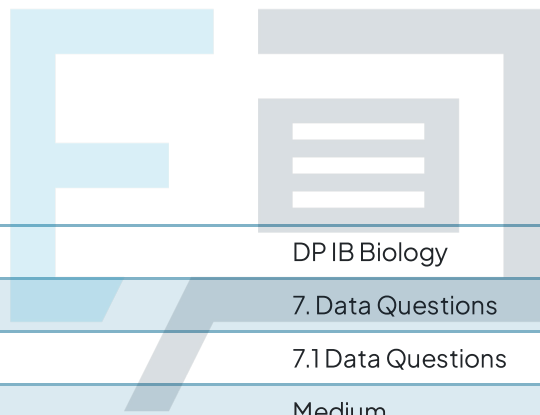


7.1 Data Questions

Mark Schemes



Course	DP IB Biology
Section	7. Data Questions
Topic	7.1 Data Questions
Difficulty	Medium

Exam Papers Practice

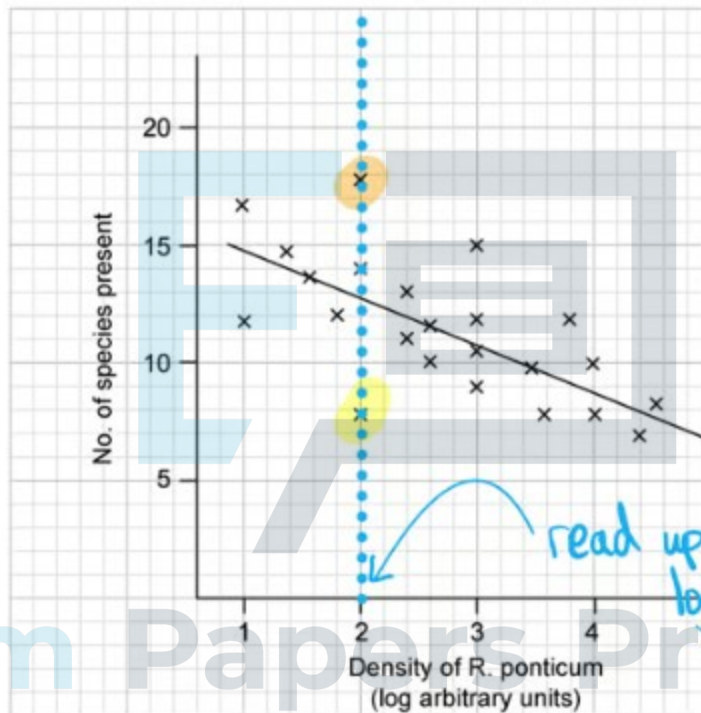
To be used by all students preparing for DP IB Biology SL
Students of other boards may also find this useful

1a

a) The range of species found at a *ponticum* density of 2 log arbitrary units is...

- $(18 - 8) = 10$; [1 mark]

[Total: 1 mark]



lowest no. of species found = 8

highest no. of species found = 18

Range = highest - lowest

$$= 18 - 8 = 10$$

[1 mark]

1b

b) The % vegetation cover can exceed 100% in a given area because...

- Plants grow in storeys / at different heights/levels so they can overlap; [1 mark]

[Total: 1 mark]

Plants grow at various heights so a vertical line drawn up from any point on the ground may encounter several species of plant in the understorey and the canopy. This can cause a % vegetation cover value greater than the overall land area of the quadrat concerned, especially if there is little or no bare ground in that area.

1c

c) A log scale is used to show the density of *ponticum* in the graphs because...

- (A log scale) captures large ranges of densities OR allows accurate plotting when densities are factors of 10/orders of magnitude different; [1 mark]

[Total: 1 mark]

A log scale will be able to compress (into one easy-to-read scale) values of plant density that are powers of 10 different, eg. 5 plants per hectare versus 5 000 plants per hectare on the same scale.

1d

d) The decline in the number of species found as the density of *R. ponticum* increases can be explained by...

Any **one** of the following:

- *R. ponticum* outcompetes other plants, reducing plant biodiversity; [1 mark]
- Prevalence of *R. ponticum* creates lower variety of habitats for animals eg. insects, invertebrates, birds; [1 mark]

[Total: 1 mark]

1e

e) Two ways in which *R. ponticum* could affect competition are...

Any **two** of the following:

- *ponticum* releases toxins into the soil that poison other plants; [1 mark]
- *ponticum* acts as a host for / provides a habitat for plant pathogens; [1 mark]
- *ponticum* overshadows other plants / takes available light; [1 mark]
- *ponticum* is better adapted to absorb soil minerals; [1 mark]

[Total: 2 marks]

R. ponticum is known to be a fast-growing plant and its presence in dense thickets suggests that it is well adapted to competing for light, space and nutrients. Animal species that rely on native plant species for food and habitat are pushed out as their hosts are outcompeted. Other means of competing with other plants could be to release toxins that make the soil uninhabitable to native species, and the harbouring of plant pathogens (like ash dieback) that can increase the competitive advantage of *R. ponticum*.

1f

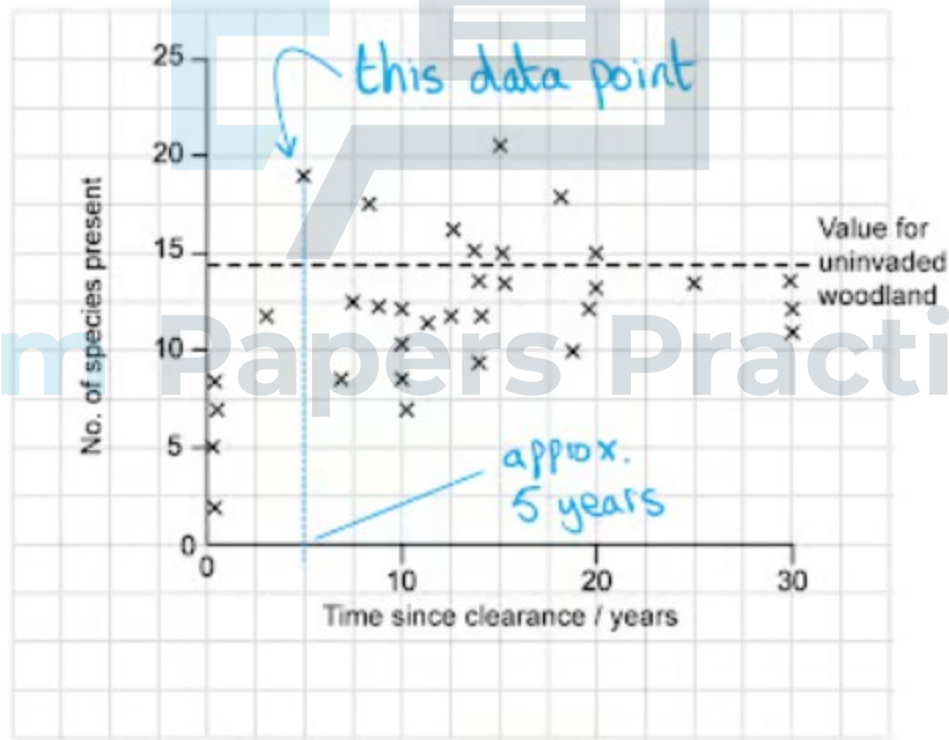
f) The number of years before the number of species found on cleared land first exceeded the number of species found in uninvaded woodland was...

- 5 years; [1 mark]

Allow 4 - 6 years inclusive

[Total: 1 mark]

The data point in question is the first point (reading left-to-right) that lies above the horizontal line. Read down from that point to the x-axis = 5 years.



1g

g) i) The clearance of *R. ponticum* can affect the recovery of the woodland as the data collected showed that the:

- Number of species present recovers (to levels comparable with uninvaded sites) after around 20 years; [1 mark]
- Percentage cover (generally) did not recover to levels of uninvaded sites; [1 mark]

ii) Suggested reason for the impact observed are:

One of the following:

- *R. ponticum* releases toxins into the soil that can poison other plants; [1 mark]
- Certain species of plant are affected more than others by the legacy of *R. ponticum*; [1 mark]

[Total: 3 marks]

The two curves show differing patterns, in that the percentage cover did not recover to levels that would have been seen prior to the invasion of *R. ponticum*. This is likely because there were not multiple overlapping layers of vegetation, despite the numbers of species having recovered to pre-invasion levels. One theory is that *R. ponticum* leaves a toxin in the soil that resists the growth of certain other species. Some species of native plants will be more susceptible to such toxins than others.

1h

h) (i) The species that was sampled on the fewest sites when the *R. ponticum* growth was densest was...

- Small cow wheat / *Melampyrum sylvaticum*; [1 mark]

(ii) This data shows that the prospects of growth of broadleaf carpet grass (*Axonopus compressus*) on cleared land following an *R. ponticum* invasion were...

- ...lowered/harmed by the invasion of *R. ponticum*, even on cleared land; [1 mark]
- (Because) only 2 seeds were found on cleared land; [1 mark]

[Total: 3 marks]

Because the ungerminated seeds of broadleaf carpet grass were found in abundance in uninvaded land, this suggests that the species can thrive in the absence of the invader. However, the soil in the presence of the invader, or even the soil after clearance, does not harbour as many seeds of broadleaf carpet grass, suggesting that broadleaf carpet grass has suffered long-term effects of the invasion and is no longer able to find its niche in cleared land.

1i

i) The species that benefited most from the clearance of *R. ponticum* from Atlantic coastal woodland is...

- European poplar / *Populus tremula*; [1 mark]

Suggested reason [maximum 1 mark]

- Ungerminated *P. tremula* seeds found on all 30 sites yet completely outcompeted in dense thickets of *R. ponticum* growth; [1 mark]
- The high number of poplar seeds found in all soils (2,959) suggests European poplar was the predominant tree species prior to *R. ponticum* invasion; [1 mark]

[Total: 2 marks]

It makes sense that another over-topping tree species such as poplar would take the place of cleared *R. ponticum* as the woodland recovers from the invasion. Even in densely-covered thickets of *R. ponticum*, poplar seeds lie dormant in the soil and can germinate when the overground conditions allow it, following *R. ponticum* clearance (light intensity will be a major factor).

2a

a) The growth conditions that gave the most favourable yield of sweet potatoes in this study were...

- 20 cm spacing **AND** 35 gm⁻² urea addition; [1 mark]

[Total: 1 mark]

'Most favourable' from the point of view of an agriculturalist/farmer usually means the greatest yield with the lowest input of cost. In this case, it isn't the lowest cost, because urea would need to be added at an intermediate level (35 gm⁻²), but the yield is very strong (5 times that of using a lower urea addition rate). It also shows that planting seedlings closer together does not necessarily improve yield, likely due to competition between plants for soil minerals and/or sunlight.

2b

b) The relationship between the mean underground dry mass and the mean crop yield of sweet potatoes in this study was...

- A positive correlation / as dry mass increased, yield increased; [1 mark]

[Total: 1 mark]

2c

c) Underground dry mass is used as an indicator of crop yield in this study because...

One of the following:

- Sweet potato is a root vegetable; [1 mark]
- The root vegetable portion of the sweet potato crop is the desired/cultivated part in farming, so will form part of the underground dry mass; [1 mark]

[Total: 1 mark]

Exam Papers Practice

2d

d) Similarities between increasing spacing and urea addition...

Two of the following:

- (crop yields) both increase from lowest to middle level **AND** decrease from middle level to highest level; [1 mark]
- The middle level (of each) gives the best crop yield results; [1 mark]
- Both have an optimum level / can be too low or too high; [1 mark]

Differences between increasing spacing and urea addition...

One of the following:

- Increasing spacing from 16 to 20 cm has a much bigger effect (on yield) than increasing urea from 30 to 35 gm^{-2} ; [1 mark]
- Spacing doesn't (significantly) affect underground mass per plant but affects yield; [1 mark]

[Total: 3 marks]

Exam Papers Practice

2e

e) A reason why the choice of units of crop yield quoted in this study (tonnes per hectare) was not an appropriate one is...

Any **one** of the following:

- Plots were very small, not representative of conditions in a field on an agricultural scale; [1 mark]
- Measurements only made in grammes / units in tonnes per hectare; [1 mark]

A reason can be...

Any **one** of the following:

- Difficult to extrapolate from such a small-scale study to predict crop yields in tonnes per hectare; [1 mark]
- Root crops may grow larger at a later stage of the plant's life cycle, so predicted yields measured after 175 days may be artificially low; [1 mark]

[Total: 2 marks]

One hectare is a large area of $10\,000\text{m}^2$, which is approximately 2 soccer fields, whereas this study was conducted in small plots of only 1.5m^2 area, which is about the size of a typical office desk. It's not necessarily appropriate / accurate to extrapolate from such small units to large ones without considering the effects of this change of scale. To be more reliable, larger plot areas would need to be tested and measured to take into account the effects of factors such as weather, land drainage, competition from other species etc.

2f

f) Statements to support the scientists' conclusion...

At least **one** of the following:

- No (incremental) yield benefit / drop in yield from increasing from 35 to 40 gdm⁻² urea; [1 mark]
- (Extra urea generates...) more growth of biomass above ground (both fresh and dry masses, and leaf length data show this; [1 mark]
- The plants allocated more nitrogen towards the growth of the stems/shoots/leaves above ground than the (underground) root vegetable tissues; [1 mark]

Statements against the scientists' conclusion...

At least **one** of the following:

- There is no additional data here on mean underground biomass, which is closely related to crop yield; [1 mark]
- No large-scale field tests have been conducted; [1 mark]
- There is no economic consideration/cost benefit analysis presented; [1 mark]

[Total: 4 marks]

'Evaluate' questions require both sides of an argument, in this case, reasons why their conclusion might be valid, but also limitations to their conclusion that might warrant further research to provide clarity. The crop of sweet potato planting is the underground root tissue; farmers are not interested in excess growth of the plant's above-ground tissues, over and above what is required to promote maximal growth of the root vegetable under the soil. Farmers are like business people in other markets, interested in maximising profit, so a cost consideration is essential before making a recommendation that a farmer is likely to accept / put into effect.

3a

a) The reason for having a group treated with no EDTA was...

- To act as a control group **OR** to allow a comparison between the groups; [1 mark]

[Total: 1 mark]

The use of a control group is an important feature of many investigations as it provides a baseline to compare the results to in order to demonstrate the effect of the independent variable. It is different from a control variable which is a methodological variable which must be kept constant in each repeat of the experiment in order to ensure that only one independent variable is being tested.

3b

b) The percentage difference between the number of bacteria in the sample treated with EDTA and the number of bacteria in the untreated sample was:

- $(3 \div 4) \times 100$
- 75 %; [1 mark]

[Total: 1 mark]

3c

c) EDTA has the following effect on the growth of bacteria:

Any **two** of the following:

- EDTA reduces the growth of bacteria **OR** proliferation / cell division (over the first 5 days); [1 mark]
- Growth of cells is measured in number but doesn't indicate actual growth of cells; [1 mark]
- The number of cells in day 5 is less than day 4 (suggesting it has a greater effect after this time); [1 mark]
- Very little growth in the first few days compared to control (no EDTA); [1 mark]
- No data after 5 days; [1 mark]

[Total: 2 marks]

3d

d) The least effective antibiotic was...

- Amoxicillin; [1 mark]

[Total: 1 mark]

The % antibiotic resistance was shown to be the highest for amoxicillin across all years studied. This indicates that *E.coli* have evolved with mutations which make amoxicillin ineffective as a treatment.

3e

e) The antibiotic resistance of the antibiotics studied can be compared as follows...

Any **two** of the following:

- All antibiotics show an increase in resistance from 2002 to 2012 **OR** % antibiotic resistance peaked for all 4 antibiotics in 2012; [1 mark]
- Amoxicillin has the highest level of resistance across all dates; [1 mark]
- Pivmecillinam showed the smallest level of resistance in 2012 (compared to the other three antibiotics); [1 mark]
- Tetracycline decreased in % resistance between 2002 and 2005; [1 mark]
- EDTA and pivmecillinam have similarly low trends / % levels of resistance between 2002 and 2005; [1 mark]

[Total: 2 marks]

When comparing data from graphs such as this, it is important that all points made in the answer are direct comparisons and use comparative words e.g. 'Amoxicillin has the **highest** level of resistance across all dates', **rather than**, 'Amoxicillin has high levels of resistance across all dates'.

3f

f) EDTA could be considered the best antibiotic because...

One from the following:

- EDTA reduces the number of cells over a 5 day period; [1 mark]
- EDTA shows low levels of resistance; [1 mark]

EDTA, however, could be considered not the best antibiotic to treat *E.coli* because...

Any **two** of the following:

- Resistance has increased in recent years; [1 mark]
- Pivmecillinam hydrochloride shows similarly low levels of resistance; [1 mark]
- There are more side effects associated with EDTA compared to pivmecillinam hydrochloride; [1 mark]
- Data is only available for growth over 5 days, longer term data not available; [1 mark]

[Total: 3 marks]

'Evaluate' questions require a consideration of all supporting and non-supporting bits of evidence provided. This may include comments on the validity of a method which may cast a shadow of doubt on the statement being evaluated.

3g

g) Some methods that could be used to help reduce the development of antibiotic resistance are as follows:

Any **two** of the following:

- Reduced prescription of antibiotics; [1 mark]
- Reducing the use of antibiotics in agriculture; [1 mark]
- Only prescribing antibiotics for bacterial infections; [1 mark]
- Complete the whole course of antibiotics; [1 mark]

[Total: 2 marks]

Exposure of bacteria to antibiotics gives a selection pressure where those which have a level of resistance will survive and reproduce. The risk of antibiotic resistance developing is emphasized by incorrect use of antibiotics e.g. if an individual taking antibiotics starts to feel better and stops taking the medication before the course is complete, it is possible that the harmful bacteria haven't been completely eliminated and the remaining bacteria are those which exhibit a level of resistance to the antibiotic. Reproduction of these resistant forms can result in a population of resistant bacteria.

Exam Papers Practice

4a

a) The most highly trained athlete from the study is . . .

- Athlete number 1; [1 mark]

[Total: 1 mark]

- Person 1: The ratio of heart rate to blood lactate is the highest for this individual which means they have achieved a high heart rate whilst maintaining a low level of lactate.
 - Ratio = $156 \div 1.8 = 86.7$

Individual	Blood Lactate mol / L	Average V_E L / min	Heart Rate min^{-1}
1	1.8	60.10	156
2	2.8	83.10	163
3	4.9	79.80	148
4	5.0	88.90	152
5	9.5	148.00	184

Calculate the ratio of heart rate to blood lactate

Person 1 = $156:1.8 = 156/1.8 = 86.7:1$

Person 2 = $163:2.8 = 163/2.8 = 58.2:1$

Person 3 = $148:4.9 = 148/4.9 = 30.2:1$

Person 4 = $152:5.0 = 152/5.0 = 30.4:1$

Person 5 = $184:9.5 = 184/9.5 = 19.4:1$

→ Person 1 has the highest ratio of heart rate to blood lactate which shows they can maintain low lactate even with a high heart rate.

[1 mark]

4b

b) The relationship between training, maximum V_E and V_E variability can be described as follows. . .

Any **two** of the following:

- V_E variability is higher in untrained individuals than trained individuals; [1 mark]
- Maximum V_E is higher in trained athletes than untrained individuals; [1 mark]
- Trained athletes show a smaller ratio of V_E variability compared to the maximum V_E than the untrained athletes; [1 mark]
- Trained athletes show a much lower V_E variability than the maximum V_E for an athlete that is training; [1 mark]

[Total: 2 marks]

When analysing the data from graphs make sure to check the scales of the axes as the units may be different, as is the case in this question.

4c

Any **three** of the following:

c) Individuals **3** and **4** could be considered equally as fit because. . .

- They have a similar ratio of lactate to heart rate; [1 mark]
- They are both able to maintain a similar heart rate at a similar level of blood lactate; [1 mark]

Individuals **3** and **4** may not be considered equally as fit because. . .

- The average V_E of person 3 is lower than of person 4; [1 mark]
- We don't have any information about the maximum V_E or the variability of V_E for individuals 3 and 4; [1 mark]
- There may be other confounding factors / name confounding factor e.g. age, health conditions, diet, length or type of exercise; [1 mark]

[Total: 3 marks]

4d

d) The lactate levels in the control group can be compared to the GM mice group as follows. . .

Any **two** of the following:

- Lactate levels start off initially at the same level in both groups (2.5 mM); [1 mark]
- Lactate levels are higher in the control group than the GM mice group throughout the whole 90 minutes; [1 mark]
- Initially (up until 10 minutes) lactate levels rose faster in the GM mice group than in the control group; [1 mark]
- After 10 minutes, lactate levels in the GM mice group levels off **WHEREAS** lactate levels in the control group continue to rise: [1 mark]
- Blood lactate levels decrease in both groups from 30 to 90 minutes; [1 mark]
- Blood lactate levels decrease at a similar rate in both groups after 30 minutes; [1 mark]

[Total: 2 marks]

When comparing data from graphs such as this, it is important that all points made in the answer are direct comparisons and use comparative words e.g. 'Lactate levels are **higher** in the control group than the GM mice group' **rather than**, 'Lactate levels are high in the control group'.

4e

e) The evidence can be evaluated as follows:

Allow **one** mark for correctly quoted data, for example:

- The maximum lactate level in GM mice was around 12.5mM compared to the control group which had a maximum lactate level of 20mM **OR** the maximum lactate level in the control group was 7.5mM higher than the maximum lactate level of the GM mice

The following evidence supports the use of protein X in the treatment of diabetes. . .

Allow up to **one** from the following:

- Lactic acid is formed from lactate so high blood lactate may result in high levels of lactic acid; [1 mark]
- GM mice showed lower levels of lactate; [1 mark]
- Data is significant because the error bars do not overlap; [1 mark]

The following evidence does not support the use of protein X in the treatment of diabetes. . .

Allow up to **one** from the following:

- The study period was short so long term effects are unknown; [1 mark]
- Mice were genetically modified to produce protein X, this would not be possible in humans **OR** the study was carried out on mice and not humans; [1 mark]
- No studies to show the effect of protein X on lactate levels in diabetics; [1 mark]

[Total: 3 marks]

'Evaluate' questions require a consideration of all supporting and non-supporting bits of evidence provided. This may include comments on the validity of a method which may cast a shadow of doubt on the statement being evaluated.

4f

f) Increasing V_E helps to reduce the risk of lactic acidosis because...

Any **two** of the following:

- Increased V_E results in increased intake of oxygen; [1 mark]
- (So) more oxygen is delivered to respiring tissues; [1 mark]
- Oxygen is used to breakdown lactic acid into CO_2 and water; [1 mark]
- This results in reduced lactic acid levels (therefore reducing the risk of lactic acidosis); [1 mark]

[Total: 2 marks]

The breakdown of lactic acid into carbon dioxide and water requires oxygen. The amount of oxygen required to break down the lactic acid is called the oxygen debt. During exercise, increased ventilation is important to minimise and pay off the oxygen debt in order to prevent excess lactic acid build up.

5a

a) The biome which shows the slowest rate of decomposition is the...

- Boreal Forest; [1 mark]

[Total: 1 mark]

5b

b) A biotic factor which may impact decomposition rates...

Any **one** of the following:

- Microbial activity **OR** presence of decomposers/saprotrophs/detritivores / named decomposer ; [1 mark]
- (Quality of dead material due to) variety/types of species present in the ecosystem; [1 mark]

[Total: 1 mark]

Biotic factors include all the living components of the ecosystem.

5c

c) Two compounds which contain carbon and are found in plants include. .

Any **one** of the following:

- Nucleic acids / DNA; [1 mark]
- Proteins / named protein; [1 mark]
- Fats/lipids / named lipid; [1 mark]
- Carbohydrates / named carbohydrate; [1 mark]

[Total: 1 mark]

5d

d) The differences between the rates of nitrogen cycling in all three forests are...

- One cycle of decomposition occurs fastest in the tropical rainforest and slowest in the boreal forest **OR** the rate of nitrogen cycling occurs fastest in the rainforest, then the mediterranean forest and slowest in the boreal forest; [1 mark]
- Any correct comparative use of figures e.g. decomposition takes 98.7 years longer in a boreal forest compared to a tropical rainforest ; [1 mark]

[Total: 2 marks]

5e

e) The relationship between primary productivity and decomposition rates can be described as follows...

Any **two** of the following:

- NPP increases whilst decomposition rate decreases / there is negative correlation; [1 mark]
- Boreal Forest has the lowest NPP **AND** the slowest rate of decomposition; [1 mark]
- Tropical Rainforest has highest NPP **AND** fastest rate of decomposition; [1 mark]

[Total: 2 marks]

5f

f) The abiotic factor which gave the biggest change in the rate of decomposition was. . .

- Temperature; [1 mark]

[Total: 1 mark]

5g

g) The effects of different abiotic factors on decomposition can be compared as follows. . .

Allow **one** mark for correctly quoted data, for example:

- Increasing the temperature from 0 to 100 % of the observed range caused a 27 % ($\pm 1\%$) decrease in mass loss; [1 mark]
- Increasing the soil nitrogen levels from 0 to 100 % of the observed range caused a 2 % ($\pm 1\%$) increase in mass loss; [1 mark]
- Increasing the moisture content from 0 to 100 % of the observed range caused an 18 % ($\pm 1\%$) increase in mass loss; [1 mark]

Any **two** of the following:

- All abiotic factors apart from temperature show a positive correlation **OR** for moisture and soil nitrogen levels, an increase in availability causes an increase in % mass loss **WHEREAS** temperature shows a decrease in % mass loss after 20 %; [1 mark]
- % mass loss increases proportionally / at a constant rate with the level of moisture **AND** the soil nitrogen level; [1 mark]
- Changes in soil nitrogen levels has the smallest effect on % mass loss (compared to moisture and temperature) ; [1 mark]

[Total: 3 marks]

5h

h) The trend shown for decomposition as a result of temperature change is because the...

Any **two** of the following:

- Increasing temperature initially results in an increase in decomposition (up to 20% of the observed temperature range) **BECAUSE** enzyme/microbe/decomposer activity is increased; [1 mark]
- Increasing temperature past 20% of the observed temperature range results in a decrease in the rate of decomposition **BECAUSE** enzymes have become denatured; [1 mark]
- (Therefore) Microbes/decomposers die leading to decreased activity; [1 mark]

[Total: 2 marks]

5i

i) Tropical rainforests have the highest rate of productivity because. . .

Any **two** of the following:

- They have higher temperatures **AND** higher moisture levels which provide the optimum rate of microbe activity; [1 mark]
- This leads to higher rates of decomposition; [1 mark]
- Nutrients are recycled more quickly **OR** nutrients are more readily available; [1 mark]
- High levels of nutrients in the soil and leaf litter allow faster/more growth of plant species (which increases productivity); [1 mark]

[Total: 2 marks]

6a

a) The difference in blood flow to the heart between when the seal is searching for food compared to when it is actively chasing prey...

- $(1275 - 950) = 325 \text{ cm}^{-3} \text{ min}^{-1}$; [1 mark]

Accept answers between $275\text{--}375 \text{ cm}^{-3} \text{ min}^{-1}$

[Total: 1 mark]

Be sure to always include the units when answering calculation questions.

6b

b) The difference in blood flow when the seal is searching for food and when it is actively chasing prey between the kidneys, flipper muscles, and brain is...

- (When seals switch from searching to chasing) blood flow to the kidneys decreases **WHILE** blood flow to the flipper muscles increases **AND** blood flow to the brain remains the same; [1 mark]
- (When seals switch from searching to chasing) the decrease in blood flow to the kidneys is small **WHILE** the increase in blood flow to the flipper muscles is large; [1 mark]

OR

The decrease in blood flow to the kidneys is (approximately) $450 \text{ cm}^{-3} \text{ min}^{-1}$ **WHILE** the increase in blood flow to the flippers is (approximately) $5000 \text{ cm}^{-3} \text{ min}^{-1}$; [1 mark]

Accept answers between $425\text{--}475 \text{ cm}^{-3} \text{ min}^{-1}$ instead of $450 \text{ cm}^{-3} \text{ min}^{-1}$

[Total: 2 marks]

Answers must refer to the **difference** in blood flow at **different activity levels**. Answers such as 'blood flow to the flippers is higher than blood flow to the brain' will not be accepted here for this reason.

The command word 'distinguish' requires you just to give the **differences**.

6c

c) Blood flow to the seal's organs is different when the seal is searching for food compared to when it is actively chasing prey because. . .

Any **three** of the following:

- Seal (flipper muscles) move more slowly when they are searching for the presence of prey in comparison to when they are actively chasing it **SO** less energy/ATP is required; [1 mark]

OR

Seal (flipper muscles) move more quickly when they are actively chasing prey in comparison to when they are scanning for the presence of prey **SO** more energy/ATP is required; [1 mark]

- More aerobic respiration needs to take place in flipper muscles when chasing prey (to produce ATP); [1 mark]
- Increased blood flow to the flipper muscles provides oxygen/glucose **OR** removes carbon dioxide (during aerobic respiration); [1 mark]
- Blood flow to the heart increases so that the heart muscle can contract more quickly **SO** increasing blood flow to the flipper muscles; [1 mark]
- Blood flow is diverted away from the digestive system/kidneys so that more blood can be sent to the flipper muscles; [1 mark]
- Brain function is essential to survival **SO** blood flow to the brain cannot be reduced; [1 mark]

[Total: 3 marks]

6d

d) The property of arterioles that enables blood flow to the organs to be regulated is. . .

- (Smooth) muscle fibres in their walls; [1 mark]

[Total: 1 mark]

6e

e) The difference between the seal's minimum and maximum heart rate throughout the monitoring period is. . .

- $(140 - 7 =) 133$ (beats per minute); [1 mark]

Accept 132–134 beats per minute

[Total: 1 mark]

6f

f) The changes in heart rate throughout the monitoring period include. . .

Any **two** of the following:

- Heart rate increases in the minutes before the start of the dive; [1 mark]
- Heart rate decreases quickly/steeply at the beginning of the dive; [1 mark]
- Heart rate is consistently low throughout (most of) the dive; [1 mark]
- Heart rate increases quickly/steeply at/towards the end of the dive; [1 mark]
- After the initial spike in heart rate at the end of the dive, heart rate begins to decrease again; [1 mark]
- Any accurate use of data to illustrate any of the above points; [1 mark]

[Total: 2 marks]

6g

g) The heart rate changes shown in part (e) might affect the seal's body during a dive in the following ways. . .

Any **two** of the following:

- The tissues/organs/muscles will have a reduced oxygen/glucose supply; [1 mark]
- The cells may need to switch to anaerobic respiration; [1 mark]
- The tissues/organs/muscles will have a buildup of lactic acid/lactate (if they switch to anaerobic respiration); [1 mark]
- The supply of ATP to the cells will be reduced; [1 mark]
- The seal's metabolic rate / rate of respiration might reduce/drop significantly; [1 mark]
- The seal may have less energy/ATP **SO** movement may be slower/reduced; [1 mark]

[Total: 2 marks]

6h

h) The volume of blood passing through the flippers during a dive would. . .

- Be reduced/decreased; [1 mark]
- Due to a (greatly) reduced heart rate **OR** the decrease in heart rate counteracts the increased blood flow during exercise; [1 mark]

[Total: 2 marks]

The huge reduction in heart rate (120 bpm down to around 10 bpm) will lead to a decrease in blood passing through the flippers despite any increased blood flow that might result from vasodilation in the arterioles. This slowing of heart rate is essential to reduce the seal's energy requirements during a dive and suggests that the seal's muscle cells may rely on alternatives to aerobic respiration while diving.

The command word 'deduce' requires you to **reach a conclusion** based on the information given.

7a

a) The viral load of species 2 when symptoms are present is. . .

- 600 (viral copies per mg of body wall tissue); [1 mark]

[Total: 1 mark]

You will notice here that the scale is logarithmic, meaning that the divisions on the y axis are unequal in size. The bar height for species 2 when symptoms are present is between 100 and 1000. Each (unequal) division here is worth 100 viral copies and because the bar sits level with the sixth division it represents a viral load of 600.

7b

b) The relationship between viral load and disease X symptoms in the different species includes. . .

Any **two** of the following:

- In species 1 and 3 viral load is higher in individuals with symptoms than without, **BUT** in species 2 viral load is higher in individuals with no visible symptoms; [1 mark]
- The difference in viral load between those with and without symptoms is smaller in species 2 than in species 1 and 3; [1 mark]
- The difference in viral load between those with and without symptoms is statistically significant (at the 5% level) in species 3 **BUT** not in species 1 and 2; [1 mark]

Accept converse statements.

[Total: 2 marks]

Statements must refer to the **relationship** between viral load and the presence/absence of symptoms, and must be **comparative**.

7c

c) The results show that. . .

- The only species in which the presence of densoviruses is related to the presence of disease X symptoms is species 3; [1 mark]

OR

There is no connection between the presence of densoviruses and disease X in species 1 or 2 but there is a connection in species 3; [1 mark]

OR

Densoviruses cause disease X in species 3 but not in species 1 or 2; [1 mark]

- (This can be seen because) there is a significant difference in the viral load of species 3 with and without symptoms, but not in the viral loads of species 1 or 2; [1 mark]

OR

(This can be seen because) the viral load of species 3 with symptoms is significantly higher than without, while there is no significant difference in the viral loads of species 1 or 2 with and without symptoms; [1 mark]

[Total: 2 marks]

7d

d) The formation of disease X lesions over the testing period involves. . .

Any **two** of the following:

- Lesions forming both with and without the addition of organic matter; [1 mark]
- Lesions forming faster in the presence of both types of organic matter than in the control; [1 mark]
- Lesions form fastest in the presence of (lab grown) algae; [1 mark]
- In all variables there are periods of new lesion formation and periods of no new lesion formation; [1 mark]
- Data from the graph to back up any of the above points; [1 mark]

[Total: 2 marks]



Exam Papers Practice

7e

e) Observations on the growth of lesions and the abundance of bacteria in the DBL could be. . .

Any **two** of the following:

- In the control variable there is an overall increase in both the number of lesions and the number of bacteria; [1 mark]

OR

Bacteria could be causing lesion growth in the control variable; [1 mark]

- There seems to be no connection between bacterial growth in the added organic matter variables and the formation of lesions; [1 mark]

OR

In the seawater variable, bacterial abundance shows an initial increase followed by a decrease, during which time, lesion growth continues; [1 mark]

OR

In the algae variable, bacterial abundance shows a decrease followed by an increase, during which time, lesion growth continues; [1 mark]

- Data from the graph to back up any of the above; [1 mark]

[Total: 2 marks]

7f

f) The number of individuals that would have lesions in depleted oxygen after 10 days is. . .

- $(0.7 \times 23 =) 16$ (individuals); [1 mark]

[Total: 1 mark]

A proportion of 0.3 urchins are lesion free after 10 days, meaning that a proportion of 0.7 urchins have lesions at this point. $0.7 \times 23 = 16.1$, but you can't have 0.1 of an individual, so this is rounded down.

7g

g) Depleted oxygen might lead to an increase in growth of disease X lesions because:

- The cells of the sea urchin will no longer be able to carry out aerobic respiration; [1 mark]
- The cells will have reduced energy / less ATP to build an immune response to infection **OR** will not have enough energy/ATP for (normal) healthy cell function; [1 mark]

OR

- Depleted oxygen may promote growth of anaerobic bacteria; [1 mark]
- Anaerobic bacteria may be responsible for causing disease X lesions; [1 mark]

[Total: 2 marks]

7h

h) Evaluative points relating to the conclusion that disease X is caused by changes in oxygen levels in the DBL of sea urchins include. . .

Strengths of the conclusion:

- The graphs show that variables with added organic matter have faster lesion growth than the control **AND** that sea stars in depleted oxygen form lesions while those in normal oxygen do not; [1 mark]

Limitations of the conclusion:

A maximum of **two** of the following:

- No statistical analysis has been presented study, so we cannot know whether the differences in results are (statistically) significant; [1 mark]
- The study involves a limited number of species, so more research is needed before the results can be applied to all cases of disease X; [1 mark]
- The results show correlation between the variables in question, but do not prove causation **OR** there may be a variable missing from the conclusion e.g. low oxygen may promote growth of certain bacteria, which themselves cause the lesions rather than low oxygen in itself; [1 mark]
- Lesions grow in the control variable (without added organic matter), so this alone is not enough to cause disease X; [1 mark]

[Total: 3 marks]

When evaluating, aim to give both supportive and critical points.

8a

a) The difference in water content between the control and dry conditions for variety 2 is...

- $(97 - 17 =) 80\%$; [1 mark]

Units required for the mark. Accept 78 - 81%.

[Total: 1 mark]

8b

b) The water content in control and dry conditions for the different varieties of wheat show that...

Any **two** of the following:

- All varieties show a reduced water content after 10 days in dry conditions (in comparison to control); [1 mark]
- V1–v3 show a (statistically) significant reduction in water content while v4 does not **OR** the difference in water content between control and dry conditions is (statistically) significant for v1–v3, but not for v4; [1 mark]
- V2 shows the greatest reduction in water content between control and dry conditions; [1 mark]
- V1 and v2 show a greater reduction in water content between control and dry conditions than v3 and v4; [1 mark]
- Data from the graph to support any of the above points; [1 mark]

[Total: 2 marks]

Answers must refer to both **control** and **dry** conditions e.g. 'All varieties lose very little water in control conditions' would not be an acceptable answer.

8c

c) The effect of 10 days without water on wheat varieties 1–4 is. . .

- All varieties show reduced health/yield/growth **OR** increased wilting/leaf death/leaf dryness; [1 mark]
- Varieties 1–2 are affected more than varieties 3–4; [1 mark]

OR

Variety 2 is the most affected; [1 mark]

[Total: 2 marks]

8d

d) Dry conditions lead to the impacts seen in part (c) because. . .

Any **one** of the following:

- Plants need water for photosynthesis **SO** photosynthesis is reduced; [1 mark]
- Reduced sugar production/availability means less respiration can take place **SO** cells die; [1 mark]
- When plant cells lose water cell turgor is lost / pressure exerted on the cell walls is reduced **SO** causing wilting; [1 mark]

[Total: 1 mark]

8e

e) The impact of dry conditions on the potassium ion content of the different varieties includes...

Any **two** of the following:

- All varieties show a decrease in potassium ion content between the control and dry conditions; [1 mark]
- V1–v3 show a (statistically) significant decrease between control and dry conditions while v4 does not **OR** the difference in potassium ion content between the control and dry conditions is (statistically) significant for v1–v3, but not for v4; [1 mark]
- V1 and v2 show a larger decrease in potassium ion content between control and dry conditions than v3 and v4; [1 mark]
- Data from the graph to back up any of the above statements; [1 mark]

[Total: 2 marks]

Answers must refer to both control and dry conditions in order to illustrate how the plants have been affected.

Exam Papers Practice

8f

f)

i. The impact of potassium ion content on the response of wheat to dry conditions is. . .

- Varieties that lose least / have highest potassium in dry conditions lose less water **AND** show a lower impact on health/growth/yield; [1 mark]

OR

Varieties that lose the most / have lowest potassium in dry conditions lose more water **AND** show a greater impact on health/growth/yield; [1 mark]

ii. Some wheat varieties are able to maximise their water content in dry conditions by...

- Plant tissue that has a higher potassium ion content will have a higher osmolarity / lower water potential; [1 mark]
- Tissues with higher osmolarity / K^+ content / lower water potential will have reduced water loss from the cells (by osmosis); [1 mark]

OR

Root cells with a high osmolarity / K^+ content / lower water potential will draw in more water from the soil; [1 mark]

OR

Tissues with higher osmolarity / K^+ content / lower water potential will have improved cell turgor / reduced wilting; [1 mark]

[Total: 3 marks]

Cells with high osmolarity / lower water potential have a high solute concentration; here due to dissolved potassium ions. If these cells have a higher osmolarity than their surroundings, water will be drawn into the cells. In the roots this can enable water uptake when water is scarce, and in the cells this helps to maintain cell turgor and prevents wilting.

8g

g) Evaluative points regarding the recommendation that variety 4 should be planted in parts of the world where drought is common include. . .

Strengths of recommendation:

A maximum of **two** of the following:

- Variety 4 does not show a (statistically) significant reduction in water content after 10 days in dry conditions **SO** can conserve water effectively; [1 mark]
- Variety 4 does not show a (statistically) significant reduction in K⁺ content **SO** has good drought tolerance; [1 mark]
- Visual observation shows that variety 4 is less affected by drought than some other varieties; [1 mark]

Limitations of recommendation:

- Study only involves 4 varieties, so there could be other varieties with better drought tolerance; [1 mark]
- Study does not take other, named factors into account e.g. pest resistance, cost of buying seeds, yield, taste, flood resistance etc.; [1 mark]

At least one named factor must be given for marking point 5 to be awarded.

[Total: 3 marks]

Remember to give both positive and negative arguments when evaluating.

9a

a) i) The line of transgenic bananas with the greatest amount of sugar is:

- Line 2; [1 mark]

ii) The difference in the mean percentage of starch in control and transgenic bananas is:

- 4.96 (%); [1 mark]

[Total: 2 marks]

9b

b) i) Differences between the levels of carbohydrate in the transgenic lines of bananas and the control lines of bananas include:

Any **two** of the following:

- Transgenic bananas have lower (%) starch than control bananas; [1 mark]
- Transgenic bananas have higher (%) sugar than control bananas; [1 mark]
- Transgenic bananas have lower total amounts (% fresh weight) of carbohydrates than control bananas; [1 mark]
- There is a greater difference between (%) starch and (%) sugar in control bananas than in transgenic bananas; [1 mark]

ii) Reasons for these differences include:

- Transgenic bananas contain (a gene that produces) an enzyme, which is active and decreases starch production; [1 mark]
- Stored sugar is normally used to produce starch, so sugar (%) is higher in transgenic bananas (as it is not being converted into starch); [1 mark]

[Total: 4 marks]

9c

c) The effects of transferring the bacterial gene on the suitability of the bananas for selling include...

Any **two** of the following:

- (All) transgenic lines/bananas have acceptable ripeness for selling / are suitable for selling **OR** (all) transgenic lines/bananas have acceptable ripeness for selling / are suitable for selling after any length of storage **OR** all values/ratings for transgenic lines/bananas are below 4; [1 mark]
- Control bananas have acceptable ripeness for selling only after 8 days storage; [1 mark]

[Total: 2 marks]

9d

d) The bacterial gene affects the storage of bananas by...

- Increasing the number of brown or black spots (forming on the skin of bananas by day 8); [1 mark]
- An increase in the number of brown or black spots decreases the length of time the bananas can be stored for; [1 mark]

[Total: 2 marks]

9e

e) Possible harmful effects of GM crops include...

Any **two** of the following:

- Populations of wild plants might be changed; [1 mark]
- Genetic modifications could cross the species barrier **OR** genes transferred to crop plants to make them herbicide resistant could spread to wild plants, making them uncontrollable **OR** herbicide resistance could spread to wild plants, forming superweeds; [1 mark]
- Proteins produced by transferred genes could be toxic (to humans or livestock) **OR** cause allergies (in humans or livestock); [1 mark]
- Transferred genes could mutate and cause unexpected problems; [1 mark]
- Non-target organisms could be affected by toxins that are intended to control pests in GM crop plants **OR** pollinators could be affected by toxins produced by GM crops; [1 mark]

[Total: 2 marks]

10a

a) The year in which the proportion of available rafts being used by *chloropus* was greatest was...

- 2014; [1 mark]

[Total: 1 mark]

10b

b) The number of rafts introduced to city park ponds and lakes from mid-2011 to mid-2012 was...

- (Approximately) 45; [1 mark]

Accept answers between 43–47

[Total: 1 mark]

This was calculated by reading off graph the 'rafts available' data.

$65 \text{ (Mid-2012)} - 20 \text{ (Mid-2011)} = 45.$

10c

c) The relationship between the number of rafts available and the number of rafts being used:

Any **two** of the following:

- Both (the number of rafts available and the number of rafts being used) show a general increase (over the time period studied); [1 mark]
- Both (the number of rafts available and the number of rafts being used) show a large increase between 2011 and 2012/2013; [1 mark]
- The number of rafts being used does not always reflect the number of rafts available as there is a decrease in the number of rafts being used in 2016, despite the total number of rafts available remaining (approximately) the same; [1 mark]
- The number of rafts available is always higher than (never equal to) the number of rafts being used; [1 mark]

[Total: 2 marks]

10d

d) For the three different predators, the use of ultrasonic repellers had the following effects on the number of visits to the pond:

Any **three** of the following:

- Foxes/cats made (significantly) more visits to the pond when ultrasonic repellers were absent compared to when they were present whereas badgers made fewer visits to the pond when ultrasonic repellers were absent compared to when they were present; [1 mark]
- The difference in the number of pond visits when ultrasonic repellers were absent compared to when they were present is smaller in badgers compared to foxes/cats; [1 mark]
- The difference in the number of pond visits (when ultrasonic repellers were absent compared to when they were present) was significant for foxes/cats (because the error bars do not overlap) but not significant for badgers (because the error bars overlap); [1 mark]
- Overall, foxes made more visits to the pond compared to badger/cats both when ultrasonic repellers were absent or when they were present; [1 mark]

[Total: 3 marks]

Statements must refer to the **relationship** between the number of pond visits and the presence/absence of ultrasonic repellers and must be **comparative**.

10e

e) Data on chick survival rates for nests on rafts were only collected from 2008 onwards because...

- Rafts only began being used (by *chloropus*) from 2008/2009 **OR** rafts only became available from 2007/2008; [1 mark]

[Total: 1 mark]

10f

f) Similarities between chick survival rates for nests on banks of ponds or lakes with chick survival rates for nests on rafts include:

Any **one** of the following:

- Both (chick survival rates) show a general increase (over the time period studied); [1 mark]
- Both (chick survival rates) temporarily decrease in 2012 **OR** both (chick survival rates) temporarily decrease between 2010 and 2012 ; [1 mark]

Differences between chick survival rates for nests on banks of ponds or lakes with chick survival rates for nests on rafts include:

Any **one** of the following:

- Chick survival rates for nests on banks of ponds or lakes are lower **OR** chick survival rates for nests on rafts are higher; [1 mark]
- Chick survival rates for nests on banks of ponds or lakes are (approximately) half chick survival rates for nests on rafts **OR** chick survival rates for nests on rafts are (approximately) double chick survival rates for nests on banks of ponds or lakes; [1 mark]

[Total: 2 marks]

10g

g) Nest location affects chick survival as...

Any **two** of the following:

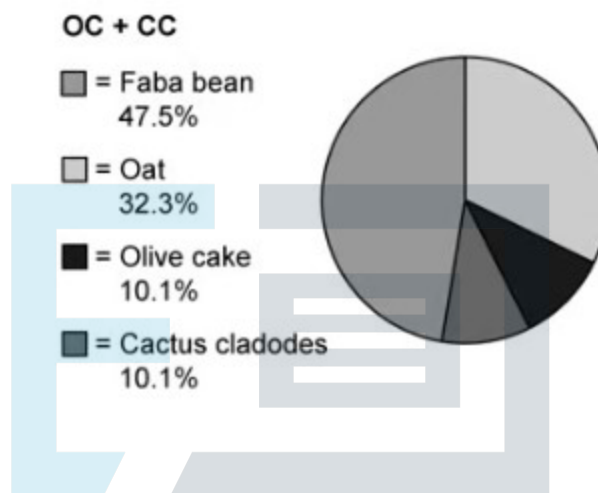
- Ultrasonic repellers can be placed on the banks of ponds and lakes and these reduce the presence/number of visits of foxes; [1 mark]
- Foxes predate on *chloropus* chicks, so chick survival increases if fox numbers decrease; [1 mark]
- Foxes cannot reach floating islands/rafts, so chick survival is higher for nests located there; [1 mark]

[Total: 2 marks]

11a

a) i) The percentage for each diet ingredient in the Olive Cake + Cactus Cladodes diet is...

- Oat 32.3%, Barley 0%, Olive Cake 10.1%, CC 10.1%, Faba bean 47.5%; [1 mark]



; [1 mark]

The percentage was calculated by determining the total mass of ALL ingredients ($456 + 0 + 150 + 150 + 680$), then dividing each ingredient by this total (e.g. $456 \div 1436 = 0.317$) and finally multiple by 100 to obtain the % (e.g. $0.317 \times 100 = 32\%$).

ii) The diets that contain the highest source of nitrogen are...

- Cactus Cladodes AND Olive Cake + Cactus Cladodes; [1 mark]

[Total: 3 marks]

Both diets are required for the mark.

11b

b i) The diet that has the lowest relative abundance of the *Proteobacteria* phyla is...

- Olive Cake; [1 mark]

ii) The effect diet has on the abundance of the key microbial phyla is...

Any **two** of the following:

- That the new diets (OC, CC, OC+CC) had little effect; [1 mark]

OR

That there was similar abundance of key microbial phyla for all diets; [1 mark]

- The OC + CC diet and the control diet had similar effects on the abundance; [1 mark]

[Total: 3 marks]

The command word **analyse** requires you to interpret the data to reach conclusions.

Exam Papers Practice

11c

c i) The significance of the statement '*are significantly different at $p < 0.05$ ' is...

Any **one** of the following:

- That there is a significant (statistical) difference between the three experimental values (diets) **AND** the control; [1 mark]

OR

That there is, a less than 5 % chance, that the difference is random; [1 mark]

OR

That there is a 95 % or more probability that results are due to the experiment (IV) and not random; [1 mark]

OR

That the null hypothesis can be rejected; [1 mark]

OR

That there is a relationship/correlation between pH and diet of goats; [1 mark]

ii) The effect of the different diets on the digestive system pH was...

Any **two** of the following:

- That there was a similar range of pH for the three experimental diets; [1 mark]
- That all experimental diets had higher / more alkaline pH than the control; [1 mark]
- That there was no significant difference between the three experimental diets; [1 mark]

[Total: 3 marks]

11d

d) The pH could affect the digestion of the different diets because...

- Enzymes require optimal pH to catalyse digestion of the feed; [1 mark]
- Enzymes will denature if not in their optimal pH; [1 mark]

[Total: 2 marks]

11e

e) The hypothesis that the microbial ecosystem digestibility is not increased by the additional feeding resources is...

Any **two** of the following:

Supported by:

- A similar abundance of key microbial phyla in the control as experimental diets / e.g. all diets had an abundance of bacteriodes within 9% of each other; [1 mark]

Not supported by:

- The control digestive pH (5.7) was more acidic than the experimental diets (OC - 6.09, CC - 6.22, OC+CC - 6.21) resulting in the experimental diets providing more optimal conditions for digestion; [1 mark]
- The study only including a small number of goats/population which may cause bias; [1 mark]

[Total: 2 marks]

If the question mentions that data must be used then full marks will not be awarded if data is not included.

12a

a) The feeding site on the *C. arietinum* that has the least percentage of feeding by larvae smaller than 8 mm is...

- Flowers; [1 mark]

[Total: 1 mark]

12b

b) The difference between the percentage of feeding by larvae less than and greater than 8 mm, on *C. arietinum* leaves is . . .

- 43 % (72 - 29); [1 mark]

Accept answers between 42 - 44 %

[Total: 1 mark]

12c

c) Small larvae show a preference for feeding on the leaves because . . .

Any **one** of the following:

- This is where the eggs were laid by the moths; [1 mark]

OR

- This is where the eggs hatched; [1 mark]

[Total: 1 mark]

12d

d) The most successful method to control larvae less than 8 mm prior to pod development was . . .

- α -Cypermethrin and Bt; [1 mark]

[Total: 1 mark]

Remember to read the root of the question carefully. In this question it was important to remember that larvae less than 8mm included the very small and small larvae, hence although α -Cypermethrin may look like it is the most successful, when the numbers are combined for the first two bars the combination of α -Cypermethrin and Bt becomes the most successful.

12e

e) Bt *C.arietinum* are more effective at controlling the larger larvae as . . .

- They are likely to ingest more of the plant and therefore the toxin; [1 mark]

[Total: 1 mark]

12f

f) A comparison of the effectiveness of the three methods in controlling the damage caused prior to pod development and during pod development includes...

Any **three** of the following:

- α -Cypermethrin being more effective at reducing the number of larvae larger than 8 mm prior to pod development then during pod development; [1 mark]

OR

- α -Cypermethrin being less effective at reducing the number of larvae larger than 8 mm prior to pod development then during pod development; [1 mark]
- α -Cypermethrin + Bt having a similar effectiveness at reducing the number of larvae prior to pod development as during pod development; [1 mark]

OR

- α -Cypermethrin + Bt having slightly less effectiveness at reducing the number of larvae smaller than 8 mm prior to pod development then during pod development; [1 mark]
- Bt being more effective at reducing the number of larvae larger than 8 mm prior to pod development then during pod development; [1 mark]

OR

- Bt being less effective at reducing the number of larvae smaller than 8 mm prior to pod development then during pod development; [1 mark]

[Total: 3 marks]

Statements must refer to the **relationship** between the methods and the stage of pod development. A mark is only awarded if a **comparison** is made.

12g

g) Evaluation of the hypothesis that the most sound pest management method is a combination of using a synthetic pyrethroid (α -Cypermethrin) on a genetically engineered (Bt) chickpea crop results in.....

Three of the following:

The hypothesis being supported as ...

- α -Cypermethrin + Bt contained the lowest number of smaller larvae prior to bud development (~1.1 per metre row) resulting in less leaf damage, as the smaller larvae were observed to be feeding on leaves 72% of the time, increasing the productivity of the crop (photosynthesis); [1 mark]
- α -Cypermethrin alone has the least effect on numbers of larger larvae compared to other methods, 2.6 per metre row during pod development resulting in lower yields; [1 mark]
- Bt alone has the least effect on numbers of smaller larvae compared to other methods, 2.0 per metre row prior to pod development resulting in lower productivity; [1 mark]

The hypothesis not being supported as ..

- α -Cypermethrin + Bt had similar numbers of larger larvae during pod development as Bt, 1.1 per metre row compared to 0.9 respectively but as spraying could lead to resistance, less use of insecticides would be the more sound method ; [1 mark]

[Total: 3 mark]

When the question refers directly to the data (in this question it asks you to use all the data provided) then use the data in your answer. Do not forget to go back to the beginning of the question to include all the data given.