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Examiners' Report
June 2017

GCE Biology 9BN0 03

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Introduction

This paper has one feature in common with the 6BI05 paper from the previous specification, in that approximately one third of the marks are linked to material in the pre-released scientific article. However, the rest of the 9BN0/03 question paper is different in nature – any of the 8 topics studied may be assessed, frequently in synoptic questions that may draw on two or more different topics.

The paper will include questions that target the conceptual and theoretical understanding of experimental methods, including mathematical analysis of experimental data.

The types of question are also different in that there is a greater requirement to apply knowledge and understanding in the context of qualitative and quantitative data provided. A new 9-mark question has been introduced to assess the ability of candidates to relate their knowledge and understanding of a range of topics to a specific aspect of biology, and in this year's exam the context was the relative importance of phospholipids and proteins in the cell surface membrane.

There were some excellent answers to many of the questions and many candidates seemed to cope well with the demands of the first of the linear assessments for the reformed A-level Biology.

Successful candidates:

- demonstrated a familiarity with practical work and could devise investigations based on procedures they had carried out themselves;
- had studied the pre-released scientific article and read up on the aspects of biology within the article that they had encountered in their A-level Biology course;
- answered questions in the context set, showing that they had read the question;
- had learnt how to interpret the newly introduced command words – such as 'determine', 'devise' and 'evaluate';
- provided specific, relevant details to their answers;
- attempted every question;
- worked through calculations in a logical sequence, showing their working;
- demonstrated the ability to convert units and orders of magnitude.

Less successful candidates:

- re-wrote information from the question, using up time and space;
- did not answer questions in context, missing both the command word and the context;
- did not understand how to interpret the command words and therefore misinterpreted questions;
- left out vital details or wrote vague answers lacking relevant facts;
- did not attempt some questions – some answer spaces were left blank;
- made errors in calculations by not checking significant figures or the numbers in the data already provided;
- did not write clearly or legibly: there were occasions where marks have been lost due to indecipherable handwriting;
- wrote answers with poor grammatical construction that lost marks where the meaning was unclear.

Implications for future teaching, learning and exam preparation – ensure that students carry out all of the core practicals and are involved in planning the procedures where there are variables that can be controlled or taken into account as well as evaluation of the results. Statistical analysis of data collected will allow students to become familiar with the reasons for selecting and using particular tests and how the results can be interpreted. The pre-released scientific article has to be studied well, in advance of the examination – however, regular reading of articles from scientific journals and magazines will help students become familiar with how the style of writing differs from that in text books or revision guides.

Question 1 (a)

This question asked candidates to describe an advantage and a disadvantage of using ropes made from plant fibres.

There were many good answers ranging across all possible ways of getting the marks, with candidates slightly more likely to get a mark for describing an advantage than for a disadvantage. Reference to the plant fibres being 'sustainable' or 'renewable' was the most common advantage described. Quite a few candidates thought it was a disadvantage that the fields used to grow plants for ropes could not be used to grow food crops and that that would lead to food shortages. Others referred to plastics being cheaper or plant fibres being carbon neutral. Other marks lost were because candidates described properties that were not applicable to ropes or their use - for example referring to biofuel production.

1 Plant fibres and oil-based plastics have both been used to make ropes.

(a) Describe one advantage and one disadvantage of using ropes made from plant fibres rather than ropes made from oil-based plastics.

(fats)

(2)

one advantage of using ropes made from plant fibres rather than oil based plastic is that it is biodegradeable meaning it can benefit the enviroment

one disadvantage of using ropes made from plant fibres rather than oil based plastic is that ~~it~~ they ropes are not as strong and will break more easily

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Examiner Comments

A good answer gaining 2/2 marks. One mark for the advantage being the biodegradable nature of the fibres and the disadvantage being that ropes would be less strong.

This answer only achieved 1/2 – for the advantage of biodegradability.

1 Plant fibres and oil-based plastics have both been used to make ropes.

(a) Describe one advantage and one disadvantage of using ropes made from plant fibres rather than ropes made from oil-based plastics.

(2)

Plant fibres are biodegradeable where as oil-based plastics aren't hence using plant fibres for constructing ropes is more environmentally sustainable and does not contribute to long term problems, e.g. climate change.

ResultsPlus

Examiner Comments

If a question asks for **one** advantage and **one** disadvantage - try to think of one of each to get full marks.

Question 1 (b)

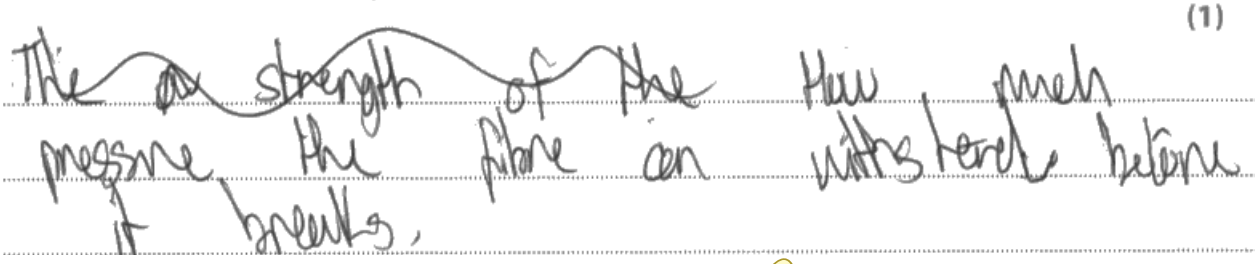
This question basically asked for a definition of tensile strength, in the context of rope. The ideal answer would refer to 'the measurement of the force required to pull something such as rope to the point where it breaks'; however, as the question was set in the context of rope and of the core practical, testing plant fibres, the mark scheme did allow for mass as well as weight or force, because candidates may have been more familiar with recording the mass required to break the plant fibres being tested.

Many candidates did not use the correct scientific terms that were acceptable for this question, instead often referring to pressure. Many definitions lacked detail and did not refer to the breaking point, and as a result failed to gain the mark.

(b) Ropes used in climbing need to have high tensile strength.

State what is meant by the term **tensile strength**.

(1)



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Examiner Comments

This was given 0/1 - if the word 'pressure' had been replaced with 'force' it would have been a very good answer.

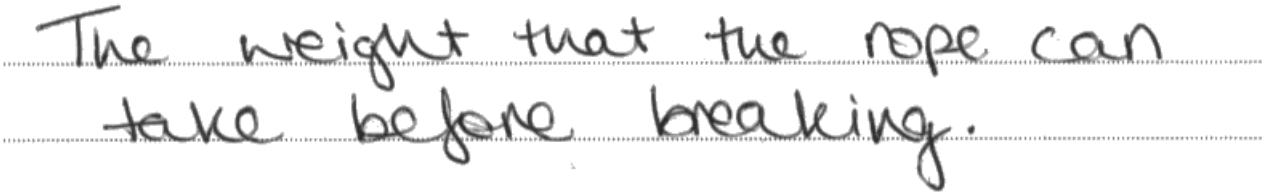
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Examiner Tip

Take care with use of technical vocabulary. Pressure does not test tensile strength.

(b) Ropes used in climbing need to have high tensile strength.

State what is meant by the term **tensile strength**.

(1)



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Examiner Comments

This answer gained 1/1 for reference to the weight that a rope can take before breaking.

Question 1 (c)

This question required the design of a valid investigation to determine the effect of storage temperature on tensile strength of rope.

There were many good, well thought out investigations that considered all aspects, including the independent and dependent variables. However, some candidates did not take into account the word 'storage' and described carrying out the experiment in different temperatures. Many varied both temperature and humidity, rather than picking out that the humidity should be controlled and kept at 60%. Many candidates gave an appropriate range of temperatures, either side of 18°C, but a few did not go above 18°C. Some students referred to keeping the fibres in a water bath; whilst this was not penalised in this question, students should be reminded to think of investigations from a practical viewpoint and make sure that the method they describe is realistic.

Many candidates considered controlled variables and referred to keeping the diameter of the rope the same but did not refer to the length. Meanwhile, some referred to using the same species of nylon rope!

It was evident from the answers seen which candidates had taken an active part in the core practical concerning testing of tensile strength. It is imperative that students do carry out the core practicals.

It is claimed that the ideal storage conditions for rope are 18 °C and 60% relative humidity.

Devise a valid investigation to determine the effect of storage temperature on the tensile strength of manila rope and nylon rope.

(4)

Set up 5 incubators of varying temperatures. This range should be 5°c, 12°c, 18°c, 30°c, 40°c.

Place one ~~fibre~~ manila rope and one nylon rope in each incubator for 24 hours.

ensure the age, diameter and moisture content is controlled.

Hang each ~~rope~~ rope up and place masses of 2g one at a time.

Record the mass added before each ~~fibre~~/rope broke.

Repeat these steps at each temperature to gain an average.

This will increase reliability.

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Examiner Comments

This response was given 3/4 marks. Marks were given for:

- a range of temperatures above and below 18°C;
- ropes kept at the different temperatures for 24 hours;
- masses added until rope broke.

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Examiner Tip

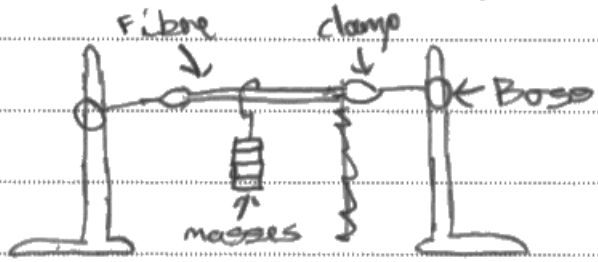
No mark for fibres being of the same diameter without mention of same length.

It is claimed that the ideal storage conditions for rope are 18 °C and 60% relative humidity.

Devise a valid investigation to determine the effect of storage temperature on the tensile strength of manila rope and nylon rope.

(4)

Take 5 fibres each of 5mm diameter, 5 manila, 5 Nylon
Place 1 fibre of each material in a storage area with
temperatures 10°, 12, 14, 16, 18, 20 °C
The humidity in the storage areas over is 60% in
all of them
Leave in these areas for a week
After a week remove the fibres
For each fibre set up as shown in diagram



Add 10g masses starting from 0 and record at
what mass the fibre breaks
IV = storage temperature DV = tensile strength
controlled variables = diameter of fibre, length of fibre,
humidity in storage

ResultsPlus
Examiner Comments

This response was given 4/4 marks. Marks were given in the following sequence:

- range of temperatures from 10 - 20°C;
- humidity of 60% in storage area;
- masses added until fibre broke;
- controlled variables described as diameter and length of fibre.

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Examiner Tip

A diagram can help make it clear what is being described and can also help the candidate to visualise the practical procedure, making it easier to then describe in words.

Question 1 (d)

This question tested knowledge of which tissues in a plant contain lignin and the position of these tissues in the stem. Many candidates correctly identified the tissues, but then went onto describe the location of lignin in those tissues, therefore not gaining any marks.

Many candidates knew that lignin is found in xylem and sclerenchyma, though phloem was also mentioned. There was a wide range of descriptions of its location with some very precise answers getting full marks, but vague references such as 'in the stem' or 'outer edge of stem' did not gain marks. Some answers were often lacking in detail and did not refer to vascular bundles. Many candidates also used vague terms like 'in front of', which is completely subjective and depends on the aspect of the viewer. Other candidates just went on to give functions of the xylem and/or sclerenchyma demonstrating the importance of reading questions carefully to ensure the response given is to the question being asked.

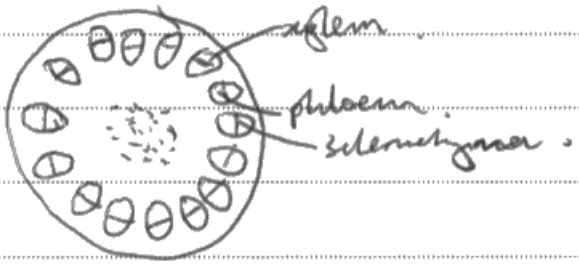
An accurately annotated diagram was given credit in this question - and it can help students if they do this to help describe biological structures.

(d) Tissues that contain lignin provide strength to plant fibres.

Describe the positions in the stem of those tissues that contain lignin.

(2)

Lignified tissues are typically found on the outermost rings of the stem, often in the xylem and in some sclerenchyma fibres. (walls of)



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Examiner Comments

This response gained 0/2 marks. Although there has been a valiant attempt at drawing a labelled diagram, the relative positions of the tissues labelled are unclear. There is also no mention of vascular bundles.

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Examiner Tip

If drawing a diagram, label it fully and make sure it is clear where the label lines are pointing. In this case drawing the vascular bundles slightly larger would have helped, especially if it was clear that the xylem was nearest the centre of the stem and not nearer the outer edge than the phloem.

(d) Tissues that contain lignin provide strength to plant fibres.

Describe the positions in the stem of those tissues that contain lignin.

(2)

Sclerenchyma tubes are positioned outside the phloem, so are the outermost part of the bundle. They are heavily lignified for strength. The xylem is the innermost part of the bundle inside from the phloem and contains lignin for waterproofing.

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Examiner Comments

This answer gained 1/2 for describing the location of the sclerenchyma as 'outside the phloem'. Although the candidate obviously knew the answer, they lost a mark by missing out the word 'vascular' in the phrase 'xylem is the innermost part of the bundle'.

ResultsPlus
Examiner Tip

Use vocabulary with care - learn the terminology. In plants the tissues are inside **vascular bundles**.

(d) Tissues that contain lignin provide strength to plant fibres.

Describe the positions in the stem of those tissues that contain lignin.

(2)

The tissues that contain lignin are the xylem and the sclerenchyma. They are found in vascular bundles in the stem. The xylem is in the innermost part of the stem, closest to the centre, whilst sclerenchyma are found on the outermost edges, next to the epidermis

(Total for Question 1 = 9 marks)

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Examiner Comments

This answer gained 2/2 marks. It is clear that the lignified tissues are correctly identified and their location in the vascular bundles is described with precision.

Question 2 (a)

This question was well answered by those candidates who took into account the context of the question.

However, it seemed that many candidates did not carefully consider the information given in the question as they were told that the women in the study had already given birth and were having pain after surgery. Very few candidates acknowledged this and made statements such as 'all women needed to be pregnant'.

A large number of responses seen referred to the 'randomness' without any selection and went on to refer to random number generators or pulling names from a hat. Even those who realised that they needed women who had undergone surgery often then went on to describe a sample which was very widespread, from all ages, ethnicities, lifestyles etc.

Furthermore, many candidates just seemed to pluck from their memories a learnt statement that 'random selection increases validity'. However, in the investigation described, random sampling would have caused there to be possible confounding variables that could greatly affect results

Yet again, context is the key.

(a) Describe how the 34 women were selected in stage 1 to ensure that this investigation was valid.

(2)

At random, by a generator, so no bias or invalidity could take place.

ResultsPlus
Examiner Comments

This gained 0/2 marks. This candidate has fallen back on the idea of random selection, without taking into account the context. For this investigation to be valid, the sample must not be random.

(a) Describe how the 34 women were selected in stage 1 to ensure that this investigation was valid.

(2)

Ensured they were the same age. Also made sure they had similar BMI's and were healthy individuals. This would prevent other factors affecting the result. A large sample size to avoid anomalies and make it more valid.

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Examiner Comments

This answer gained 1/2 for describing how the condition of the mothers would be taken into account by ensuring they were of the 'same age'.

(a) Describe how the 34 women were selected in stage 1 to ensure that this investigation was valid.

(2)

The women would be the same age and all had surgery to aid childbirth. They should have similar lifestyle factors, e.g. if they smoked.

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Examiner Comments

This answer gained 2/2 marks for describing the women as all being of the same age and also all having had surgery to aid childbirth.

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Examiner Tip

Remember the context - check back and make sure that the investigation referred to has been understood.

Question 2 (b)

This question asked candidates to explain the purpose of the TENS machine being used without pulses for group C.

On the whole, the majority of responses correctly identified C as a control; however, many answers were too vague about what it was being used to compare with for the second mark. A significant minority dismissed the results for group C as only the placebo effect, not recognising that they were relevant.

Some candidates simply repeated a generic, memorised definition of a control group and stated 'for comparison' without explaining that it was to compare with the other two groups.

Although indicative of sound revision, it is important that students take into account the context when writing down memorised definitions.

(b) Explain why group C was included in this investigation.

(2)

Group C is the control group so that results from A and B can be compared with group C to see significant differences.

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Examiner Comments

This gained 2/2 for understanding that group C acted as a control group - so that its results could be compared to the results of groups A and B.

(b) Explain why group C was included in this investigation.

(2)

Group C was a control. It is used as a comparison to check the level of pain with and without the TENS machine.

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Examiner Comments

This answer was given 1/2 marks for stating that group C was a control. Although there is mention of it being for comparison, the details are incorrect as C also involved the TENS machine being applied - but without pulses.

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Examiner Tip

Read through all the information provided to make sure context is addressed correctly.

Question 2 (c)

The command word for this question was 'determine'; in the specification it states that for this command word: "The answer must have an element which is **quantitative** from the stimulus provided, or must show how the answer can be reached quantitatively. To gain maximum marks there must be a **quantitative** element to the answer".

Most candidates got marks for describing the TENS machine as being effective at providing pain relief and that the high frequency was the most effective. Many answers also referred to the lack of overlap between before and after TENS in all cases and a significant number recognised the overlap of B with C.

It was good to see that candidates tried to manipulate the data provided to support their conclusions and not just quote figures directly from the graph. Many gained marks for correctly determining that the 4.8 reduction in pain was greater than the 2.3 reduction for the low frequency TENS (or 2.8 reduction in the control). However, some of those that did the calculation appeared to struggle with simple subtraction as the answers given were frequently incorrect.

However, it was disappointing to note that a large proportion of candidates could not correctly read the values off the bar graph, which is a skill that A-level students should have. Candidates should ensure they practise reading graphs as part of their exam preparation for data handling questions.

Determine the effectiveness of the use of a TENS machine in relieving pain following surgery.

(4)

the TENS machine is effective in relieving pain following the surgery. The higher the frequency of the TENS machine, the more relief from the pain. This is shown by Group A having a decrease of 4.8 in pain where as low frequency is 2.8 and control is 2.7. This shows it is effective as it reduces pain by 2.1 more than the control group. The range bars do not overlap for group A which further their effectiveness, however the bars for group B and C do overlap which suggests lower frequency pulses from the TENS machine does not have a significant effect, further proved by a 0.1 difference in pain.

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Examiner Comments

This response gained full marks - 4/4 as follows:

- TENS machine is effective in relieving pain;
- the higher the frequency the more relief from pain;
- group A had a decrease of **4.8** and the low frequency had a decrease of **2.8;**
- range bars overlap for groups B and C.

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Examiner Tip

Remember that **'determine'** as a command word requires an element of **quantitative** analysis. This means doing more than repeating numbers from tables or graphs. This example demonstrates how to achieve this - working out the decrease in pain for all three groups allows comparisons to be made to support the conclusion that A is most effective. A percentage decrease calculation would be another way of achieving this mark.

Determine the effectiveness of the use of a TENS machine in relieving pain following surgery.

(4)

The TENS machine is effective in relieving pain, especially at a high frequency of impulses. This group had the biggest reduction in mean pain level of 2.5 from 7.3. Low frequency of impulses also has an effect, although not as great as those in group A. Group C showed some reduction in mean pain level which suggests that it may not be the TENS machine that causes the reduction, it may be due to the placebo effect.

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Examiner Comments

This answer gained 2/4 marks. One mark was given for TENS being effective in relieving pain and one for group A having the biggest reduction in mean pain level.
The quantitative mark could not be given for just reading the figures from the bar chart - 2.5 and 7.3, and then not comparing the decrease in pain with one of the other groups. There is also no reference to results for B and C overlapping.

Question 2 (d)

This question asked for a description of the process at a synapse that leads to habituation. However, a large number of responses described the transmission of an impulse across a synapse, with a line or two squeezed in at the end describing what is different when habituation has occurred. By reading the question carefully, many candidates could have saved themselves time and space writing out unnecessary details.

There was also some confusion about which ions were either being released or entering the pre-synaptic neurone, i.e. calcium or sodium ions, with many answers referring to calcium ions being released into the synaptic cleft. Wording of responses was also an issue here as candidates frequently said that calcium ions diffuse **into** the membrane rather than through the membrane, or into the pre-synaptic neurone.

The mark most commonly missed was the one for stating that the calcium ion channels become less responsive.

(d) This investigation used only one 30-minute session of TENS pulses. This was done to reduce the risk of habituation.

Describe the process that occurs at a synapse that leads to habituation.

(4)

As calcium ions arrive at the presynaptic neurone triggering vesicles to fuse with the presynaptic membrane and release neurotransmitters via exocytosis into the synaptic cleft, they become less sensitive if a stimuli is repeated over and over. This means less calcium ions are released so there's less neurotransmitter is released meaning they effect/ reaction they cause is reduced in intensity until it doesn't happen at all and habituation has happened

(Total for Question 2 = 12 marks)

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Examiner Comments

This answer was given 1/4 marks. This candidate has used up four lines describing what normally happens - which is not relevant to the question - and then gains just one mark for 'less neurotransmitter is released'.

(d) This investigation used only one 30-minute session of TENS pulses. This was done to reduce the risk of habituation.

Describe the process that occurs at a synapse that leads to habituation.

(4)

The calcium ion channels on the pre synaptic neurone membrane become insensitive to calcium ions so less enters the neurone. Therefore less neurotransmitter-filled vesicles leave by exocytosis. The chance of the post-synaptic membrane being sufficiently depolarised is decreased and less or no action potentials will be produced in the post synaptic neurone.

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Examiner Comments

This response was given a mark of 3/4. The marks awarded were for:

- calcium ion channels on pre-synaptic neurone become insensitive;
- fewer calcium ions enter the neurone (in the context of the pre-synaptic neurone);
- reduced chance of post-synaptic membrane being depolarised - so less action potentials.

Unfortunately, the release of neurotransmitter was muddled with vesicles leaving and therefore the mark for 'less neurotransmitter released' could not be given.

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Examiner Tip

Make sure that individual statements are clear and not overlapping - vesicles do not leave, they fuse with the membrane and their contents leave the cell.

Question 3 (a) (i)

This question asked candidates to 'comment on the evidence'. In the new, reformed specification, the command phrase **'comment on'** requires 'the synthesis of a number of variables from data/information to form a judgement'.

Most responses failed to gain more than one or two marks for describing the main trends in the data. Almost all candidates described the correct relationship between heart rate and the conditions coronary heart disease (CHD) and cancer. Many then tried to explain the causes of the trends - this was not required and did not gain credit in the context of the question.

Some candidates just cited data from the table with no attempt to manipulate it - therefore they failed to identify the fact that the actual magnitude of increase in the incidence of cancer was greater than that of CHD.

Some wrote at length on whether causation could be demonstrated, or whether suitable sample sizes had been used, and therefore did not answer the question.

(i) Comment on the evidence for a link between resting heart rate and the percentage incidence of coronary heart disease and cancer.

(5)

- The table suggests there is a positive correlation between resting heart rate and coronary heart disease and cancer as as increased heart rate the incidence of coronary heart disease and cancer increases.
- The data from the table is reliable as a large sample size was used meaning the results were more.
- Increased heart rate would cause an increase in the chance of coronary heart disease as if blood is pumped more often there is an increased risk of damage to the endothelium leading to plaque forming narrowing the coronary artery.
- Data might be unreliable as there are no error bars.

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Examiner Comments

This answer was given 1/5 marks for stating that the table of data shows a positive correlation between resting heart rate and incidence of both coronary heart disease and cancer.
The rest of the response describes the reasons for the data being reliable and then discusses possible reasons for the correlation - neither of which were required to answer this type of question.

(i) Comment on the evidence for a link between resting heart rate and the percentage incidence of coronary heart disease and cancer.

(5)

There is a positive correlation between the resting heart rate and the % incidence of cancer and % incidence of coronary heart disease. ^ However in both conditions, after a ^ resting heart rate of 99 beats per minute, the % incidence begins to decrease which could imply that a higher resting heart rate may ^ decrease the % incidence of both diseases again. However just because there is evidence of a correlation it doesn't necessarily provide evidence of a causational link as it is likely that other factors such as genetics and gender and environment are involved in your a person's risk of developing these diseases. Also there is already a greater risk of heart disease than cancer ^ as the resting heart rate increases by 40bpm, the % incidence of coronary heart disease increases by 1% and for cancer increases by 3%.

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Examiner Comments

This response was given 2/5 marks - the most frequently seen score for this question, with almost half of candidates getting these two marks. Marks were given for:

- correlation between heart rate and incidence of cancer and coronary heart disease;
- a decrease in the incidence of both at resting heart rates above 99 bpm.

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Examiner Tip

Some attempt has been made to comment on the evidence, but not in enough depth to gain more marks.

(i) Comment on the evidence for a link between resting heart rate and the percentage incidence of coronary heart disease and cancer.

(5)

There is a positive correlation between resting h.r. and % incidence of cancer & and ~~stroke~~. CHD. Both CHD and cancer decrease % @ >99 heart rate, but the sample size is significantly smaller than other ranges thus it may be anomalous / inaccurate, plus the decrease is small. Evidence is stronger for cancer as it increases 3.8 times from <59 to >99, whereas ~~whereas~~ CHD only increases 1.89 times, and CHD is already a risk despite the heart rate whereas cancer starts at a low percentage → 4.2 times greater than cancer at lowest heart rate.

When a high or least heart is reached % for both decreases.

>79

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Examiner Comments

This excellent answer very nearly scored full marks - but was given 4/5. Marks were given as follows:

- positive correlation between resting heart rate and incidence of cancer and CHD;
- both cancer and CHD decrease at over 99 bpm;
- evidence is stronger for cancer;
- increase in cancer incidence from <59 to >99 bpm is times 3.8.

Unfortunately, the fifth marking point was lost as the candidate referred to an increase of **1.89** times for CHD instead of **1.88**, it seems as if they rounded up 1.8809 incorrectly to 1.89.

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Examiner Tip

Take care when rounding figures up or down - double check your figures very carefully!

Question 3 (a) (ii)

This question asked for reasons why the numbers of people in each resting heart group were different.

Whilst many understood the idea of varying frequency within the population, very few made reference to the reduced number of people at the extremes because of other health risks. Many candidates misinterpreted the question and explained why there was a big range of heart rates and went on to link this to factors such as diet and exercise.

(ii) Give two reasons why there were different numbers of people in each resting heart rate group.

(2)

• Each individual has a different resting heart rate

• some rates are more common e.g. 60-69 and 70-79

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Examiner Comments

This answer was just enough for 1/2 for identifying some heart rates as being more common.

(ii) Give two reasons why there were different numbers of people in each resting heart rate group.

(2)

larger number of people in groups 60-69 and 70-79 because this a common resting heart rate for many people
few less people have really low resting heart rate eg lower than 60bpm is bradycardia and less people have really high.

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Examiner Comments

This answer gained 1/2 - for making it clear that there would be more people with the mid-range heart rates than the extremes.

(ii) Give two reasons why there were different numbers of people in each resting heart rate group.

(2)

heart rate follows a normal distribution : bpm levels in the middle of the range are more common. Less people from really high/really low bpm as they are more likely to be in hospital due to being ill from really high or really low bpm

ResultsPlus
Examiner Comments

This answer gained 2/2. Not only has this candidate recognised that there is a normal distribution of heart rate in the population, they have also identified that those with very low or very high heart rates are likely to have other health conditions.

Question 3 (a) (iii)

This question asked why the number in each group did not affect the validity of the investigation.

Many candidates picked up on the fact that percentages were calculated. The use of percentages was understood by many candidates as a good way to compare data and the large sample sizes were also referred to correctly. Less often seen was reference to the wide range of heart rates considered.

(iii) Give two reasons why the number of people in each resting heart rate group did not affect the validity of this investigation.

(2)

Percentages were taken from each group so comparison is valid as changes in group size do not affect percentages. Percentages are representative of the population.

ResultsPlus
Examiner Comments

This response gained 1/2 marks for correctly stating that percentage incidence was used and that it would not be affected by group size.

(iii) Give two reasons why the number of people in each resting heart rate group did not affect the validity of this investigation.

(2)

The percentage of incidence of each condition was measured rather than the number of cases. This means that the results can be directly compared. Also each group contained a large enough number to draw a conclusion.

ResultsPlus

Examiner Comments

This gained 2/2 for reference to percentage incidence being calculated and the large sample sizes.

Question 3 (b)

This was a straightforward question assessing knowledge of the events during prophase in an animal cell.

Just over half of the candidates achieved full marks on this question and few major errors were seen, although some candidates confused prophase with the events in interphase, whilst some referred to events in metaphase such as the lining up of chromosomes at the equator.

Where marks were lost, it was most frequently due to confusion over the key terms with centrioles and centromeres being the most commonly muddled, but there was also inconsistency with the use of the following terms: chromosome, chromatid and chromatin.

(b) Cancer can be due to body cells continuing to undergo mitosis and cell division. Prophase is one stage of mitosis.

Describe the events that occur during prophase in an animal cell.

(3)

In prophase, the nuleur envelope of cell breaks down the and the chromosones condense, they get shorter and fatter and spindle fibers line up from centromere to es opposite side of the cell.

ResultsPlus

Examiner Comments

This answer gained 2/3. One mark for the breaking down of the nuclear envelope (misspelling ignored) and one for condensing of chromosomes.
No mark for describing spindle fibres lining up from the centromere to the opposite sides of the cell - although the candidate is describing what they have seen in diagrams, they have not correctly described the formation of the spindle fibres.

(b) Cancer can be due to body cells continuing to undergo mitosis and cell division. Prophase is one stage of mitosis. I PMAT

Describe the events that occur during prophase in an animal cell.

(3)

During prophase chromosomes condense becomind shorter and fatter, the nuclear envelope breaks down, centrioles move to oposite poles and produce spindle fibres.

ResultsPlus

Examiner Comments

This is a good example, gaining full marks - 3/3 - whilst covering all possible marking points as follows:

- chromosomes condense;
- nuclear envelope breaks down;
- centrioles move to opposite poles;
- spindle fibres produced.

Question 4 (a) (i)

This was a basic question, requiring the calculation of the mean value for a set of results.

Most candidates achieved full marks on this question. However, some did not allow themselves to be guided by the figures in the table with regards to the number of significant figures. Many worked out the answer correctly, but then reduced the answer to 0.64 rather than leaving it at 0.644. Others placed 0.644 in the table and then put 0.64 on the answer line.

(a) (i) Calculate the mean length of shrimp three days after hatching in the 5% salt solution. Give your answer to an appropriate number of significant figures. 3

(1)

$\text{Total} = \frac{6.44}{10} = 0.644$

Answer 0.644 (3sf) mm

ResultsPlus
Examiner Comments

This answer gained 1/1.
The candidate has underlined key parts to the question to help focus them on the data to analyse and they have also underlined the phrase 'significant figures' and written the number '3' next to it - having noted the numbers in the table of data.

ResultsPlus
Examiner Tip

Look at the data provided to determine what an appropriate number of significant figures is - even if not prompted to do so.

Question 4 (a) (ii)

This question asked for an explanation of how the data could be used to show the effect of salt concentration on the **rate** of growth of the brine shrimp.

Most candidates failed to understand what was required for this question. There was evidence that many failed to read the question carefully enough to realise that they were being asked **how** to use the data. In addition, very few seemed to take account of the word **'rate'** in the stem of the question and fewer still seemed to recognise that rate of growth in this context would be calculated in terms of mm per day. Consequently, many suggested that the brine shrimp grew more in the 3% salt solution, as the figures were larger. There were many suggestions of a variety of statistical tests, including Spearman's rank correlation, that could be used to analyse the data, as well as graphs to show the results, although none appeared to suggest using the gradients to calculate rates of growth.

In practical work, students should encounter the need to work out rates and should know how to do it.

However, the main reason for failing to score marks for this question was reading it as 'Explain the effect of salt concentration on growth of brine shrimp' - this emphasises the need to read the questions very carefully.

(ii) Explain how these data can be used to show the effect of salt concentration on the rate of growth of brine shrimps.

(2)

The change in mean length can be calculated between the 3 – 7 days after hatching by subtracting the mean length after 3 days from the mean length after 7 days. This can then be divided by the time (4 days) to find the rate of growth. The mean rate of growth for the 3% and 5% solutions can then be compared

ResultsPlus

Examiner Comments

This is an excellent answer and gained 2/2 marks. One mark for very clearly explaining how the rates of growth could be calculated and then one mark for comparing the mean growth rates for 3% and 5% solutions.

(ii) Explain how these data can be used to show the effect of salt concentration on the rate of growth of brine shrimps.

(2)

The mean length at the different salt concentrations can be used. The rate of growth can be calculated by dividing the ~~long~~ mean length by the number of days / hours it is left in the salt solution. A graph can then be drawn of ~~long~~ rate of growth against concentration to show if there is a significant difference at different salt concentrations.

ResultsPlus

Examiner Comments

This answer gained 1/2 marks. Although the candidate has explained how rate of growth can be calculated - by dividing mean length by number of days, they have not explained that this would allow comparison between 3% and 5% salt solutions.
This candidate has only fully answered part of the question in explaining how rate of growth can be measured.

Question 4 (b) (i)

This question asked candidates to draw a line to show normal distribution for a population of brine shrimp on a set of axes already provided with the x axis labelled as 'length/mm'.

Approximately 60% of the candidates did well on this question with a majority demonstrating knowledge of the concept of a bell-shaped curve. Many candidates, however, did not appear to know what was meant by a **normal distribution** and were not able to apply knowledge from other topics such as variation to this context. Straight line graphs or plateaus were frequently seen. Many marks were lost by not including tails clearly, or for lines that were drawn too far up from the x-axis.

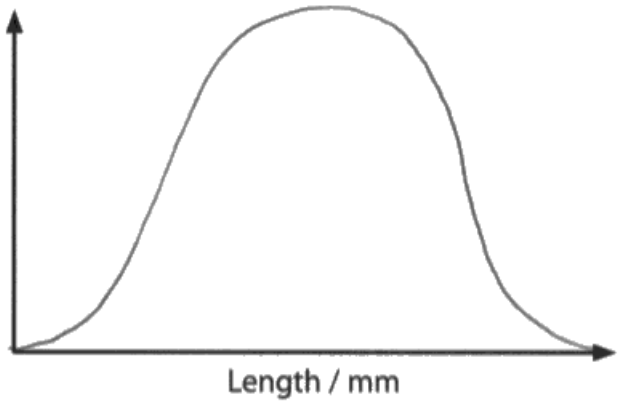
Candidates should be reminded that care needs to be taken over sketching graphs, as a number were not credited for being too much like an enzyme-temperature graph with a rapid decline phase.

A small but significant number did not even attempt this question, which was disappointing as it does not take much time to sketch the graph. This could also have been because there was no answer line and candidates may not have bothered to read the information assuming there was no question to answer - it should be emphasised that anything printed on the exam paper is there because it needs to be read, as it is necessary for answering the questions set.

The student selected the *t*-test because the data are normally distributed.

(i) Draw a line on the graph to show a normal distribution for a population of brine shrimp.

(1)



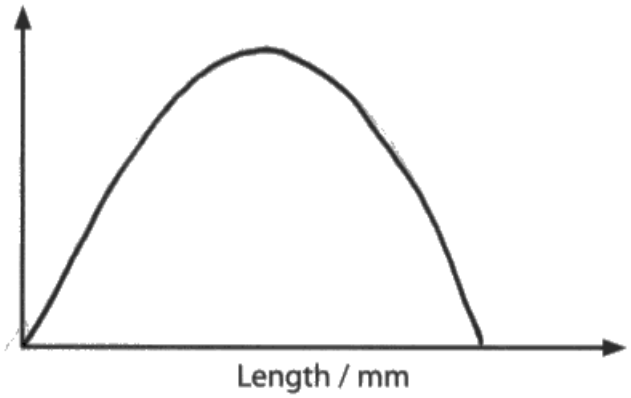
ResultsPlus
Examiner Comments

A good example of a bell-shaped curve to show normal distribution. This answer gained 1/1.

The student selected the *t*-test because the data are normally distributed.

(i) Draw a line on the graph to show a normal distribution for a population of brine shrimp.

(1)



ResultsPlus

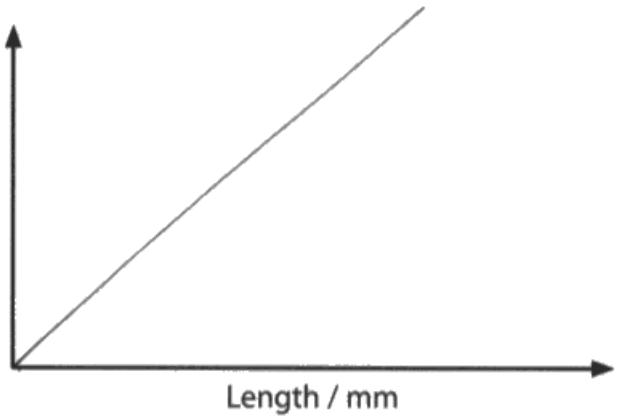
Examiner Comments

This did not gain the mark because there were no 'tails' drawn to indicate the smaller numbers expected at the extremes when data is normally distributed.

The student selected the *t*-test because the data are normally distributed.

(i) Draw a line on the graph to show a normal distribution for a population of brine shrimp.

(1)



ResultsPlus
Examiner Comments

No marks for this answer.
Straight lines - indicating a positive correlation and not a normal distribution - were often seen in answer to this question.

Question 4 (b) (ii)

This question required the completion of the table by calculating the square of 1.13 and then adding up the figures in the column as indicated.

Most candidates did well on this question although again, some failed to allow themselves to be guided by numbers already in the results table with regards to the number of significant figures that would be considered appropriate.

(ii) Complete the table by filling in the missing value for specimen 7 and then calculate the value for Σx_1^2.

(1)

Specimen number (n)	3% salt solution		5% salt solution	
	Length of specimen (x_1)	Square of length of specimen (x_1^2)	Length of specimen (x_2)	Square of length of specimen (x_2^2)
1	1.00	1.000	0.98	0.960
2	1.25	1.563	0.95	0.903
3	1.10	1.210	0.93	0.865
4	1.03	1.061	0.83	0.689
5	1.15	1.323	0.98	0.960
6	1.08	1.166	1.08	1.166
7	1.13	1.278	0.95	0.903
8	1.05	1.103	1.03	1.061
9	1.18	1.392	0.88	0.774
10	1.05	1.103	0.88	0.774
Sum (Σ)	$\Sigma x_1 = 11.020$	$\Sigma x_1^2 = 12.199$	$\Sigma x_2 = 9.490$	$\Sigma x_2^2 = 9.055$
Mean	$\bar{x}_1 = 1.102$		$\bar{x}_2 = 0.949$	

ResultsPlus
Examiner Comments

This scored 0/1.
This candidate has squared the figure 1.13 and taken the answer of 1.2769 and rounded it up to 1.278 instead of 1.277. Consequently, the sum of all the squares is also incorrect at 12.199 instead of 12.198.

ResultsPlus
Examiner Tip

Take care with rounding figures - write them down in the space available on the question paper as it is then easier to see how to round up or down correctly than on a calculator, especially in an exam situation.

(ii) Complete the table by filling in the missing value for specimen 7 and then calculate the value for Σx_1^2.

(1)

Specimen number (n)	3% salt solution		5% salt solution	
	Length of specimen (x_1)	Square of length of specimen (x_1^2)	Length of specimen (x_2)	Square of length of specimen (x_2^2)
1	1.00	1.000	0.98	0.960
2	1.25	1.563	0.95	0.903
3	1.10	1.210	0.93	0.865
4	1.03	1.061	0.83	0.689
5	1.15	1.323	0.98	0.960
6	1.08	1.166	1.08	1.166
7	1.13	1.272	0.95	0.903
8	1.05	1.103	1.03	1.061
9	1.18	1.392	0.88	0.774
10	1.05	1.103	0.88	0.774
Sum (Σ)	$\Sigma x_1 = 11.020$	$\Sigma x_1^2 = 12.198$	$\Sigma x_2 = 9.490$	$\Sigma x_2^2 = 9.055$
Mean	$\bar{x}_1 = 1.102$		$\bar{x}_2 = 0.949$	

1.2769.

ResultsPlus
Examiner Comments

This answer gained 1/1 for getting both figures correct and to an appropriate number of significant figures.

ResultsPlus
Examiner Tip

This candidate has written down the figure of 1.2769, the square of 1.13 and has then correctly rounded up.
Use the space that is available for noting figures for calculations.

Question 4 (b) (iii) – (iv)

Parts (iii) and (iv) required the calculation of variance and the t value for the data, using the formulae provided.

Most candidates did well on this question, although some substituted in the wrong values and got an incorrect answer. Many candidates placed the correct numbers into the equation, then used their calculators to work out the final answer. However, candidates should be encouraged to break equations down into stages, if possible, so that they can access partial marks even if their final answer is wrong due to an error along the way. Unfortunately, many calculations were poorly laid out such that those gaining an incorrect final answer could often not be awarded any mark for a correct top line to the calculation.

(iii) The variances are used in the calculation of a *t*-value.

The variance for the 3% salt solution $S_1^2 = 0.0059$.

Calculate the variance for the 5% salt solution (S_2^2) using the formula

$$S_2^2 = \frac{\Sigma x_2^2 - \frac{(\Sigma x_2)^2}{n}}{n-1}$$

n = the number of specimens

(2)

$$\frac{9{\cdot}055 - \frac{9{\cdot}490^2}{10}}{9} = 5{\cdot}44 \times 10^{-3}$$

$0{\cdot}0054$

9·006

S_2^2 0·0054

(iv) Calculate the *t*-value using the formula.

Give your answer to an appropriate number of significant figures.

$$t = \frac{\bar{x}_1 - \bar{x}_2}{\sqrt{\frac{s_1^2}{n_1} + \frac{s_2^2}{n_2}}}$$

(3)

$$t = \frac{11.020 - 9.490}{\sqrt{\frac{0.0059}{10} + \frac{0.0054}{10}}} \quad 1.53 \quad 0.0336 \quad = 45.5$$

$t =$ 45.5

ResultsPlus
Examiner Comments

This answer scored 2/2 for (b)(iii) and 1/3 for (b)(iv). The variance was correctly calculated as 0.0054. However, when calculating the t value, the sum of all the values figures was used and not the means for the two solutions, i.e. 11.020 instead of 1.102 and 9.490 instead of 0.949. One mark was given for calculating the bottom line of the equation correctly to give 0.0336.

ResultsPlus
Examiner Tip

Make sure that the correct figures are being inserted into equations.
Always show working - this allowed the wrong answer for part (iv) to still gain one mark.

(iii) The variances are used in the calculation of a *t*-value.

The variance for the 3% salt solution $S_1^2 = 0.0059$.

Calculate the variance for the 5% salt solution (S_2^2) using the formula

$$S_2^2 = \frac{\Sigma x_2^2 - \frac{(\Sigma x_2)^2}{n}}{n-1}$$

n = the number of specimens = 10

(2)

$$S_2^2 = \frac{9.055 - \frac{(9.490)^2}{10}}{9}$$

5.44×10^{-3}

S_2^2 0.0054 (2sf)

(iv) Calculate the *t*-value using the formula.

Give your answer to an appropriate number of significant figures.

$$t = \frac{\bar{x}_1 - \bar{x}_2}{\sqrt{\frac{s_1^2}{n_1} + \frac{s_2^2}{n_2}}}$$

(3)

$$t = \frac{1.102 - 0.949}{\sqrt{\frac{0.0059}{10} + \frac{0.0054}{10}}}$$

$t =$ 4.55 (3sf)

ResultsPlus

Examiner Comments

This answer gained 2/2 for (b)(iii) and 3/3 for (b)(iv). Setting out the calculations like this helps in the calculation and makes it clear how the answers are derived.

Question 4 (b) (v)

In case candidates made mistakes calculating the t value in (b)(iv), this question states that the t value calculated for the data was greater than the critical value at p= 0.05. The question then asked what this indicates about the effect of salt concentration on the length of brine shrimps.

Most candidates recognised that this question was related to significance, but very few linked it back to the question or to the type of statistical test, so it was not always recognised that the results showed a significant **difference** and not a correlation**.** Many candidates linked the wrong aspects, frequently commenting on the correlation between salt concentration and length of the brine shrimp rather than the idea that the results between the two salt concentrations were significantly different. Many responses described a negative correlation between salt concentration and length of brine shrimp, having noted shorter lengths for those in 5% salt solution than in the 3% salt solution.

Some understood what the 5% significance level indicated, but many just repeated the 0.05 figure. Others made references to the null hypothesis, which was not relevant to the question.

Candidates need to be aware of the different types of statistical test used in biology - especially those that test for differences between two sets of data and those that assess the correlation between one variable and another. This was not evident in most of the responses to this question, with almost 60% of candidates scoring zero.

(v) The calculated *t*-value is greater than the critical value at $p = 0.05$.

Describe what this result indicates about the effect of salt concentration on the length of brine shrimp.

(2)

This result indicates that there is a significant difference between the effect of salt concentrations of 3% and 5% on the length of brine shrimp at the 5% significance level. Therefore you can be 95% sure that the results are not due to chance.

ResultsPlus

Examiner Comments

This was a very good answer, gaining 2/2. One mark for clearly describing a 'significant difference between' the effects of 3% and 5% salt solutions and one mark for stating clearly that this was significant at the 5% level, which meant that someone could be 95% sure that the 'results are not due to chance'.

(v) The calculated *t*-value is greater than the critical value at $p = 0.05$.

Describe what this result indicates about the effect of salt concentration on the length of brine shrimp.

(2)

Because the t-value is greater than the critical value at p=0.05, you can be 95% that there is a significant difference. Therefore, the salt concentration does have a significant effect on the length of brine shrimp.

ResultsPlus
Examiner Comments

This answer gained 1/2 marks for linking 95% to significant difference, even though it appears that the word 'sure' has been left out. The sense is clear enough to award the mark.
However, the second mark could not be given as the answer suggests a correlation between salt concentration and length of brine shrimp, instead of a difference between the two salt solutions.

(v) The calculated *t*-value is greater than the critical value at $p = 0.05$.

Describe what this result indicates about the effect of salt concentration on the length of brine shrimp.

(2)

~~The results~~ The results is greater than the critical value therefore it indicates that there is a correlation between the ~~effect of~~ salt concentration and the length of the brine shrimp.

ResultsPlus
Examiner Comments

This gained 0/2 marks. This candidate has made the common error in assuming that the statistical test carried out was to find a correlation.

ResultsPlus
Examiner Tip

Learn that the main types of stats test used in biology are to find out if there are either differences between sets of data, or a correlation between two variables.

Question 5 (a)

This was a simple question asking for the location of chlorophyll in the chloroplast.

Most candidates did well on this question. Of the wrong answers, thylakoid (without the membrane) was given most frequently although some seemed to think chlorophyll is in the cytoplasm of the cell.

Candidates should try to remember that the photosystems are embedded in the thylakoid membrane and are not floating loose in a thylakoid sac, which is why thylakoid on its own did not gain the mark.

Some lost the mark by also mentioning the stroma in their answers. Spelling was generally very good – a pleasing sign that care is taken over the spelling of technical vocabulary.

5 The pigment content of mountain plants can be affected by various environmental factors. These factors include altitude (height up a mountain), exposure to ultraviolet radiation (UV-B) and temperature.

These pigments include chlorophyll, found in chloroplasts, and flavonoids that are found in sap vacuoles.

Flavonoids can protect plants from ultraviolet radiation (UV-B) that can damage DNA.

(a) State the location of chlorophyll in a chloroplast.

(1)

Granum is a chloroplast contains pigments (molecules) of chlorophyll on thylakoid membrane.

ResultsPlus

Examiner Comments

This was given 1/1 - the mark could have been given for either granum or thylakoid membrane - although the chlorophyll is **in** the membrane and not **on** it.

5 The pigment content of mountain plants can be affected by various environmental factors. These factors include altitude (height up a mountain), exposure to ultraviolet radiation (UV-B) and temperature.

These pigments include chlorophyll, found in chloroplasts, and flavonoids that are found in sap vacuoles.

Flavonoids can protect plants from ultraviolet radiation (UV-B) that can damage DNA.

(a) State the location of chlorophyll in a chloroplast.

(1)

~~thylakoid membrane~~ ~~cytoplasm~~

thylakoid membrane

ResultsPlus
Examiner Comments

This gained 1/1 for 'thylokoid membrane' - spelling was close enough to be unambiguous. Cytoplasm would have been wrong.

ResultsPlus
Examiner Tip

If thinking of changing an answer - think again! First instincts are nearly always correct.

5 The pigment content of mountain plants can be affected by various environmental factors. These factors include altitude (height up a mountain), exposure to ultraviolet radiation (UV-B) and temperature.

These pigments include chlorophyll, found in chloroplasts, and flavonoids that are found in sap vacuoles.

Flavonoids can protect plants from ultraviolet radiation (UV-B) that can damage DNA.

(a) State the location of chlorophyll in a chloroplast.

(1)

Chlorophyll is found in the thylakoids (thylakoid membrane)

ResultsPlus
Examiner Comments

This answer gained 1/1 for thylakoid **membrane** - thylakoid on its own would not have gained the mark.

Question 5 (b)

This question, assessing the ability to devise a practical procedure required the application of skills from two separate core practicals - ecological sampling and the core practical where pigment concentration was measured using a colorimeter to assess the effect of temperature on membranes..

Answers to this question were very variable and the design aspect of this experiment left many candidates floundering. Some candidates did not attempt it at all, which was disappointing as one of the core competencies for the practical endorsement is to design practical investigations. Candidates should at least have been able to identify the variables.

Most seemed to appreciate the need for having plants at different altitudes and the collection or growing of plants was also a common theme. However, a significant number tried to swap the altitude for temperature and stated that this would mimic the conditions. A number of responses referred to using a transect along a mountain without making it clear that they were using the gradient of the mountain and thus sampling different altitudes. Standardisation of plant material was an infrequent mark and even less often seen was reference to any meaningful monitoring of abiotic data other than light intensity or temperature. There were also many responses where quadrats were used to measure the frequency or size of plants at different altitudes - also irrelevant.

Most answers glossed over descriptions of how the flavonoid could be extracted or measured, even though in the introduction to the question it was stated that flavonoid is a pigment found in sap vacuoles. However, there were some good answers where candidates did use practical experience, referring to using hot water or ethanol to extract the flavonoids in a similar manner to the membrane permeability core practical.

However, many were confused and described aspects of DNA extraction or the Hill reaction, whilst others referred to counting the flavonoids using a microscope. Some decided to analyse DNA for damage as they linked increased flavonoid with decreased damage to DNA, although measuring the flavonoid would have been easier.

(b) The altitude at which a plant grows on a mountain affects its flavonoid content.

Devise a procedure to show that an increase in altitude increases the flavonoid content of one species of plant found growing on a mountain.

(5)

Samples of the plant should be collected from different altitudes up the mountain. they shold be the same age if possible so collect ones that are similar sizes. A small piece should be cut from the each plant. It should be the same size and mass. All the pieces shold be washed in distilled water to remove excess pigment. They Shold then all be placed in the same concentration and volume (e.g. 10cm^3) of ethanol and left for the same length of time e.g. 2 minutes in seperate testubes. The liquid from each test tube shold be pured into a cuvet and the absorbence should be measured with a colorimeter. the higher the absorbence the more pigment the plant contained so the higher the altitude

ResultsPlus

Examiner Comments

This excellent response was given 5/5. Marks were awarded as follows:

- plant material collected from plants of the same age;
- samples collected from different altitudes;
- samples to be the same mass;
- pigment extracted using ethanol;
- absorbance of pigment extract measured using colorimeter.

(b) The altitude at which a plant grows on a mountain affects its flavonoid content.

Devise a procedure to show that an increase in altitude increases the flavonoid content of one species of plant found growing on a mountain.

(5)

I would have 6 different conditions 1500km above sea level, 600km, 700km 800km, 900km and 1000 km. I would only use one species of plant e.g Primrose. I would all plant them on the same mountain on the same side of the mountain when the plants are all the same age. I will have 10 plants at each altitude. I will measure the amount of flavonoid in each plant once a week for 3 months taking measurements for all the plants that I have grown to create averages. I will measure the amount of flavonoids by taking samples of the sap that are found in vacuoles.

ResultsPlus
Examiner Comments

This answer was given 2/5 marks. One mark was given for the idea of six different altitudes - the units of km were ignored, although students should be aware that mountains on Earth are not hundreds of kilometres in height! The other mark was for growing 10 plants at each altitude.

ResultsPlus
Examiner Tip

Although this candidate recalled the location of flavonoid in the sap vacuoles, there was no description of how it could be either extracted or measured.

Question 5 (c) (i)

The definition in the specification for **'compare and contrast'** is: 'Looking for the similarities **and** differences of two (or more) things. Should not require the drawing of a conclusion. Answer must relate to both (or all) things mentioned in the question. The answer must include at least one similarity and one difference.'

The majority of answers referred to the fact that chlorophyll decreased and flavonoid increased, although not always described as a difference. Furthermore, many candidates compared chlorophyll to flavonoids, instead of comparing both to UVB, as the question asked. Many just re-wrote the data from the table.

Of those who managed to refer to the decrease between 0 and 20 minutes, few made effective use of comparative statements. A pleasing number identified that the change in flavonoid levels was greater than the change in chlorophyll.

Practice with 'compare and contrast' questions is vital to improve performance in these types of question.

(i) Compare and contrast the effect of length of exposure to UV-B on the chlorophyll and flavonoid content of these plants.

(3)

As length of exposure increases, mean chlorophyll content decreases, whereas increased exposure to UV-B increases mean flavonoid content. There is only a slight decrease (8 au) of mean chlorophyll as a result of increased exposure, however mean flavonoid content increased from 25 to 40 arbitrary units.

ResultsPlus
Examiner Comments

This answer was given 1/3 marks - but nearly achieved 2. One mark was given for noting that chlorophyll decreased and flavonoid increased as UV-B increased. This candidate has recognised that there is a difference in the magnitude of change - but does not make a comparative statement. If they had stated that 'the decrease in chlorophyll is less than the increase in flavonoid' they would have gained 2/3.

ResultsPlus
Examiner Tip

For compare and contrast questions, make sure that statements made are comparative, e.g. 'the change in flavonoid is greater than the change in chlorophyll'.

(i) Compare and contrast the effect of length of exposure to UV-B on the chlorophyll and flavonoid content of these plants.

(3)

- As the length of time exposed to UV-B increased, mean chlorophyll content decreased, whereas mean flavonoid content increased overall.
- Both are affected in some way by the length of time exposed to UV-B
- Between 0 – 20 minutes exposure to UV-B, both chlorophyll and flavonoid content decreased very slightly.

ResultsPlus

Examiner Comments

This answer gained 2/3 marks for describing the one difference and one similarity in clearly comparative statements. One mark for stating that chlorophyll decreased whereas flavonoid increased and one for stating that between 0-20 minutes, both decreased slightly.

(i) Compare and contrast the effect of length of exposure to UV-B on the chlorophyll and flavonoid content of these plants.

(3)

Exposing the plants to UV-B for a greater length of time lead to an overall increase in flavanoid content and a decrease in chlorophyll content. The effect of exposure for 20 minutes a day actually caused a slight decrease in flavanoid content but the change is so small it is insignificant. There was a 6% decrease shown in chlorophyll levels. After 60 minutes exposure per day, flavonoid content had increased by 60% whilst chlorophyll levels had decreased by 25%. There is a greater effect of flavonoid content than on chlorophyll content but the flavonoid change happens significantly between 20 and 60 minutes exposure a day with little change occuring from 40-60 mins a day. Whilst the change in chlorophyll levels is more consistent

ResultsPlus

Examiner Comments

This gained full marks for noting the similarity in that both decreased from 0-20 minutes, and the difference that after 60 minutes chlorophyll decreased whilst flavonoid increased. This candidate also noted a greater effect on flavonoid content.

Question 5 (c) (ii)

Some candidates did very well on this question and many made excellent attempts at using the data to deduce the effects of increasing altitude on plant growth. However, many candidates lost marks as a consequence of not considering all the information given to them in the stem of the question, and not linking those ideas to plant growth and altitude (as was asked of them in the question). Many candidates referred to temperature rather than altitude and some made too much of issues relating to temperature and gene expression; others provided unnecessary details about transcription factors and repressor molecules.

A common problem was that some candidates did not make it clear whether the changes they described were linked to an **increase** or to a **decrease** in altitude. Some even switched between describing the effects of increasing altitude to the effects of decreasing altitude in the same sentence, leading to very confused answers.

(ii) As altitude increases on a mountain, the temperature decreases and the UV-B radiation increases.

Scientists have found that a rise in temperature decreases flavonoid gene expression in plants.

Analyse the data to discuss why altitude can affect plant growth.

(5)

The data shows that as UV-B increases, the mean content of chlorophyll decrease. So this means as altitude increases, UV-B increases so chlorophyll decrease. If there is less chlorophyll, that means less photosynthesis will take place. And with less photosynthesis, the plant won't get the correct amount of energy and glucose to grow. This means that UV-B will affect plant growth by decreasing it.

ResultsPlus
Examiner Comments

This answer was given 2/5 marks for discussing how increased UV-B would cause a reduction in chlorophyll that would result in less photosynthesis.

T ↓ UV-B ↑

(ii) As altitude increases on a mountain, the temperature decreases and the UV-B radiation increases.

Scientists have found that a rise in temperature decreases flavonoid gene expression in plants.

Analyse the data to discuss why altitude can affect plant growth.

(5)

The ~~higher~~ longer exposed to UV-B / more UV-B radiation, (higher altitude) the less chlorophyll the plant has. This means less photosynthesis occurs which decreases the plants growth.
As the altitude increases, the temperature decreases. This increases the amount of flavonoid genes expressed in plants which gives the plants more protection from UV-B radiation which increases as the altitude increases. More protection from UV-B means there is less damage to DNA and less chance of mutation or cell death which allows the plant to grow. However As the flavonoid content increases the mean chlorophyll content decreases which means the plant does less photosynthesis to produce sugars it needs to grow.

ResultsPlus
Examiner Comments

This response nearly gained full marks, but was given 4/5. Poor expression and unclear wording lost one of the marks that could have been given if the biology was accurate. Marks were given for:

- higher altitude - less chlorophyll;
- less photosynthesis;
- flavonoid protects from damage by UV-B - less damage to DNA (pieced together from two sentences);
- less chance of mutation.

ResultsPlus
Examiner Tip

Take care with how statements are made - make sure they are biologically correct.

(ii) As altitude increases on a mountain, the temperature decreases and the UV-B radiation increases.

Scientists have found that a rise in temperature decreases flavonoid gene expression in plants.

Analyse the data to discuss why altitude can affect plant growth.

(5)

The data shows that the levels of flavonoid and chlorophyll change with altitude. With increased altitude, the chlorophyll content drops, ~~shows~~ and as a result, the plant can photosynthesis less. Hence it is able to produce less glucose, and ~~as~~ fix less carbon. It thus has less fuel for respiration or sugars with which to build new cells, ~~and~~ reducing its growth rate. As altitude increases, more flavonoid is made. This is needed ~~so~~ to protect the cells DNA from UV reducing ~~reducing~~ mutations. This leads to increased growth of vacuoles to ~~grow~~ further cell division can still occur, since the DNA isn't destroyed.

Altitude changes the content of plants, which alters what they are able to do and produce, altering growth.

UV light activates transcription factors which enables genes to be activated.

ResultsPlus

Examiner Comments

This response gained 5/5. Marks were given in the following order:

- with increased altitude chlorophyll content drops;
- plant can photosynthesise less;
- as altitude increases more flavonoid is made;
- to protect cell's DNA from UV radiation;
- reducing mutations.

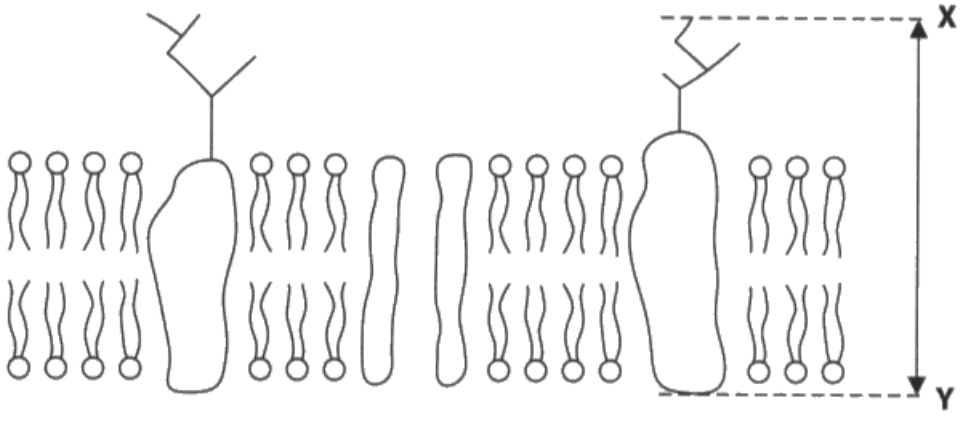
Question 6 (a)

This question was carefully constructed so that the distance that had to be measured was exactly 50 mm/5 cm - however, although it would seem that some candidates were unable to use a ruler correctly, others managed to record lengths to fractions of a millimetre.

Then there were many candidates who did not know how to use the information given and rearrange equations, many multiplying rather than dividing by the magnification factor.

However, the units provided were frequently inappropriate, using metres, centimetres or millimetres, or in some instances no unit at all, despite clear instruction to 'give your answer with an **appropriate unit**'. A worrying number of candidates were not able to convert units properly and it was surprising to see that so many could not convert or manipulate numbers with different orders of magnitude, a mathematical skill that is expected at this level.

(a) The drawing shows the cell surface membrane of a liver cell. The drawing has a magnification of 5×10^6.



cm) x10
mm) x1000
µm) x1000
nm

1/ATM

Calculate the actual length of the glycoprotein between points **X** and **Y**.
Give your answer with an appropriate unit.

(2)

I = actual x magnification.

I = 50mm x 5×10^6

I = 50000µm x 5×10^6

= 2.5×10^{11} µm

Answer 2.5×10^{11} µm

ResultsPlus
Examiner Comments

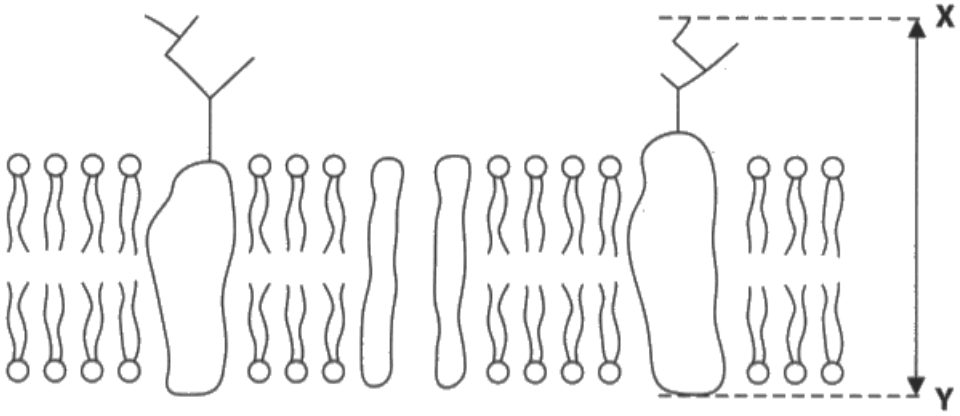
This answer scored 0/2.

Although the line has been measured correctly, as 50 mm, and the conversion to μm has been done, the candidate has multiplied this by the magnification instead of dividing. This gives an incorrect answer.

ResultsPlus
Examiner Tip

Learn the formula for calculating actual size from image size and magnification.
Be aware of the units and orders of magnitude - e.g. 2.5 x 10^{11} μm would give a membrane thickness many kilometres wide!

(a) The drawing shows the cell surface membrane of a liver cell. The drawing has a magnification of 5×10^6.



Calculate the actual length of the glycoprotein between points **X** and **Y**.
Give your answer with an appropriate unit.

(2)

$M = \frac{I}{S}$

$5 \times 10^6 = \frac{5}{\text{Specimen}}$

$\text{Specimen} = \frac{5}{5 \times 10^6}$

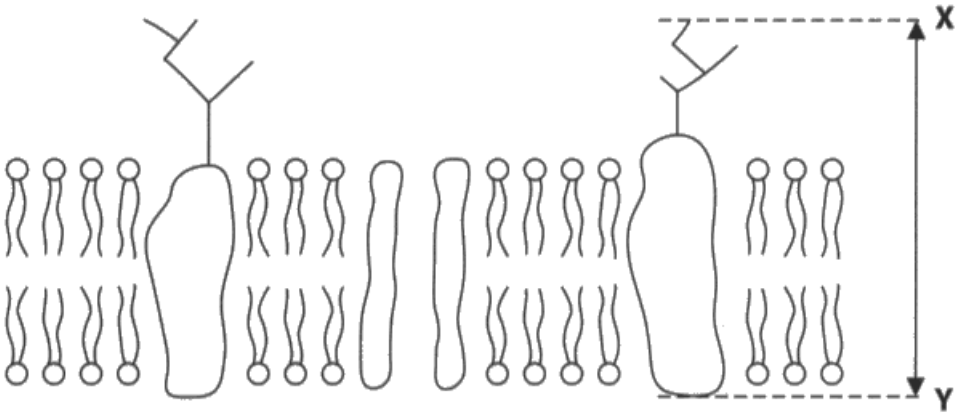
Answer 1×10^{-6} cm

$= 1 \times 10^{-6}$ cm

ResultsPlus
Examiner Comments

This answer gained 1/2 marks for correctly dividing a length of 5 by the magnification. However, the units are not appropriate - nm or µm should have been used.

(a) The drawing shows the cell surface membrane of a liver cell. The drawing has a magnification of 5×10^6.



Calculate the actual length of the glycoprotein between points **X** and **Y**.
Give your answer with an appropriate unit.

(2)

50mm ÷ (5 × 10^6) = 25 000

1×10^{-5} mm

× 1000 = 0.01 µm

Answer 0.01 µm

ResultsPlus
Examiner Comments

This gained 2/2 - the correct answer is given and the calculation has been clearly laid out so the working is easy to see.

Question 6 (b)

The 9-mark question is a new addition to the reformed A-level examination paper, designed to assess application of knowledge synoptically. The answers to this question ranged widely in quality with the modal value being towards the lower end of the mark scale. Answers that were awarded Level 1 marks simply repeated the figures provided or listed the functions already stated and added little extra detail in support of their argument. It should be noted that the data provide the context to the question and that there is nothing to be gained from listing the facts already given.

The better answers showed a pleasingly broad knowledge of the roles of proteins in the cell surface membrane, although some diverged to explain the roles of proteins throughout the cell, which was not relevant. There were some excellent answers, however, that discussed the relevant importance of the bilayer and proteins using well-chosen examples which were accurately detailed and compared.

Many candidates did confuse the proportion of proteins in the cell membrane compared to those in other organelles and the proportion in the surface membrane compared to the proportion of phospholipids. Many described the bilayer as providing structural support for the cell. The stem of the question asked them to evaluate a statement about proteins in the **cell surface membrane** and decide whether they were more important than the membrane itself. However, many candidates did not narrow their discussion to only referring to proteins in the cell surface membrane and instead re-wrote much of the data from the previous page that was not relevant to the question. Furthermore, the stem of the question specifically mentioned the **functioning** of the cell, yet many candidates did not explain how the proteins helped with the functioning of the cell and instead just gave lists of types of proteins.

Where responses moved from Level 1 to Level 2 was where the examples of proteins linked to function, such as channel or carrier proteins involved in transport, was expanded to discuss specific examples, such as Na+/K+ pumps in the axon or the CFTR channel protein for dilution of mucus. The main examples given for proteins were transport and receptors which were often also linked to the immune response. For the phospholipid bilayer, fluidity was mentioned in the context of enabling exocytosis and its involvement in the release of neurotransmitters or endocytosis involved in phagocytosis; Level 1 answers just described it as a barrier without mentioning separation of two aqueous environments.

d Analyse the data to evaluate the following statement.

'The variety of different proteins present in the cell surface membrane makes them more important than the phospholipid bilayer to the functioning of that cell.'

(9)

- Phospholipid bilayer only allows lipid soluble and uncharged molecules to pass in and out of the cell membrane.
- The proteins however allow for bigger, water-soluble, ~~and~~ insoluble and charged molecules to pass ~~and~~ in and out of the cell.
- The number and type of protein determine the function of the cell.
- ∴ The variety of different proteins is more important because proteins serve more specific and advanced purpose than the cell surface membrane.
- This is because the cell surface membrane is only used for transport and the shape of the cell. however ~~proteins~~ 41 1.5% of the cell surface membrane is proteins used for everything else like regulation or receptors.

ResultsPlus
Examiner Comments

This was a Level 1 response - given 2/9 marks.

This response focuses on just the aspect of transport into cells, describing how charged molecules can enter through proteins and how lipid-soluble and uncharged molecules can pass through the phosholipid bilayer.

If carrier or channel proteins had been mentioned, this would have gained 3/9.

ResultsPlus
Examiner Tip

This answer is vague and lacks specific details.

Analyse the data to evaluate the following statement.

'The variety of different proteins present in the cell surface membrane makes them more important than the phospholipid bilayer to the functioning of that cell.'

(9)

The phospholipid bilayer allows fluiding and movement of the cell membrane, allowing more efficient transport of substances in and out of the membrane. 68·2% of a cell's proteins are in the cell surface membrane meaning that they must be important to the functioning of a cell. It is concluded that the proteins in the cell membrane are more important than the phospholipid bilayer because they help carry out many functions. The graph shows that regulation is massively helped by proteins in the cell membrane. Functions such as facilitated diffusion, ~~are~~ take place in the ~~protein~~ carrier and channel proteins in the cell membrane, they allow transport. The cell membrane proteins are also important for the immune response (4·1%). ~~as they~~ For example, the CD4 receptor on a T helper cell can identify the MHC on an APC, ~~the~~ this is because of the ~~proteins~~ glycoproteins in the cell membrane of the T helper cell (the CD4 receptor).

ResultsPlus
Examiner Comments

It was judged to be Level 2 for the following reasons:

- **discussion of more than one membrane protein** - channel and carrier proteins, CD4 receptor, glycoprotein;
- **discussion of roles of phospholipids** - allows fluidity.

ResultsPlus
Examiner Tip

Reference to exocytosis and endocytosis as properties related to the fluidity of the phospholipid bilayer would have raised this to a higher Level 2 response.

Analyse the data to evaluate the following statement.

'The variety of different proteins present in the cell surface membrane makes them more important than the phospholipid bilayer to the functioning of that cell.'

(9)

The statement is true to some extent because the proteins on the cell surface membrane can carry out many functions that the phospholipid bilayer cannot. For example, channel and carrier proteins are essential for the transport of charged and large molecules during facilitated diffusion, which otherwise wouldn't be able to diffuse into and out of cells. Carrier proteins also aid ~~xxx~~ active transport, which is essential for many processes ~~xxx~~ e.g. transmission of nerve impulses down a neurone. Proteins on the cell membrane are also essential for the regulation of entry of certain molecules - if this wasn't there harmful pathogens could enter cells. In addition, receptors like CD4 receptors on t-helper cells are a key part of the specific immune response which protects the body from disease.* On the other hand, the phospholipid bilayer is arguably equally important, as it acts as a physical barrier to things entering the cell which could be harmful. It is also permeable to some molecules, which can move through by ~~facilitated~~ diffusion down their concentration gradient. The membrane itself also creates a concentration gradient, which enables diffusion. Overall, both the proteins and the phospholipid bilayer are essential for the functioning of the cell.

*by binding to antigen-presenting cells.

(Total for Question 6 = 11 marks)

ResultsPlus

Examiner Comments

This was a Level 3 response and was given 8/9. In order to be marked as a Level 3 response the following aspects were looked for by examiners:

- **a number of examples of membrane proteins** - in this answer, the following were given: channel and carrier proteins - linked to movement across membranes and nerve impulse transmission, CD4 receptors - linked to binding to antigen presenting cells;
- **discussion of roles of both proteins and phospholipids** - in this answer, consideration has been made of controlling movement in and out of the cell, via facilitated diffusion, active transport and the role of the phospholipids in producing a barrier that allows concentration gradients to exist;
- **links made between proteins and phospholipids** - not so strong in this response and no mention of fluidity of phospholipid bilayer allowing exocytosis etc, therefore this was the element limiting the response to 8/9 instead of gaining full marks.

Question 7 (a)

Question 7 required candidates to use the information in the scientific article and their own knowledge to answer parts (a) to (k).

Generally, those who had studied the article in advance of the examination were able to apply their knowledge reasonably well to the contexts provided in the article.

Part (a) asked how 'the anaerobic respiration of methane' could be a 'key climate regulator'.

Candidates who understood the question did very well. However, many seemed confused by the mention of anaerobic oxidation and began to discuss how the methane would be broken down during respiration. Some described how it would be oxidised to give carbon dioxide that would increase global warming. Some candidates did not fully grasp the concept of the decomposition of methane and referred to this process being anaerobic and (somehow) therefore not releasing as much carbon dioxide which in turn has a less harmful impact on climate.

Most responses gained two marks for stating that methane was a greenhouse gas and that it trapped heat energy in the atmosphere. However, the removal of methane from the atmosphere and the subsequent reduction in global warming proved elusive to quite a few.

7 The scientific article you have studied is adapted from an article from '*The Scientist*'.

Use the information from the scientific article and your own knowledge to answer the following questions.

(a) Explain why the 'anaerobic oxidation of methane' could be a 'key climate regulator' (paragraph 2).

(3)

Methane is anaerobically oxidised which means without oxygen and therefore indicates a different climate of that area. These organisms can respire methane which must play a role in the climate of the area.

ResultsPlus
Examiner Comments

This answer was given 0/3. There is no indication that the candidate has linked methane and climate regulation to the greenhouse effect.

7 The scientific article you have studied is adapted from an article from '*The Scientist*'.

Use the information from the scientific article and your own knowledge to answer the following questions.

(a) Explain why the 'anaerobic oxidation of methane' could be a 'key climate regulator' (paragraph 2).

(3)

- Methane is one of the greenhouse gases
- Which contribute to global warming
- Would likely produce CO_2 rather than toxic carbon monoxide.



ResultsPlus

Examiner Comments

This answer gained 1/3 for identifying methane as a greenhouse gas.

7 The scientific article you have studied is adapted from an article from '*The Scientist*'.

Use the information from the scientific article and your own knowledge to answer the following questions.

(a) Explain why the 'anaerobic oxidation of methane' could be a 'key climate regulator' (paragraph 2).

(3)

methane is a greenhouse gas as it absorbs infrared radiation and traps in in the earths atmosphere, increasing the temperature of the earth. The anaerobic oxidation of methane is where an organism would break down methane in order to undergo anaerobic respiration. This decreases the amount of methane in the atmosphere or decreases the amount that could be released into the atmosphere. Thereby ~~prevents~~ removing the ~~ga~~ gas and inhibiting the greenhouse effect and by extension global warming, thereby regulating the climate.

ResultsPlus

Examiner Comments

This answer was given full marks 3/3. The marks could have been given as follows:

- methane is a greenhouse gas;
- which traps infra red radiation in the atmosphere;
- oxidation of methane decreases the amount in the atmosphere;
- inhibiting the greenhouse effect/global warming.

Question 7 (b)

This question asked for reasons why bacteria could be considered less complex than eukaryotes.

Surprisingly, not all responses gained full marks even though simple statements along the lines of 'no nucleus and no mitochondria' would have sufficed. Many mentioned bacteria being only single-celled and not contrasting it to multicellular eukaryotes and therefore failed to gain that mark. Indeed, many were let down by poor phrasing of their answers by referring to prokaryotes as having 'fewer organelles' than eukaryotes.

Many responses described all aspects of the differences between prokaryotes and eukaryotes, without focusing on the idea of complexity - for example, references to smaller ribosomes, which is not a reason for describing prokaryotes as less complex.

(b) Give reasons why 'humble microbes', such as bacteria, are considered less complex than eukaryotes (paragraph 4).

(2)

Bacteria and other microbes are single celled and have no membrane bound organelles. They have less complex metabolic systems than Eukaryotes.

ResultsPlus
Examiner Comments

This answer gained 1/2 marks - the mark awarded was for stating that the bacteria have no membrane-bound organelles. The candidate mentioned that bacteria are single-celled, but did not compare this with eukaryotes being able to be multicellular, so did not gain the second mark.

ResultsPlus
Examiner Tip

This question calls for a comparison between bacteria and eukaryotes to show how bacteria are less complex - so comparative statements are better.

(b) Give reasons why 'humble microbes', such as bacteria, are considered less complex than eukaryotes (paragraph 4).

(2)

They are always single celled instead of multi-cellular, they reproduce asexually and do not contain membrane-bound organelles or a true nucleus.

ResultsPlus

Examiner Comments

An excellent answer that gained full marks - 2/2. It clearly states that bacteria are single celled instead of multi-cellular, and they do not contain membrane-bound organelles or a true nucleus.

Question 7 (c)

This question asked for a definition of the phrase 'fix carbon into biomass'.

Most candidates appeared to be confounded by this question and just paraphrased the question, writing statements such as: 'fix carbon into biomass'. However, some candidates did make a link to the processes involved in photosynthesis, referring to carbon dioxide being incorporated into GP, GALP or glucose, with reference to the light independent reactions.

Some responses lost marks because there was no specific reference to inorganic carbon or carbon dioxide.

Many candidates appeared to have struggled with the idea that the process of carbon fixation resulted in the production of new biomass or increased the biomass of the organism by becoming part of it.

(c) State what is meant by the phrase 'fix carbon into biomass' (paragraph 4).

(2)

They allow carbon to be converted into glucose through the krebs cycle which is converted into biomass. They allow it to combine with coenzyme A to form acetyl coenzyme A and enter the krebs cycle.

ResultsPlus

Examiner Comments

This answer was given 0/2. Carbon on its own was insufficient - but even if this answer had mentioned inorganic carbon or carbon dioxide, it still would not have gained any marks as it describes processes of respiration and not photosynthesis.

(c) State what is meant by the phrase 'fix carbon into biomass' (paragraph 4).

(2)

- In the light independent stage of photosynthesis
- Carbon dioxide from atmosphere fixates with RuBP using RUBISCO (enzyme) to form GP. (3C).

ResultsPlus
Examiner Comments

This answer was given 1/2 marks. It was given a mark for a description of how carbon dioxide was fixed in the light independent stage of photosynthesis. However, there is no reference to how the GP produced then went on to become part of the organism's biomass.

(c) State what is meant by the phrase 'fix carbon into biomass' (paragraph 4).

(2)

During the Calvin cycle in photosynthesis, carbon dioxide is fixed onto RuBP (5C) using enzyme to catalyse reaction (RUBISCO). This produces GP (3C) which is reduced to GALP (3C) which is then converted into glucose (2/12 GALP) to make amino acids and protein which make up new biomass.

ResultsPlus
Examiner Comments

This gained 2/2 - one mark for fixation of carbon dioxide in the Calvin cycle to produce glucose, and one mark for going on to say that this was used to make amino acids and proteins which formed new biomass.

Question 7 (d)

This question required a description of the role of oxygen in respiration.

There were many good answers gaining 3 or 4 marks. However, there were many responses that approached the question at a more basic level, simply stating that, in the absence of oxygen, anaerobic respiration would occur and that it would produce less energy - this does not explain the role of oxygen, it just states what would happen if it was not present.

There were also a number of responses that discussed how oxygen is made available to cells, indicating that some had not separated the chemical process of respiration from the physical processes of ventilation and circulation.

Some also, incorrectly, referred to oxygen being required at other stages of respiration such as the link reaction and Krebs cycle.

Those that tackled the question with precision, usually referred to oxygen as the final electron acceptor - although a few just referred to protons and missed out the electrons - and the production of ATP. Many also referred to oxidative phosphorylation, with the least frequently seen point being the role of oxygen in oxidising the reduced coenzymes such as NAD and FAD.

Although many candidates did gain full marks, it seemed that most were just writing all they could remember about aerobic respiration without responding directly to the requirements of the question.

(d) Humans have a 'requirement for oxygen' (paragraph 5).

Explain the role of oxygen in human respiration.

(4)

Oxygen acts as the final electron acceptor at the end of the electron transport chain. If the oxygen was not presene, there would be a build up of H^+ ions in the ~~interes~~ interspace membrane and the electrons would not be able to undergo the series of redox reactions.

ResultsPlus

Examiner Comments

This answer was given 1/4 marks for stating that oxygen acts as the final electron acceptor at the end of the electron transport chain.

(d) Humans have a 'requirement for oxygen' (paragraph 5).

Explain the role of oxygen in human respiration.

(4)

The oxygen is the final electron acceptor @ in a electron transport chain at the final stage of respiration. the movement of electron allows H protons to be sent out of the mitochondria matrix into the inter membrane space and the high concentration in the inter membrane space would cause H^+ ~~@~~ to be moved back in into the matrix through a protein of ATP synthase and the movement of H^+ generates energy for the synthesis of ATP.

If oxygen is absent, then there will not be the final electron acceptor so less ATP is formed.

ResultsPlus

Examiner Comments

This was given 2/4 for stating that oxygen was the final electron acceptor and that it was needed for the formation of ATP.

(d) Humans have a 'requirement for oxygen' (paragraph 5).

Explain the role of oxygen in human respiration.

(4)

Oxygen is the final electron acceptor of the electron transport chain. It allows ~~other~~ electrons to ~~move through~~ ~~pass~~ pass through proteins to provide energy to pump H^+ ions across the mitochondrial membrane which generates a ~~chemios~~ electrochemical gradient that enables H^+ ions to ~~pass~~ diffuse through ATP synthase by chemiosmosis which produced ATP by oxidative phosphorylation of ADP. The movement of electrons through the ETC enables NADH and FADH to be oxidised and reused in glycolysis and the Krebs cycle of respiration.

ResultsPlus

Examiner Comments

This excellent answer was given 4/4 marks. Marks were awarded as follows:

- final electron acceptor;
- production of ATP;
- by oxidative phosphorylation;
- and enabled the oxidation of NADH and FADH.

Question 7 (e)

This question asked for an explanation of how the unfolding of enzymes made them ineffective at 60°C.

It was pleasing to see that many candidates appeared well practised at explaining the effects of temperature on enzymes, with many scoring full marks.

Most knew that unfolding of the enzyme happens due to the breaking of bonds, and many correctly identified these as hydrogen bonds. A small number incorrectly stated that peptide bonds would also be broken. Almost all candidates made reference to the enzyme being denatured or to a change in tertiary structure, with many explaining that this would result in changes to the shape of the active site. Additionally, the consequences of this were well described.

Although most candidates did well on this question, it should be noted that it is more accurate to state that the shape of the active site is changed than to suggest that the 'active site becomes denatured'.

(e) Explain how the unfolding of the enzymes in *E. coli* makes them 'become ineffective at 60 °C' (paragraph 12).

(3)

The protein is denatured. This causes the active site to change shape. The active site is very specific to the substrate. This change of shape means it can no longer form an enzyme-substrate complex and catalyse reactions.

ResultsPlus

Examiner Comments

This response was given 2/3 marks for change in shape of the active site, meaning that enzyme-substrate complex could not form.
Reference to the protein denaturing was not quite enough for a mark - the candidate should have referred to the enzyme being denatured.

(e) Explain how the unfolding of the enzymes in *E. coli* makes them 'become ineffective at 60 °C' (paragraph 12).

(3)

The enzymes are ineffective because their active sites have denatured. The high temperatures of 60°C have caused the bonds (ionic, hydrogen and disulphide) in the tertiary structure to break. This changes the 3D structure, which means the active site is a different shape and it is no longer complementary to its substrate, so the enzyme-substrate complexes cannot be formed.

ResultsPlus
Examiner Comments

This answer was given 3/3 marks as follows:

- change in 3D shape;
- change in shape of active site;
- enzyme no longer able to form enzyme-substrate complex.

ResultsPlus
Examiner Tip

The sentences about bonds being broken would not gain a mark as this was not linked to the unfolding. Also, the disulphide bonds would not be broken. The enzyme is denatured rather than the active site. However, this candidate has written enough to gain 3 marks despite the statements that were not quite worth awarding marks to.

Question 7 (f)

What seemed to be a straightforward question asking for a definition of genome proved more difficult than anticipated.

It could be seen from this question that the use of correct scientific terminology needs to be emphasised. Terms like 'gene', 'DNA' and 'exons and introns' need to be clearly distinguished.

Many responses were imprecise in defining the 'genome' or used the wrong words, with many vaguely referring to 'all the genes in the DNA' - unaware that the genome consists of both coding and non-coding DNA.

Candidates generally failed to understand the difference between genes and DNA: many seemed to believe that the genes were in the genome and that only those were important. Very few mentioned introns and exons. Indeed, recent research has pointed out that the introns, previously thought of as 'rubbish DNA', may play a very important role in the organism's life.

Some answers described a thermophile rather than a genome and others attempted both.

However, many did elaborate on their answers and eventually got the definition right even though only a minority of responses presented definitions or explanations that contained the words 'exons' and 'introns'.

(f) State what is meant by the genome of a thermophile (paragraph 14).

(1)

The genome of a thermophile is the thermophiles whole genetic gene sequence. Where the gene sequence involves genes that code for a protein

ResultsPlus
Examiner Comments
No mark could be given for this answer that only mentions genes.

(f) State what is meant by the genome of a thermophile (paragraph 14).

(1)

The genetic material, all it's DNA, of the organism.

ResultsPlus
Examiner Comments
One mark for 'all its DNA, of an organism'.

Question 7 (g)

This question required the discussion of natural selection in the context of the adaptations to a particular selection pressure described within the scientific article. Interestingly there were two distinct approaches to this question observed - candidates tended to either discuss natural selection in general terms, or the specific adaptations of the thermophiles. Rarely were both aspects seen in a response, so few scored full marks for this question.

Those who discussed natural selection processes referred to random mutations and high temperature as a selection pressure - although some were caught out by the common misconception that the selection pressures bring about the mutations. Many went on to correctly explain that those with advantageous alleles survived to reproduce and pass on the allele to future generations – even though some responses did refer to sexual reproduction, but this was ignored if the concept of passing on the allele was clear.

Concerning the adaptations described in the article, a lot of responses did refer to the development of heat stable enzymes, although many did not appreciate that the cysteine was an amino acid that provided the disulphide bridges responsible for making the **protein/ enzyme** molecule more stable.

(g) Explain how cyanobacteria evolved to 'handle high temperatures' (paragraphs 14 and 15).

(5)

The sulfur containing cysteine amino acids ~~of~~ positioned strategically within the protein structures, it can resist unfolding so enzymes will not denature (due to high temps). there are also other adaptations such as the simple protein folds and fewer hard metal ions which act as another guard against molecular destabilisation in face of thermal stress.

Some thermophilic enzymes have larger hydrophobic cores, away from protein active site and it acts as additional give to fight thermal destabilisation. they are 'heat stable' enzymes so they still function ~~and~~ as active site is not disrupted, disulphide and ionic bonds remain intact.

ResultsPlus
Examiner Comments

Better answers did not just copy out sentences from the article, but showed that the candidates understood the science and were able to apply it to their knowledge of enzyme structure and evolution by natural selection.

(g) Explain how cyanobacteria evolved to 'handle high temperatures' (paragraphs 14 and 15).
(5)

The sulfur containing cysteine amino acids ~~of~~ positioned strategically within the protein structures, it can resist unfolding so enzymes will not denature (due to high temps). there are also other adaptations such as the simpler protein folds and fewer bound metal ions which act as another guard against molecular destabilisation in face of thermal stress.

Some thermophilic enzymes have larger hydrophobic cores, away from protein active sites and it acts as additional give to fight thermal destabilisation they are 'heat stable' enzymes so they still function ~~and~~ as active site is not disrupted, disulphide and ionic bonds remain intact.

ResultsPlus
Examiner Comments

This answer gained 3/5 marks. It focused on the adaptations of the thermophiles to high temperatures rather than the process of natural selection. Marks were given for the following:

cysteine in proteins;
allows them to resist unfolding (same marking point as heat stable enzymes - also mentioned);
simpler protein folds to resist thermal stress (same marking point as enzymes with large hydrophobic cores - also mentioned).

Without reference to the process by which the cyanobacteria could evolve, it was not possible to gain full marks for this question.

(g) Explain how cyanobacteria evolved to 'handle high temperatures' (paragraphs 14 and 15).

(5)

mutations in the thermophile's genome meant that their enzymes had thermal stability with adaptations such as strategically placed cysteine amino acids and enzymes with larger hydrophobic cores. This mutation's adaptations that were introduced provided an advantage in surviving the harsh thermal selection pressures of the hot springs. These cyanobacteria were more likely to survive the harsh conditions, and therefore were more likely to reproduce and produce offspring to which they may have passed this advantageous allele on to. Over time, the allele frequencies for the more heat-stable enzymes (and also for things like simpler protein folds / fewer bound metal ions) would have increased within the population of cyanobacteria, and therefore they evolved to handle the high temperatures in their habitats.

ResultsPlus

Examiner Comments

This is an excellent answer that takes into account both the adaptations described in the article and the process of evolution. It was given 5/5 marks as follows:

- reference to mutations (in the thermophile's genome);
- resulted in enzymes with thermal stability (heat stable enzymes specifically mentioned towards the end of the response);
- enzymes with larger hydrophobic cores;
- harsh thermal selection pressures of hot springs;
- ability to survive, reproduce and pass on advantageous allele to 'offspring'.

Question 7 (h)

This question simply asked for a description of the 'structure of the protein-synthesis machinery in bacteria', but it seemed to confuse many.

Most candidates recognised that this question was referring to a ribosome, but very few went on to 'describe the structure' as asked in the question. Furthermore, many thought that it consisted of mRNA or simply said RNA and almost no candidates mentioned the correct answer of rRNA (ribosomal RNA).

Many did score one mark by stating that ribosomes were used to synthesise proteins. Some also scored a mark for describing the ribosome as comprising a large and small subunit.

Worryingly, despite the question concerning prokaryotes, candidates also frequently listed membrane-bound organelles that would be involved in protein synthesis in eukaryotes, demonstrating that they are not focusing on what the question is asking them and just homing in on reference to 'protein synthesis'.

(h) Describe the structure of the 'protein-synthesis machinery' in bacteria (paragraph 20).
(2)

The protein-synthesis machinery is the ribosome and its 70S.

ResultsPlus
Examiner Comments
One mark for this answer for ribosome.

(h) Describe the structure of the 'protein-synthesis machinery' in bacteria (paragraph 20).
(2)

The protein-synthesis machinery in bacteria consists of 70s ribosomes. These ribosomes consist of a smaller subunit and a larger subunit. The larger subunit is 40s and the smaller subunit is 30s.

ResultsPlus
Examiner Comments
An excellent answer gaining 2/2 for ribosomes made of a larger and a smaller subunit.

Question 7 (i)

This question asked how the production of antibiotics by one species of bacteria can reduce interspecific competition – hence testing knowledge and understanding of both competition between species and the mechanisms by which antibiotics work.

This question was not answered well, with a range of responses indicating that the question had not been read carefully, quite a few referring to antibodies instead of antibiotics, and some describing *Streptomyces* as having an immune system. Some confused interspecific with intraspecific competition and few referred to resources that the different species of bacteria could be competing for.

Better answers did make reference to how antibiotics work, with some linking damage to cell walls with lysis and others linking interference with protein synthesis with bacteriostatic effects.

It was also surprising that very few responses made the simple statement that the antibiotics produced would reduce the numbers of other species of bacteria.

Reading of the scientific article in preparation for the exam should have made candidates aware of the fact that *Streptomyces* was a species of bacteria and that it was in competition with *Cyanobacteria* for limited resources.

(i) Explain how the production of antibiotics by *Streptomyces* species can reduce interspecific competition (paragraph 20).

between different (3)

The antibiotics reduces competition between different species. There will be less competing for resources, such as space and nutrients.

ResultsPlus

Examiner Comments

This gains 1/3 for reference to reduced competition between different species for resources such as nutrients.

(i) Explain how the production of antibiotics by *Streptomyces* species can reduce interspecific competition (paragraph 20).

(3)

Antibiotics released by Streptomyces into the surrounding area / tissue will kill any bacteria close to it by disrupting its cell membrane, or destroying its cell wall, both causing lysis. Or the antibiotics will prevent the reproduction of the bacteria by preventing protein synthesis, transcription and translation. Therefore, the number of bacteria will decrease and competition will reduce.

ResultsPlus

Examiner Comments

This answer gained full marks. One mark for causing lysis by disrupting cell walls, one for preventing reproduction by preventing protein synthesis (and therefore growth) and one for stating that the number of bacteria would decrease.

Question 7 (j)

This question asked for one difference in the structure of pyruvate and the acetyl group in acetyl CoA - and the answer required was 3 carbons compared to 2 carbons. Although many referred to there being 2 carbons in acetyl CoA, this was accepted - even though there are 21 carbons in the coenzyme, as it was taken that the candidates were referring to the acetyl group as stated in the question.

Although most candidates got the mark, some missed out by referring to pyruvate having '1 more carbon' without stating the correct numbers. Some got the numbers of carbon atoms wrong and others confused these molecules with the intermediate compounds of the Krebs cycle. Others clearly demonstrated that they understood that carbon dioxide and hydrogen ions were removed during the link reaction, but then made incorrect deductions about the structural differences.

(j) Pyruvate is one of the products of glycolysis (paragraph 20).

State one difference between the structure of pyruvate and the structure of the acetyl group in acetyl CoA.

(1)

Pyruvate is ~~made of~~ a 3 carbon compound whereas acetyl CoA is a 5 carbon compound.

ResultsPlus
Examiner Comments

No mark for this answer, as it incorrectly described acetyl CoA as being a 5 carbon compound.

(j) Pyruvate is one of the products of glycolysis (paragraph 20).

State one difference between the structure of pyruvate and the structure of the acetyl group in acetyl CoA.

(1)

Pyruvate is a 3-carbon compound while acetyl is only a 2-carbon compound.

ResultsPlus
Examiner Comments

This gained 1/1 for correctly stating that pyruvate is a 3-carbon compound and acetyl is a 2-carbon compound.

Question 7 (k)

This question assessed an understanding of the dormancy of *Mycobacterium tuberculosis* as studied in Topic 6 of the specification and the ability to compare and contrast it with the dormancy described for *Bacillus subtilis* as described in the pre-released scientific article. Bearing in mind that the command phrase '**compare and contrast'** requires descriptions of both similarities and differences, this could only be well attempted by candidates who had revised the relevant topics and studied the article.

Despite being asked to compare the dormancy of the two species, most candidates discussed the stages either before or after dormancy, with very little discussion of the distinguishing features of the dormancy period for each species.

Many responses made references to reasons for coming out of dormancy rather than entering it.

Good answers did refer to both species of bacteria forming capsules, lack of metabolic activity and the different reasons for entering dormancy. Some overlooked formation of a capsule for *Mycobacterium* and focused on it remaining inside phagocytes. Many attempted to explain why both would enter dormancy but answers often lacked detail or correct information.

It was frequently observed that many candidates just regurgitated the contents of the scientific article and it appeared that, although they may have read it, they had not understood the important points. This made it very difficult for many to introduce the vital comparative element to their responses and many wrote about aspects of each organism separately. Some of those with a better understanding of the facts unfortunately failed to use clear, precise language to demonstrate this.

It appeared that the scientific article information was not well understood by many candidates. This could be because they had not spent sufficient time properly analysing the article after it had been released and before the exam, or that lack of exposure to this level of writing simply meant that they were not capable of drawing out and understanding the key and salient points. However, the pre-released scientific article had been an element of the previous specification, so is not completely new to the reformed A-level.

(k) *Bacillus subtilis* 'initiate a hibernation protocol' (paragraph 25).

Mycobacterium tuberculosis can also become dormant for long periods of time.

Compare and contrast the dormancy of these two species of bacteria.

(4)

Bacillus subtilis replicates its genetic material & packages it into a protective ~~capsule~~ capsule, whereas ~~myco~~ mycobacteria tuberculosis ~~does~~ has a thick cell wall that resists lysing by ~~lysozyme~~ * lysozyme in lysosomes, so it is sealed off in a tubercule where it can survive anaerobically.

Similarly though, B. subtilis' protective capsule does protect it from the immediate environment & both organisms wait until ideal conditions to ~~reactivate~~ 'reactivate', B subtilis so it can survive ~~reproduce~~, while

(Total for Question 7 = 30 marks)

TOTAL FOR PAPER = 100 MARKS

M. tuberculosis to infect the body during times of decreased immunity e.g. with HIV/AIDS.

Both wait out extreme conditions, but M. tuberculosis' protection has evolved in response to direct attack from the immune system (avoiding detection by effecting Antigen presentation/ ~~activation~~ while B. subtilis ~~is~~ is less prone to lack of resources.

* during phagocytosis

ResultsPlus

Examiner Comments

This answer gained 3/4 for the following points:

- both form a protective capsule;
- *Bacillus* packages genetic material in capsule;
- *Mycobacterium* enters dormancy to avoid the immune system and *Bacillus* in response to a lack of resources.

Paper Summary

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

- make sure that all core practicals are studied in preparation for this examination;
- read all the information provided – especially where practical procedures are being described in unfamiliar contexts;
- learn the command words and the types of answers expected;
- read the whole question, identify the command word and the context;
- set out calculations carefully – show each stage of your working, in case a mistake is made at the final step;
- attempt every question – time permitting, always at least make an educated guess and read the stem of the question carefully as there is often helpful information in there that might help;
- add specific, precise details – do not expect the examiners to fill in the gaps for you!
- use bullet points if it helps you organise your answers to questions requiring longer responses – but make sure the statements contain details and are not too brief.

Grade Boundaries

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

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