov con cond	anow fo	or rapid	release	of energy	y for the organism.



-7	Compact, so lots of storage
-7	terhary shuchne held by Hydrogen bonds
-17	Branched So can release energy when needed
	by hydrolysis



LU THE CEUS - IT IS COMPACE SO POESNIE TAKE UP SPACE. - GLYCOSIDIC BONDS ANE EASILLY BHOKEN SO ALLOWE TON QUER DELEASE OF ENERGY



This answer scored two marks for the first two lines.

It would have scored one mark for compact, but not the second for the explanation as it does not refer to energy storage.

The last points would not have scored at all, because they did not refer to branching (just glycosidic bonds) and they referred to energy release rather than breakdown of starch.

### Question 2 (a)(i)

This question is about Core Practical 7: dissect an insect to show the structure of the gas exchange system.

Candidates were asked to add a line to a diagram of a locust to show where it would be cut to expose the gas exchange system.

To gain credit, candidates were expected to draw a line which was roughly horizontal (straight or curved), going through the thorax and abdomen, in the upper part of the body (which was lighter grey on the diagram).

Some candidates drew lines which would have exposed the gas exchange system well. The most common errors were to not include the thorax, or to draw the line either far too high or far too low.

A few candidates drew a vertical line through the body.

- 2 Insects, such as locusts, can be dissected to show their gas exchange system.
  - (a) (i) The diagram shows a dead locust.



Draw a line on this locust to show where you would cut through the exoskeleton to expose the gas exchange system.



This gained one mark for a correctly placed line going through the thorax and abdomen.





This also gained one mark for a correctly placed line – curved this time.





This line was too short as it did not reach the thorax, so did not get a mark.





### Question 2 (a)(ii)

Candidates were asked why the dissected locust would be covered with water.

Almost half achieved this mark, saying that it would make the gas exchange system (or a named visible part of it) easier to see. Some candidates described how the air-filled structures would appear silvery-grey.

If candidates named a structure that would not be visible, eg tracheoles, this was ignored.

A surprising number of candidates think locusts have blood, and that the water would wash this away. This did not gain credit.

To allow the gas system structures to become they can easily be seen. Silvery so Examiner Comments This scored one mark. io that the internal structures as U Oppear Examiner Comments This answer did not score, as "internal structures" is too vague. Reculte Examiner Tip When you are carrying out core practicals, make sure you know why the steps you are following are needed.

(1)the Frachedes he the trachedes / tracheae visible to make 25 This scored one mark. Here the candidate mentioned making tracheoles more visible. As tracheoles are not visible to the naked eye this was ignored, but credit was given for saying that the tracheae are visible with water. 5 this removes any blood left inside it, it cleans inside and

makes it cosier to see the respiratory system



Any reference to locust blood prevented an answer from achieving the mark.

### Question 2 (b)(i)

Candidates were given a photomicrograph of a dissected locust gas exchange system and asked to label two parts. Around half of all candidates scored both marks, but about a third were unable to name either structure.

Common errors included naming the wrong parts of insect systems eg tracheoles, or naming part of the gas exchange systems of other animals eg lamellae, alveoli, bronchi etc.

(b) The photograph shows part of the dissected gas exchange system, as seen using a microscope.



(Source: © blickwinkel/Alamy Stock Photo)

(i) Name the structures labelled A and B.

(2)

A trachea B Spiracle



### Question 2 (b)(ii)

Candidates were asked to name the structure that supplies oxygen directly to the muscle tissue in a locust. Over half correctly named the tracheole.

Errors included naming the wrong part of the insect gas exchange system eg spiracles / air sacs, or part of the gas exchange systems of other animals. A surprising number of candidates gave an answer involving blood, eg capillaries, haemoglobin, red blood cells etc.

(ii) Name the structure that supplies oxygen directly to the muscle tissue.

(1)

-----





### Question 2 (b)(iii)

This question involved making two measurements from a photomicrograph (at points A and X) and using these to calculate the actual size of the structure at X.

The majority of candidates carried out the measurements accurately and used them to calculate the actual size as 0.18mm, or achieved an answer within the accepted tolerance levels.

It was pleasing to see that many candidates laid out their answers logically, with some using the formula: magnification = image size divided by actual size.

Around three quarters of candidates achieved both marks in this question. The most common error was to give an answer a factor of 10 out – this was usually due to confusion when converting from centimetres to millimetres (which was not actually necessary if the original measurement was made in millimetres).

Candidates who made an error and gave an incorrect final answer could still score one mark if they had clearly given an image size for either A or X. Almost all candidates took note of the instruction to give the final answer to two decimal places.

(iii) At the point labelled A, the structure is 0.9 mm in diameter.

Calculate the diameter of the structure at the point labelled X.

Give your answer to two decimal places.

X Image diande = Imm Actual diante = 1 = 0.18mm

Answer 0.18 mm

(2)

(Total for Question 2 = 7 marks)





(2) # 3 5mm for A # 3 0.9 JXS.56 X=0.1 0.1 x S.SC = 0.556 Answer 0.556 mm



This candidate scored one mark for correctly measuring A as 5mm. Their calculation was incorrect, as they divided 5 by 0.9 instead of dividing 0.9 by 5.

This candidate would not have scored marking point 2 even if their answer had been correct, as it was not to 2 decimal places.

#### Question 3 (a)(i)

In a flow diagram of the steps in genetic modification of soya beans, almost half of all candidates could name DNA ligase as the enzyme needed to insert a gene into a plasmid in step C. The most common error was to name the enzyme as restriction endonuclease.

3 In genetic modification, DNA from one species is joined to DNA from another species, to form recombinant DNA.

This recombinant DNA is inserted into the host organism using a vector.



(a) (i) Name the enzyme used in Step C.

(1)

DNA ligase



### Question 3 (a)(ii)

Almost three quarters of candidates could use the information given in the stem of the question to identify the vector in this process.

Acceptable answers included bacteria / *A. tumfaciens* / plasmid. The most common incorrect answers were vectors not named in the flow diagram eg viruses or gene guns; some candidates thought that the soya bean plant was the vector.

(ii) Name the vector in this process.

(1)

plasmids



(ii) Name the vector in this process.

**Examiner Tip** 

(1)





Always use the information you are given in the stem of a question – it is there for a reason.

#### Question 3 (b)

Candidates were asked why it is possible to clone many herbicide-resistant plants from one infected plant. This proved very challenging, with only around a fifth of candidates scoring any marks at all.

All four marking points were seen, with marking points 2, 3 and 4 equally common. Mark point 1 was less often seen.

There was a lot of confusion with many candidates suggesting taking cuttings or using seeds, rather than collecting infected cells from the tumour that grew and propagating these.

(b) Explain why it is possible to clone many herbicide-resistant plants from one infected plant in Step F. [2] BECOUSE INFECTED PLANT WITH THE PLASMICH From agro bactenum NMEFACIONS bachena produces a gail aut growth from prom the plants which contains ceus which contain the recombinant herbicide-nesistant DNA .: ceus can be extracted Prom the outgrowth gail and cloned in 1ab using Mitrisis to accur and produce plants

This was a strong answer which scored marking points 2, 3 and 4, achieving maximum 2 marks.

One injected plant produces a gall. or its Cells can then ke exclorated from the gall and used to grow a new pto many new resistant plants. The cells are ably to rapidly by mitasis. dende





By rertilisation of other plants with the poller grains

· New plants formed also possess the herbiliche-resistantape

This candidate did not score. They referred to sexual reproduction rather than cloning, and although they mentioned herbicide resistance, they did not make it clear that the gene for resistance was in the cells.

· The Herbicide-resistant soya been has the genel allele for rest stance against herbicids. So when it reproduces to form more saya been the gene/ allele for this resistance will be passed on to the next generation and so on until many herbicide - resistant plants have been produced



This answer did not gain any marks. They do not make it clear that the gene for herbicide resistance is in the cells, and they mention reproduction, rather than cloning.

## Question 3 (c)

Candidates were asked why herbicide resistance would improve the yield of GM soya bean plants compared to non-GM soya bean plants. The stem of the question had told them that herbicides are chemicals that kill plants and that they can be used to kill unwanted plants.

This question proved unexpectedly difficult for some candidates.

It was expected that candidates would write that herbicide resistant plants could be sprayed with herbicide, and that this would kill weeds around them, but not kill the plants. This would result in lack of competition (from weeds) for named resources, eg water, light, mineral ions, leading to greater photosynthesis or synthesis of a named product eg chlorophyll, in herbicide resistant plants.

The answer could have been written in terms of non-GM plants, which would be killed by herbicides; so herbicides could not be used, therefore competition with weeds for light, minerals etc was high, and photosynthesis / synthesis of a named product was reduced.

There was no credit for simply saying that yield was increased in GM plants (or reduced in non-GM plants) as this was in the stem of the question.

Many candidates misunderstood and thought that spraying would occur anyway, and that the dead non-GM plants would have a lower yield than the live GM plants. A small number of candidates did not use the information given in the stem and thought that herbicides killed insects which might eat the plants.

· herbicides kills plants such as weld plants
. when its used to kill unwanked plants "herbornelies can
also kull soya bean plantr nearby
· herbin herbicicle resistance pre in GM plants allows these
Soya beans to survive but not the non-GH
soya plants
compared to those not GM.



This answer scored marking point 1 for stating that the herbicide kills the weeds, but not the GM plants nearby.

They go on to suggest that non-GM plants will be killed by the herbicide and so will have a lower yield, so do not get any further marks.

(c) Explain how herbicide resistance would improve the yield of GM soya bean plants compared to non-GM soya bean plants.

me hebicide would be mid to kill weds
however it wouldn't affect the copy been plants
because g the herbicide resistance. Mare weeds killed
mans mae space and resources available par
GM soya bea plants increasing the yield



This answer achieves marking point 1 on lines 1 – 3.

They do not refer to competition directly, so cannot get marking point 2.

Although they give examples (space and resources), neither of these are enough for marking points 3 or 4.

(3)

If herbicides can be used on the lift says bear plants it will reduce their competition by killing weeds but not the says plants This mean the paya plants have more accent to mineral and water from the fait and da nat have to campete with other speciel for space and light to the rate of photogethesis can secrease and the plants grow mare.



This is a very strong answer which covers all five marking points, achieving maximum three marks.

It gets marking points 2 (less competition) and 1 in lines 1 – 3. Then marking points 3 and 4 in lines 4 – 6 for water, minerals and light.

In line 6 – 7 they link the increased light to increased rate of photosynthesis, achieving marking point 5.

```
The yield of 64 soy bean plants would increase as me
plant would be unaffected by heroiders. There, the conformation
soy bean plants would have reduced 1 less yield a composed
to 64 plants as they can be affected by heroides which
(an reduce the population.
```

This answer did not get any of the marking points. They misunderstood what would happen and thought that both GM and non-GM plants would be sprayed with herbicides, that the non-GM plants would be killed and that this would reduce the yield. There is no

reference to weeds or competition at all.

### Question 4 (a)(i)

Question 4 related to Core Practical 14: investigate the effect of gibberellin concentration on the production of amylase in cereals using a starch agar assay.

In Q04(a)(i) candidates were asked to describe how to dilute a stock solution of 1g per dm<sup>3</sup> to make a test solution of  $300\mu$ g per dm<sup>3</sup>.

This could be done as a two-step process:

- dilution by {1 in 1000 / 1 : 999}.
- dilution in ratio of {3 in 10 / 3 : 7}.

or as a single step process eg 0.3 cm<sup>3</sup> stock + 999.7 cm<sup>3</sup> water.

These are examples and equivalent volumes could be used.

Many candidates found this extremely challenging and were unable to gain any credit. The most common errors were adding a mass of gibberellin to a volume of water (instead of using the 1g per dm<sup>3</sup> stock solution) or being out by a factor of 10.

About a quarter of candidates scored one mark, usually for the idea of diluting in a ratio of 3 : 7, and some managed the one-step process correctly. A small number of candidates were able to describe the method needed to reach the desired concentration and scored both marks.

- 4 When cereal grains germinate, stored starch is broken down by amylase.
  - (a) A student investigated the effect of gibberellin concentration on the production of amylase in cereal grains.

This method was used:

- Step 1 Dilute a stock solution of gibberellin to give five different concentrations.
- Step 2 Cut the cereal grains in half and discard the half containing the embryo.
- **Step 3** Soak the remaining halves of the grains in sodium hypochlorite solution for five minutes.
- Step 4 Soak one grain in each of the gibberellin solutions for 24 hours.
- (i) The stock solution of gibberellin has a concentration of 1 g per dm<sup>3</sup>.

Describe how you would dilute this stock solution to give a test solution of 300 µg per dm<sup>3</sup>.

3xiô (2)9 in solution into a test tube and add 7 cm3 st wal A de aibborell Add lan 3tt 0.3 g par dun vater and nix & 9 cm Strates an



This is a strong answer, gaining both marks. They diluted in the ratio of 3:7, then carried out three rounds of serial dilution to achieve the desired concentration.

	$\frac{1}{2} = 1000 \text{ my} = 1000,000 \text{ mg} (2)$
.n	LOL to use 35.57 ratio of stock southern
to	worker. 60 to IF 100 Miller of 10
<b>e</b> .9 3	cm <sup>3</sup> of stock souther with 9997 cm <sup>3</sup> of outfilled water.
	This answer also scored two marks, this time for the one step process.
	300 µg per dm <sup>3</sup> . $0, 3 \text{ Mg}$ $19 = 1000 \text{ Mg} - 300 - 300 3 (2)$
	Add 3 & Cm3 of the stock sometion to 7 cm3 of dishilled work
	Use a new pipette to take I cm <sup>3</sup> of this solution and add 9 cm
	of distilled water. Do that huice more , to this is serial
	dunn.
	Another strong answer gaining 2 marks.
•	1g = 1000 mg toos +++ Pipette 3 cm <sup>3</sup> of stock solution
	into testude
•	Then add 7 cm <sup>3</sup> of distilled water



## (n a 10 dm<sup>3</sup> SOIUTION airure 0.3 dm<sup>3</sup> a) Shoeners gibbereur ro 27 dm<sup>3</sup> water Using a pippete.



This is a variation of the 3 in 10 method, as they are diluting 3 in 100 and gains mark point 2.

#### Question 4 (a)(ii)

Candidates were given a method for the investigation and asked the reason for two of the steps: cutting the grains in half and discarding the half containing the embryo; and soaking the remaining halves of the grain in sodium hypochlorite solution.

There were some excellent answers, with the majority of candidates scoring at least one mark. Where candidates did not score it was not clear if this was because they were not familiar with the practical, or that they did not know the reasons behind the steps they had followed.

Many candidates knew that the embryo could produce gibberellin, so this should be removed; far fewer gave the alternative marking point that the endosperm part was retained because it produces the amylase.

The most common misconception was that the sodium hypochlorite was needed to increase uptake of gibberellin, rather than killing any microbes which may produce amylase.

(ii) State one reason for each of the following steps in the method.

	,	(2)
	Step 2	
The	energy embryo half contains the gibberellin which	nould
aff	ect the results as there would be varying conce	entrations
•6	gibberellin.	44444,12819922222
	Step 3	
To	disinfect them and kill any bacteria	as they
CAN	produce amplase which would accept the results.	

This is a good answer which gets both marking points.

Examiner Comments

Step 2
The embryo hasp contains giberelin
that may affect the result by causing
more anylase to be produced.
Step 3
to sterilise the endosperm half in
order for an aseptic techniqueto be
achieved and reduce contamination.



Step 2 embryo does not contain starch, partwith conjudon does.

Step 3 heals	dou	m	allulose	cell	walls to	enatu	
 giberr	iliy	to en	<del>ار</del> ۲۰				

This candidate did not score any marks. They did not give a correct explanation relating to gibberellins or amylase in step 2 and suggested that sodium hypochlorite allows uptake of gibberellins in part 3.
### Question 4 (b)(i)

Candidates were asked to name an abiotic factor and a biotic factor that should be controlled and describe how to control them.

This was not very well done, with only around one in ten candidates scoring both marks.

The most common error was to name the factor but not to give an effective method of control, eg using a water bath rather than an incubator for agar plates; or controlling species of grain by choosing the same species, rather than by collecting the grains from the same plant or from the same packet.

A few candidates gave a method of control, eg use of an incubator, without saying that it was temperature they were controlling; or collecting seeds from the same parent plant without saying that this would control species.

Some candidates suggested controlling the concentration of starch in the agar plates or the concentration of iodine in potassium iodide solution – these were not given credit as they are made to standard recipes.

A small number of candidates confused biotic and abiotic factors.

- (b) The student completed the investigation using the following steps:
  - the grains soaked in gibberellin solution were transferred to starch agar plates using forceps
  - after 12 hours the surface of each plate was covered with iodine in potassium iodide solution, which was then poured away
  - the diameter of the clear zone around each grain was measured.
  - (i) Describe how you would control **one** named abiotic variable and **one** named biotic variable.

(2) Abiotic

Biotic

e grains used shound be of e same species, mass and



This answer gets marking point 1 for the abiotic factor, but not marking point 2.

For the biotic factor, the candidate knows which factors should be controlled, but has not given a method of control for any of the factors mentioned.



Make sure that you know what the question requires – here it was two named factors and the methods of control.

Ter	Abiotic nprruhva,	After	bras	find to		agar pl	ak, Use
Rn	Intubato,	- lo	Kuop	at 25°c	10	prent	Pathgenic
gcowli							
	Biotic						
barleria	x /	Sterlise	Coupment	Forieps	m	Suctarias	10
pren	+	Volverled	61	hrin	Fram	taking	Shary
agar	plates,	vsc	Asplic	Fechnica	111555554544414111155555		



This is a strong answer, gaining both marks.

They name temperature and describe controlling it in an incubator.

They state that aseptic technique should be used to prevent unwanted bacteria from entering the plates.

Abiotic Temperature - en cub ate tre seeds at tre samé temperature e.g 25°C en an en cubarir par tre 12 noun.

Biotic

Species of cereal grain - ensure an seeds used are from the same species, such as getting them from the same packet or crip.



They correctly describe how to control temperature and suggest getting the grains from the same parent or crop to control species.

Abiotic The type of agar plate (starch) should be pept the same for each seed.

**Biotic** The species of cereal gain should be nept-me same - use seeds from the same species.



This candidate did not score any marks for this answer.

The suggestion that the type of agar plates should be the same was not given credit as these would be made to a standard method. They recognised that the species of grain was important but did not give an effective method of control.

# Question 4 (b)(ii)

This question asked candidates to describe three further improvements to the method outlined in parts (a) and (b).

Credit was given for:

- rinsing the grains in water after soaking in hypochlorite.
- using more than one grain at each concentration of gibberellin.
- giving an example of aseptic technique.
- measuring the diameter of the clear zone several times.
- using a control without gibberellin.

All marking points were seen.

As the command word was describe, candidates were not required to provide a reason for these improvements, although in practice many did.

The most common errors were to give additional biotic and abiotic factors to control. A few candidates suggested controlling the concentration of starch in the agar plates or the concentration of iodine in potassium iodide solution, but this was not given credit as these are made to standard recipes.

Almost three quarters of candidates achieved one or two marks.

(ii) Describe **three** further improvements to the method outlined in parts (a) and (b) that would improve the validity of the results.

(3) Seal nultiple grany (at least 3) in each gibberelun concentration and repeat so a mean or standard deviations can be carouated Use a control e.g. seeds that placed m gibhereling or an ager plate inthe fleds to act as a companison to nescuts The forceps used to transfer feede should be My sterile to prevent containe containination morned nexults area of the clear zone should be calculated



The candidate got marking point 2 on lines 1 – 4, marking point 5 on lines 5 – 6, marking point 3 on lines 8 – 10, then marking point 4 on lines 11 – 12.

I would also roak a fee grain in diffilled water rather than a gibber ellin solution, this of a control experiment. I would prepare enough grains to repeat the experiments 3 times for each gibberdlin iduate (and the control experiment). I'd then find mean values. After step 3, I would not the see grains with Astilled noter to remove the sodium hypochlorite solution.



Another good answer, this time achieving marking point 5 on lines 1 – 2, marking point 2 on lines 4 – 5, and marking point 1 on lines 7 – 8.

e.9 epea

UDING





The suggestion of carrying out the investigation at different temperatures was also not creditworthy.

Run a Control - See how much produced by normal embrya Completley unterende.

Smaller incriments between concentrations, harger Panye of Concentrations Covered.



## Question 5 (a)(i)

Candidates were asked to give two differences in the structure of prokaryotic and eukaryotic cells. Almost half scored both marks and the majority of the rest scored one mark.

The main problems were non-matching statements or only half of a statement given, and inaccurate descriptions relating to DNA.

Where the cell wall was the factor being compared, candidates were expected to say that prokaryote cell walls contain peptidoglycan (or other suitable material), whereas eukaryote cell walls contain cellulose or chitin; they could also say that all prokaryotic cells have a cell wall but not all eukaryotic cells do.

References to plasmids were ignored.

- 5 (a) Bacteria are prokaryotes.
  - (i) Give **two** differences between the structures of a prokaryotic cell and a eukaryotic cell.

Philesongh, Prokangatic cells have 70s ribonnes, erekangatic cells have 8Ds inbosomes. Protecnyotic cells have civilar DNA, Eukaryotic collo have linear DNA with histories.

(2)



This is an example of an answer scoring 2 marks.

They get marking point 5 in lines 1 – 2 and marking point 1 in lines 2 – 3.

- different size riposomes (70s and 50s) - promanyotic cells do man new a cell wall while enhargotic cells don't and just have numbranes. This answer scored zero. This candidate attempted marking point 5 but did not say which cells have which ribosomes (and also compared 70s with 50s, which is incorrect). The last statement about cell walls is also incorrect as some eukaryotic cells have cell walls. Prokaryotos have smaller 705 ibosmes

utanyotes Enkanyotes have a Acre



#### Question 5 (a)(ii)

This question tested knowledge of Gram staining and how the information gained can be used to inform treatment. Overall it was well done with over a third of candidates scoring 3 marks, about a quarter scoring 2 marks and a quarter scoring 1 mark.

Some candidates had only very basic knowledge (or none at all) but there were some excellent answers to this, giving lots of relevant details.

Marking point 4 was for saying that the information should be used to determine which antibiotics to use. The most common error was to refer to treatment (which was in the stem of the question) rather than antibiotics. No details of antibiotics were expected.

(ii) Gram staining is often used to help identify bacteria.

A sample of bacteria from an infected person was tested by using Gram staining.

The bacteria stained red.

(Explain why the bacteria <u>stained red</u> and why this information is <u>useful for</u> treating the infected person.

(3)ined re 80 mi bacteria ; suff balting Actors ĸ 165 person



- The gran stained red as it is a gran negative bacteria - Therefore it cannot hold a purple gran stain. - This is useful as the person can take antibibities that are specific to the bacteria structure. Such as in gran positive pactera you would take antibiotics hat allect peptiladyour structure white for gran reseture you take antibiotics but can allect the outer remboure rule of lipppolysacharides and poters.

Results lus Examiner Comments	
This answer also scored full marks, for marking points 1, 2 and 4.	
Gram-possible & Gram-negative backing bore difficing cell wall structure identifying which type allow	~5
the backia to be directly forgeted more affect	ally
by using medication suited for destruction of the mall.	celt



This answer scored zero, as there was not enough detail on any of the marking points.

bacteria stained red Lacouse in removed rom rtidoglycan wo in neon were aran and 0 LIN2 .



> the backing shaining red th e person is injected by 51 Muy Now can pocus 01 - to provid one parit



## Question 5 (b)(i)

This question asked candidates to describe the method used in Core Practical 13: isolate individual species from a mixed culture of bacteria using streak plating.

It generated a wide range of responses – some candidates had clearly done it and could remember the key points, but others had only very basic knowledge of the steps. Far too many candidates stopped at the point that bacteria had been transferred to the agar plate, so could not get beyond two marks. Credit was given for:

- use of inoculating loop to transfer bacteria.
- {description / diagram} of streak plating.
- incubation for suitable period.
- incubation at suitable temperature.
- identification of {bacteria / colonies} by {colour / shape}.
- transfer to separate agar plates.

There were some excellent answers covering all six marking points.

100	can gi use Streak	
plaking	. In which you speed	
nale	Sheatter across the	
agor	plate. This spreads out	
Nie	Bactura colonies do	
Mat	an adjuiduar colaria	
Cha		



This answer does not include enough details to get credit.

For marking point 2, the words "streak plating" are not enough, we need a diagram or description.

At the end, they suggest that the individual colonies can be picked up, but for marking point 6 they need to be transferred to separate agar plates. (b) (i) Describe the method used to isolate individual species from a mixed culture of bacteria in nutrient broth.





This is a very strong answer which gained maximum marks:

Marking point 1 on lines 1 – 2, marking point 2 for the description of streak plating, marking points 3 and 4 on line 8, marking point 5 on line 12 and marking point 6 on lines 13 – 14.

burner. Pour agar into a petri dish and let it set. Flame your innoculating loop and dip it into the bacteria sample. Carry out streak plating - streak 3 straight lines in one direction and then three more which average the previous lines and 3 more which again averlap. Incubate the bacteria at 25°C higher is too close to human body terma. temperative. Leave for ent species he differ norld be planned inoculating

This candidate scored maximum marks, achieving mark points 1, 2, 3, 4, and 6.

They provided an excellent, clear diagram of streak plating.

- Streak Plating
- Flame inociating in loop (aseptic technique)
- Did in the mixed cuture sonce at the start
- Streak me innoculating loop across agar jelly in a straight line, moving the place 90° each time
The Alex Frage Streat 3
- This aimres the bactoma on me innoculating loopas
YOU IN POR, SU ON ME LUST STREAK, INDIVIONAL COLONIES CAN be
White a gave pitte tor As novers in smerite conditions
- isolate the indidual species
individues



This is a strong answer which gained three marks (mark points 1, 2 and 3). However, they did not include enough details to achieve marking point 5 or 6.

# Question 5 (b)(ii)

This related to the previous question and asked for an explanation of three precautions to avoid the growth of pathogenic bacteria.

There were 4 marking points, some including groups of alternatives. Candidates generally knew the steps of aseptic technique and described them adequately. Marking point 1 could be given for either saying that aseptic technique should be used, with a suitable reason, or for giving an example of aseptic technique with a reason. Marking point 2 was for an example of aseptic technique with a reason.

However, less than one in ten candidates scored 3 marks, and around a third scored zero. This was usually because although they gave a list of precautions to be taken, they did not **explain** why they were needed, ie to avoid contamination / kill bacteria / prevent the growth of anaerobes etc.

The most common error apart from this was to say that working next to a lit Bunsen burner would kill bacteria in the air, rather than creating a convection current to draw bacteria away from an open petri dish. A surprising number of candidates thought that putting a lid on an agar plate (rather than leaving it uncovered) was an example of aseptic technique; we were looking for the idea of partially opening the plate or opening for the shortest possible time.  Explain three precautions that would be taken to reduce the growth of pathogenic bacteria.

(3) as ster Aseptic techniques wo ench before Equipment Surfaces a du dat Breaken nea ann oculatio CH. coal tenyese



This candidate has given three suitable suggestions, but no reasons, so has scored zero.



When the command word is **explain** make sure you are providing an explanation, not just a description.

Only open hid stythly so pathogus con 4 in the a Jursen Sumer Work reg thog current the convection on struck loop. so to hill human Ju ones mont 0 develop perthogenic 50 MO 9481 na little (Total for Question 5 = 12 marks)

This very good answer includes correct precautions with reasons and therefore scores maximum marks. It gets marking points 1 and 2 on lines 1 – 3, marking point 3 on lines 5 – 6 and marking point 4 on lines 7 – 8.

# Question 6 (a)(i)-(ii)

In this pair of linked questions, candidates carried out a simple calculation of water potential then deduced and explained the direction of movement of water.

Quite a few candidates struggled with the calculation, even though it was very straightforward – this seems to be an area which needs more revision. The most common errors were to get answers of – 900kPa, 900kPa, – 20,000 kPa and – 0.8kPa.

The answers to Q06(a)(ii) were expected to match Q06(a)(i), so if a candidate carried out the calculation wrongly, they could still achieve both marks in Q06(a)(ii).

Answers for marking point 3 could be phrased in several ways, but in all cases they had to be comparative to gain credit eg water moves from an area of high water potential to an area of low water potential.

The most common errors in Q06(a)(ii) were to fail to mention osmosis for marking point 2 and to get confused with terminology or direction for marking point 3.

Around a third of candidates scored all 3 marks, about a quarter scored one mark (usually for the calculation) and a significant minority of candidates scored zero marks.

- 6 Water potential determines the direction of movement of water in and out of cells.
  - (a) The diagram shows a plant cell.



(i) Calculate the water potential ( $\psi$ ) of this cell. =  $T_P + \sigma_s m d_{10} \rho d_{10}$  (1) 400 - 500

Answer - 100 kPa

(ii) Explain the direction of net movement of water for this plant cell when it is placed in a sucrose solution with a water potential ( $\psi$ ) of -400 kPa.

(2)the nater potential is laver outside the cell, therefore vater leaves the plant cell by osmosis he a highe to lover concentration of water by a semi-pe





Water potential calculations are pretty straightforward. Make sure you know the formula and that you can do them.

- 6 Water potential determines the direction of movement of water in and out of cells.
  - (a) The diagram shows a plant cell.



- (i) Calculate the water potential ( $\psi$ ) of this cell.
- -S00 + 400 = = -100 KPa
- (ii) Explain the direction of net movement of water for this plant cell when it is placed in a sucrose solution with a water potential ( $\psi$ ) of -400 kPa.

Water moves	from less r	regutive to	more neg	petive
water poter	Hill. Since	the weiter	potentia	101
this cell is	less regive	than the	fucrate	water
will more	out of the	cell caus	ing plass	molysis.



This candidate got the correct answer of – 100kPa for Q06(a)(i), gaining one mark.

They gave the correct direction of movement of water in Q06(a)(ii), but did not mention osmosis, so did not get marking point 2.

They got marking point 3 for a correct explanation, so overall, two marks awarded.

(1)

- 100

(2)

**k**Pa

Answer .....

- 6 Water potential determines the direction of movement of water in and out of cells.
  - (a) The diagram shows a plant cell.



(i) Calculate the water potential  $(\psi)$  of this cell.

$$\Psi = P + N$$

$$= 400 + -500 = -100$$

(1)





This candidate carried out the calculation correctly in Q06(a)(i), gaining 1 mark.

They did not explain correctly how water moves, saying it was from low to high water potential and therefore that it would move from the solution into the cell. For these reasons they scored zero for Q06(a)(ii).

- 6 Water potential determines the direction of movement of water in and out of cells.
  - (a) The diagram shows a plant cell.



(i) Calculate the water potential  $(\psi)$  of this cell.

-0.8 Answer **kPa** 

(ii) Explain the direction of net movement of water for this plant cell when it is placed in a sucrose solution with a water potential ( $\psi$ ) of -400 kPa.

(2)

(1)

The concentration gradient would increase and osmosis

would occur.



movement or suitable explanation, so did not score any marks.

# Question 6 (b)(i)-(ii)

Q06(b) related to a water potential investigation using potato cylinders. This is Core Practical 6: determine the water potential of plant cells.

In Q06(b)(i) candidates were asked to plot a graph of percentage change in mass at various concentrations of sucrose solution and to identify the intercept point. As there were both positive and negative changes this was not completely straightforward, but it was generally well done.

Marks were given for:

- axes correctly orientated and labelled with units.
- all values accurately plotted on a linear scale.
- points joined with straight lines.

The most common errors were to choose an odd scale which made plotting accurately very difficult, to make other plotting errors, to draw a line of best fit, or to forget to label axes. Many candidates made life more difficult for themselves by choosing a very small scale which covered less than half of the graph paper.

In Q06(b)(ii) they were asked to determine the concentration of sucrose solution which caused no change in mass. This was done by reading off the value of the intercept point and most candidates scored this mark.

Almost three quarters of candidates scored three or four marks for this question, which tested indirect practical skills that they should be very comfortable with.

(b) A student carried out an investigation to determine the water potential of cells from a potato tuber, using a range of concentrations of sucrose solutions.

Cylinders of potato were cut using a cork borer, and the cylinders were then cut into discs.

The mass of each disc was recorded. One disc was placed in each sucrose solution and left for 12 hours. Each disc was then reweighed.

The table shows the data collected.

Concentration of sucrose solution / mol dm <sup>-3</sup>	0.0	0.1	0.2	0.3	0.4	0.5
Percentage change in mass of potato disc	+14.2	+1.9	-9.8	-22.7	-31.9	-37.1

(i) Plot a suitable graph of these results.

Join the points with straight lines.



(3)

(ii) Determine the concentration of sucrose solution that causes no change in mass, using your graph.

(1)

Answer 0.12 mol dm<sup>-3</sup>



This answer scored all three marks for graph drawing and a further mark for a correctly determined intercept.

The graph is accurate, with a suitable scale, correctly labelled axes, and carefully plotted points joined with straight lines, so scored maximum marks.

(b) A student carried out an investigation to determine the water potential of cells from a potato tuber, using a range of concentrations of sucrose solutions.

Cylinders of potato were cut using a cork borer, and the cylinders were then cut into discs.

The mass of each disc was recorded. One disc was placed in each sucrose solution and left for 12 hours. Each disc was then reweighed.

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(i) Plot a suitable graph of these results.

Join the points with straight lines.



(ii) Determine the concentration of sucrose solution that causes no change in mass, using your graph.

0-13 (1) Answer 023 (1) moldm<sup>-3</sup>



This graph scored only one mark (mark point 1). The points at 0.2 and 0.3 mol dm<sup>-3</sup> were plotted incorrectly, and the points were joined with a line of best fit, rather than straight lines.

However, the intercept was correctly read from the graph, scoring a further mark for Q06(b)(ii).

(b) A student carried out an investigation to determine the water potential of cells from a potato tuber, using a range of concentrations of sucrose solutions.

Cylinders of potato were cut using a cork borer, and the cylinders were then cut into discs.

The mass of each disc was recorded. One disc was placed in each sucrose solution and left for 12 hours. Each disc was then reweighed.

The table shows the data collected.

Concentration of sucrose solution / mol dm <sup>-3</sup>	0.0	0.1	0.2	0.3	0.4	0.5
Percentage change in mass of potato disc	+14.2	+1.9	-9.8	-22.7	-31.9	-37.1

(i) Plot a suitable graph of these results.

Join the points with straight lines.



(ii) Determine the concentration of sucrose solution that causes no change in mass, using your graph.

(1)

Answer 0, 11 mol dm<sup>-3</sup>



This graph scored only one mark (mark point 1). The point at 0.4 mol dm<sup>-3</sup> was plotted incorrectly, and the points were incorrectly joined. The line was also extrapolated beyond the 0.5 mol dm<sup>-3</sup> point, which would have lost marking point 3 even if the rest of the line had been drawn accurately.

However, the intercept was correctly read from the graph, scoring a further mark for Q06(b)(ii).



Graph drawing is an important scientific skill to learn. Make sure you can choose a suitable scale, plot points accurately and follow instructions about the type of line that is required.

(b) A student carried out an investigation to determine the water potential of cells from a potato tuber, using a range of concentrations of sucrose solutions.

Cylinders of potato were cut using a cork borer, and the cylinders were then cut into discs.

The mass of each disc was recorded. One disc was placed in each sucrose solution and left for 12 hours. Each disc was then reweighed.

The table shows the data collected.

Concentration of sucrose solution / mol dm <sup>-3</sup>	0.0	0.1	0.2	0.3	0.4	0.5
Percentage change in mass of potato disc	+14.2	+1.9	-9.8	-22.7	-31.9	-37.1

(i) Plot a suitable graph of these results.

Join the points with straight lines.

(3)


(ii) Determine the concentration of sucrose solution that causes no change in mass, using your graph.



# Question 6 (b)(iii)

Candidates were asked to evaluate whether the method described for this investigation would give valid results. This question discriminated very well, and some candidates gave excellent answers, identifying a balance of strengths and weaknesses in the method.

Many candidates realised that the cork borer gave a standardised size; they noted that temperature was not controlled, the discs were not cut to a uniform thickness, that more than one disc should have been placed in each solution, they should have been dried before being reweighed, and that more molarities should have been tested near the intercept point.

Marking points 1, 7, 8, 9, 10 and 11 were most commonly seen and marking points 2, 3, 5 and 12 were least common; all marking points were seen.

The most common error was to assume that different potatoes had been used in this investigation, rather than all of the discs coming from the same potato cylinder.

For marking point 3, a lot of candidates said that it was good that discs had been left for the same time but did not recognise that this was long enough for no further water movement to occur.

For marking point 10, it was not enough to say that more molarities should be tested; these had to be near the intercept point.

A small number of candidates ignored the command word evaluate (and the method they had been given), and instead wrote a plan for the investigation. This allowed them to gain marks for weaknesses (by suggesting improvements), but not to recognise strengths. For full marks at least one strength and one weakness had to be identified.

This was generally well done with over half of candidates scoring 3 marks or more and less than 2% scoring zero.

(iii) Evaluate whether the method used in this investigation would provide valid results for the water potential of potato cells.

(5)

discs that are cut the thickness
is not specified it long are all the
same SA: V as that will affect speed
of osmosis / duffusucn
no information on species / age of portato
potato is not blotted to remove excess
water before on after weighing
Locard course an inderstimate / overest
inelle
no repectes or SD to look of mas
for anomaines or average significance
is more dusces in each conc.
They do use a control & good range of
sucrose conc. could repeat with smaller
intervals to find exact sucrose conc. for
no mass change. (Total for Question 6 = 12 marks)
conce parer ensures ever circumbrance.



This is a very strong answer which gained maximum marks. They got marking points 7, 9, 8, 5, 10 and 1.

(iii) Evaluate whether the method used in this investigation would provide valid results for the water potential of potato cells.

- The Cutting with a conte boner guarantees same diameter for each disk, homener the Hickness does not seem to be controlled to surface area: volume nationay may between discs -> Kange of concentrations of sucrose provides a good vange af data which shows a fairly consistent thend. - Only one disc was used per solution homener so there is statis no way of excluding anomalous nemetts or taking an arerage, which would increase mary -> more repeats of the experiment would be desirable too. - Variables mich as temperature are not controlled, This may affect the nate of ormotis



Another very good answer scoring maximum marks. They got marking points 1, 7, 5, 8 and 11.

(5)

(iii) Evaluate whether the method used in this investigation would provide valid results for the water potential of potato cells.

(5)The student left the discs for 12 hours which is time for osmoses to occur. They cut the potate so the disce wou rave had th a corh The student also used section range of concentrations. However, it is not Surose same potato rom the may o they not discs night age or species. The har length so the surface area to volume ratio May for each disc. turthermore, at least tire ice chou sucrose solution to identify aroma been placed ea deviation Ca dard paper tore remeigh A wide range of concerta excess vater. es O 2-3 retto should ne heen not produce va would were not contalled (Total for Question 6 = 12 marks)



Another excellent answer which gained maximum marks. This got marking points 3, 1, 7, 8, 9 and 10.

# Question 7 (a)(i)

Q07 related to an investigation into the area of leaves in sun and shade. Candidates were told that 20 leaves of a single species (hedge woundwort) were collected from areas in the sun and shade, and that their area was measured to find the effect of light intensity on leaf area.

Q07(a)(i) asked them to write a null hypothesis for this investigation.

Around a third of candidates wrote an appropriate null hypothesis that could be tested, while two thirds did not. This is an area that centres could usefully work on.

Common errors were to look for a correlation, rather than a difference; to refer to light intensity rather than sun and shade (or high and low light intensities); or to give an answer related to effect or relationship. Inexplicably, some candidates gave height of the plant as the dependent variable.

It was very rare to see candidates referring to the named species in the null hypothesis, with most simply saying that there would be a difference in leaf area in the sun and shade. This could be taken to refer to leaf area of all species, rather than the species being investigated. Please note that in future years, the name of the species being investigated will be needed to gain credit when writing a null hypothesis. 7 The photograph shows hedge woundwort (Stachys sylvatica).



(Source: © imageBROKER/Alamy Stock Photo)

(1)

This plant grows on the edge of woodlands and can be up to one metre in height.

A student investigated whether light intensity had an effect on the leaf area of hedge woundwort.

The student measured the area of 20 leaves from plants growing in <u>full sun</u> and 20 leaves from plants growing in shady conditions.

(a) (i) Give a suitable null hypothesis for this investigation.

· There is no difference between teaf area of hedge woundwort in the sun or chade.



There is	no si	gniticant c	witherence	ίn
area of	leaves	of plants	grown	in Gui
sun a	shady	condition	21	





This did not score as the candidate suggested that they were looking for a correlation.

the leaves growing in full sun will have a greater leaf area than play leaves growing in Shady conditions.



This is not a null hypothesis – a null hypothesis would state that there was no difference in leaf area, rather than that one of the conditions would have a bigger leaf area.

# Question 7 (a)(ii)

Candidates were asked to devise a fieldwork method that could have been used to carry out this investigation. This is Core Practical 16: investigate the effect of one abiotic factor on the distribution or morphology of one species.

Credit was given for:

- random selection of plants to be studied.
- measuring the leaf area of {hedge woundwort / Stachys sylvatica}.
- describing the method of measurement eg using squared paper.
- suggesting a method of control of which leaf to measure.
- (selecting leaves in) light and shade.
- {controlling / monitoring} one other relevant named factor.

There were some good answers which outlined how bias could be avoided (by using random sampling to select plants and having a system to determine which leaf on the plant to measure), gave details of how to measure the leaf area and suggested a variable which should be controlled or monitored.

The most common error was to carry out a transect from the light to the shade, despite the fact that 20 leaves were measured in sunny areas and 20 in shade.

Many candidates did not suggest a method they could use to measure leaf area, or even restrict their measurements to the single species named in the investigation. There were some attempts at standardising which leaf to measure eg the biggest on each plant, and some suggested monitoring / controlling other variables eg soil water / pH / time of year. Many candidates did not realise that controlling the time of day the leaf area was measured would not have a measurable effect on the outcome.

Around a quarter of candidates scored three marks or more. This was disappointing for a relatively straightforward description of fieldwork sampling.

(ii) Devise a valid fieldwork method that the student could use to compare the leaf areas of the plants growing in full sunlight with the leaf areas of the plants growing in shady areas.

with hedge woundwort (4) Find an area with full sunlight, and find a shady area. In each everator area use random sampling the by using randam number to generate coordinates to place the guadrate. hedge woundworf in the quadrat 20 times areas of th at each set area to calculate the mean and standard deviation do a t-test. At each site, also measure the ter and soil pH and wind speed at the sample sites.



This is a good answer which gained four marks.

They got marking point 5 on line 1, marking point 1 on lines 2 – 3, marking point 2 on lines 3 – 4 and marking point 6 at the end.

- Set up a 10 × 10 metre grid a in an area of full sunlight nhere
hedge noundmost grows - use a random number generater to generate
random co-ordinates at which leaf area will be recorded
- At each generated co-ordinate, pick the largest leaf on the plant and
meeisure its width and length - multiplying these to get teaf area.
- Reparen Repear this until 20 har areas have been recorded - calculate
a mean leaf and the fir planes growing in Full sunlight
- Repeat the investigation in an area of shade, compete the the means
- Do beth expensionanta invistigations at the same time of day during
the summer where worker concerne in letter orcers is likely to be similar

Results Plus Examiner Comments

Another good answer gaining four marks.

They got marking point 1 on lines 1 – 3, marking point 4 on line 4 (for largest leaf), marking point 2 on lines 2 and 5, and marking point 5 on line 1 and 8.

They did not achieve marking point 3 as the method described (multiplying length by width) would not give an accurate value. Controlling time of day that the measurements were taken is not creditworthy for marking point 6.

Establish 10 x 10 m in Flag. MAAM a er\* be cl matin there 11. IY On is y anes.



This answer gets mark points 1, 2, 3 and 5.

Although it is not initially clear on lines 1 – 2 whether the grid is in a single area which has both sun and shade, lines 11 – 12 make it clear that there are two areas being tested by saying "ensure **each** area is shaded / sunny....".

This candidate described a suitable method to measure leaf area.

Thesent could use a best tranget The gradient of has a to morde. which Stakes shade and onee cency from it. 200 each at the quartant KOND ECt measure me me rights no port spears abundance Coverco endmare the Coverage X dent in early drigersup repear experiment 2m unni you even MOON. 20m Le got you abundarie percentrus enhor con make a companison



This candidate suggested using a transect from light to shade with quadrats at 2 metre intervals – this method would not provide the data required ie 20 leaves in the light and 20 in the shade.

They suggest estimating the abundance and coverage of plants in the quadrat, rather than measuring leaf area, so did not get mark point 2.

They get mark point 5 for measuring the light intensity at each sampling point.

### Question 7 (b)(i)

Candidates were given the mean and standard deviation for sun and shade leaves and told that 95% of all leaves fell within + / – two SD of the mean. They were asked to calculate this range.

This should have been a straightforward calculation, requiring candidates to:

- select the correct mean and SD from the stem of the question.
- calculate the value for two SD (here it was 19.24).
- add this to the mean and subtract it from the mean to get the upper and lower values of the range.

Many candidates misunderstood and although they calculated the two values correctly (8.31 and 46.79) they subtracted one from the other giving a value of 38.48. This was given credit.

The most common error was to find a value based on +/ – one SD of the mean.

(i) The mean leaf area for leaves from plants in full sun is 27.55 cm<sup>2</sup> with a standard deviation of 9.62 cm<sup>2</sup>.

The mean leaf area for leaves from plants in shady conditions is  $55.50 \text{ cm}^2$  with a standard deviation of  $13.40 \text{ cm}^2$ .

Two standard deviations on either side of the mean will include 95% of the leaves.

Determine the size range that would include 95% of leaves from plants in full sun, using the standard deviation value.

(2)

$$27.55 + 2(9.62) = 46.79$$
  
 $27.55 - 2(9.62) = 8.31$ 

Answer 8.31-46.79 cm<sup>2</sup>



This candidate set out the working clearly and followed the right steps to get the correct answer. Full marks.

# Question 7 (b)(ii)-(iii)

In this pair of linked questions candidates were asked to calculate the *t* value from data provided, and to use this value to comment on the results of the investigation.

Q07(b)(ii) was generally well done. Most candidates could use the formula they were given to calculate *t*, and achieved 3 marks. However, a significant number gave a negative *t* value. Whilst this was not penalised here, it caused a lot of problems for candidates in Q07(b)(iii).

Candidates should realise that whether the *t* value is positive or negative simply depends on the order of the subtraction and it does not matter. They should ignore the sign and proceed with the number as if it is positive. A simple rule to avoid confusion is to always subtract the smaller value from the larger one (here it would be 55.50 – 27.55) and get a positive *t* value.

In Q07(b)(iii) candidates were asked to comment on the results of the investigation using their *t* value. This was less well done and some candidates who had carried out the calculation with no problems left this section blank.

Around a third of all candidates could find the critical value, compare it to the *t* value, reject the null hypothesis and give a suitable conclusion. The word significant was required in the conclusion, as this was the point of doing the *t* test.

The most common errors were:

- to say that 7.58< 2.02, which led to further errors.
- to use the wrong number of degrees of freedom (although this often gave the same critical value so was not penalised in this case).
- to give an incorrect conclusion either linked to correlation or to changing light intensity.

(ii) The student analysed the data using a *t*-test.

Calculate the value of t.

Use the formula

$$t = \frac{(\overline{\mathbf{x}}_{\mathsf{A}} - \overline{\mathbf{x}}_{\mathsf{B}})}{\sqrt{\frac{(\mathsf{S}_{\mathsf{A}})^2}{\mathsf{n}_{\mathsf{A}}} + \frac{(\mathsf{S}_{\mathsf{B}})^2}{\mathsf{n}_{\mathsf{B}}}}}$$

where:

 $\overline{x}$  is the mean for each set of data

n is the number of samples in each set of data

S is the standard deviation for each set of data

$$\overline{z}_{A} = 27.55 \quad \overline{x}_{0} = 55.50$$

$$S_{A} = 9.62 \quad S_{B} = 13.40$$

$$n_{A} = 20 \quad n_{B} = 200$$

$$+ = \frac{(27.55 - 55.50)}{\sqrt{\frac{(9.62)^{2}}{20} + \frac{(13.40)^{2}}{20}}}$$

Answer #7.58

Comment on the results of this investigation.

Use the information in the table to support your answer.

The degrees of Fredom are 40-2 = 38. Manne We negen réjecture null hypothesis because de t value is greater man me onheat value of 2.02 arme 5% o significance cecel. This means there is a significant n leaf area in areas of sun and creat of erence shade. This means mar light in tensity must affect leafarea.

(3)



This is a very strong answer, gaining all six available marks.

In Q07(b)(ii) they correctly calculated the t value as 7.58, gaining three marks.

In Q07(b)(iii) they stated that their t value was greater than the critical value of 2.02 (they had also circled this value in the table), that they would therefore reject the null hypothesis and that there is a significant difference in the leaf area in the sun and shade. Full marks for Q07(b)(iii).

Comment on the results of this investigation.

Use the information in the table to support your answer.

of E is greater Ele than all the contrinal the Gable, and since 40-2=38 lon 0.1 and p = 0.01 pz P=0.05 120 Ho that there ditte Co



This candidate correctly calculated the t value as 7.58 and gained 3 marks for Q07(b)(ii)

In Q07(b)(iii) they did not state the critical value (or circle it in the table), so could not get mark point 1.

They got mark points 2 and 3.



Always make a clear statement of the critical value and how it compares to your test value when you are analysing a statistical test. it is not enough just to say that your value is bigger than the critical value, you must show what the critical value is.

(3)

Comment on the results of this investigation.

Use the information in the table to support your answer.

(3) degree of preedon (40-1) at the the critical value 20,0 10 9 00 and 2.02 0 Ab as there is sufficient ect RI Chese vce. Q states Gical difference Oct ser light Or leaf area 0 woundwork and 0 hance



This candidate gained 3 marks for Q07(b)(ii) for a correct calculation. However they gave the t value as – 7.58.

In Q07(b)(iii) they incorrectly said that – 7.58 < 2.02, so could not get mark point 1.

# Question 8 (a)(i)

Candidates were asked to explain how the structure of haemoglobin enables it to combine with oxygen in the lungs.

This was generally well done with many candidates giving relevant details of structure, eg four polypeptide chains, binding between haem or iron and oxygen, and describing co-operative binding. There were some excellent descriptions of co-operative binding.

The most common errors were to describe binding between haemoglobin and oxygen, rather than haem or iron and oxygen for marking point 2; or to omit the detail that there are **four** subunits, so **four molecules** of oxygen can be carried for marking points 1 and 3.

A surprising number of candidates confused haemoglobin and red blood cells, stating that haemoglobin had a biconcave shape and no nucleus.

- 8 Haemoglobin transports oxygen around the human body.
  - (a) (i) Explain how the structure of haemoglobin enables it to combine with oxygen in the blood vessels of the lungs.

(3)mar orroud ſλ ra hard sahuana au



- 8 Haemoglobin transports oxygen around the human body.
  - (a) (i) Explain how the structure of haemoglobin enables it to combine with oxygen in the blood vessels of the lungs.

- biconcave shape allows it to be easily
transponed and cubsorbed in bloodsuream
- Lack of nucleus so can absorb more
oxygen
- haem group which kinds to oxygen
so has high affinity for oxygen

(3)



### Question 8 (a)(ii)

Candidates were provided with an oxygen dissociation curve for haemoglobin in blood in the lungs and asked to add a line to show the curve for haemoglobin in blood in respiring muscle tissue. This proved exceptionally difficult for some candidates – there were all permutations of lines drawn.

We were looking for a curve drawn lower and to the right of the existing curve, with the same start and end points. Some candidates were close to scoring but did not if the line did not reach 100% saturation.

Only about a quarter of candidates achieved this mark.

 (ii) The partial pressure of carbon dioxide affects how readily haemoglobin picks up and releases oxygen.

The graph shows an oxygen dissociation curve for haemoglobin in blood in the lungs.



The oxygen dissociation curve for haemoglobin in blood in the tissues of respiring muscle is different.

Sketch this curve onto the axes.



This curve gained the mark. It is a bit wobbly, but started and ended in the correct place and was always below and to the right of the existing curve.

(ii) The partial pressure of carbon dioxide affects how readily haemoglobin picks up and releases oxygen.

The graph shows an oxygen dissociation curve for haemoglobin in blood in the lungs.



The oxygen dissociation curve for haemoglobin in blood in the tissues of respiring muscle is different.

Sketch this curve onto the axes.



(ii) The partial pressure of carbon dioxide affects how readily haemoglobin picks up and releases oxygen.

The graph shows an oxygen dissociation curve for haemoglobin in blood in the lungs.



The oxygen dissociation curve for haemoglobin in blood in the tissues of respiring muscle is different.

Sketch this curve onto the axes.



This came close to scoring but did not, as the line they have drawn overlaps the existing line at around 9kPa.

(ii) The partial pressure of carbon dioxide affects how readily haemoglobin picks up and releases oxygen.

The graph shows an oxygen dissociation curve for haemoglobin in blood in the lungs.



The oxygen dissociation curve for haemoglobin in blood in the tissues of respiring muscle is different.

Sketch this curve onto the axes.



Another common error – this line is drawn higher and to the left of the existing line, so did not score.

(ii) The partial pressure of carbon dioxide affects how readily haemoglobin picks up and releases oxygen.

The graph shows an oxygen dissociation curve for haemoglobin in blood in the lungs.



The oxygen dissociation curve for haemoglobin in blood in the tissues of respiring muscle is different.

Sketch this curve onto the axes.



Variations of this line were seen several times and did not score.

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

Candidates were asked to explain the advantage of this change in position of the curve.

Marking point 1 was for a simple statement that oxygen was more likely to be released from haemoglobin in the respiring tissue. This was the most commonly seen mark.

The other two marking points required a reference to carbon dioxide concentration and were more rarely seen – candidates did not make the link between the statement above the graph in Q08(a)(ii) (that partial pressure of carbon dioxide affects how readily haemoglobin picks up and releases oxygen) and the answer in Q08(a)(ii).

Marking point 2 was for stating that the concentration or partial pressure of carbon dioxide is higher is respiring tissue.

Even when candidates referred to the Bohr shift, they rarely linked this to increasing carbon dioxide, so could not get marking point 3.

(iii) Explain the advantage of this change in the position of the oxygen dissociation curve.

(2) The 3 Shr shift at high Coz concentrations means that Haemoglobin releases Oz more readily (as the Oz affinity (oners), ensuing that Oz is released at sites of actine respiration where it is most



This is a strong answer which gains maximum marks.

They get mark point 3 at the start for linking the Bohr shift to high carbon dioxide concentration, then mark point 1 in lines 2 – 4 for saying the haemoglobin releases oxygen more readily at the site of active respiration.

(iii) Explain the advantage of this change in the position of the oxygen dissociation curve.

The change in popition is caused by the Bohr High. This higher John pressures of CO2 sere mana 0 dresharted reduces the e oth Os, caush loaded relogedte the respiring and



This is another very strong answer which gained maximum marks.

They get mark point 3 on lines 1 - 2, then mark point 2 on lines 2 - 3 (high partial pressure of carbon dioxide in respiring tissue), then mark point 1 in lines 3 - 6.

(2)

(iii) Explain the advantage of this change in the position of the oxygen dissociation curve.

(2)

(2)

Oxygen distocrates more readily from haeniggiotic ping trasses, to more to released at a is pp of 02. This means tat the resping table auropore. is supplied with more oxuper and to respiration can occurs more raindly resulting in more ATTP being produced.



This candidate gets marking point 1 for the clear statement that oxygen dissociates more readily from haemoglobin at the respiring tissues.

(iii) Explain the advantage of this change in the position of the oxygen dissociation curve.

Oxyagen is more reading combined with harmographia die organism can respire acrobicany for 101ger. This means draw de production of lacoic acid win be derayed.



# Question 8 (b)(i)

Q08(b) was about beta thalassaemia.

Q08(b)(i) asked for the probability that two heterozygous parents would have an affected child, and almost all gave the correct answer of 0.25 / 25% for 1 mark.

Many candidates drew a Punnett square to support their answer.

The most common errors were incorrect probabilities (50% was most often seen) and candidates who gave two conflicting answers eg 25% and 1:4.

(b) Beta thalassaemia is an inherited condition affecting the gene for beta-globin (HBB gene).

People with beta thalassaemia have less or no beta-globin.

The most common form is a recessive condition caused by a mutation in the HBB gene.

(i) State the probability that two parents who are heterozygous for this condition would have a child who has beta thalassaemia.

25%	1	в	b	
6	3	66	ВЬ	
	0	вь	60	



A well set out answer gaining one mark. The Punnett square was not needed, but helped the candidate to avoid making a mistake. (1)

(b) Beta thalassaemia is an inherited condition affecting the gene for beta-globin (HBB gene).

People with beta thalassaemia have less or no beta-globin.

The most common form is a recessive condition caused by a mutation in the HBB gene.

(i) State the probability that two parents who are heterozygous for this condition would have a child who has beta thalassaemia.

(1)





This candidate scored zero.

25% is the correct answer for the probability that two heterozygous parents would have an affected child.

3:1 is not the correct answer, as they are not more likely to have an affected child – if they had written it as 1:3, it would have been correct.

Where there are two contradictory answers, no credit is given.

# Question 8 (b)(ii)

Candidates were asked why a heterozygous person does not show the symptoms of the disease.

About three quarters could explain that a heterozygous person has one dominant and one recessive allele or that for the condition to show in the phenotype, both alleles must be recessive. Very few candidates went on to say that this means heterozygotes could make the beta globin protein, so marking point 2 was rarely seen.

The most common error was to write about genes instead of alleles.

(ii) Explain why a person who is heterozygous does not show the symptoms of beta thalassaemia.

(2)

- Dive to the conduction being recessive, two vecessive
alleles are required for the condition to actually
terrice effect
- this person does not have the direase, they
are only a Camer



This answer was typical of most that we saw.

The candidate provides a very good explanation for marking point 1 but does not attempt marking point 2.

 Explain why a person who is heterozygous does not show the symptoms of beta thalassaemia.

- for the phenorype of beta thalassaemia to Show, The person needs to be homozygous recessive because it is a recessive condition. the dominant arrele (which a heterory gous person has) will always be expressed so beta-globin will be present in the harmoglobin they will not show a symptoms. Smiebure and

(2)



This is a strong answer which covers both marking points well.

(ii) Explain why a person who is heterozygous does not show the symptoms of beta thalassaemia.

-The gene is resserive so is only presented when both gener are present The dominant gene will mask the mutated HBB gene.



This answer was typical of those that did not score.

The candidate has confused alleles with genes and refers to genes throughout.

(ii) Explain why a person who is heterozygous does not show the symptoms of beta thalassaemia.

Since beta	tha lassa emia	is eccessive	(2) traile
you need	two recessive	alleler for	beta
thulasseemia	to be pres-	ent. Jy three two	~~ <b>~</b> ~
not present the	body conhi	nver to produce	Lormal
better amount o	t beta-globin	So they don.	t suffer
any s	iy mptons.		



(2)

6 m 6
## Question 8 (c)(i)

This was a Hardy-Weinberg calculation related to proportions of people with beta thalassaemia on a Mediterranean island.

Candidates were told that 280 in 1000 people have beta thalassaemia and asked to calculate the probability that a person on the island is heterozygous, giving the answer to 2 significant figures.

Almost 40% of candidates were able to carry out this calculation correctly and gain three marks. Some who knew the method involved, but made errors, were able to pick up marking points 1 or 2 for interim steps in the calculation – this shows the value of setting out working clearly.

However there were a significant number of candidates who had no idea what was needed in this calculation.

In some parts of the world it is much higher.

- In one Mediterranean island, 280 in 1000 people have beta thalassaemia.
- (i) Calculate the probability that a person on this island is heterozygous for beta thalassaemia.

Use the Hardy–Weinberg equation

$$p^2 + 2pq + q^2 = 1$$

Give your answer to two significant figures.

$$\frac{36}{1696} = \frac{280}{1000} = 0.28$$

$$q^2 = 0.28$$

$$q = 0.53$$

$$p = 0.117$$

$$p^2 = 0.22$$

$$\frac{1}{2} \left( 6 \cdot 47 \times 6 \cdot 53 \right) = 0.50$$
  
= 0.4982 = 0.4982

Answer 6-SO %

(3)



In some parts of the world it is much higher.

- In one Mediterranean island, 280 in 1000 people have beta thalassaemia.
- (i) Calculate the probability that a person on this island is heterozygous for beta thalassaemia.

Use the Hardy-Weinberg equation

$$p^2 + 2pq + q^2 = 1$$

(3)

Give your answer to two significant figures.

$$q^{2} = 0.28$$
  
 $q = 0.52915$   
 $1 = p + q$   
 $1 - q = p$   
 $p = 0.4708497371$   
 $= 0.50$ 

In some parts of the world it is much higher.

In one Mediterranean island, 280 in 1000 people have beta thalassaemia.

 (i) Calculate the probability that a person on this island is heterozygous for beta thalassaemia.

Use the Hardy-Weinberg equation Heltworygous.  $d_{normo}^{(n)}(p) + 2pg + g = 1$ Give your answer to two significant figures.  $280 \div 1000 = 0.28 = \text{Necestare homeorygous}$  0.72 = 0.8485281374 P  $\sqrt{0.28} = 0.5291502622 \text{ g}$  0.901(3)

0.90

Answer 0.90



In some parts of the world it is much higher.

- In one Mediterranean island, 280 in 1000 people have beta thalassaemia.
- (i) Calculate the probability that a person on this island is heterozygous for beta thalassaemia.

Use the Hardy–Weinberg equation

$$p^2 + 2pq + q^2 = 1$$

Give your answer to two significant figures.

 $\frac{280}{1000} = 0.28 = q^{2}$   $q = 0.529 \qquad 2 \times 0.68$   $P^{2} = 0.282 0.47 \qquad = 0.448$  0.72  $0.686 \qquad \times 100$  = PPE. 72.67.  $2 \times 37.$ 

Answer 73%

(3)



This person got the final answer wrong as well. However they got mark point 1 for  $q^2 = 0.28$  and mark point 2 for q = 0.529.



This shows how important it is to show working and to set it out clearly. This person got 2 marks for the interim steps, although the final answer was completely wrong.

## Question 8 (c)(ii)

Candidates were asked for two reasons why the value they had calculated in Q08(c)(i) might not be accurate. Many candidates realised that they were being asked about the assumptions made for Hardy-Weinberg, and it was pleasing to see that many related them to the island context,

eg migration.

Answers could either be phrased as the assumptions that are made for Hardy-Weinberg (it should be a large population) or what is actually happening on the island leading to possible inaccuracy (the population on the island may be small).

Overall this was well answered and almost half of all candidates scored two marks.

Some missed the point and thought that not everyone had been tested or that people may not realise they had the disease.

It was clear from the answers given that some candidates have become confused between the assumptions made for Hardy-Weinberg and the conditions needed for mark-release-recapture to give an accurate estimation of population size.

(ii) Give two reasons why this value may not be accurate.

(2)sa small population on an Island People mig ate away



(ii) Give two reasons why this value may not be accurate.

me hardy weinburg equation only works with no muranions and an Denared population - hard to manage and to mainvain ranner prevent muranion)

Another strong answer scoring both marks, this time mark points 5 and 1.

(ii) Give two reasons why this value may not be accurate.

(2)

(2)

- assumes that theres no mutation

- assumes no migration

This answer scored 2 marks (mark points 5 and 1) expressed as the assumptions that are made.

(ii) Give two reasons why this value may not be accurate.

Not all of the people may have been bested for befa bualassaenia. Not all will be presenting to they could be Homozygous dominant.

This answer shows the one of the most common errors – to assume that they cannot tell how many heterozygotes there are, because people have not been tested for the disease. (2)

# Question 9 (a)

Candidates were asked to explain how atherosclerosis can cause CHD and can lead to death.

Although most candidates had a reasonable idea of the sequence of events involved, imprecise language and lack of detail prevented some from scoring more highly. We were looking for:

- {plaque / clot / atheroma} forms in (coronary) artery.
- causing {narrowing / blockage} of the **coronary** artery.
- therefore reducing the blood supply to {cardiac / heart} {muscle / tissue / cells}.
- so {cardiac / heart} muscle dies.
- heart (muscle) stops contracting (if enough cardiac muscle cells die).
- so oxygen not supplied to brain cells (causing death).

There were some very strong answers and around a third of candidates scored at least three marks. The most commonly seen marking points were 1, 4 and 5.

However, a lot of candidates missed out on marks they came close to achieving, due to lack of detail. Examples of this included:

- referring to a blood vessel rather than an artery (mark point 1).
- referring to an artery rather than a coronary artery (mark point 2).
- saying less blood reached the heart rather than reached the heart muscle or cells (mark point 3).
- not considering what happens if the heart stops contracting (mark point 6).
- not explaining how this could lead to death (mark point 6).

9 Coronary heart disease is a major cause of death in Europe.

(a) Explain how atherosclerosis can cause coronary heart disease and can lead Doften due to stress to death. and (4) high blood pressure On Atherosclerosu the OCCUTS when ŧΟ artery are damaged the resi cholesterol immune response is triggered hardens laid down in the vessel. This is atheroma. plaque, forming Into an rentually The atherano and arow  $(\Omega)$ the 0 teri n(upstream the 11 muscle the the b 0 OC from respure ٦is leni to death produce US MUSCIO CODR  $C \cap$ 1100 pump This means blood a Ct rmtra brain overtime the (1)ill be the heart wort beat ar strong enoug ne go into Will fibrilation.



This is a very well structured answer which contained correct biological details and achieved maximum marks.

They got mark points 1, 2, 3 and 5.

Not mark point 4 as they do not say that cardiac muscle dies and not mark point 6 as they refer to the brain, not brain cells.

- 9 Coronary heart disease is a major cause of death in Europe.
  - (a) Explain how atherosclerosis can cause coronary heart disease and can lead to death.

	high blood pressure due to smoking, diet etc
-7	inclammatory response and arrival of white blood cells
7	deposits of cholesterol
-7	Formation of plaque atherama
-7	causes blockage of blood vessels increasing
******	blood pressure

(4)



Although this candidate knew some of the steps of the process they did not score as there was lack of detail.

Not mark point 1 as although they said a plaque forms, they did not say it was in an artery. They did not explain how high blood pressure could lead to death.

- 9 Coronary heart disease is a major cause of death in Europe.
  - (a) Explain how atherosclerosis can cause coronary heart disease and can lead to death.

(4) Formation plaalle Car a nes making Callber aue 7 Sime MARCONZ T) her 190 TISPABE atta Poor Can RAW diet COUSE substances build D sitioms eromo U



narrows

They achieved mark point 1 on line 1 and mark point 4 on lines 6 – 7.

- 9 Coronary heart disease is a major cause of death in Europe.
  - (a) Explain how atherosclerosis can cause coronary heart disease and can lead to death.

(4) He if a person has athenos cleased, mey have atheromas and plaques in the coronary antenes / m blood vessels. Hence if more choilesters and platelets & shill to the plague / atherana the atheroma would become large and would block the b) bud from froming to the e hear musues, hence blood flow arhenoscienois increases blood pressure, to the heart is low. As the due to a narrow lumen, nence it's more likely for an as endometium is dumaged as endometion is dumaged the other alpensmas to form. if heart muscles receives less blood it receives less oxygen hence less aeropiz respiration occurs and 1855 ATP is generated hence the heart is unable to contract so can lead & death it no blood can reach the body via the hear.

Results Plus Examiner Comments

This is a strong answer which gained four marks.

It got mark point 1 on lines 1 – 2, mark point 2 on lines 2 and 4, mark point 3 on line 5 and mark point 5 on lines 10 – 11.

"It can lead to death if no blood can reach the body" was too vague for mark point 6.

- 9 Coronary heart disease is a major cause of death in Europe.
  - (a) Explain how atherosclerosis can cause coronary heart disease and can lead to death.

Atheroscierosis is raised when taxs and chearesterals age built up in blood actery a sticks to the wall of the actern. This will accumulates over time, -lesulting in atherana getting bigger. Platelets and From will also tra to form a west retwork, clothing the attregue The bit of atherana could lead to higher pressure as the artery uner becomes narrower. This could result in damage of elastic fibres and muscle fibres. Eventually built up Atherana will result in insufficient supply of axygen to targeted argan to death



Although everything in this answer is correct it only gets one mark, because it focuses entirely on marking point 1.

(4)

### Question 9 (b)

This was the 9-mark levels-based question. Candidates were given data: a table of deaths from CHD in several European countries in 1990 and 2019 and a graph showing deaths from CHD for males in the UK between 1979 and 2013.

They were asked to discuss the validity of the following suggestion: that the change in deaths from coronary heart disease in the UK is due to improved lifestyle choices, and that coronary heart disease could be reduced to almost zero in the UK if people made better choices.

The command word **discuss** requires candidates to explore all aspects of the situation being considered and to investigate it using reasoning.

The indicative content was divided into three areas:

- L points, which were factors that could reduce deaths (including better lifestyle choices, healthcare, improved awareness).
- C points, which were factors that could prevent deaths reaching zero (including genetic predisposition, age, sex).
- D points, which were for data analysis.

To achieve Level 1, candidates could make points from any of the three areas.

To achieve Level 2, candidates must make points from a minimum of two areas, including D points.

To achieve Level 3, candidates must make points from all of the three areas and consider validity. For 9 marks the answer must include a reasoned argument assessing validity.

Generally candidates did very well on this question, using the information given and their own knowledge to build strong arguments. There were many excellent, thoughtful answers including relevant biological detail which scored 9 marks.

A small number of candidates got stuck at a particular level because they did not meet the criteria to progress, eg if they had lots of L and C points they could not get more than 3 marks unless some D points were also included.

Overall 40% of candidates achieved Level 3, 36% achieved Level 2, 23% achieved Level 1 and a very small number of candidates failed to score at all, usually for leaving the pages blank.

style. However here is quite a trashic de crease of deaths coursed by caranans heart disease in he last za years which shows there has been some sort of improveners this could be due to better I more accurate health ave however as there are now medicing and more food subshibites to brance choloster levels, overhave more excersise equipment has become available and it is a Popular King to go to the gum and eur healthie poss union could be Why he revel of deaths is incrasing Mr is a 581. decorase in deature in Just 29 years which could keep decreasing over the years and



This candidate shows that they know some of the factors involved in CHD eg lack of exercise and build-up of cholesterol in arteries due to diet. However they do not give an A-level standard explanation of why this happens, so scored a single L point for knowing the factors, but not describing the effect of them.

On line 12 – 13 they scored an L point for recognising that better healthcare would have an effect.

They go on to quote data from the table (that there is a 58% decrease in deaths in 29 years) but this is not a D point as it is simply quoted, not used in any way.

This candidate went on to score a C point and therefore achieved 3 marks overall.



Do not just quote data from the stem of the question, as this will not gain credit. Use it in some way to build your argument. Here the candidate could have compared the decline in the UK to other countries in Europe.

- Nowadays		its	easier	to	eart	Food	
with	sah	rated	Parts	n. W	nich	increas	C
cholesterol.							
- There	13 a	nuch	wider	Food	ron	ge tra	of
trings	ю	eat	compar	ed to	o e	ven a	5
early	as	100	years	<u>ago.</u>			
- Foods	line	Fast	Food	ore	cheqpe	r and	******
much	easie	es to	And	ond	ear	then	
whole	Foods.						
- Media	ati on	end	healthcar	c hai	s im	proved	50
much	we	now	know	what	١Ì	better	ho
eart	then	other	things		**********		



This candidate recognises the effect of diet on CHD but does not make a valid A-level standard point.

They get one L point for improved healthcare on line 10.

Ireland has seen a -63% decrease. Coronary heart disease can be caused by factors like lack of exercise obesity, smoking and gender. While some of these are modificuble risk factors, others, like gender, are not. In males CHD is more likely as males do not produce cestrogen which is said to reduce Cholesterol buildup. Similarly, age increases risk as as you age vessels lose elasticity so an atherana in the coronary arteries is more likely to block them and cause CHD. However, the UK can encourage healthy eating and exercise to reduce the risk factor. Arguably, factors beyond lifestyle choices play a role as technology across

Europe has improved over time. The UK may have a decrease in deaths as more treatment SOON been made available overtime. diagnosu has and fair to suggest this has had a bigger impact lt 1S lifestyle choices as lifesture choices reduce incidence. can only only country The On the improvement link the cost d to mo heart surgener coronary to cultural be Clou however mo but, this can be disproved Balkan European that other the fact Albania have still seen a like countries decrease in deaths. It could be argued that



This candidate lists some of the factors involved in causing CHD and gets one L point for the list.

They go on to give a more detailed description of the effect of sex and age, achieving two C points.

They get one L point for stating that improved medical technology has an effect and another for recognising that this may have a bigger effect than lifestyle choices in reducing deaths.

They get a D point for comparing Montenegro to other Balkan countries.

Overall, this candidate produced an excellent answer. They went on to make further L, C and D points and scored 9 marks.

LO NO data has been provided to show
liferryle has improved within the UK so
cannot say this is definity the and the
it it has caused the 55% degreak in the
UK OVER 79 YOUNS
- The healthcare technology has massively
increated meaning people are staying alive
for much longer which could increase the
more likely to suffer with it.
- Gender is a factor in healt disease, with
male, being more likely to have it
40 this is mainly down to genetics and
moles having a worse more manualy
labour based lifestyle
-> malei who have healt disease is inter
decreasing by around 340# per 1000 between
1979 and 2013 but Gernale decleage is not
Shown in compasion and this data is
now relatively old.
*



This candidate correctly states that data has not been provided to back up the claim that lifestyle choices have caused this effect and gets a D point.

They state that healthcare has improved, but link this to living longer, and therefore being more at risk from CHD due to age, so get a C point.

They recognise that males are more at risk, so get another C point.

In their last bullet point they get two D points because they read figures from the graph to get the decrease in data for males, and also recognise that the data is incomplete because no data is given for females.

Overall this candidate made a lot of D and C points and two L points, so was able to score 9 marks.

It has been suggested that the change in deaths from coronary heart disease in the UK is due to improved lifestyle choices, and that coronary heart disease could be reduced to almost zero in the UK if people made better choices.

(9)

Discuss the validity of this suggestion.

Use the data and your own knowledge to support your answer.

We can see that there is a decrease of deaths from caronary oK Since 1990, however it discose heart the 0650ml this is solely down to people marking whe choices the data que shows no signs or decrease so we cannot assume. There are name decreasing the death rate by CHIV Corld och as treatment, works to hind it before deadly impraced Causes CHD-The data Shows who died Knowledge what onla outo sylfered from it so it could 14 not More flo the treatment has improved significantly had it but [lon len earo Shahely this could be caused rak (pureabled) knowledge or healthcare off 0 libety that impound lipshik choices likely reduce your nok 1+ Such as appopriate to suggest no Smoking but its not poeter with out poper eidence this is the leading



It has been suggested that the change in deaths from coronary heart disease in the UK is due to improved lifestyle choices, and that coronary heart disease could be reduced to almost zero in the UK if people made better choices.

Discuss the validity of this suggestion.

Use the data and your own knowledge to support your answer.

• This suggestion is supported ke cause resuler less shors, less abesting exercise of smorting, and a healthler diet
would improve decrease change of
developing athorosclorasis, as less stoss
reduces blood pressure so reduces chance
or damago to arten wall se so test
solurcied pats in diet reduces satur
available for build up in arteries so less
atterimans formed and less par build up
reduces blood pressure so less chance of
damagod caused
· Also, bable shows on average number of
deaths decreate from 1990 to 2019 as
information on uppstyle chaices is more
research and more educated on sc poople
Hend to read hearthier upostyle reducing
chances of atterasclarsis and .: reducing
chances of heart disease and doath.
· Monnever, allero scleros is can be cause by
geres and ago and genow

(9)



This candidate achieved three L points (for the list of factors and then details of how stress and cholesterol in the diet increase CHD).

They achieved two C points for genes and age.

However there were no D points, so they were restricted to Level 1, 3 marks.

It has been suggested that the change in deaths from coronary heart disease in the UK is due to improved lifestyle choices, and that coronary heart disease could be reduced to almost zero in the UK if people made better choices.

Discuss the validity of this suggestion.

Use the data and your own knowledge to support your answer.

- The table shows that the UK had the Zord biggest percentage devease in deallis from 1990 to 2019 it was -58% (not as moch as republic of ireland at -63%) so in the space of 29 years in decreased by half, this makes the discussion lessualid as it took 29 years to have the number of deaths so it will take a very long time to reduce deaths to zero and so a very long time to reduce coronary heart disease to zero. Also this suggestion isn't valid as one factor of increasing risk of coronary heart disease is genetics which isn't a lifestyle choice and it would therefore mean that coranary heart disease rait be reduced to almost zero since its unethical to not allow people who's families have lots of coronary heart disease to repoduce. In the table the UK had a larger > decorcase in deaths (-58:) cauparent to Europe as a whole (-38%), however this decrease may just correlate with the fact that lifestyle choices have improved rather than be caused by it (correlation not causatian), Stress also anxes heart disease and people cont cantrol it. Also the decrease in 7. of heart discuse deaths may be due to the improved healthcare system and medications and scientific knowledge which can breat heart disease rather than improved lifestyle conditions especially since fast good is more available now and people sit on their phones and don't

(9)

walk around as much as they used to in 1997, so despite the fact that there is a little less smaking now doesn't mean that lifestyle choices have improved as subroted juts and cholestand are more available to be eater and people is general have more sedentary lipstyles now. | think the statement is right to say that caronary heart disease could be reduced if people made better lifestyle choices because lack of exercise, eating high cholesteol good and smoking will all increase the risk of heat disease barnene so making better ducices not to do these things should decrease the risk however the statement is wrong to say that the charge is deaths was due to improved likestyle choices as there's no evidence to say lifestyle choices have impound and there's no evidera to say that lifestyle choices were responsible for the decrease i.e it could have ben better healthcare that reduced the number of deaths. The graph shows a decrease from 450 to 120 deaths for de francheat disease from 1979 to 2013 but its only data for men so no eviderce that number of deaths also reduces for Jenales, also just because the number of heart disease related deaths has devensed doesn't mear that the number of people with heart disease has decreased. Also in the table the number of deaths in Monteregro has increased by 4% and there is no evidence to say whether lifestyle choices have got better or warse there because life shyle choices could have gotten better but deaths could have increased due to poor healthcare system Overal 1 don't thick the suggestion is valid because firstly there is no evidence that the × of deaths due to coronary heart disease is due to improved lifestyle choices as other factors like genetics also affect it, also no evidence that coronary heart disease cases have been reduced any evidence that the number of deaths from it has reduced, although I agree with the jack that heart disease could (Total for Question 9 = 13 marks) reduce 18 people made better choices I don't thick it would reduce to almost zero as quetics also contribute to heart disease and gender as males are more likely to get heart disease



This is an excellent answer which fully deserved the 9 marks it achieved.

They cover a lot of ground:

D points – that it may be correlation not causation, no evidence that lifestyle choices have changed, no evidence that lifestyle choices are responsible for decline, data read from graph, no data for females in the UK, fewer people dying but no data on incidence of CHD.

C points – genetics increases risk, males are more at risk, deaths very unlikely to reach zero.

L points – better healthcare decreases risk, more sedentary lifestyle/ smoking / poor diet increase risk, stress increases risk.

These points are put together to build a strong argument with validity being discussed throughout.

#### Question 10 (a)

Q10 related to a simple respirometer containing maggots. This is Core Practical 9: investigate factors affecting the rate of aerobic or anaerobic respiration using a respirometer. Candidates were given a diagram and the results of an investigation achieved by 5 groups of candidates.

Q10(a) told them oxygen uptake was measured in mm<sup>3</sup> per minute per gram and asked what additional measurements must be made to calculate rate of oxygen uptake in these units.

Many candidates realised that mass of maggots was required and some also suggested radius or diameter of the capillary tube.

About a third of candidates did not score, and most suggested what was already in the description of the investigation: the time the maggots were left or the distance moved by the coloured liquid.

(a) The rate of aerobic respiration was determined as the oxygen uptake calculated in mm<sup>3</sup> per minute per gram.

State the **two** additional measurements that you would make to calculate the rate using these units.

diameter of the tube capillary tube mass of the

(2)



(a) The rate of aerobic respiration was determined as the oxygen uptake calculated in mm<sup>3</sup> per minute per gram.

State the **two** additional measurements that you would make to calculate the rate using these units.

- the diameter of the capillary tube so that He volume can be calculated using TITZL. Gliameter reeded for The radius. - the mass of the maggers only in grams Should be calculated [ neasured.



Another strong answer which scored both marks.

For mark point 2 the candidate said that diameter should be measured, as well as giving the formula to calculate the area.

(2)

(a) The rate of aerobic respiration was determined as the oxygen uptake calculated in mm<sup>3</sup> per minute per gram.

State the **two** additional measurements that you would make to calculate the rate using these units.

Distance moved by coloured liquid in comm · Time taken for investigation in 51



This answer is typical of those that did not score.

The candidate has suggested two measurements that were already given in the stem of the question – this was in the sentence "The distance the coloured liquid had moved was measured after 15 minutes".

## Question 10 (b)

Candidates were asked to justify two improvements to ensure the validity of the investigation.

The command word **justify** requires candidates to give evidence to support their choice – in this case the reason that the improvements they are suggesting would ensure validity.

As expected, candidates found this challenging, with over three quarters scoring zero.

Many candidates were able to suggest suitable improvements, eg controlling the age of the maggots, but did not say why they were needed (because age may affect respiratory rate).

Some candidates left out key details of the answer, eg suggesting using a control but without saying it had no maggots in it or using a water bath that was not thermostatically controlled.

Several candidates suggested replacing the potassium hydroxide regularly, but as there was no evidence that the apparatus was used more than once by each group, this was not given credit.

A number of candidates thought that reading the position of the liquid every minute (instead of once, after 15 minutes) would improve validity; however this is likely to introduce errors as small changes in position are being read frequently.

(b) Justify two improvements that would ensure the validity of this investigation.

(2)

Let the maggots actimatise to the new conditions for at least 5 minutes 180 the oxygen uptake is accounts for the lag. Ensure that the maggots were of the same age and were all healthy so this would not affect the rate of oxygen uptake.



When the command word is **justify**, make sure you give a reason for the improvements you suggest.

(b) Justify two improvements that would ensure the validity of this investigation.

(2)

Allow 5 minutes with the 3-way tap open byfore starting the stopwatch to allow the magget to adjust on to the new environment, as their behaviou while adjusting could affect their rate of respiration. Place the beaker of water in a thermostatically controlled water bath at 15°C to ensure the temperature remain since temperature affects the rate of espiration the same throughput



This candidate has explained their points very clearly and achieved mark points 5 and 1.

GCE Biology B 9BI0 03 142

(b) Justify two improvements that would ensure the validity of this investigation.

- repeat at hast 5 times to ensue the elumination of

anomalow repits and validity, and most the reputs can

ne repricated

- represh potation undroxide each repeatand me

beciting water in a water both to entre

temperative is maintained and constant.



This candidate did not score. There was no credit for repeating the investigation or for refreshing the potassium hydroxide solution.

They came close to mark point 1 with the suggestion of putting the beaker of water in a water bath but they did not say it should be thermostatically controlled.

## Question 10 (c)(i)

Candidates were told that in enzyme-controlled reactions, a 10°C rise in temperature doubles the rate of reaction. They were asked to predict the rate if there was a 10°C decrease in temperature.

To do this, they had to complete two steps:

- calculate the mean rate from the results for 5 groups.
- halve this value.

Around two-thirds of candidates were able to carry out the calculation necessary to achieve this mark.

(c) (i) For enzyme-controlled reactions, a 10°C rise in temperature will double the rate of reaction.

Predict the mean rate of oxygen uptake if the water bath had been set at 5°C.

0.14 + 0.16 + 0.13 + 0.12 + 0.14 = 0.69 = 0.14

Answer  $m^3 min^{-1} q^{-1}$ 

(1)


(c) (i) For enzyme-controlled reactions, a 10°C rise in temperature will double the rate of reaction.

Predict the mean rate of oxygen uptake if the water bath had been set at 5°C.

15 → 25°C 0.0138 ×2 0.138 → 0.276 -2

(1)



Although this candidate appeared to be going in the wrong direction, they came to the right answer for one mark.

# Question 10 (c)(ii)

Candidates were asked to explain why decreasing temperature affects the rate of respiration in maggots.

About a third of candidates scored 1 mark, usually for recognising that enzymes had less kinetic energy. Stronger candidates also scored the second mark for saying that collisions were less likely or less frequent. However, around half of all candidates scored zero on this question.

The most common problems were:

- referring to number of collisions rather than likelihood or frequency.
- saying that enzymes work more slowly (no reason).
- that they are denatured at lower temperatures.

A surprising number of candidates did not realise they were being asked about enzymes at all and wrote about maggots needing to generate heat to stay warm, or said that maggots were ectotherms and if they were cold they would become less active.

 Explain why decreasing the temperature affects the rate of respiration of maggots.

As temperature decreases, enzymes like
ATP synthase involved in derobic respiration
have less kinetic energy. As a result,
less collision occurs so a enzyme-substrate
complexes form less frequently so rate of
a uptake of oxygen is reduce and



This is a strong answer which scores both available marks:

- mark point 1 for enzymes have less kinetic energy.
- mark point 2 for E S complexes form less frequently.

(2)

 Explain why decreasing the temperature affects the rate of respiration of maggots.

- decreasing the temperature reduces the rate of respiration because the enzymes involved in respiration and the substrates have less Kinepic energy they are use vikely to could and Therefore bring about the next stage of respiration

(2)



Another strong answer gaining both marks:

- mark point 1 for enzymes and substrates have less kinetic energy.
- mark point 2 for they are less likely to collide.

(ii) Explain why decreasing the temperature affects the rate of respiration of maggots.

decreasing temperature lowers the kinetic energy of putides so par enzyme move slower (i.e. enzyme coA in link reaction) Se [RSS enzyme substrate complexes form per unit time so the rate of respiration is Slower as pespiration is calcular by erzyner



Two points clearly explained for two marks:

- mark point 1 for lowers the kinetic energy of particles, so enzymes move more slowly.
- mark point 2 for less E-S complexes form per unit time.
- (ii) Explain why decreasing the temperature affects the rate of respiration of maggots.

(2)

(2)

enzyme, nave less kinens energy so dont

read as a providing with the work of the

cellisions these enzyme substrate complexes

so respuration rate concers to conserve every



(ii) Explain why decreasing the temperature affects the rate of respiration of maggots.

(2)

Respiration on Control ecreose ect.V.t

Both of the statements in this answer are true, but they lack the detail needed to score any marks, as no reason is given for the decrease.

(ii) Explain why decreasing the temperature affects the rate of respiration of maggots.

The magging are excinemy and therefore need the entronment to be worm enough to continue to function appropriate decreate rate of other remarkanon Temperative would mederally reprinting as me croanim begins to that down /die.



not score any marks.

Chemical	reach	ions	with	enzy	nes	are	
slover	due	ro	derch	Ma o	+ +	ne	
enzymes	50	read	nions	and	othe	<u>ل</u>	
processes	<i></i>	m4	mappen	as	Fast	as	*****
	***********************		the backet		***********************************	*****	******

usual.



#### Question 10 (d)

Candidates were asked to describe the role of oxygen in the formation of ATP during aerobic respiration.

Credit was given for:

- oxygen is the {final / terminal} {hydrogen acceptor / electron acceptor}.
- allows electrons to pass down electron transport chain.
- allows {FAD / NAD} to be replaced.
- {hydrogen ions / protons} move through {ATP synthase / ATPase} forming ATP.

About a third of candidates gained one mark for saying that oxygen was the final electron acceptor, but further knowledge was limited for most.

Stronger candidates got two marks (usually for describing hydrogen ions moving through ATPase) and but very few were able to get a third mark. Around a third of candidates did not score at all.

(d) Describe the role of oxygen in the formation of ATP during aerobic respiration.

(3)

	-7	oxygen acts as a terminal election acceptor
	-7	allows the release of ATP when it is reduced
	-77	Forms water 3 +7H+ -7 H20
	-7	ATP is Formed when electron passed down
		election transport chain.
,,,,		



(d) Describe the role of oxygen in the formation of ATP during aerobic respiration.

(3)

Ozujgen is more electron acceptor ~ the (ETC) Electron transport chain, during actorit respirates Oxupen is notal in the ETC as it allows electrony to more wrongh conners to princip Ht who we with very prace, as it is 50 fial electron accelote, morant it the electrons would To wave many (Total for Question 10 = 10 marks) not be able the conero is necessary, as the pumped n' in weate ~ concentration graderite to mis are Has troop by chemedomesis dant meis ALLA Synthese electrocensar gradent, when results i ATP ber conned.

This is a rare example of an answer scoring all three marks:

- mark point 1 on line 1.
- mark point 2 on lines 6 8.
- mark point 4 on lines 8 11.

#### Question 11 (a)(i)

Q11 related to a citizen science project to find the number of wildflowers in lawns in the UK in 2019 and 2020. Candidates were given an outline method and a table of data for the five most commonly recorded plant species in 2020, showing their percentage change relative to 2019.

Q11(a)(i) told them that scientists thought that the warm weather in spring 2020 might be responsible for the changes and asked them to suggest a factor other than temperature that could cause a change in the number of flowers.

Many candidates approached this from a fieldwork point of view and thought about what they would like to measure or control, rather than thinking of it in relation to a garden in two different years.

We were looking for things that may change from one year to the next, eg rainfall, mowing / trampling / disease, or factors relating to how the data was collected, eg at a different time of year.

Only a quarter of candidates named a suitable factor, with light intensity being by far the most common incorrect answer.

In 2019 and 2020, a citizen science project was carried out in the UK to investigate the numbers of flowers of wild plant species found in lawns.

Volunteers across the UK were asked to survey their own lawns to find out which wild flowering plants were growing there.

Participants were asked to mark out a one metre-squared area on their lawn, chose at random, and count the number of flowers of each species within this area.

In 2020, the data were recorded from over 9 000 one metre-squared areas.

The table shows data for the five most commonly recorded wild plant species in 2020.

Wild plant species	Total number of flowers recorded in 2020	Percentage change from 2019 (%)
Daisy	208 589	-40
White clover	101 117	+16
Selfheal	73 344	-11
Creeping buttercup	56719	+48
Bird's-foot trefoil	30 646	-32

- (a) Scientists who analysed the data suggested that the unusually warm weather in Spring 2020 might be responsible for the change in the numbers of flowers recorded in 2020 compared to 2019.
  - (i) Name **one** factor, other than temperature, that could cause the change in the numbers of flowers of these five species.

water availability.

(1)

One mark for water availability.

In 2019 and 2020, a citizen science project was carried out in the UK to investigate the numbers of flowers of wild plant species found in lawns.

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.....

(1)

Examiner Comments One mark for rainfall.

Rainfall.

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(1)

It intersity affected by number of doudy days



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(1)The length of suntrunt present in a day = length of daylight

Although this is not expressed very clearly, length of daylight is enough

for a mark.

Examiner Comments

In 2019 and 2020, a citizen science project was carried out in the UK to investigate the numbers of flowers of wild plant species found in lawns.

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(1)

populations. More time at honne leading to non time meaning and treating lawns .



# Question 11 (a)(ii)

Candidates were asked to evaluate the method of data collection in this survey.

Most commonly seen marking points were 1, 3, 4, 5, 6 and 7. Marking points 2 and 8 were more rarely seen, but all points were seen in the course of marking.

There were many excellent, considered answers recognising the strength and weaknesses of the method. For full marks, candidates had to include at least one strength and one weakness.

Some candidates approached this from a fieldwork perspective and criticised the method for not controlling things like soil pH or shade which could affect the number of flowers, without realising that the purpose was to simply survey how many flowers were present, not why the numbers differed.

Some candidates misunderstood the table of data and thought that data was only collected for these five species, rather than that these were the most commonly found species.

A few candidates ignored the instruction to evaluate the method they were given and simply wrote a new one; they were able to score marks for weaknesses when their method could be compared to the original.

There was a big spread of marks with around 40% of candidates scoring at least 3 marks.

Evaluate the method of data collection in this survey.

(5) more 02 0 error Ma



This candidate scored mark point 1 for recognising it was a large data set.

Their comment about human error was too vague to score any of the marking points – if they had provided more details it could have achieved mark point 4, 6 or 7.

(5)

Evaluate the method of data collection in this survey.

-> Volunteers may not be the same people tooth years, so areas heing surreyed many differ -> Vounteers may not produce accurate results due to misidentification of species, misconsting, may to validate the results -> Very lange-scale project, however, so produces a large set of data meaning that The uncertainties are less significant -> Volusteer-based = cost effective, sames time - Squares on lourns may not be and mandomly ebosen - people may subcancionsly choose most dense anea



This achieved 5 marks.

Evaluate the method of data collection in this survey.

(5)

- There were many participants so a large sample size may barre is good to validify results - me plant same gardens may not have been Surreyed each time ( in 2 differing years) - people in have may not have randomly chosen me garden point they were surveying with randonly generated numbers which would mean that bias was inmanced to the experiment. People who have lawns may not represent contain parts of UK. - People may have weeded the wild flowers out from 2019 to 2020 as pardening increased in popularity due to lockdown : less wild towers in 2020. This introduces biased data. &-people may misidentify the plants is they are not versed and study flowers . inacculate data. -Involving the public increases interest for the results of survey - more people invested in plant growth.



Another excellent answer, gaining full marks.

Mark point 1 on lines 1 – 2, mark point 8 on lines 3 – 4, mark point 5 on lines 5 – 8, mark point 4 on lines 9 – 10, and mark point 6 on lines 15 – 17.

While correct, the other points they made (increased weeding during lockdown, and increased interest in plants) did not gain any credit.

Evaluate the method of data collection in this survey. (5) The method relices on coloureers and the process is not monitored to ensure it is being consider out properly. It is observe him al ordentreform the detern is subjecture, which can also held to human error for example a miscent. Differt order will have different above for example a the method is effective in evening the is a logic songle Size, an it is nowed former in at gotary results.

This answer scored mark point 7 on lines 4 – 5 for miscounting and mark point 1 on lines 7 – 8.

Evaluate the method of data collection in this survey.

(5) Having 9000 sample means the investigation is reliable as there Balage anoutof data, However, it is Using a randon area removed human bias and neutrus the reputs and walid hervere participants May not have adhered to this rule. No scientists validated the data from the atizens some so some reports may have been false. People very also have misidentified vare plants. It is under how many samples vertaken in 2019, so the dake set for this yearney have been less reliable if it had feur samples. Different participants mayhave sant in data lass eper so there naybe a shift is hild flaver species due to different laws Northerent areas beingused. This study ney not have been representatived the whole use as sample distribution very have been champed if volunteers encourage people in their local commity to contribute



This was a very strong answer gaining maximum marks.

Mark point 1 on lines 1 – 2, mark point 3 on lines 2 – 3 and mark point 5 on lines 3 – 4, mark point 6 on lines 5 – 6, mark point 8 on lines 8 – 10 and mark point 4 on lines 11 – 13.

Evaluate the method of data collection in this survey.

	(5)
Nalid:	,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,
- Large group of people provided data a	-> large
number of gardens counted -> more r	representative
of the entire population	
- % change calculated instead of raw	difference
6 more valid comparison	
- ALTOSS THE UK - LARGE SPREAD OF LOCAD	ons -> mone
general conclusion	
NOC Valid:	
- Number of one meter-squared arreas	unknown
tor 2019 - invalid comparison	
- One meter-squared area in gardens	may not
be: 1) accurate area; 2) randomly ch	idsen
(human bias hard to eliminate)	
- cannot conclude without data of etu	er flowers
- Identification of flowers not all to spec	ives revel
- Some flowers may be planted instead of	f grown
naturally	



Another excellent answer gaining maximum marks.

It got mark point 1 on lines 2 – 4, mark point 8 on lines 10 – 11, mark point 4 on lines 12-13, mark point 5 on line 13, and mark point 6 on line 16.

## Question 11 (b)(i)

Candidates were given data from one quadrat containing four species and asked to calculate the biodiversity index.

Over half of all candidates were able to use the formula they were given to get the correct answer.

Some candidates made mathematical errors when calculating n(n - 1) for each species, and some were able to gain at least one interim mark.

Some simply had no idea what to do; surprisingly, a quarter of all candidates scored zero.

Wild plant species	Total number of flowers recorded	
Daisy	11	110
Dandelion	8	56
Cat's-ear	14	182
Selfheal	2	2

(b) The table shows the total data collected in one quadrat placed on a lawn.

(i) Calculate the biodiversity index (D) for the quadrat, using the data in the table.Use the formula

$$\mathsf{D} = \frac{\mathsf{N}(\mathsf{N}-1)}{\Sigma\mathsf{n}(\mathsf{n}-1)}$$

$$N(N-1) = 35(35-1) = 1190$$

$$\frac{1190}{350} = 3.4$$

Answer 3.4

(3)



Wild plant species	Total number of flowers record

(b) The table shows the total data collected in one guadrat placed on a lawn.

Daisy

Daisy	11
Dandelion	8
Cat's-ear	14 <sup>7</sup>
Selfheal	2

(i) Calculate the biodiversity index (D) for the quadrat, using the data in the table. Use the formula

$$D = \frac{N(N-1)}{\Sigma n(n-1)}$$

$$H (H-1) \simeq H0 \qquad \underline{4(4-1)}$$

$$S (8-1) \simeq 56 \qquad \underline{4(4-1)}$$

$$300 \simeq 0.03428571$$

$$A (H4-1) \simeq 62$$

$$2 (2-1) \simeq 1$$

$$350$$
(3)



Wild plant species	Total number of flowers recorded	
Daisy	11	
Dandelion	8	
Cat's-ear	14	
Selfheal	2	

(b) The table shows the total data collected in one quadrat placed on a lawn.

(i) Calculate the biodiversity index (D) for the quadrat, using the data in the table.

Use the formula

$$D = \frac{N(N-1)}{\Sigma n(n-1)} \xrightarrow{\text{spec.} < S}_{\text{btalflow}}$$
(3)

Answer 0.01



# Question 11 (b)(ii)

Candidates were asked for two improvements to the method to give a more accurate measure of biodiversity – we expected to see counting number of plants rather than number of flowers and counting all plant species not just wild flowers.

Only 1% scored both marks and 20% scored 1 mark.

The most common incorrect answers suggested repeating the investigation, using a bigger quadrat or using random sampling.

(ii) Describe **two** improvements which should be made to the method to give a more accurate measure of the biodiversity index for this guadrat.

Count the number of actual plants (by the stem) Count all the species in the quadrat, not just flowering plants. instead of the flowes.



A rare example of a candidate who scored two marks.

Mark point 2 for counting plants not flowers, then mark point 1 for counting all species, not just flowering plants.

(2)

 (ii) Describe two improvements which should be made to the method to give a more accurate measure of the biodiversity index for this quadrat.

(2)Don't just count frome's open count me number plants, at one plant may have more than one fromer and some plants may not have prometed. Theat Include other plant species, not just ones that flower (eg. grasses) as This gives a more accurate value for the biodiversity as it takes into account all species.





This answer is much more typical. The candidate focuses on where the quadrat is placed and how the plants are counted, rather than thinking about the actual data collected. This does not score.

(ii) Describe **two** improvements which should be made to the method to give a more accurate measure of the biodiversity index for this quadrat.

- use a larger quadrat to get a wider representation of the lawn. use a huo transects and a random number generator to place the guadrant at a particular coordinate to enforce a random samp State



Again, a very typical answer involving size and placement of quadrat. This does not score. (2)

# Question 11 (c)(i)-(ii)

This pair of linked questions compared the amount of nectar per unit area in 2019 and 2020 and explored the possible consequences of this.

Q11(c)(i) related to the amount of nectar produced in a standard area in 2019 and the number of bees it could support. Candidates were given the amount of nectar produced in 2020 and asked to calculate the number of bees it could support. Many were able to do this and achieved the two marks available.

Q11(c)(ii) asked them to explain the possible short and long term consequences of the decline in wildflowers in lawns in 2020.

While most candidates realised that there would be fewer bees as there was less nectar (and gained 1 mark), many were unable to go on to explain the consequences of this; less pollination of flowers resulting in less seed produced, leading to further decline in the number of wildflowers in future years, leading to further decline in number of bees.

There was also credit for considering effects on other plants pollinated by bees, effects on genetic diversity and effects on predators of bees.

There were four marks for Q11(c)(ii).

There was a very wide spread of marks for Q11(c); of the six marks available, around a quarter of candidates scored 0 or 1, around a quarter scored 2 marks, around a quarter scored 3 marks and around a quarter scored 4 – 6 marks.

(c) (i) Bees feed on nectar in flowers.

The mean mass of nectar sugar produced per square metre of lawn was calculated for 2019 and 2020.

Scientists then calculated the mean number of bees per square metre that could be supported by the nectar.

The table shows the data.

2019		2020	
Mean mass of nectar sugar / mg m <sup>-2</sup>	Mean number of bees supported per m <sup>2</sup>	Mean mass of nectar sugar / mg m <sup>-2</sup>	Mean number of bees supported per m <sup>2</sup>
41912	3.8	38885	2.7

Calculate the mean number of bees supported per square metre of lawn in 2020.

(2)



	-/	 /
Answer	C	 

3-8- 1.1- 2.7

(ii) Bees are important pollinators of a variety of plants.

Explain the possible short-term **and** long-term consequences of the decline in flowers of wild plant species in lawns in 2020.

(4)

his (and vesult elvease In a d pres (er lung te rangert de en (UU d cong ton a short bees

Results Plus Examiner Comments

This candidate scored one mark for the calculation in Q11(c)(i).

Although the final answer was incorrect, they got a mark for the interim step 41912 divided by 38885 = 1.08

Their answer to Q11(c)(ii) also scored 1 mark, mark point 4 for decline of wildflowers.

Not mark point 1 as they did not link the decrease of bees to a lack of food, and not mark point 5 as they did not describe the effect on the reproduction of bees, simply saying it had an effect.

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41912	3.8	38885	

Calculate the mean number of bees supported per square metre of lawn in 2020. (2)0.0000090666 11029.473. 38865 1102a.473 3.5. Answer

(ii) Bees are important pollinators of a variety of plants.

Explain the possible short-term **and** long-term consequences of the decline in flowers of wild plant species in lawns in 2020.

(4) Food for ferre would be bees changes could bees behaviou course In agi bar more poid of will lang there O time SC less The bees a of food Jack For them sehavious ges ih would an be of term sno due the Jach Food 10 100 DRE Feed ho ha Good Atle wit



This candidate scored 2 marks for a correct answer in Q11(c)(i).

In Q11(c)(ii), they scored mark point 1 but did not go on to think about the consequences of there being fewer bees, so did not gain any more marks.

(c) (i) Bees feed on nectar in flowers.

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41912	3.8	38 885	

Calculate the mean number of bees supported per square metre of lawn in 2020.

	41912	_	11070 . 4 111	(2)
	3.8	-	10 CM ng of nector needed to	
*	<b>\$</b>		support thea	

	3.5
Answer	C. C

(ii) Bees are important pollinators of a variety of plants.

Explain the possible short-term **and** long-term consequences of the decline in flowers of wild plant species in lawns in 2020.

(4)short term consequence is that men mass of the re less flower ireases as the de Reek d the msas as s 5 pollins tion 45 ot the. his. decreases deccase the So wa America 20 number the must so the Nes rely on bees for pollisation may consectition Jur adv Xs. rated els. his may acing the prod



This candidate achieved both marks for a correct answer in Q11(c)(i).

They gave a strong answer to Q11(c)(ii).

They worked methodically through the sequence of events, achieving mark point 1 on lines 1 – 3, mark point 3 on lines 4 – 6, mark point 4 on lines 7 – 8 and mark point 5 on line 8. Credit was not given for extinction.

Overall this answer got full marks with 2 marks for Q11(c)(i) and 4 marks for Q11(c)(ii).

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41912	3.8	38885	

Calculate the mean number of bees supported per square metre of lawn in 2020.

$$1bcc = 11029.5$$
  
 $38885 \div V = 3.525$ 

Answer 3.5

(2)
(ii) Bees are important pollinators of a variety of plants.

Explain the possible short-term **and** long-term consequences of the decline in flowers of wild plant species in lawns in 2020.

(4)

Sochterm - mary bees would die I population would duore due to the backos nicka to support them - reducing good gor birds - causing their population Edulme two. lorg trens - store populators would decreas then are sme bees Epollerate then - in two causing besieves less bacs and birds - hus as count on entire good chain -as well as human 4 sod 5 such as have



(c) (i) Bees feed on nectar in flowers.

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41912	3.8	38885	

Calculate the mean number of bees supported per square metre of lawn in 2020.

41912 =	sugar 1m2 mg xm2 = 9000 m2 total.	(2)
1422-4.8868	3.8×197. = 0.722	
	3.8-0.727 = 3.078	

54

Answer 3.018 3.5

262034 41912: 3.8 38885: 5.520 (ii) Bees are important pollinators of a variety of plants.

Explain the possible short-term **and** long-term consequences of the decline in flowers of wild plant species in lawns in 2020.

(4)

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been which routs in reducing population do been in curring. This thinkore
names for supply of animals and Lives that feed on been therefore reducing
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as many flowering presents vely an tres to policient the files praints with reducing
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seeds produced which notices the genetic diversity is their wild flower populations that
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I recorrier allelles causing as higher rive of genetic chicases within wild flower
Dar 13 (Chionas .



In Q11(c)(i) they got two marks for a correct answer.

In Q11(c)(ii) they produced a very strong answer covering four of the marking points.

Mark point 1 on lines 1 – 2, mark point 7 on lines 2 – 4, mark point 4 and 3 on lines 5 – 8.

They also referred to genetic diversity of wildflowers decreasing which was the alternative mark point 4.

Overall, full marks for this question.

## **Paper Summary**

Based on their performance on this paper, candidates should:

- Be familiar with the command words used in this specification and make sure that your answers reflect the information required. The words justify, discuss and evaluate cause particular difficulties for some candidates.
- Always show working in calculations and set out this working clearly this can help you get marks if the final answer is wrong.
- Make sure, if you are asked to give an answer to a particular number of significant figures or decimal places, that you do this.
- Make sure that you know how to write a null hypothesis, and that you can analyse the results of a stats test as well as carrying out the calculation of the test value.
- Ensure that where lists of differences are required, you always give them in matching pairs, eg A has a nucleus but B does not.
- Know the key points of all the core practicals and be prepared to explain the reasons for the steps.

## **Grade boundaries**

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

https://qualifications.pearson.com/en/support/support-topics/results-certification/gradeboundaries.html

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