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Examiners' Report
June 2023

GCE Biology A 9BN0 01

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June 2023

Publications Code 9BN0_01_2306_ER

Introduction

Overall this paper gave candidates the opportunity to display their knowledge. The majority of candidates were able to score at least one mark on most of the questions. There was a full range of marks, allowing for stronger candidates to show their depth of knowledge.

Many candidates were able to use key terminology correctly but this is an area centres may want to stress. Most candidates had good knowledge of the core practicals. Many would benefit from more practice at applying this knowledge in unfamiliar situations.

Level based questions will always require candidates to incorporate more than one piece of information in their answers, which may be presented in a variety of ways. It is important to include all of the information given.

Question 1 (b)(i)

This question asked candidates to describe the process of electrophoresis. There were many good answers using the correct terminology. Some candidates started their response with a description of PCR, which did not answer the question and did not gain any marks. Most candidates then went on to gain marks with a correct description, but time was wasted.

(b) A fossil bone discovered in China is thought to be from a new species, *Homo longi*.

(i) Samples of DNA from this bone and bones from other *Homo* species can be amplified using PCR.

Describe how these amplified samples of DNA can be prepared for analysis using gel electrophoresis.

(3)

- Restriction enzymes are used to cut genes of DNA samples
- DNA is amplified using polymerase chain reaction.*
- DNA samples are added to DNA wells in agragose gel.
- An electric current is applied to gel, DNA travels towards anode.
- DNA is sorted in bp size order
- electrophoresis is run until DNA is shown as ladders.

* PCR is prepared by Primers, restriction enzymes, free nucleotides and taq polymerase added to test tubes. With DNA sample.
Sample heated to 95°C to break hydrogen bonds then cooled to 55°C to allow DNA primers to bind.
Then heated to 72°C to allow ~~transcription~~ taq polymerase to replicate. Process repeated ~~30~~ 50-70 times.

ResultsPlus
Examiner Comments

This response gains 3 marks for a clear description of gel electrophoresis, with a good use of correct terminology.

The details of PCR do not answer the question and use up valuable time.

ResultsPlus
Examiner Tip

Always read the question carefully and make sure you select the correct information.

Question 1 (b)(ii)

Most candidates recognised that there is a greater similarity in banding if species are closely related, but not all candidates explained what the differences were.

(ii) Explain how the results of this analysis would show whether *Homo longi* is closely related to other *Homo* species.

(2)

- The bands of Homo longi could be compared with other to Homo species.
- The more bands which match (DNA fragments which travelled the same distance), the more closely related they are.

ResultsPlus
Examiner Comments

This response gains 2 marks.

Bands travelling the same distance equates to position of the bands.

ResultsPlus
Examiner Tip

Try to use correct terminology in your responses.

(ii) Explain how the results of this analysis would show whether *Homo longi* is closely related to other *Homo* species.

(2)

~~This~~ The different bands on the DNA profile can be compared. ~~How~~ Their position, size and the ~~same~~ number of bands can be ~~compared~~ compared. The more similar the bands, the more closely related the species are.

ResultsPlus
Examiner Comments

This gains 2 marks for a clear explanation of how to use the analysis.

Question 2 (b)(i)

Most candidates were able to fill in the table correctly.

(b) Brown Moss is a site of special scientific interest. It is an area containing shallow ponds, inhabited by birds and rare plants.

The biodiversity of plants growing in two ponds, A and B, at Brown Moss was studied. The table includes data collected from the two ponds.

	Species	Number (n) in pond A	n(n–1) for pond A	Number (n) in pond B	n(n–1) for pond B
1	*Azolla filiculoides*	5	20	0	0
2	*Lemna minuta*	29	812	0	0
3	*Lemna trisulca*	50	2450	0	0
4	*Alisma plantago-aquatica*	2	2	0	0
5	*Alopecurus aequalis*	11	110	0	0
6	*Carex pseudocyperus*	2	2	0	0
7	*Equisetum fluviatile*	0	0	71	4970
8	*Juncus effusus*	0	0	60	3540
9	*Menyanthes trifoliata*	16	240	0	0
10	*Polygonum amphibium*	0	0	25	600
11	*Ranunculus circinatus*	13	156	0	0
12	*Sparganium erectum*	3	6	0	0
13	*Typha latifolia*	5	20	0	0
	Total	136	~~8360~~ 3818	156	9110

(i) Complete the table for pond A giving the value for n(n–1) for *Ranunculus circinatus* and give the totals.

ResultsPlus
Examiner Comments

All parts of the table were completed correctly.

(b) Brown Moss is a site of special scientific interest. It is an area containing shallow ponds, inhabited by birds and rare plants.

The biodiversity of plants growing in two ponds, A and B, at Brown Moss was studied. The table includes data collected from the two ponds.

Species	Number (n) in pond A	n(n–1) for pond A	Number (n) in pond B	n(n–1) for pond B
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Ranunculus circinatus	13	156	0	0
Sparganium erectum	3	6	0	0
Typha latifolia	5	20	0	0
Total	136	3818	156	9110

(i) Complete the table for pond A giving the value for n(n–1) for *Ranunculus circinatus* and give the totals.

ResultsPlus
Examiner Comments

The table is correctly filled in.

Question 2 (b)(ii)

This question required candidates to substitute numbers into the equation for diversity. Marks were lost by using the wrong denominator.

(ii) Calculate the index of diversity for pond B using the formula

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

70 + 60 + 25 = 156

(2)

$D = \frac{(156 \times 155)}{(71 \times 70) + (60 \times 59) + (25 \times 24)} = 2.65$

$D = \frac{(156 \times 155)}{9110 \times 9109} = 2.91 \times 10^{-4}$

Answer 2.65

ResultsPlus
Examiner Comments

Numbers are correctly substituted into the equation and diversity calculated.

ResultsPlus
Examiner Tip

You will always be given the equation for this type of question. Make sure that you use the correct numbers.

(ii) Calculate the index of diversity for pond B using the formula

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

$$= \frac{156(156-1)}{9110} = \frac{24180}{9110}$$

$$= 2.654226125$$

(2)

Answer 2.65 (3sf)

ResultsPlus
Examiner Comments

A correct calculation of diversity.

Question 2 (b)(iii)

Candidates were asked to comment on the differences in biodiversity between the two ponds. Most gained one mark for stating the difference. Many candidates were able to link this to survival but few went on to comment on the need for adaptation, or to link the numbers of individuals in pond B with the lack of competition.

(iii) Pond B is close to a farm and some houses.

Chemicals and waste from the farm and houses have increased the levels of pollutants in pond B.

The biodiversity index for pond A is 4.81.

Comment on the effect of pollutants on the biodiversity of pond B.

(3)

The biodiversity of pond B will be lower than pond A, Due to chemicals (pollutants) which are toxic to some species, therefore reducing the number of species in pond B which reduces overall biodiversity.

ResultsPlus
Examiner Comments

2 marks awarded, for stating that biodiversity in B is lower because the polluting chemicals may be toxic.

(iii) Pond B is close to a farm and some houses.

Chemicals and waste from the farm and houses have increased the levels of pollutants in pond B.

The biodiversity index for pond A is 4.81.

Comment on the effect of pollutants on the biodiversity of pond B.

(3)

Biodiversity Index in pond B is much lower than pond A. The pollutants has meant that few species can survive in the conditions. Only 3 out of 13 species have survived in the conditions. This is because pond water may have higher pH or CO_2 levels. The few living species however have had huge increase in population size compared to pond A.

ResultsPlus
Examiner Comments

This gained 2 marks for stating that biodiversity is lower in B therefore few species can survive.

Although it states that there are large numbers of the species present in B, it is not linked to a lack of competition so this mark is not awarded.

ResultsPlus
Examiner Tip

Always think about the command word for a question and make sure that your answer recognises this.

Question 3 (a)

Most candidates were able to answer this question, although some only gained one mark because they did not name the nitrogenous bases.

3 The genetic information for a cell is stored in the DNA.

(a) Describe the structure of a DNA mononucleotide.

A DNA mononucleotide is made up of a phosphate group, containing a base nitrogen and a pentose sugar - The sugar is deoxyribose. (2)

ResultsPlus
Examiner Comments

This response gains 1 mark for describing a mononucleotide but it does not name the nitrogenous bases.

ResultsPlus
Examiner Tip

Give as much relevant information as possible in your answer.

3 The genetic information for a cell is stored in the DNA.

(a) Describe the structure of a DNA mononucleotide.

(2)

DNA consists of a deoxy ribose sugar which is joined to a phosphate group ~~from~~ with phosphodiester bonds. The sugar also has Hydrogen bonds with nitrogenous bases like Thymine, Guanine, cytosine, ~~Thymine~~ Adenine. ~~Thymine~~ Adenine and Guanine are Purines and Cytosine and ~~Adenine~~ Thymine are Pyrimidines.

ResultsPlus
Examiner Comments

A good description of the structure of a mononucleotide gaining 2 marks.

Question 3 (b)(ii)

Most candidates were able to describe DNA replication. Marks were lost where only one DNA strand was used as a template or the role of the enzymes was confused.

(ii) Describe how DNA is replicated.

(4)

- helicase enzyme Breaks hydrogen bonds Between the complementary bases in the DNA double helix
- Strands are separated
- Free DNA nucleotides are activated By an addition of phosphate
- They align next to the template and lagging strand
- Complementary base pairing occurs between the DNA nucleotides and DNA strands
- DNA polymerase joins up the DNA nucleotides, forming phosphodiester bonds, making replicated strands

ResultsPlus
Examiner Comments

This response gained full marks for clearly explaining the process of DNA replication.

ResultsPlus
Examiner Tip

Always use correct terminology and make sure that you know the names and roles of all the enzymes.

(ii) Describe how DNA is replicated. (4)

First the hydrogen bonds between the two (helicase)
strands of DNA in the double helix break. This
causes the DNA to unzip and unwind.
Free DNA nucleotides complementary base pair
with with the each strand.
DNA polymerase allows phosphodiester bonds to be
formed between the phosphate and deoxyribose
sugar of each nucleotide.
This creates two new DNA helixes, both with
one new strand of DNA and one original strand.
This is semi-conservative replication.

ResultsPlus
Examiner Comments

A clear answer gaining 4 marks.

It is clear that both strands of the DNA form new DNA molecules. The enzymes are named correctly.

Question 4 (a)(ii)

Most candidates were able to describe some of the steps in this core practical. Heating and the use of hydrochloric acid were often omitted. Not all candidates were able to correctly identify the stain.

(ii) Describe how other plant tissues can be prepared to find out if the cells are undergoing mitosis.

(3)

Cut part of the root tip off with a scalpel. Submerge root tip in 60°C HCL and dye with ~~toluidine~~ toluidine blue to allow the cell to be visable. Squash root tip on a slide with a slide cover and observe through a microscope

ResultsPlus
Examiner Comments

This candidate gained full marks for correctly listing all the steps in this core practical.

ResultsPlus
Examiner Tip

Make sure you know the different stains used in each of the practicals you have completed.

Also make sure you are familiar with all of the core practicals.

(ii) Describe how other plant tissues can be prepared to find out if the cells are undergoing mitosis.

(3)

First cut of 5mm from the bottom of the root (growing region). Put the root in 5cm^3 hydrochloric acid ~~and put it~~ in a test tube and put in a water bath for 10minutes at 60°C. Take the test tube out and pour away acid. Place root tip on a watch glass and rinse with water then remove excess water with filter paper. Transfer to a microscope slide and add two drops of acetic orcein stain and leave for 10minutes to stain the structures. Next squash the root to make a single layer of cells for light to pass through, so it can be observed under a microscope.

ResultsPlus
Examiner Comments

A clear description of all the steps in the practical.

Question 4 (b)

A few candidates described interphase but most were able to describe the events of prophase.

(b) Describe what happens inside a cell during prophase of mitosis.

(4)

The chromosomes will condense and become visible under a light microscope. The nuclear membrane breaks down. & centrioles will go to opposite ends of the cell and spindle forms for chromosomes to attach to in metaphase.

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Examiner Comments

This answer gains 4 marks for correctly describing metaphase, using correct terminology.

(b) Describe what happens inside a cell during prophase of mitosis.

(4)

the chromosomes condense, getting shorter and fatter. Tiny bundles of protein move to opposite sides of the cell creating a ~~spindle~~ network of protein fibres called Spindle. Centricle is formed and the envelope (nuclear) breaks down so the chromosomes are free in the cytoplasm.

ResultsPlus
Examiner Comments

This response gains 3 marks for stating that the chromosomes condense, the spindle forms and the nuclear envelope breaks down.

Although centrioles are mentioned, the context is wrong.

ResultsPlus
Examiner Tip

Make sure you use correct terminology in the right context.

Question 5 (a)(i)

Most candidates knew that the seeds were dried and kept in cold conditions, although some candidates lost a mark by referring to cool rather than cold seeds are stored at – 20.

Few candidates referred to cleaning the seeds. Many candidates described the process of testing for germination, which is not linked to preservation.

5 Many plants are known to have medicinal properties and are used in traditional medicines. These plants are often endangered.

A drug to treat breast cancer has been extracted from *Taxus brevifolia*, the Pacific yew tree.

(a) Seeds from endangered plants are placed in seed banks to conserve the species.

(i) Describe how the seeds are preserved for long periods of time in a seed bank.

(3)

- The seeds are kept in cold enviroments (usually well below 0°c) to keep them from germinating.
- They are washed and dried to get rid of any bacteria which could kill the seed
- They are stored in dry, dark conditions to stop moisture or sunlight getting to the seed

ResultsPlus
Examiner Comments

This response gains 3 marks for correctly stating that the seeds are washed and then stored in cold and dry conditions.

5 Many plants are known to have medicinal properties and are used in traditional medicines. These plants are often endangered.

A drug to treat breast cancer has been extracted from *Taxus brevifolia*, the Pacific yew tree.

(a) Seeds from endangered plants are placed in seed banks to conserve the species.

(i) Describe how the seeds are preserved for long periods of time in a seed bank.

(3)

Seeds are disinfected and dried to prevent germination Seeds are stored in cold conditions to increase their lifespan Seeds are X-rayed frequently to check for viability.

ResultsPlus
Examiner Comments

3 marks for stating that the seeds are disinfected, dried and kept in cold conditions.

Information about checking viability is not relevant to the question.

Question 5 (a)(ii)

Many candidates recognised the link to genetic diversity and some were able to link this to survival or adaptation.

Some candidates did not read the question properly and explained the advantages of seed banks in general or of having a large number of seeds.

(ii) Seed banks obtain seeds collected from a number of plants of each species.

Explain the advantages of this for the conservation of a plant species.

(2)

ensures genetic ~~variety~~ variation, also helpful if a certain speacs is endangerd, it will be kept safe so it does not become extinct. Also ensures speaes variation. Different Species can be Used to manifacture different drugs also.

ResultsPlus
Examiner Comments

This gains 2 marks for ensuring genetic variation and preventing extinction.

ResultsPlus
Examiner Tip

Always read the question carefully and identify the key points.

(ii) Seed banks obtain seeds collected from a number of plants of each species. The seeds can stay there

Explain the advantages of this for the conservation of a plant species.

(2)

This increases the genetic diversity as different plant seeds will have different alleles for genes and so there will be an increased gene pool and more variation within the plant species when the seeds are planted. This means the plant species will be more able to adapt and evolve in responce to changing environments and will be less likely to become endangered and go extinct.

ResultsPlus
Examiner Comments

This response correctly explains that genetic diversity is increased, allowing adaptation in response to a changing environment. It gains a maximum of 2 marks.

Question 5 (b)(ii)

Most candidates were able to describe stage 1 of clinical testing, but many were confused about stages 2 and 3. Some candidates lost a mark by describing animal testing as a stage in clinical trials.

Question 5 (c)

This is an explain question. The conditions preventing infections are acidity in the gut and the presence of gut flora. To gain 2 marks there must be a condition described followed by an explanation.

Marks were lost for a lack of accuracy – it is the stomach that is acidic, not the whole gut.

(c) The gut has barriers to prevent pathogens entering the body.

Explain the role of conditions in the gut in preventing infection by microorganisms.

(2)

- The gut contains flora. Flora compete with infecting microbes for nutrients/ space.
- Conditions for flora may be maintained by high temperatures/moisture.
- HCl in the stomach provides acid conditions, preventing infections reaching lungs

(Total for Question 5 = 11 marks)

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Examiner Comments

This response gained 1 mark. Both conditions are described but there isn't an explanation for either.

Question 6 (b)(i)

There were some good responses to this question but marks were lost due to lack of detail, or a failure to make a link between the structure and the uptake of oxygen.

(b) Shrews are very small mammals that maintain a body temperature of 40 °C.

They require a good supply of oxygen as they lose heat rapidly.

(i) Explain how the structure of their lungs enables shrews to get oxygen into the body rapidly.

(4)

- many alveoli increase surface area for rapid gas exchange
- thin alveolar & capillary walls allow for short diffusion distance for oxygen, allowing rapid oxygen intake
- good supply of blood means levels of oxygen reaching alveoli are high
- steep concentration gradient is maintained, allowing for rapid gas exchange.

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Examiner Comments

This gained 3 marks for linking alveoli to an increased surface area for gas exchange, the thin walls of the alveoli and the short diffusion distance.

The mark for maintaining the concentration gradient was not awarded because it wasn't linked to the capillary network.

ResultsPlus
Examiner Tip

Make sure your answers are precise and accurate.

(b) Shrews are very small mammals that maintain a body temperature of 40 °C.

They require a good supply of oxygen as they lose heat rapidly.

(i) Explain how the structure of their lungs enables shrews to get oxygen into the body rapidly.

(4)

They have many alveoli which is also folded increasing surface area for diffusion.
Their lungs also has constant ventilation to ~~increase~~ maintain a steep concentration gradient of oxygen between the lungs and capillaries.
The walls of alveoli & capillaries are only one cell thick to reduce the diffusion pathway.
Additionally, there is a dense capillary network surrounding ~~outside~~ the alveoli reducing diffusion pathway & maintaining a steep concentration gradient.
This all increases the rate of diffusion of oxygen into the blood as so more oxygen available in the blood to circulate the body.

ResultsPlus
Examiner Comments

A well-constructed answer gaining 4 marks for linking the alveoli to surface area and diffusion, thin walls of the alveoli, reducing the diffusion pathway and the capillary network maintaining the concentration gradient.

Question 6 (b)(ii)

This question on evolution was not answered as well as may be expected. Marks were lost because the answers were generic and not put in the context of the question.

(ii) Some species of shrew have evolved to feed on insects found in cold water streams. They are semi-aquatic, spending part of their lives diving in water and part of the time living on land.

These shrews have large concentrations of the protein myoglobin in their muscles.

Myoglobin stores oxygen, which can be released for aerobic respiration during a dive.

The myoglobin in these shrews has a different, tertiary structure than in other species of shrew. This allows larger quantities of myoglobin to be stored in their muscles.

Describe how these species of semi-aquatic shrew may have evolved.

(4)

A random mutation could have caused some individuals to have the gene coding for the different tertiary structure of myoglobin. This gives them a selective advantage due to selection pressures - they have more oxygen stored so can dive for longer and eat more insects. This means that these individuals are more likely to survive and reproduce, passing on the advantageous allele to their offspring, who are also able to do the same. Over time, this becomes more common as the allele freqeuncy increases in the gene pool, and so the species has evolved.

The new species is unable to interbreed and produce fertile offspring with other species.

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Examiner Comments

This response gained full marks. It correctly identified that the mutation changed the structure of the myoglobin, enabling the shrews to dive for longer. These shrews were more likely to survive and reproduce, passing on the advantageous allele.

The answer was in the context of the question.

(ii) Some species of shrew have evolved to feed on insects found in cold water streams. They are semi-aquatic, spending part of their lives diving in water and part of the time living on land.

These shrews have large concentrations of the protein myoglobin in their muscles.

Myoglobin stores oxygen, which can be released for aerobic respiration during a dive.

The myoglobin in these shrews has a different, tertiary structure than in other species of shrew. This allows larger quantities of myoglobin to be stored in their muscles.

Describe how these species of semi-aquatic shrew may have evolved.

(4)

- Natural disaster or selection pressure may have split a population of shrews, geographical isolation
- One of the two populations ~~to~~ inhabit new area by cold water streams whilst other population remains in similar ~~of~~ same habitat
- Different selection pressures and environments in different habitats so natural selection occurs seperately in both populations, reproductive isolation and reduced gene flow
- Of population by cold water streams shrews with allele ~~which~~ ~~mutation~~ which meant they could hunt in the water, so cold swim or due to water or not afraid of water, (behavioural adaptation) could survive as water streams only place food was available, this is a selection pressure
- Those with allele ~~mutation~~ which lead to the adaptation (successful adaptation) survived to breed and reproduce and pass on allele, ~~mutation~~ and adaptation to offspring so they could live and swim as well
- Frequency of ~~allele~~ ~~adaptation~~ ~~increased~~ allele leading to adaptation will have increased over time
- ~~Species were~~ → New species formed as now genetically distinct and cannot interbreed to

ResultsPlus
Examiner Comments

This response was awarded 4 marks for identifying the selection pressure of lack of food, the ability of these shrews to obtain food from the water, increasing the chance of surviving to reproduce and pass on the advantageous allele.

The comments about geographical isolation were not relevant to the question.

ResultsPlus
Examiner Tip

Always identify the context when answering questions on evolution. Generic answers are unlikely to gain full marks.

Question 6 (b)(iii)

Many candidates missed the reference to the triplet code, which is the first step in the process of a change in the base sequence. Most candidates recognised that there is a change in the sequence of amino acids.

(iii) **Explain why a change in the base sequence of the gene coding for myoglobin could change its tertiary structure.**

(3)

* A change in the DNA ~~base sequence~~ triplet would could result in a change in the codon of the mRNA transcribed from the gene
* This codon could therefore code for a different amino acid
* Therefore, during translation, a polypeptide would form with a different amino acid sequence
* Therefore, different bonds would form between R groups changing how the polypeptide folds, thus changing the tertiary structure of Myoglobin.

(Total for Question 6 = 12 marks)

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Examiner Comments

This gained 3 marks for the change in the triplet code, a change in the amino acid sequence and a change in the formation of bonds.

(iii) Explain why a change in the base sequence of the gene coding for myoglobin could change its tertiary structure.

(3)

A change in the base sequence causes the triplet to change and causes a different amino acid to be coded for, which has a different R group, and this leads to different bonds forming which causes myoglobin to fold differently, which causes a change in the primary structure and causes myoglobin structure to change and to be more compact so more myoglobin can be stored so more oxygen can be stored.

(Total for Question 6 = 12 marks)

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Examiner Comments

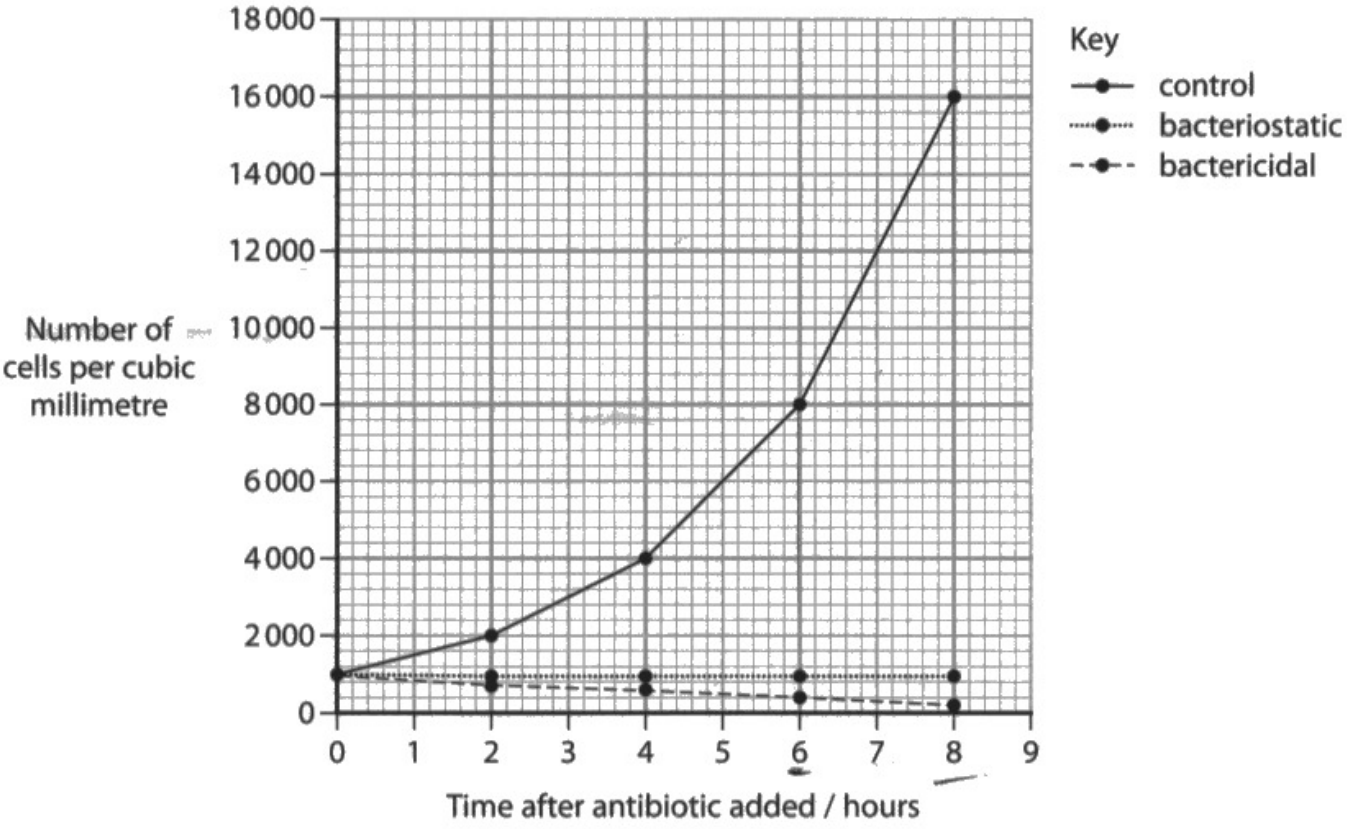
A well-constructed answer explaining the change in the triplet code, a different sequence of amino acids, a change in the formation of bonds.

Question 7 (b)(i)

Candidates were asked to state what is meant by the term bactericidal antibiotic. They were required to state that the bacteria were killed, not just describe the possible effects on the cell wall or cell lysis.

(b) Some bacteria are pathogenic. Bacteriostatic and bactericidal antibiotics are drugs used to treat diseases caused by bacteria.

The graph shows the effects of two types of antibiotic on the growth of bacteria. The control line shows the growth of bacteria with no antibiotic present.



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

(1)

an antibiotic that kills bacteria possibly by cell lysis

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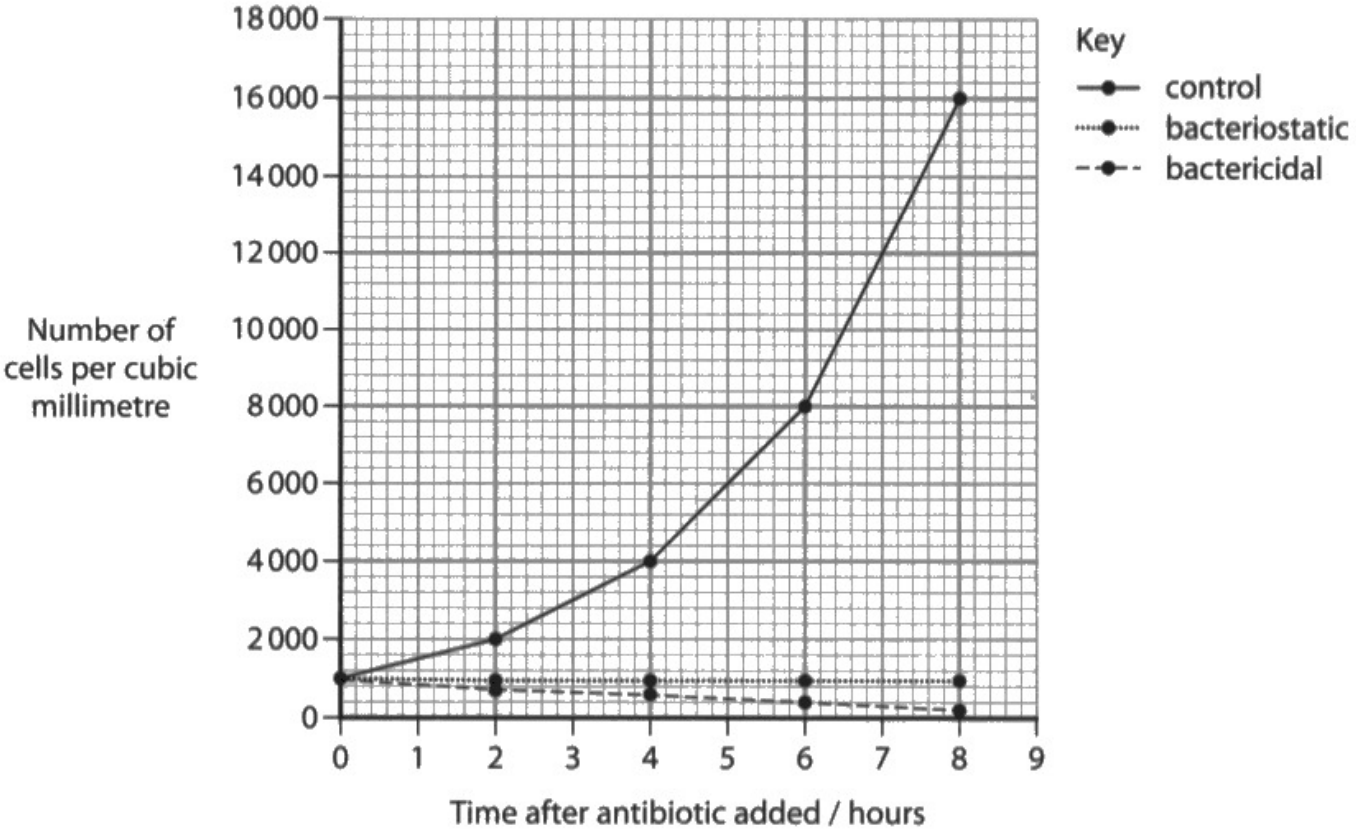
Examiner Comments

Mark awarded for killing bacteria.

(b) Some bacteria are pathogenic. Bacteriostatic and bactericidal antibiotics are drugs used to treat diseases caused by bacteria.

The graph shows the effects of two types of antibiotic on the growth of bacteria. The control line shows the growth of bacteria with no antibiotic present.



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

(1)

This is when the antibiotics kill the bacteria by causing them to burst open.

ResultsPlus
Examiner Comments

Mark awarded for killing the bacteria. Cell lysis alone would not gain the mark.

Question 7 (b)(ii)

This calculation question asked for the answer in standard form. Many candidates were able to carry out the calculation and convert it to standard form, but lost marks because they didn't give the units.

(ii) Calculate the mean rate of increase in the number of bacteria in the control from 6 to 8 hours.

Give your answer in **standard form**.

(2)

16 000

8000

8000 per 2 hrs

4×10^{-3} mm / hour

$+4 \times 10^{3}$ mm / hour

Answer [illegible]

ResultsPlus
Examiner Comments

A correct answer, with units, gaining 2 marks.

ResultsPlus
Examiner Tip

Always give the units for a calculation, even if not specifically asked for.

(ii) Calculate the mean rate of increase in the number of bacteria in the control from 6 to 8 hours.

Give your answer in **standard form.**

(2)

$16,000 - 8,000 = 8000$

$\text{rate} = \frac{\Delta y}{\Delta x} = \frac{8000}{2} = 4000$

$4 \times 10^3 \text{ mm}^3 \text{ hour}^{-1}$

Answer $4 \times 10^3 \text{ mm}^3 \text{ hour}^{-1}$

ResultsPlus
Examiner Comments

A correct answer, with units, gaining 2 marks.

Question 7 (b)(iii)

Candidates were asked to explain the role of the inflammatory response. Many candidates gave a detailed account. Marks were lost for lack of specific detail, eg linking dilation to the wrong blood vessels.

Some candidates incorrectly described the specific immune response.

(iii) Symptoms of bacterial infection include fever and inflammation.

Explain the role of the inflammatory response in protecting the body from bacterial infection.

(4)

The inflammatory response begins with the release of histamine by infected cells, which results in dilation of arterioles. This increases blood flow to the site of infection which increases the number of white blood cells in the area to fight the infection, and there are more macrophages to engulf bacteria. The capillaries become leaky, so more blood plasma containing white blood cells reach the infected cell, so the infection is controlled around the area and prevents spread of the bacterial infection around the body by killing the bacteria at the site of infection. The site of inflammation can be hot, and increased temperatures can prevent the enzymes of bacteria from working and cause denaturation.

ResultsPlus Examiner Comments

This gains 4 marks for the release of histamine, dilation of the arterioles, increasing blood flow, increasing white blood cells in the site of infection.

(iii) Symptoms of bacterial infection include fever and inflammation.

Explain the role of the inflammatory response in protecting the body from bacterial infection.

(4)

when a part of the body becomes infected it releases histamines that trigger an increase of ~~pla~~ blood flow towards the infected site and capillaries become more permiable so that white blood cells and plasma seep into the infected site to destroy the pathogen thus causing swelling

ResultsPlus
Examiner Comments

A concise answer awarded 4 marks for release of histamine, increase in blood flow, permeability of the capillaries and more white blood cells at the infected site.

ResultsPlus
Examiner Tip

Use correct and accurate terminology to gain full marks.

Question 7 (c)

This is a level based question using information given about antibiotic resistance linked to hospital practices from own knowledge. Each level has to be achieved before moving on to the next level, and this requires both parts of the question to be answered. There were some detailed descriptions about the mechanisms of antibiotic resistance, but many candidates were limited to 3 marks because they only described one hospital practice, linked to the use of antibiotics. Some candidates thought the drugs could be modified to overcome resistance. Some candidates confused the action of antibiotics with the specific immune response.

Discuss the mechanisms bacteria have developed to become resistant to antibiotics and the codes of practice used to overcome this resistance.

(6)

- The reasons for why bacterial resistance arises within human individuals is because when the doctor gives an individual a prescription and medicine for a certain amount of time the patient doesn't finish the course and stops allowing it to once they feel better, however this causes the bacteria to become resistant to the antibiotic - so that person has to be kept in isolation so they don't infect others with this resistant strain of bacteria while scientists find a cure for it. Bacteria reproduce very rapidly so during the time that patient doesn't take the medicines prescribed, the bacteria reproduce rapidly and this allows for mutation for in the bacteria and even after patients take the drug again, all the non-resistant bacteria will die leaving the resistant ones to reproduce rapidly causing the individual to feel unwell progressively. Bacterial mechanisms include destroying the antibiotic so it can no longer work by creating enzymes that destroy the drug such as penicillin. another way is by adapting the structure such as cell wall permeability by which bacteria prevents drugs from taking effect on the bacteria, or by producing pumps that remove the drug from inside the cell or by changing shape of the receptor so antibiotic can't bind to it in the first place. These all all examples of how bacteria can mutate to become resistant to antibiotics - these people with resistant bacteria are asked if they have come into contact with anyone and they are all isolated to prevent spread of the resistant bacteria.

- patients must ensure full course of medication is taken and they isolate themselves until illness has gone.

ResultsPlus
Examiner Comments

This is a Level 3 response, 5 marks. Two hospital practices are described and two mechanism of resistance, with a description of how resistance evolves (Level 2). An explanation of how completing antibiotics reduces resistance is Level 3.

Discuss the mechanisms bacteria have developed to become resistant to antibiotics and the codes of practice used to overcome this resistance.

(6)

One mechanism is to destroy the antibiotic, enzymes secreted by the bacterial cell which destroy the antibiotic, this affects both bacteriostatic & bactericidal antibiotics. and ~~to overcome this resistance~~ Mechanism causing a decrease in antibiotic uptake, so fewer antibiotics able to enter bacteria cell so ~~bacteria~~ bacteria can only be broken down by bactericidal antibiotics which destroy the cell wall, as bacteriostatic antibiotics require entering the bacteria cell. Pumps in the cell membrane to remove toxins means that toxins released by antibiotic are quickly removed from bacteria cell therefore does not destroy the bacteria. Mutations in binding site means antibiotic cannot bind therefore cannot destroy ~~cell~~ bacteria cell. These methods of resistance have evolved due to natural selection, as random mutations in bacterial DNA mean the bacteria possess those characteristics and therefore survive. Bacteria can transfer genetic material horizontally through plasmids. Methods to ~~avoid~~ overcome the resistance are using different types of antibiotic in combination to target infection. Only using narrow spectrum antibiotics to treat infections. Not prescribing antibiotics for non-serious infection. Isolating infected patients in hospitals to prevent horizontal gene transfer of bacteria

(Total for Question 7 = 14 marks)

ResultsPlus
Examiner Comments

This is a clear answer with all components of Level 2 and an explanation of the spread of resistance through plasmids. It gains Level 3 – 5 marks.

ResultsPlus
Examiner Tip

Level based questions require the synthesis of two or more pieces of information in a novel situation. Make sure that you use all the information given and apply your own knowledge to answer the question.

Question 8 (c)(i)

This question asked candidates to explain why the increase in greenhouse gases is linked to a decrease in seagrass. Many candidates started with an unnecessary explanation of the greenhouse effect. Most candidates recognised that this led to an increase in water temperature, although some lost marks by referring to a general increase in temperature. Many candidates knew that the acidity of the oceans is increasing, although not always why.

(c) Seagrass cannot survive if the water becomes warmer or more acidic.

Seagrass in the Mediterranean Sea has declined by 34% in the last 50 years.

(i) Explain why the increase in greenhouse gases is leading to a decrease in the growth of seagrass.

(3)

Greenhouse gasses such as carbon dioxide trap infrared radiation as heat, heating up the atmosphere. This will heat the water which will cause the enzymes in the seagrass to denature, causing much of it to die. The increase in CO_2 will also make the water more acidic as more CO_2 will dissolve into the water. This will cause even more seagrass to die.

ResultsPlus
Examiner Comments

3 marks for increased temperature causing denaturing of enzymes, an increase in acidity of the water due to carbon dioxide dissolving.

(c) Seagrass cannot survive if the water becomes warmer or more acidic.

Seagrass in the Mediterranean Sea has declined by 34% in the last 50 years.

(i) Explain why the increase in greenhouse gases is leading to a decrease in the growth of seagrass.

(3)

Due to an increase in carbon dioxide. Carbon dioxide is dissolved in the sea making the sea more acidic. Increase in greenhouse gases causes an increase in the earth's mean surface temperature. This warms up the sea therefore seagrass can no longer survive

ResultsPlus
Examiner Comments

A clear answer gaining 3 marks for an increase in carbon dioxide dissolving in the sea, making it more acidic, an increase in temperature warming the sea.

ResultsPlus
Examiner Tip

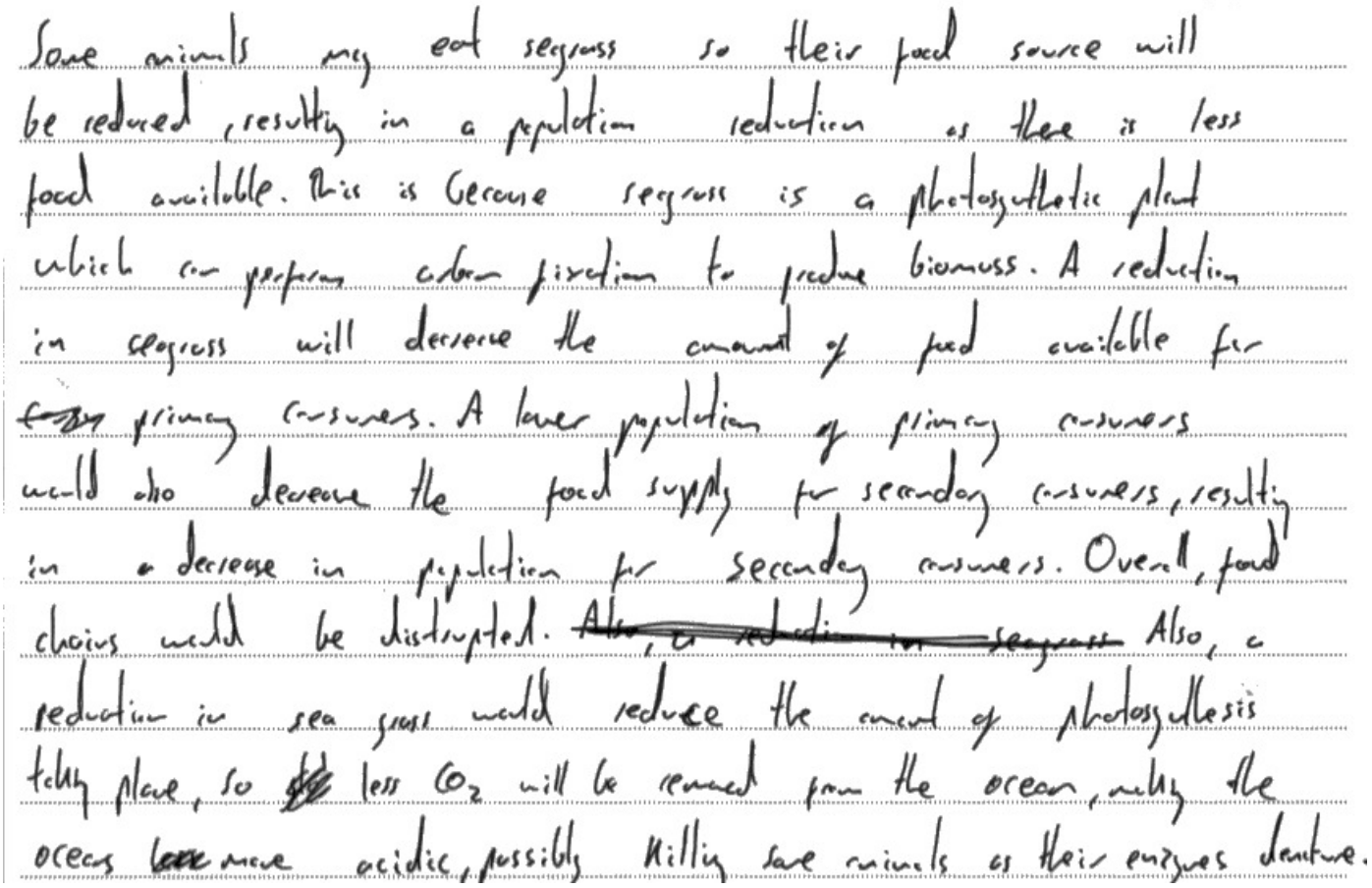
Try not to include information not linked to answering the question. You won't lose marks, but it may take up valuable time.

Question 8 (c)(ii)

This question asked candidates to discuss the effects of a reduction in seagrass on the animal population. Most candidates recognised that there would be a reduction in animal numbers due to less food, but very few made the link to respiration or oxygen levels.

(ii) Discuss the possible effects of a reduction in seagrass on animals living in the Mediterranean Sea.

(4)


Some animals may eat seagrass so their food source will be reduced, resulting in a population reduction as there is less food available. This is because seagrass is a photosynthetic plant which can perform carbon fixation to produce biomass. A reduction in seagrass will decrease the amount of food available for ~~f~~ primary consumers. A lower population of primary consumers would also decrease the food supply for secondary consumers, resulting in a decrease in population for secondary consumers. Overall, food chains would be disrupted. ~~Also, a reduction in seagrass~~ Also, a reduction in sea grass would reduce the amount of photosynthesis taking place, so ~~less~~ less CO_2 will be removed from the ocean, making the oceans ~~less~~ more acidic, possibly killing some animals as their enzymes denature.

ResultsPlus
Examiner Comments

This was awarded 4 marks for recognising a decrease in the number of animals due to less food for primary consumers. Less photosynthesis reduces food availability, with an impact on the food chain.

(ii) Discuss the possible effects of a reduction in seagrass on animals living in the Mediterranean Sea.

(4)

- Will affect the food chain
- seagrass are a producer that sea organisms rely on as their source of food
- less seagrass equals less food for organisms which leads to ↓ in life as less survive
- fewer primary consumers = fewer secondary consumers as less food sources and ↑ competition
- ↓ biodiversity and species richness
- less biomass ∴ lower NPP overall

ResultsPlus
Examiner Comments

3 marks awarded for a reduction in animals, due to a reduction in food availability having an impact on the food chain.

ResultsPlus
Examiner Tip

Try to include all aspects of the effects of a reduction in seagrass. The reduction in photosynthesis would have a major impact.

Question 8 (c)(iii)

This question asked candidates to explain why healthy seagrass reduces the release of carbon dioxide. Most candidates made the link with photosynthesis but few went on to refer to the effects of decomposition or identify seagrass as a carbon sink.

(iii) Seagrass is long-living and more resistant to breakdown by microorganisms than plants living in the rainforest.

Explain why maintaining a healthy population of seagrass reduces the release of carbon dioxide into the atmosphere.

(3)

- sea grass acts as a carbon sink, lots of will remove CO_2 from the atmosphere for carbon fixation in the light independent reaction of photosynthesis (Calvin cycle) thus reducing levels of CO_2 in atmosphere over a long period of time. by hydrolysis,
- As its more resistant to breakdown by microorganisms, less respiration of microorganisms will occur, as they will not be able to break down/digest the grass into small soluble organic molecules like glucose to use for respiration, therefore due to less decomposition and less (aerobic) respiration less CO_2 will be released into atmosphere; as more microorganisms might try release CO_2. Sea grass will not decay as easily.

ResultsPlus
Examiner Comments

This well-written answer clearly explains that seagrass is a carbon sink, carbon dioxide is taken up in photosynthesis and less respiration by microorganisms reduces release of carbon dioxide.

(iii) Seagrass is long-living and more resistant to breakdown by microorganisms than plants living in the rainforest.

Explain why maintaining a healthy population of seagrass reduces the release of carbon dioxide into the atmosphere.

(3)

As seagrass is a carbon sink, it stores carbon dioxide from the atmosphere. This means that a bigger population of seagrass will store a larger amount of carbon dioxide. Seagrass also undergoes photosynthesis, so removes carbon dioxide from the atmosphere and replaces it with oxygen. This means that a larger population of seagrass means more carbon dioxide removed from the atmosphere via photosynthesis in a given time.

ResultsPlus
Examiner Comments

This response gains 2 marks for stating that seagrass is a carbon sink that takes carbon dioxide from the atmosphere for photosynthesis.

ResultsPlus
Examiner Tip

Make sure you use the terms carbon and carbon dioxide correctly. They are not interchangeable.

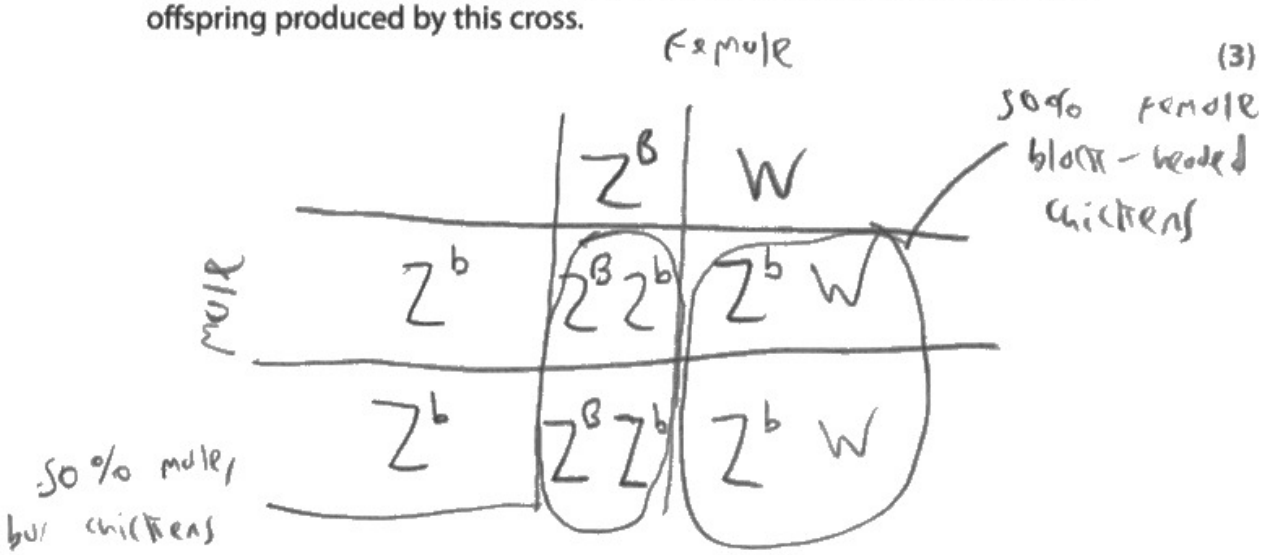
Question 9 (a)(ii)

Many candidates were able to draw a Punnett square to show this sex-linked cross. Marks were lost if the phenotypes were not stated. Some candidates did not realise that there are no alleles for head colour on the W chromosome.

(ii) A bar-headed female chicken was crossed with a black-headed male chicken.

Draw a genetic diagram to show the genotypes and phenotypes of the offspring produced by this cross.

(3)



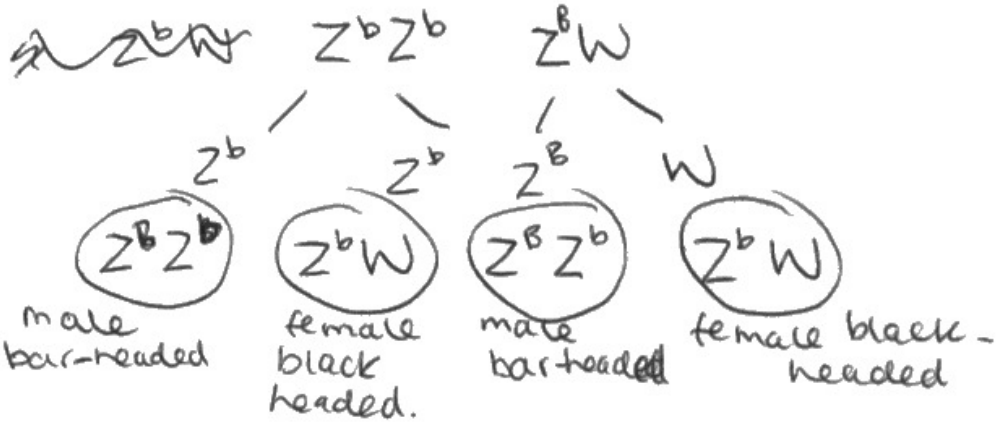
ResultsPlus
Examiner Comments

This response gained all 3 marks.

(ii) A bar-headed female chicken was crossed with a black-headed male chicken.

Draw a genetic diagram to show the genotypes and phenotypes of the offspring produced by this cross.

(3)



ResultsPlus
Examiner Comments

This response used a different format to gain 3 marks.

ResultsPlus
Examiner Tip

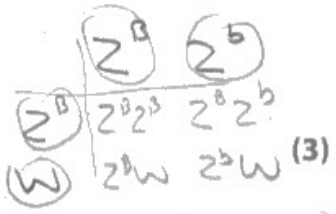
Remember to give all aspects of the phenotype when answering a question on genetic crosses.

Question 9 (a)(iii)

This question asked candidates to deduce why a particular cross would produce both bar-headed and black-headed females. Candidates found it difficult to describe why this would happen. Many of the candidates who did score used Punnett square to demonstrate the cross.

(iii) Male chickens produced by this cross were crossed with a bar-headed female chicken.

Deduce why this cross will produce both bar-headed and black-headed females.



(3)

The male chickens ~~crossed~~ crossed with the bar-headed females would be heterozygous. This means there is 25% chance to produce a bar-headed female and 25% chance to produce a black-headed female.

ResultsPlus
Examiner Comments

This response gained 2 marks. The fact that the male is heterozygous was clearly stated and the Punnett square demonstrates how the alleles are inherited by the female.

(iii) Male chickens produced by this cross were crossed with a bar-headed female chicken.

Deduce why this cross will produce both bar-headed and black-headed females.

(3)

	Z^B	Z^b
Z^B	$Z^B Z^B$	$Z^B Z^b$
W	$Z^B W$ ← bar headed female	$Z^b W$ ← black headed female

- females cannot innent the Z^B allele from the mother
- the father has the alleles coding for bar headed and black headed (heterozygote for the alleles gene).
- females get W allele from mother and either Z^B (bar) or Z^b from father.

ResultsPlus
Examiner Comments

This response gains 2 marks. The text explains that the male is heterozygous and the female will inherit B or b from the male. This is reinforced by the Punnett square.

Question 9 (b)

This question about gene expression is linked to modification of RNA. Some candidates confused this with mutation or methylation of DNA, but many were able to explain the role of introns and exons.

(b) Gene expression leads to the synthesis of proteins that give rise to the phenotype.

Describe how one gene can give rise to more than one protein.

(3)

Pre-mRNA contains introns & exons. Introns ~~& sem~~ are removed & exons are spliced together. This leads to more than 1 mRNA forming which can be translated to produce more than 1 protein.

ResultsPlus
Examiner Comments

This response was awarded 3 marks for explaining that introns are removed leading to more than one mRNA. It correctly states that translation produces more than one protein.

(b) Gene expression leads to the synthesis of proteins that give rise to the phenotype.

Describe how one gene can give rise to more than one protein.

(3)

Between transcription and translation mRNA splicing occurs which allows one gene to code for multiple proteins. The mRNA strand produced on transcription is spliced using restriction enzymes. This removes introns and leaves the exons to be reassembled ~~on~~ into their original order or different combinations to be used. Therefore one gene can be used to code for multiple proteins as the reassembled exons are then translated in the cytoplasm.

(Total for Question 9 = 10 marks)

ResultsPlus
Examiner Comments

3 marks awarded here for removal of introns, different orders of exons and translation into multiple proteins.

Question 10 (a)

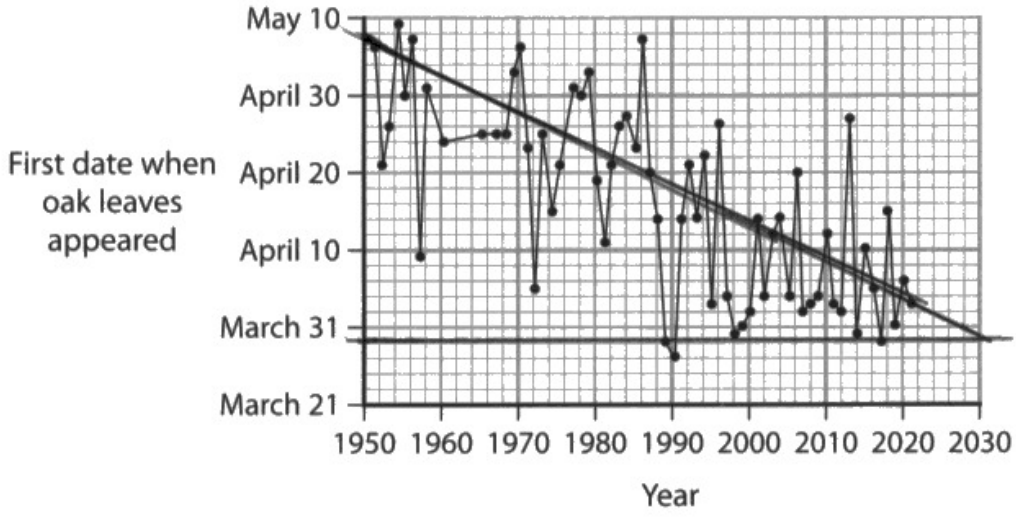
Most candidates correctly drew a trend line and read the correct date off the graph.

10 The average spring temperature in the UK has increased by 0.5 °C from 1995 to 2014. This is due to climate change.

This has affected plants and the insects that feed on them.

(a) Many butterfly species depend on oak trees.
The larvae feed on the young leaves in spring.

The graph shows the date when oak leaves first appeared on one tree between the years 1950 and 2021.



Draw a trend line to predict when oak leaves will first appear in the year 2030.

(2)

Date March 28th

ResultsPlus
Examiner Comments

2 marks awarded.

10 The average spring temperature in the UK has increased by 0.5 °C from 1995 to 2014. This is due to climate change.

This has affected plants and the insects that feed on them.

(a) Many butterfly species depend on oak trees.
The larvae feed on the young leaves in spring.

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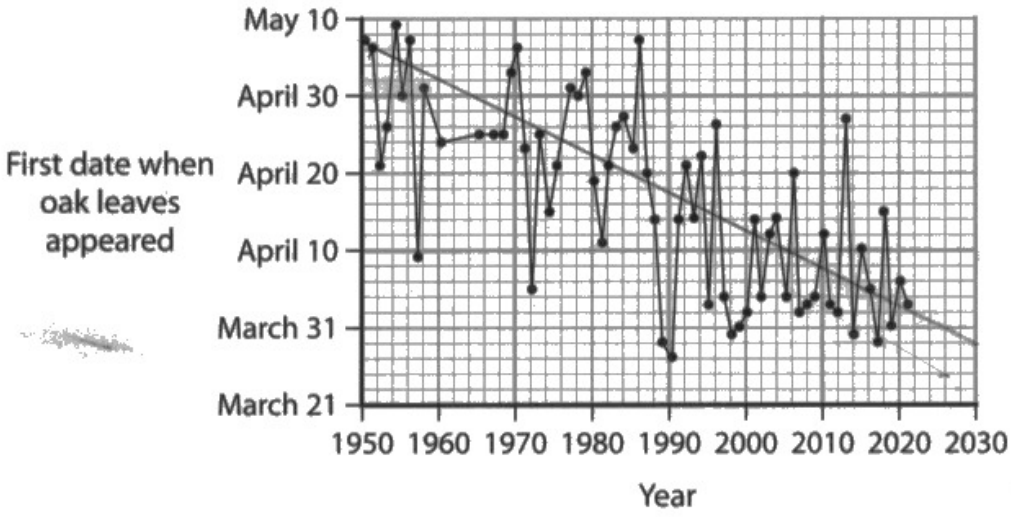


Draw a trend line to predict when oak leaves will first appear in the year 2030.

(2)

Date March 29

ResultsPlus
Examiner Comments

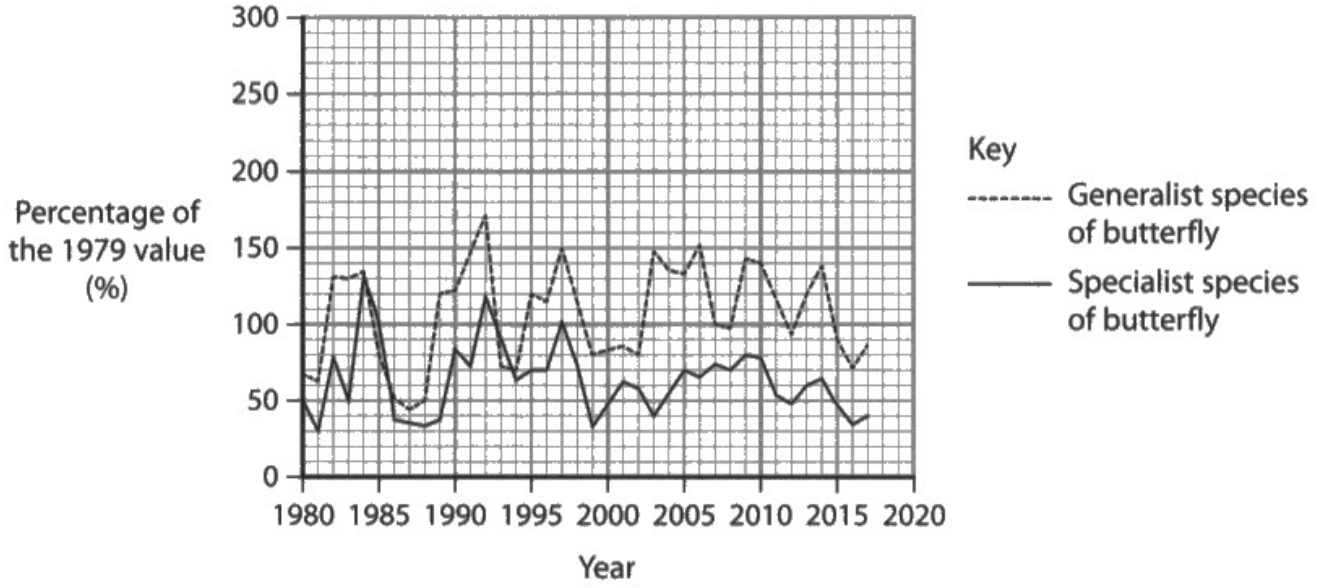
2 marks awarded.

Question 10 (b)

This question asked candidates to explain why a specialist species of butterfly may find it more difficult to adapt to changes in spring temperatures. Many candidates recognised that there would be a lack of food as they only feed on one species. Some candidates stated that there would be more competition but did not say it would be interspecific. The word adapt in the question led some candidates to talk about natural selection.

(b) Specialist butterfly species feed on only one plant species. Generalist butterfly species feed on a range of plant species.

The graph shows the changes in the population sizes of the two types of butterfly from 1980 to 2017.



Explain why specialist butterfly species may find it more difficult to adapt to the changes in spring temperatures.

(3)

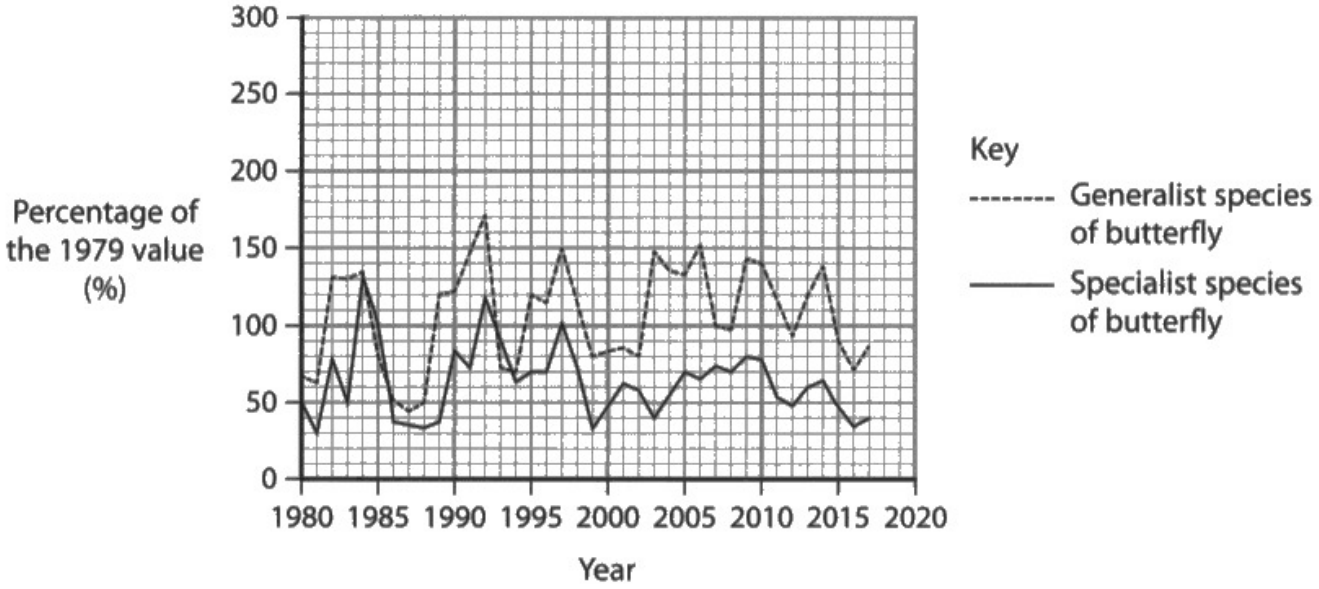
The rising spring temperature may cause ~~some plant~~ aspect the life cycles/distribution of some plant species, making them unavailable at the time when the specialist butterfly species would usually feed on them. As they only feed on one plant species, if that plant species is unavailable, their only source of food is gone.

ResultsPlus
Examiner Comments

This answer clearly explains that the plant may not be available at the right time for the specialist butterfly. As it only feeds on one plant, there would be a shortage of food.

(b) Specialist butterfly species feed on only one plant species. Generalist butterfly species feed on a range of plant species.

The graph shows the changes in the population sizes of the two types of butterfly from 1980 to 2017.



Explain why specialist butterfly species may find it more difficult to adapt to the changes in spring temperatures.

(3)

as specialist butterfly species only feed on one plant species, if ~~they~~ that plant species in less available ~~or hasn't~~ it means they are less likely to be able to ~~do~~ eat enough food to survive. As spring temperatures increased, leaves on oaks appearing earlier & lifecycle of Specicelist butterflies may no longer align with timings of ~~just~~ leaves in Spring. Specialised butterflies may not reproduce ~~not come out of cocoon~~ in time ^ for larvae to feed on leaves, therefore young larvae have no food source, so will not survive.

As generalist feed on a range of plant species, able to obtain food from other sources if lifecycle does not align with leaves production of one plant species, so able to survive.

ResultsPlus
Examiner Comments

This gains 3 marks for explaining that as the butterfly only feeds on one type of food, they may not have enough to eat. There is a clear explanation of the effect of early appearance of oak leaves on the larvae, and that generalist butterflies are more likely to find another source of food.

Question 10 (c)(i)

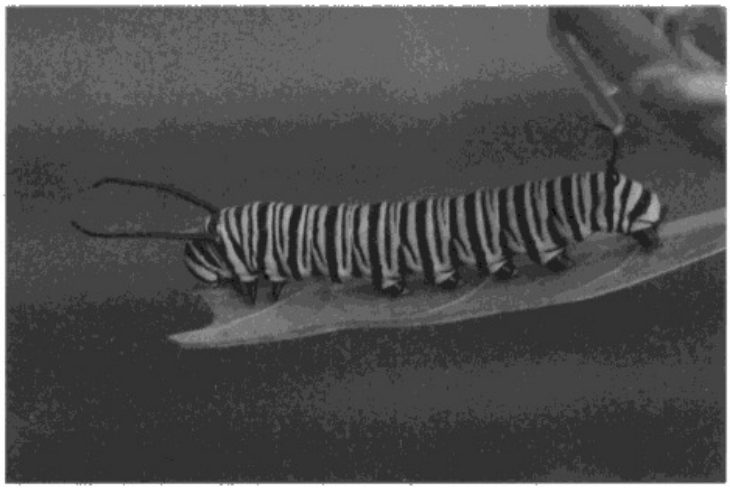
This question required candidates to make the link between an increase in temperature and the rate of enzyme action. Marks were lost because the increase in kinetic energy was not linked to the enzymes. Many candidates recognised that there were more enzyme-substrate collisions but they did not say they were more frequent, therefore losing the mark.

(c) The effect of the rise in spring temperature on the life cycle of butterflies was studied.

These insects have a typical life cycle of four stages:

egg, larva, pupa and adult.

The photograph shows a butterfly larva (caterpillar) feeding on a leaf.



(i) Explain why an increase in environmental temperature may lead to a shorter life cycle.

(2)

Increased temperature increases metabolic reactions as enzyme activity is increased, due to enzymes increasing in kinetic energy and more frequent successful collisions happening, hence reaction rates are catalysed more and so increased. This means they grow into an adult quicker than in lower temperatures.

ResultsPlus
Examiner Comments

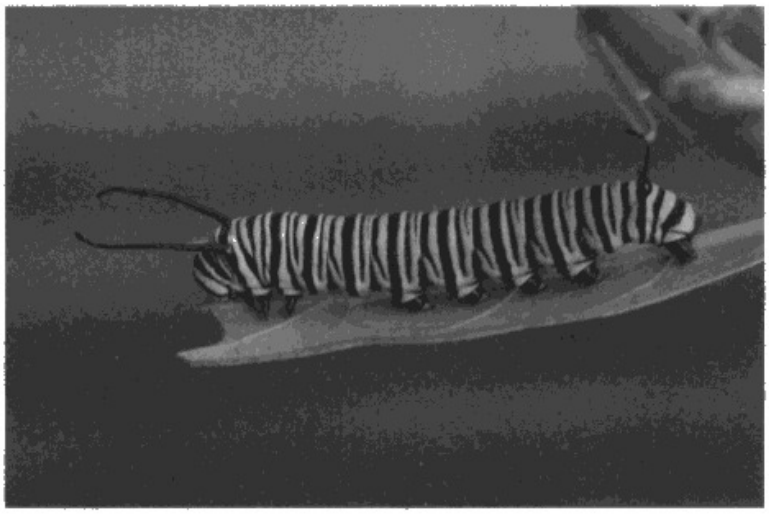
This response gains a maximum of 2 marks for referring to metabolic reactions, explaining that the enzymes have more kinetic energy leading to more frequent successful collisions.

(c) The effect of the rise in spring temperature on the life cycle of butterflies was studied.

These insects have a typical life cycle of four stages:

egg, larva, pupa and adult.

The photograph shows a butterfly larva (caterpillar) feeding on a leaf.



(Source: © dossyl/Shutterstock)

(i) Explain why an increase in environmental temperature may lead to a shorter life cycle.

(2)

Increase in environmental temperature increase kinetic energy of particles, more frequent enzyme substrate complexes form increase rate of metabolic reactions leading to a short life cycle.

ResultsPlus
Examiner Comments

2 marks awarded for more frequent formation of enzyme-substrate complexes and an increase in metabolic reactions.

Question 10 (c)(ii)

This is a level based question asking candidates to devise an experiment to study the effect of temperature on the duration of the larval stage. It requires modification of a core practical. Many candidates achieved Level 2 but some were limited to Level 1 by missing out basic steps in the design of any investigation, eg carrying out repeats. Those candidates that carried out repeats often did not go on to calculate the mean or didn't state the range of temperatures to be used.

*(ii) Devise a laboratory investigation to study the effect of temperature on the duration of the larval stage in a specialist butterfly species.

(6)

Set up 6 different incubators, of temperatures 5°C, 10°C, 15°C, 20°C, 25°C and 30°C. Each incubator should contain the same mass of soil of the same pH and water content. Each incubator should also contain 12 leaves of the same size from the same tree, as a food source for the caterpillars. four caterpillar eggs of the ~~sp~~ same specialist butterfly species should be placed in each incubator. when the eggs hatch in each incubator, a stopclock should be started, and the time and date of the hatching noted down. A camera should be recording the incubators to observe the larvae development constantly. The time should be noted when the larvae in each temperature condition start to show signs of becoming pupa. A mean larval stage duration should be calculated for each incubation temperature. A statistical test can be carried out on the data to determine whether the difference in temperature had a significant effect on the duration of the larval stage in this specialist species.

ResultsPlus
Examiner Comments

This response gives a suitable range of 6 temperatures with repeats at each temperature. Several variables are controlled and there are repeats at each temperature, used to calculate the mean. A camera is used to monitor the length of the larval stage. All of Level 1 and Level 2 are achieved. It clearly states that the time measured is from egg hatching to formation of the pupa, Level 3, but does not gain both marks for Level 3 as although there is reference to a statistical test, it is not named.

5 marks awarded.

*(ii) Devise a laboratory investigation to study the effect of temperature on the duration of the larval stage in a specialist butterfly species.

(6)

take several butterfly eggs (e.g. 20) and place them in an enclosed area at a known temperature. (e.g. 28°C) when the eggs hatch into larvae, measure the length of time the larvae remain larvae before moving onto the next stage (pupa). Repeat this experiment at different temperatures (e.g. 15°, 20°, 25°, 30°, 35°) At the end of the ~~result~~ experiment, calculate the means for all the durations at each temperature and use the t-test to determine if there is a significant difference between the results that allow the rejection of the null hypothesis that temperature does not affect the duration of the larvae ~~species~~ stage in a specialist butterfly species. Control variables include; using the same species of specialist butterfly, keeping the environments identical (e.g. same light intensity, plants/food sources, humidity) apart from temperature.

ResultsPlus
Examiner Comments

A suitable range of 5 temperatures, 20 eggs at each temperature (repeats), used to calculate a mean. Measuring the time spent in the larval stage achieves all of Level 1 and Level 2. It is clear that the time is measured from hatching of eggs to formation of the pupa (Level 3). Although a T-test is carried out, this is not the correct statistical test so it does not gain the mark.

5 marks awarded.

ResultsPlus
Examiner Tip

A level based question about a practical will be based on a core practical but will always be in a different situation. Start by identifying the core practical then use the information you are given to modify the practical appropriately.

Always include all of the basic steps, eg repeats to calculate the mean.

Paper Summary

Based on their performance on this paper, candidates should:

- Read the question carefully and consider the information required to construct your answer.
- Make sure you know the definition of all the key terms in the specification.
- Ensure your answer is specific and includes sufficient detail.
- Be aware of all the command words used on the exam paper and use them to construct your answer.
- Use the correct terminology in your answers.

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