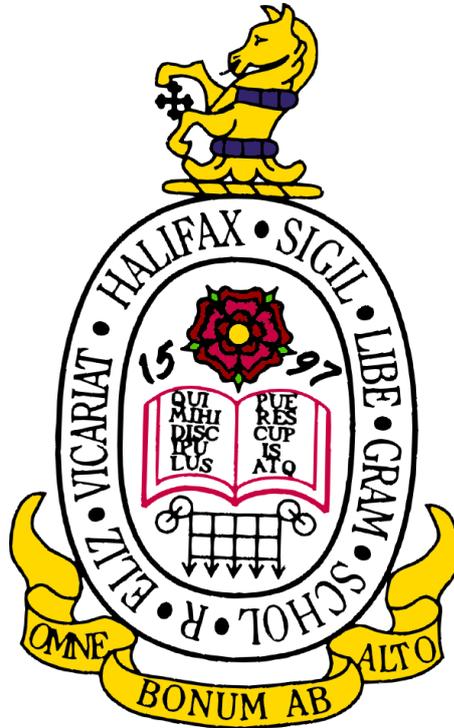


A level Biology



Bridging the Gap

Making the transition between GCSE and A level

Contents

1. Introduction
2. Expectations
3. Relevant links to GCSE specification
4. Summer Tasks
5. Ted talks and wider reading

Introduction

Biology is an interesting subject to study at advanced level as it provides an understanding of life at all levels from molecules and cells to ecosystems and the biosphere. A good grade in the subject rewards students with the respect of future employers and a wealth of career opportunities. The most challenging part of A-level Biology is bridging the gap between GCSE and A level work. The transition between GCSE and A-level is large, even for pupils who have completed a single GCSE in Biology and achieve a high grade.

If you have completed a double award science then the transition is even more challenging. The objective of this booklet is to help make this transition more easily.

There are 3 problems encountered when making the transition from GCSE to A-level Biology:

The first is making sure you have a secure knowledge of GCSE Biology. While it is useful to have studied Triple Science the extra knowledge is not essential.

Second is the quantity of material that you must learn - it is fascinating stuff which helps.

Third, and most importantly, A-level Biology includes a large new vocabulary of keywords which you need to be able to use and explain in great detail to answer A-level exam question.

Expectations

As you embark upon your study of A-level Biology, you will begin to explore cells and important biological molecules. As well as developing skills, knowledge and understanding in Biology and the necessary literacy skills to communicate your ideas, you will also need to demonstrate competence in applying practical and mathematical skills as well as the ability to apply your understanding to unfamiliar contexts. Such knowledge and skills will all be assessed through short answer questions, comprehension questions and extended response questions within the three exam papers you will sit at the end of Year 13. In addition, to reach the highest grades in A-level Biology, you should engage in wider reading around the subject to develop your understanding beyond the specification, driven by a genuine interest in the subject, as you will need to write an essay in one of the exam papers.

Expectations for this booklet would be:

- 1.** Complete in the last week of the summer holidays so you arrive with the knowledge still fresh in your mind ready to start lessons.
- 2.** You are expected to spend a minimum of 2.5 hours on this, if you do not complete Task 1 because you have done Single Science Biology you would be expected to spend 2.5 hours on the others tasks.
- 3.** There will be a baseline test at the start of the course, these tasks will help you with this.

Relevant links to GCSE specification

If you wish to look directly at the specification for AQA GCSE Biology you can visit the AQA website www.aqa.org.uk and follow the links to GCSE Biology and the specification is available in full from there. You are only expected to understand the topics that come up again in A-level biology and these are outlined below.

BIOLOGY (Topics found in separate science and not Trilogy)

Culturing microorganisms

Required practical - Effect of antibiotics on bacterial growth

Monoclonal antibodies

Detection and identification of plant diseases

Plant defence responses

The brain

The eye

Plant hormones

Required practical - Germination

Advantages and disadvantages of sexual and asexual reproduction

DNA Structure

Cloning

Theory of Evolution

Speciation

The understanding of genetics

Required practical – Decay

Impact of environmental change

Trophic levels

Pyramids of Biomass

Transfer of Biomass

Factors affecting food security

Farming techniques

Sustainable fisheries

Role of biotechnology

Summer Tasks

Instructions

Task 1 is **compulsory if you did not study Biology as a single Science at GCSE** (suggested time: 2.5 hours). The idea of this is to help double science students to catch up.

Task 2 is **optional for all students** (suggested time: 90 minutes)

Task 3 is **optional**, but there are two pathways to complete it – pathway B is more challenging than pathway A (suggested time: 90 minutes)

This activity will therefore take a fairly substantial amount of time and it is worth doing this well in preparation for A-level. You must be prepared to commit to Biology work **outside of lessons per week (not including homework)** if you are to succeed and manage your workload in the subject. Four hours is the minimum that you must be prepared to commit to **Biology work outside of lessons per week (not including homework)**.

Task 1

Compulsory if single GCSE Biology not taken; optional otherwise.

Read the information on the following pages of BBC Bitesize:

Treating, curing and preventing disease

<https://www.bbc.com/bitesize/guides/z8fkmsg/revision/5>

Monoclonal antibodies

<https://www.bbc.com/bitesize/guides/zt8t3k7/revision/1>

Plant disease

<https://www.bbc.com/bitesize/guides/z3tgw6f/revision/2>

The brain and the eye

<https://www.bbc.com/bitesize/guides/zprxy4j/revision/5>

Control of body temperature, Maintaining nitrogen and water balance in the body and Negative feedback

<https://www.bbc.com/bitesize/guides/zxgmfcw/revision/1>

Plant hormones

<https://www.bbc.com/bitesize/guides/zc6cqhv/revision/1>

Advantages and disadvantages of sexual and asexual reproduction, DNA Structure and Cloning

<https://www.bbc.com/bitesize/guides/z9pkmsg/revision/1>

Theory of Evolution

<https://www.bbc.com/bitesize/guides/zcqbdxs/revision/1>

Speciation

<https://www.bbc.com/bitesize/guides/zcqbdxs/revision/6>

The understanding of genetics

<https://www.bbc.com/bitesize/guides/zg8f4qt/revision/1>

Required practical – Decay

<https://www.bbc.com/bitesize/guides/zy7gw6f/revision/4>

Impact of environmental change

<https://www.bbc.com/bitesize/guides/zt8f4qt/revision/1>

Trophic levels, pyramids of Biomass and transfer of Biomass

<https://www.bbc.com/bitesize/guides/zs7gw6f/revision/1>

Factors affecting food security, Farming techniques, Sustainable fisheries and Role of biotechnology

<https://www.bbc.com/bitesize/guides/ztwvk2p/revision/1>

Produce a summary, in your own words, detailing the extra knowledge and understanding you have gained from this reading.

This could be presented in a variety of formats – as long as it is accurate and detailed - for instance, as handwritten paragraphs, a detailed mind map, or a series of flash cards. Use the 'Revision techniques' section below to help you.

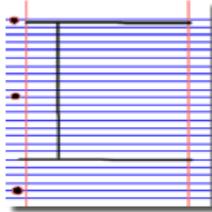
When you are confident you have completed a significant amount of revision try the practice GCSE questions. The mark scheme is at the end of the questions so you can mark the work yourself or get a family member to mark the answers (this will hopefully avoid bias!).

After the questions have been marked you should then go back through the answers using the examiners' report (at the end of the mark scheme) and highlight those areas you have not done as well in. It is probably worth revising these topics again. Alternatively it could be your exam technique. Some ideas for helping you improve your exam technique are provided in this booklet.

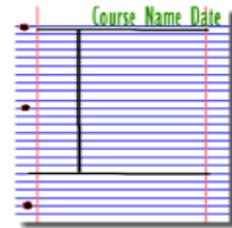
Revision technique 1

Making Cornell notes

1. Divide your page into three sections like this



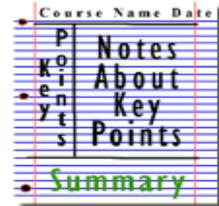
2. Write the name, date and topic at the top of the page



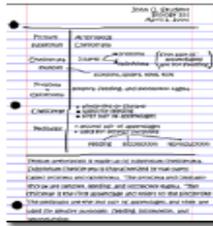
3. Use the large box to make notes. Leave a space between separate ideas. Abbreviate where possible.



4. Review and identify the key points in the left hand box



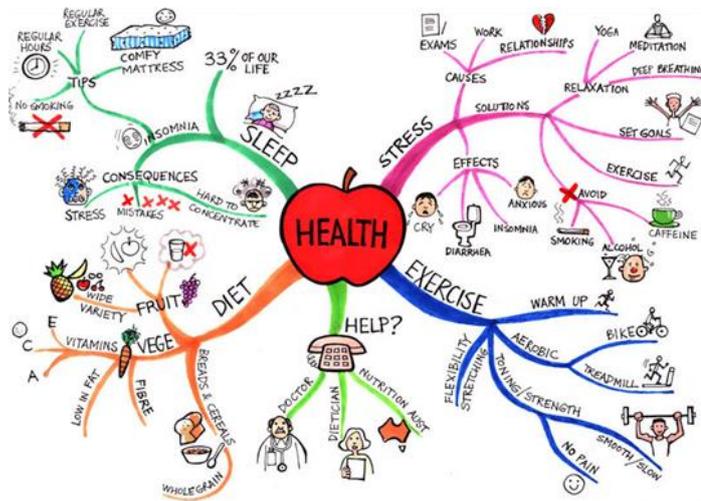
5. Write a summary of the main ideas in the bottom space



Revision technique 2 Mind mapping

Definition of a mind map

A mind map is a visual representation of a big amount of information that includes a central topic surrounded by connected branches of associated ideas/concepts.



Benefits of mind mapping

- Engages creative parts of the brain
- Makes connections between ideas
- Helps to organise ideas
- Links details into the bigger picture
- Colourful and fun to make
- Works especially well for those who remember pictures easily

Tips for a good mind map

- Choose a topic
- Add the associated ideas and concepts
- Limit use of words, use more images and symbols
- Use lines and colours to group and link these ideas

Revision technique 3

Flash cards

Flash cards are cards with a question and often some key words or information on one side and the answer to that question on the other side.

When reading your notes about a topic, ask yourself: "Can I think of a (test) question about what I just read?" If you can, you write this question on a card.

When you've finished reading the notes, write the answers to your questions on the back of your cards; then check they are correct.

By writing the answers on the cards, you are already starting to memorise those answers. And you have made a summary of the topic!

Effective flash cards

Key vocabulary.

For longer answer questions in tests.

For mathematical problems.

For complex diagrams to learn.

For processes. E.g. production of monoclonal antibodies.

Questions to develop understanding. I.e. Things you have found difficult

Techniques for answering exam questions

Read these tips to help you answer the questions that follow.

1. Check how many marks the question is worth. If it is worth 2 marks you have to make two separate points to get both marks.
2. On any questions that ask you to *describe* the graph you should start by referring to the x-axis (which will be the independent variable) and say how this changes the variable on the y-axis. If there is a change in the trend of the line then you will need to refer to this. Finally, to get high marks on graph questions you should give figures from the graph.
Example answer: In the first 10 minutes (this tells you the independent variable is time) the rate of the reaction (the dependent variable) increases to [insert figure here]. The rate of reaction then starts to slow down from 11 minutes onwards until it reaches [insert figure here]. By 20 minutes the rate of the reaction has completely stopped.
3. If you are asked to **explain** a graph you need to use your scientific knowledge, i.e. you will need to use scientific key words in your answer. The examiner is expecting you to tell them *why* something is happening.
4. If you are given an **Evaluate** question you need to work out advantages and disadvantages of the topic being asked by the examiner. You also need to give a conclusion. Your conclusion can't just say 'I think this is a good/bad idea'. You need to write a one sentence conclusion which summarises your perspective e.g. 'This is a good idea because the advantage of ... far outweighs the disadvantage of ...'.
5. Avoid using words like 'it'. Say what 'it' is. If the examiner is unsure what you are referring to they will automatically mark it wrong.
6. Don't panic if you see a question you don't believe you have learned. Sometimes examiners throw these kinds of questions in and expect you to be able to *apply* your knowledge. Usually this kind of question will start with '**Suggest...**'. Read the question very carefully and highlight the key words. Ask yourself: what part of this course is this likely to link to. Then try to answer the question.

(i) There are areas on the agar jelly where **no** bacteria are growing.

Why?

(1)

(ii) The student concluded that disinfectant **D** would be the best for using around the home.

Give **one** reason why the student might be correct.

Give **one** reason why the student might **not** be correct.

(2)

(Total 9 marks)

Q2.

A virus called RSV causes severe respiratory disease.

(a) Suggest **two** precautions that a person with RSV could take to reduce the spread of the virus to other people.

1. _____

2. _____

(2)

(b) One treatment for RSV uses monoclonal antibodies which can be injected into the patient.

Scientists can produce monoclonal antibodies using mice.

The first step is to inject the virus into a mouse.

Describe the remaining steps in the procedure to produce monoclonal antibodies.

(3)

(c) Describe how injecting a monoclonal antibody for RSV helps to treat a patient suffering with the disease.

(2)

A trial was carried out to assess the effectiveness of using monoclonal antibodies to treat patients with RSV.

Some patients were given a placebo.

(d) Why were some patients given a placebo?

(1)

A number of patients had to be admitted to hospital as they became so ill with RSV.

The results are shown in the table below.

Treatment received by patient	% of patients within each group admitted to hospital with RSV
Group A : Monoclonal antibody for RSV	4.8
Group B : Placebo	10.4

The trial involved 1 500 patients.

- Half of the patients (group **A**) were given the monoclonal antibodies.
- Half of the patients (group **B**) were given the placebo.

(e) Calculate the total number of patients admitted to hospital with RSV during the trial.

Total number of patients admitted to hospital = _____

(2)

(f) Evaluate how well the data in the table above supports the conclusion:
'monoclonal antibodies are more effective at treating RSV than a placebo'.

(2)

(Total 12 marks)

Q3.

Tobacco mosaic virus (TMV) is a disease affecting plants.

The diagram below shows a leaf infected with TMV.



Yellow patches where
TMV has destroyed
chloroplasts

© Nigel Cattlin/Visuals Unlimited/Getty Images

(a) All tools should be washed in disinfectant after using them on plants infected with TMV.

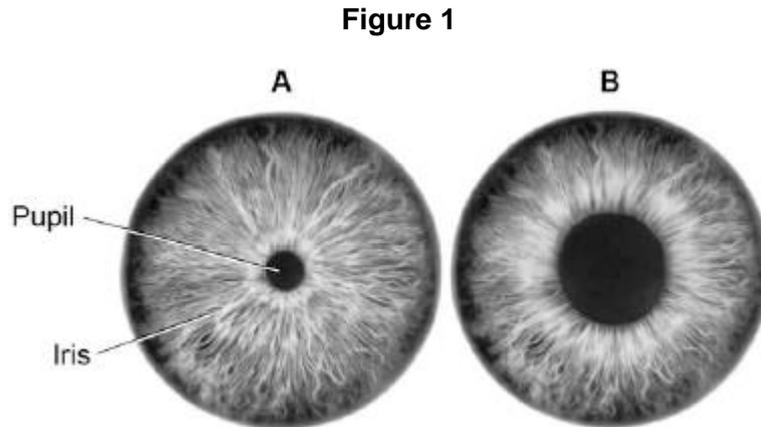
Suggest why.

(1)

(b) Scientists produced a single plant that contained a TMV-resistant gene.

Q4.

Figure 1 shows a reflex in the iris of the human eye in response to changes in light levels.



@ Gande Vasan/Stone/Getty Images

(a) Describe the changes in the pupil and iris going from **A** to **B** in **Figure 1**.

Explain how these changes occur.

Refer to the changes in light level in your answer.

(4)

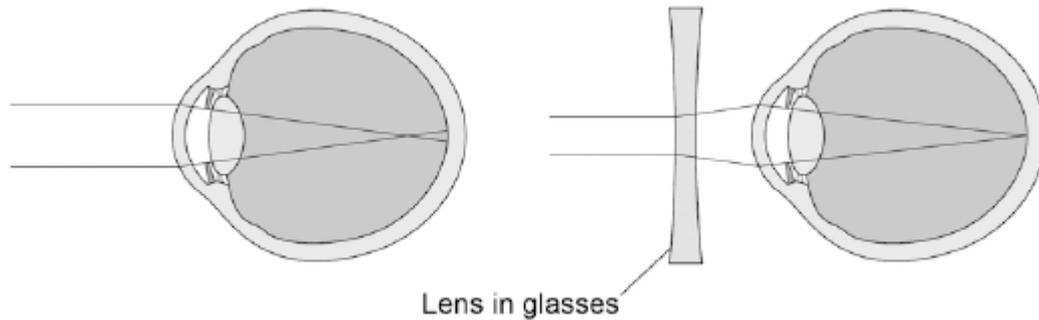
(b) Some people wear glasses to improve their vision.

Figure 2 shows light entering the eye in a person with blurred vision.

Figure 3 shows how this condition is corrected with glasses.

Figure 2

Figure 3



Compare **Figure 2** and **Figure 3**.

Explain how the blurred vision is corrected.

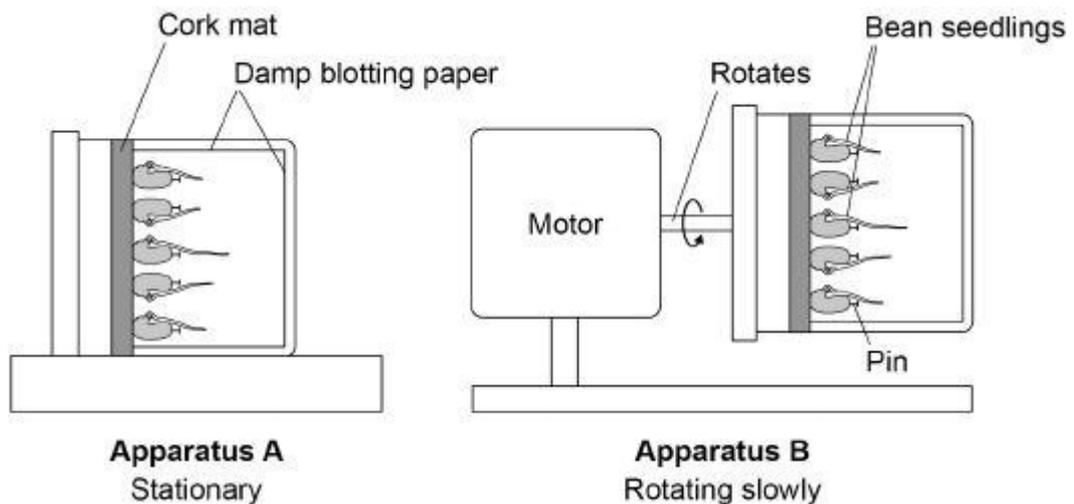
(2)
(Total 6 marks)

Q5.

Some students investigated geotropism in the roots of bean seedlings.

Figure 1 shows the apparatus used.

Figure 1



This is the method used.

1. Measure the length of the root of each of 10 bean seedlings.
2. Pin 5 seedlings to the cork mat in apparatus **A**.

3. Pin 5 seedlings to the cork mat in apparatus **B**.
 4. Leave **A** and **B** in a dark cupboard for 2 days.
 5. After the 2 days:
 - make a drawing to show the appearance of each seedling
 - measure the length of the root of each seedling.
- (a) Why did the students surround the seedlings with damp blotting paper?

Tick **one** box.

- To prevent light affecting the direction of root growth
- To prevent photosynthesis taking place in the roots
- To prevent the growth of mould on the roots
- To prevent water affecting the direction of root growth

(1)

Apparatus **B** is a control.

Apparatus **B** rotates slowly.

(b) How does apparatus **B** act as a control?

(1)

The table below shows the students' results.

	Apparatus A					Apparatus B				
Seedling number	1	2	3	4	5	1	2	3	4	5
Length at start in mm	35	41	32	33	39	30	33	29	28	31
Length after 2 days in mm	49	57	43	45	54	45	45	44	29	44
Length change in mm	14	16	11	12	15	15	12	15	1	13
Mean length change in mm	14					11				

(f) In horticulture plant hormones are used for controlling plant growth.

Draw **one** line from each plant hormone to the correct use of that hormone.

Plant hormone	Use of hormone
Auxin	To reduce the time taken for tomatoes to ripen
Ethene	To slow down the growth of plant stems
Gibberellin	To promote seed germination
	To stimulate root growth in plan cuttings

(3)
(Total 10 marks)

Q6.

(a) When a seed starts to grow, the young root grows downwards towards gravity. The young shoot grows upwards, away from gravity.

(i) Name this type of plant response to gravity.

(1)

(ii) Give **two** reasons why it is useful for a young root to grow towards gravity.

1. _____

2. _____

(2)

(iii) The root grows towards gravity due to the unequal distribution of a substance in the root.

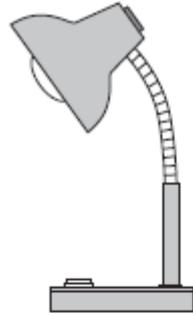
Draw a ring around the correct answer to complete the sentence.

This substance is

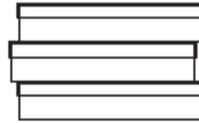
auxin.
chlorophyll.
sugar.

(1)

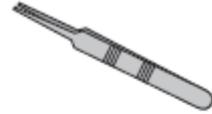
(b) The drawings show some apparatus and materials.



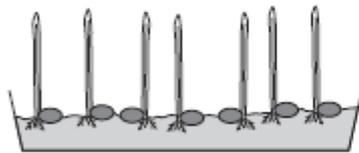
Lamp



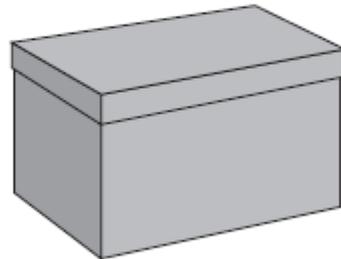
Petri dishes



Forceps



50 maize seedlings
on damp cotton wool



Supply of cardboard boxes with lids



Ruler



Scissors

In this question you will be assessed on using good English, organising information clearly and using specialist terms where appropriate.

Describe how the students could use some or all of the apparatus and materials shown in the drawings to investigate the growth response of maize seedlings to light shining from one side.

You should include a description of the results you would expect.

Bluebell plants grow in woodlands in the UK.

- Bluebells can reproduce sexually by producing seeds.
- Bluebells can also reproduce asexually by making new bulbs.

(b) One advantage of asexual reproduction for bluebells is that only **one** parent is needed.

Suggest **two** other advantages of asexual reproduction for bluebells.

1. _____

2. _____

(2)

(c) Explain why sexual reproduction is an advantage for bluebells.

(4)

(Total 8 marks)

Q8.

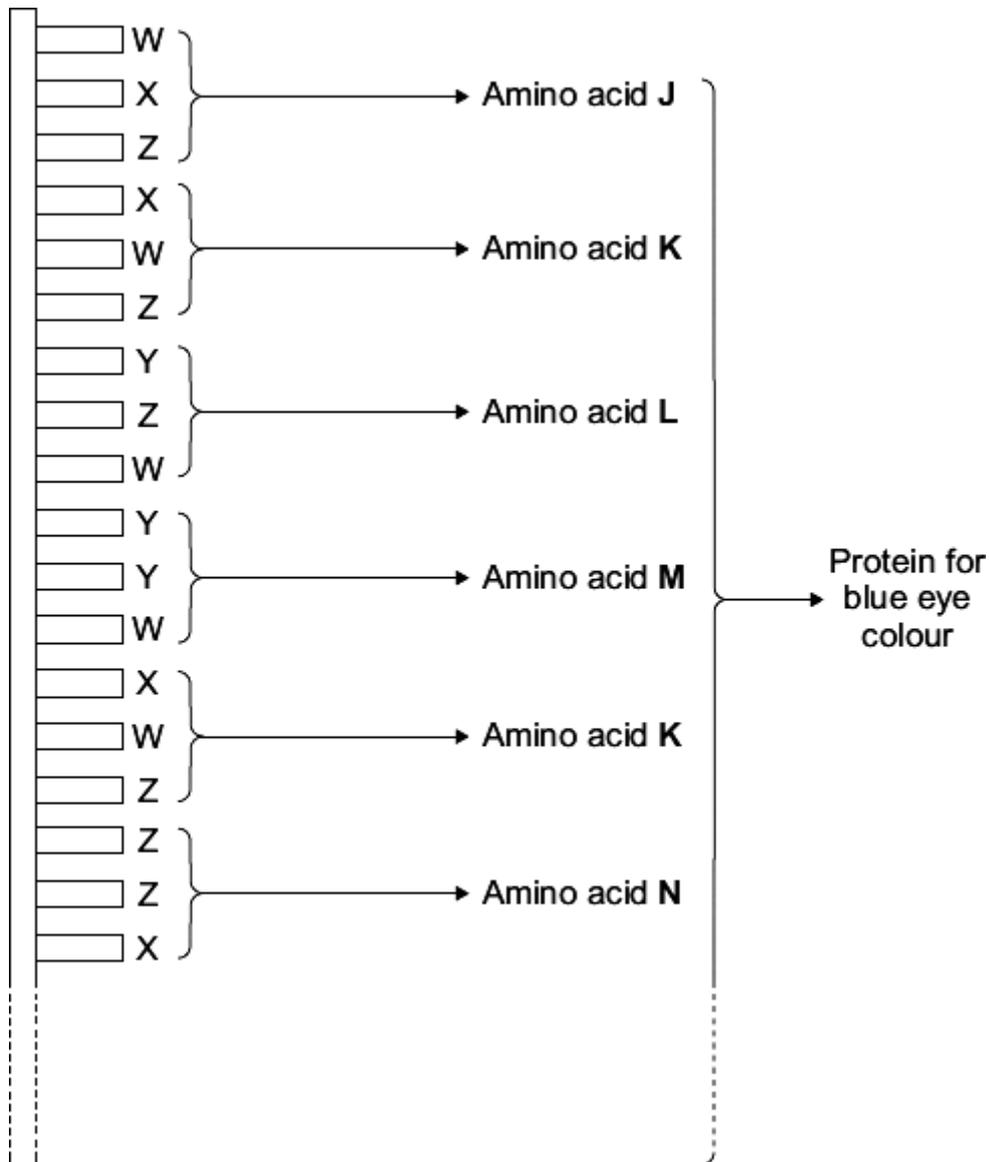
A molecule of DNA contains four different bases, **W**, **X**, **Y** and **Z**.

The four bases are arranged in a long chain.

The chain of bases controls the synthesis of a protein.

The diagram shows a small section of a DNA molecule.

This section is responsible for synthesising the protein for blue eye colour.



(a) What word is used to describe 'a small section of a DNA molecule that controls the synthesis of a protein'?

(1)

(b) In the cell, where are proteins synthesised?

(1)

(c) Describe how the protein for blue eye colour is synthesised.

To gain full marks you must use information from the diagram.

(3)

(d) Mistakes sometimes occur when DNA molecules are copied during cell division.

Suppose that one of the **W** bases shown in the diagram was substituted by an **X** base.

(i) What would happen to the structure of the protein synthesised by this part of the DNA molecule?

(1)

(ii) What might be the effect of this change in structure of the protein?

(1)

(Total 7 marks)

Q9.

The photograph shows a zorse.



By Kumana @ Wild Equines [CC-BY-2.0], via Wikimedia Commons

A zorse is a cross between a male zebra and a female horse.
The zorse has characteristics of both parents.

(a) The zorse was produced by *sexual reproduction*.

(i) What is *sexual reproduction*?

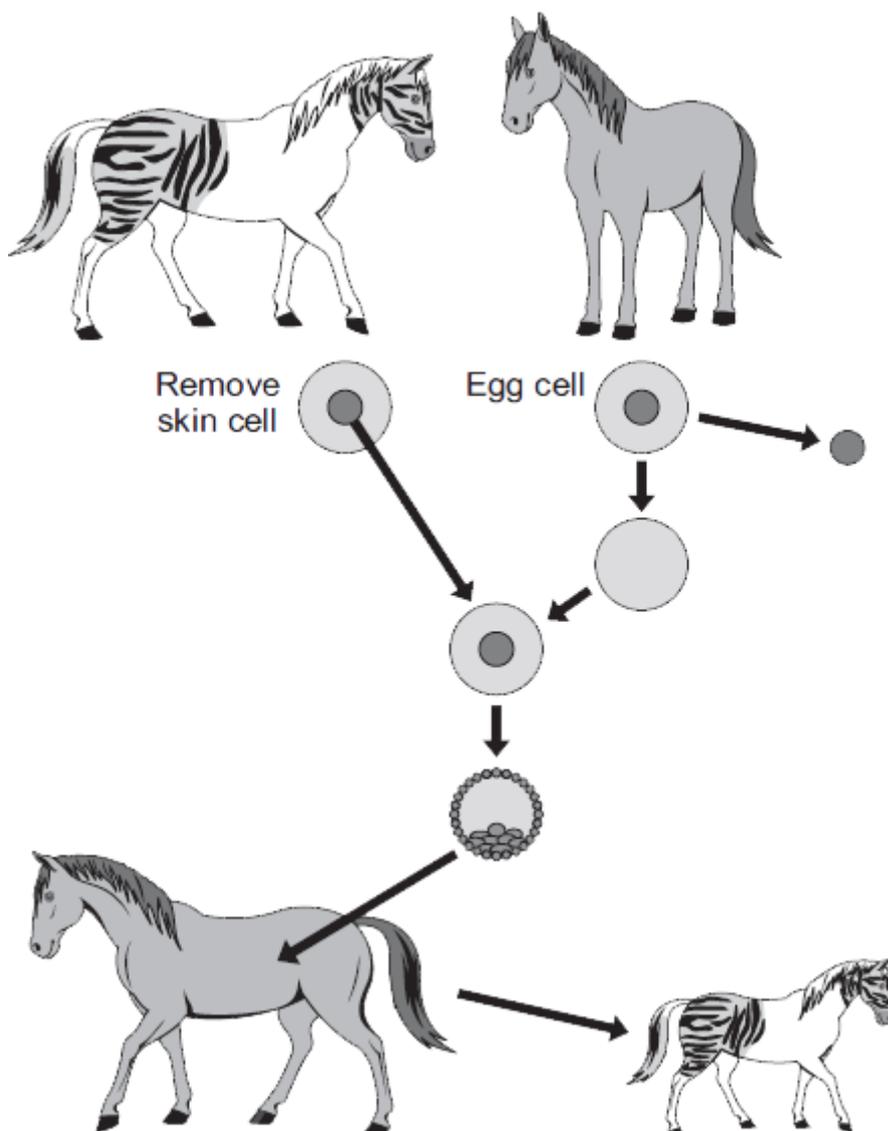
(1)

(ii) The zorse has characteristics of a zebra and a horse.
Why?

(2)

(b) Zorses are **not** able to breed.
Scientists could produce more zorses from this zorse by adult cell cloning.

The diagram shows how the scientists might clone a zorse.



Classification group	Name
Kingdom	<i>Animalia</i>
Phylum	<i>Chordata</i>
	<i>Mammalia</i>
	<i>Primates</i>
	<i>Lemuroidea</i>
Genus	<i>Lemur</i>
	<i>catta</i>

(a) Complete the table above to give the names of the missing classification groups.

(2)

(b) Give the binomial name of the ring-tailed lemur.

Use information from the table above.

_____ (1)

Lemurs are only found on the island of Madagascar.

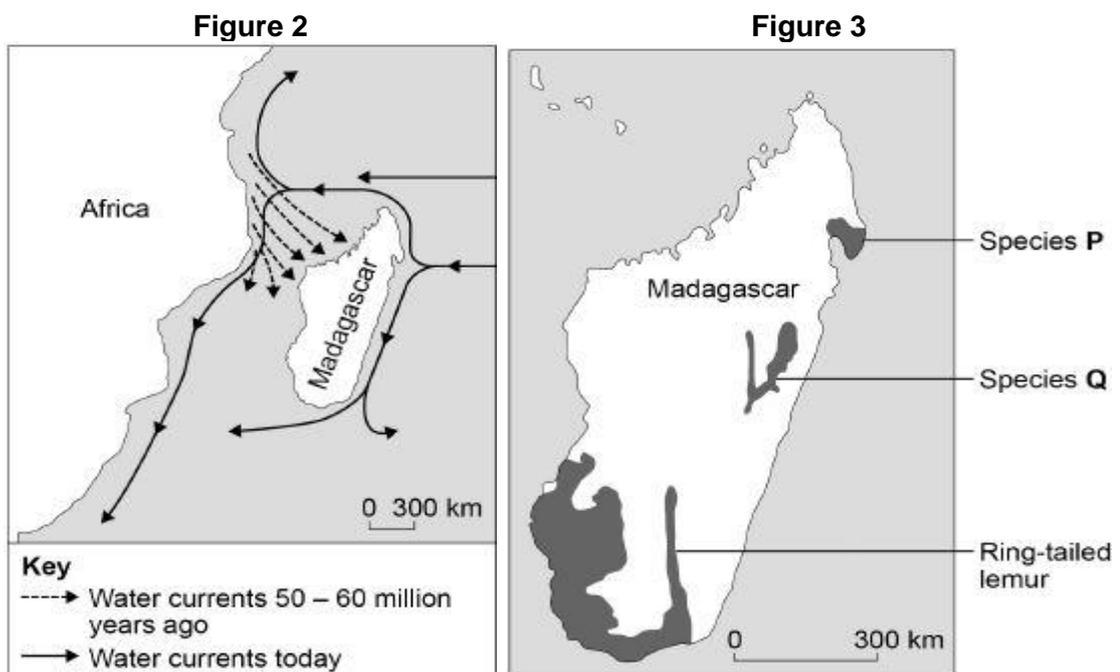
Madagascar is off the coast of Africa.

Scientists think that ancestors of modern lemurs evolved in Africa and reached Madagascar about 50-60 million years ago.

Today there are many species of lemur living on Madagascar.

Figure 2 shows information about water currents.

Figure 3 shows the distribution of three species of lemur on Madagascar.



A species of fox, called the Island Fox, lives on each of the six islands shown in **Figure 1**.

Figure 2 shows an Island Fox.

Figure 2



© GaryKavanagh/iStock

The foxes on each island are slightly different from those on the other islands.

The Island Foxes are similar to another species of fox, called the Grey Fox.

The Grey Fox lives in mainland California.

(a) Suggest how scientists could prove that the six types of Island Fox belong to the same species.

(2)

(b) Scientists believe that ancestors of the modern Island Fox first colonised what is now Santa Cruz Island during the last Ice Age, approximately 16 000 years ago. At that time, lowered sea levels made the three northernmost islands into a single island and the distance between this island and the mainland was reduced to about 8 km.

(i) How could the Island Fox have developed into a completely different species from the mainland Grey Fox?

(5)

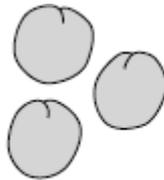
(ii) Suggest why the Island Foxes have developed into different varieties of the same species instead of six different species.

(1)

(Total 8 marks)

Q12.

In the 1860s, Gregor Mendel studied inheritance in nearly 30 000 pea plants. Pea plants can produce either round seeds or wrinkled seeds.



Round pea seeds



Wrinkled pea seeds

(a) Mendel crossed plants that always produced round seeds with plants that always produced wrinkled seeds.

He found that all the seeds produced from the cross were round.

Use the symbol **A** to represent the dominant allele and **a** to represent the recessive allele.

Which alleles did the seeds from the cross have? _____

(1)

(b) Mendel grew hundreds of plants from the seeds of the offspring. He crossed these plants with each other.

(i) Mendel's crosses produced 5496 round pea seeds and 1832 wrinkled pea seeds.

Explain why Mendel's crosses gave him these results.

In your answer you should use:

- a genetic diagram
- the symbols **A** and **a**.

(3)

(ii) One of Mendel's crosses produced 19 round seeds and 16 wrinkled seeds.

These numbers do **not** match the expected ratio of round and wrinkled seeds.

Suggest why.

(1)

(c) The importance of Mendel's discovery was not recognised until many years after his death.

Give **one** reason why.

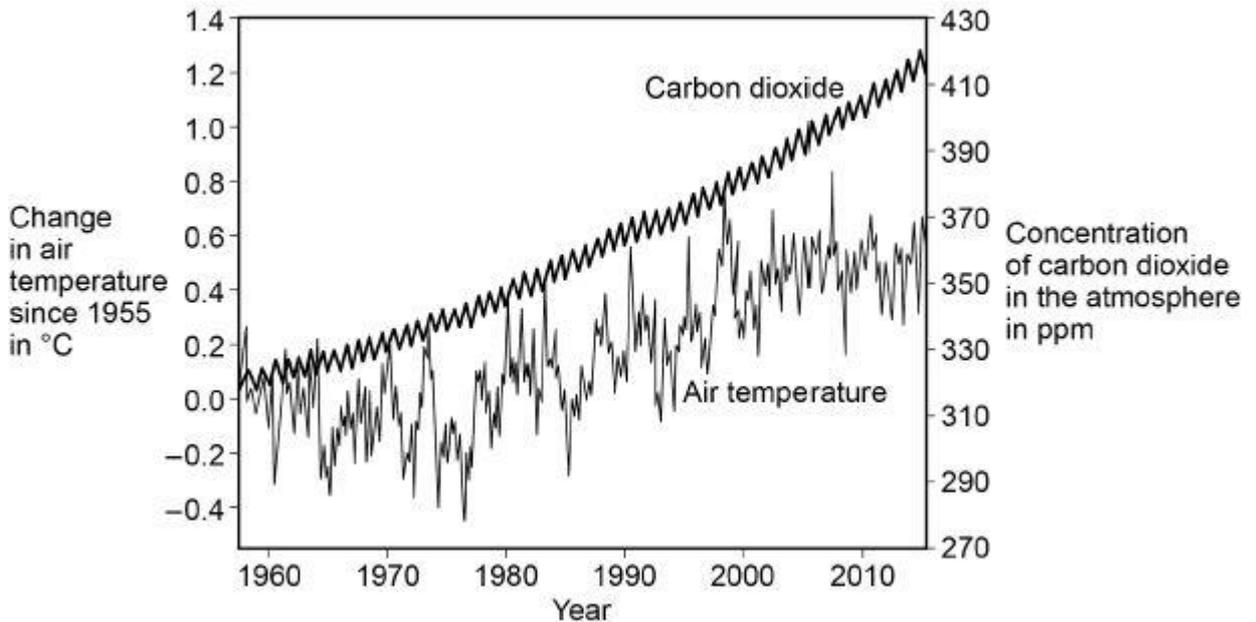
(1)

(Total 6 marks)

Q13.

Many scientists think that global air temperature is related to the concentration of carbon dioxide in the atmosphere.

The graph below shows changes in global air temperature and changes in the concentration of carbon dioxide in the atmosphere.



(a) Complete the table below.
Use information from the graph above.

Choose answers from the box.

You may use each answer once, more than once or not at all.

		constant	decreasing	increasing
		1960 – 1977	1977 – 2003	2003 – 2015
Trend in carbon dioxide concentration		Increasing		
Trend in air temperature				

(2)

Many scientists think that an increase in carbon dioxide concentration in the atmosphere causes an increase in air temperature.

(b) How would an increase in the concentration of carbon dioxide in the atmosphere cause an increase in air temperature?

(1)

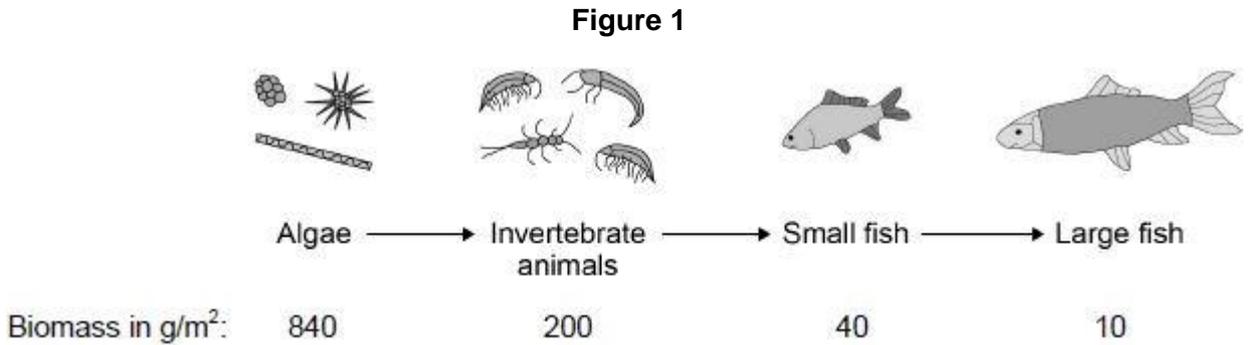
(c) Evaluate evidence for and against the theory that an increase in the concentration of carbon dioxide in the atmosphere causes an increase in air temperature.

Use data from the graph above and your own knowledge.

Q14.

Figure 1 shows:

- a food chain for organisms in a river
- the biomass of the organisms at each trophic level.

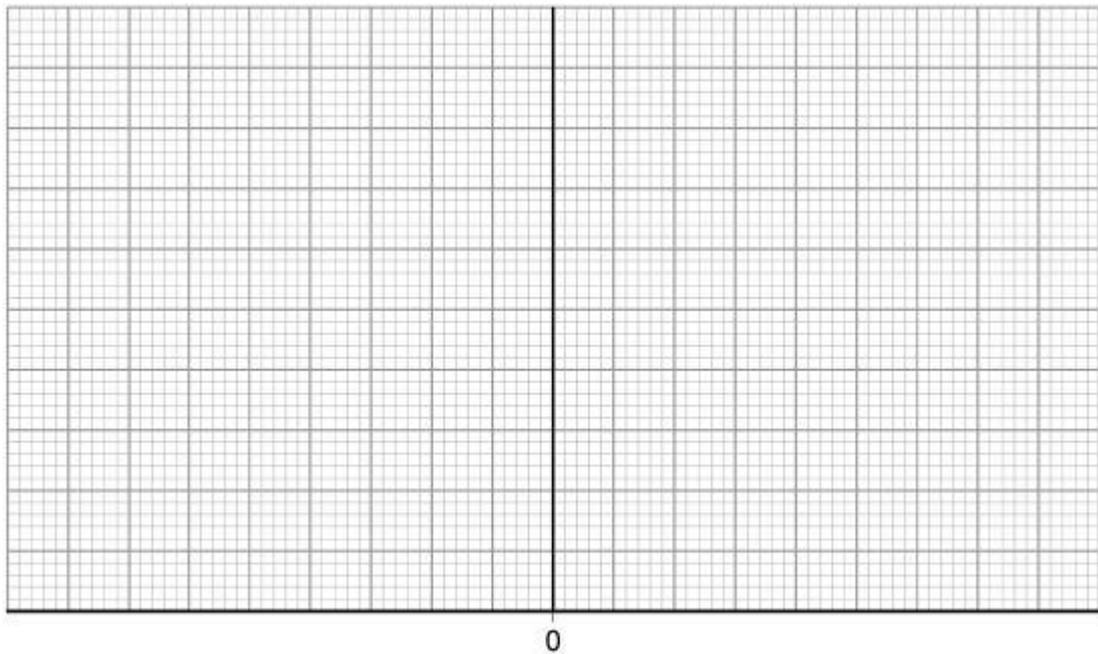


(a) Draw a pyramid of biomass for the food chain in **Figure 1** on **Figure 2**.

You should:

- use a suitable scale
- label the x-axis
- label each trophic level.

Figure 2



(4)

(b) Calculate the percentage of the biomass lost between the algae and the large fish.

Give your answer to 2 significant figures.

Q15.

A student plans an investigation using mould.

(a) Mould spores are hazardous.

Give **one** safety precaution the student should take when doing this investigation.

(1)

(b) A student made the following hypothesis about the growth of mould:

‘The higher the temperature, the faster the growth of mould’.

The student planned to measure the amount of mould growing on bread.

The student used the following materials and equipment:

- slices of bread
- sealable plastic bags
- a knife
- a chopping board
- mould spores.

Describe how the materials and equipment could be used to test the hypothesis.

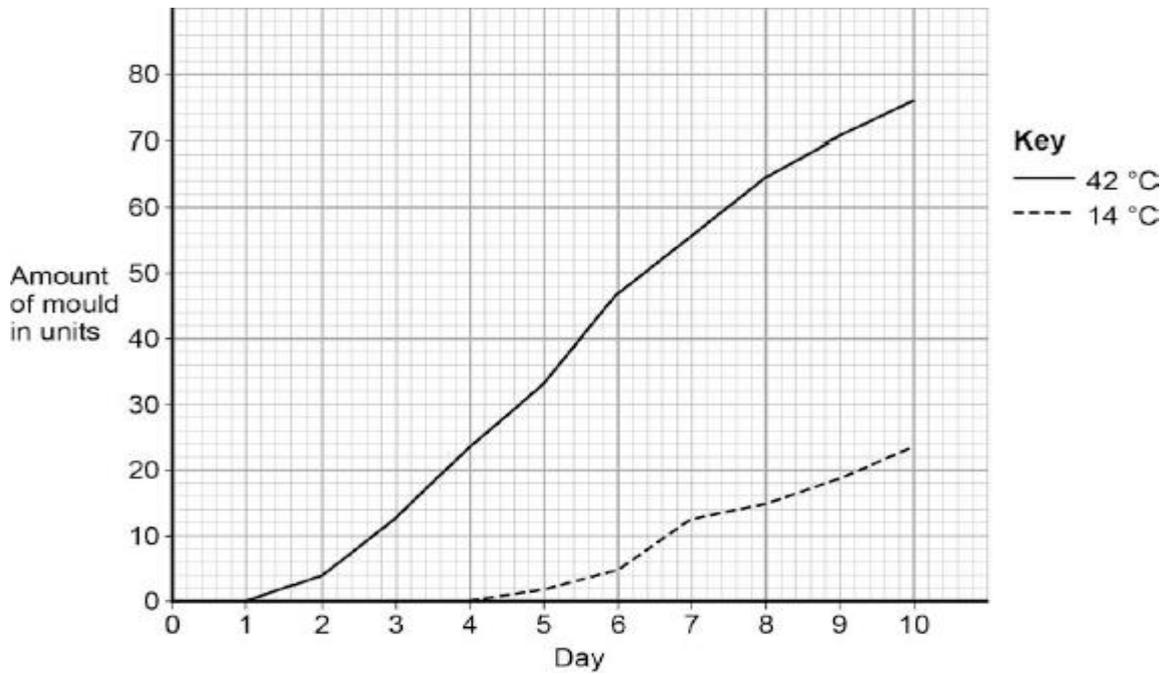
(4)

(c) Give **one** variable the student should control in the investigation.

(1)

(d) Another student did a similar investigation.

The diagram below shows the results.



Determine the rate of mould growth at 42 °C between day 2 and day 7.

Rate of mould growth = _____ units per day (2)

(e) The growth of mould shows decomposition of the bread.

Give a conclusion about decomposition from the results in the diagram above.

(1)

(Total 9 marks)

Q16.

Cows are reared for meat production.

The cows can be reared indoors in heated barns, or outdoors in grassy fields.

The table shows energy inputs and energy outputs for both methods of rearing cows.

	kJ / m ² / year		
	Energy input		Energy output
	Food	Fossil fuels	Meat production
Indoors	10 000	6 000	40
Outdoors	5 950	50	X

(a) The percentage efficiency for rearing cows **outdoors** is 0.03%

Calculate the energy output value **X**.

Use the equation:

$$\text{percentage efficiency} = \frac{\text{energy output}}{\text{total energy input}} \times 100$$

Energy output value **X** = _____ kJ / m² / year

(3)

(b) The percentage efficiency for rearing cows **outdoors** is 0.03%

Calculate how many times more efficient it is to rear cows indoors than to rear cows outdoors.

Use the equation from (a).

Answer = _____ times

(3)

(c) A large amount of energy is wasted in both methods of rearing cows.

Give **two** ways in which the energy is wasted.

1. _____

2. _____

(2)

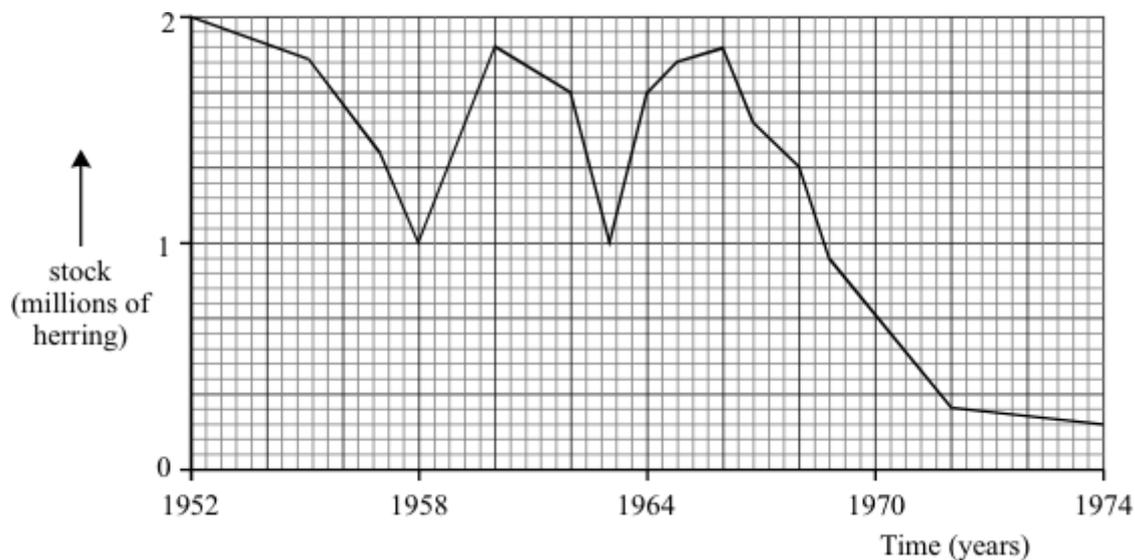
(d) Suggest **two** reasons why it is more efficient to rear cows indoors than to rear cows outdoors.

1. _____

2. _____

(2)
(Total 10 marks)

Q17.



The graph shows the variations in the North Sea herring population between 1952 and 1974. These fish were formerly caught in large numbers by fleets of trawlers but fishing has been restricted since 1974 as a conservation measure. Herrings lay about 20 000 eggs per year but do not reproduce until they are about 3–5 years old, when they are about 25cm long. It takes 11 years for a herring to reach its mature adult length.

The following measures have been suggested to prevent overfishing:

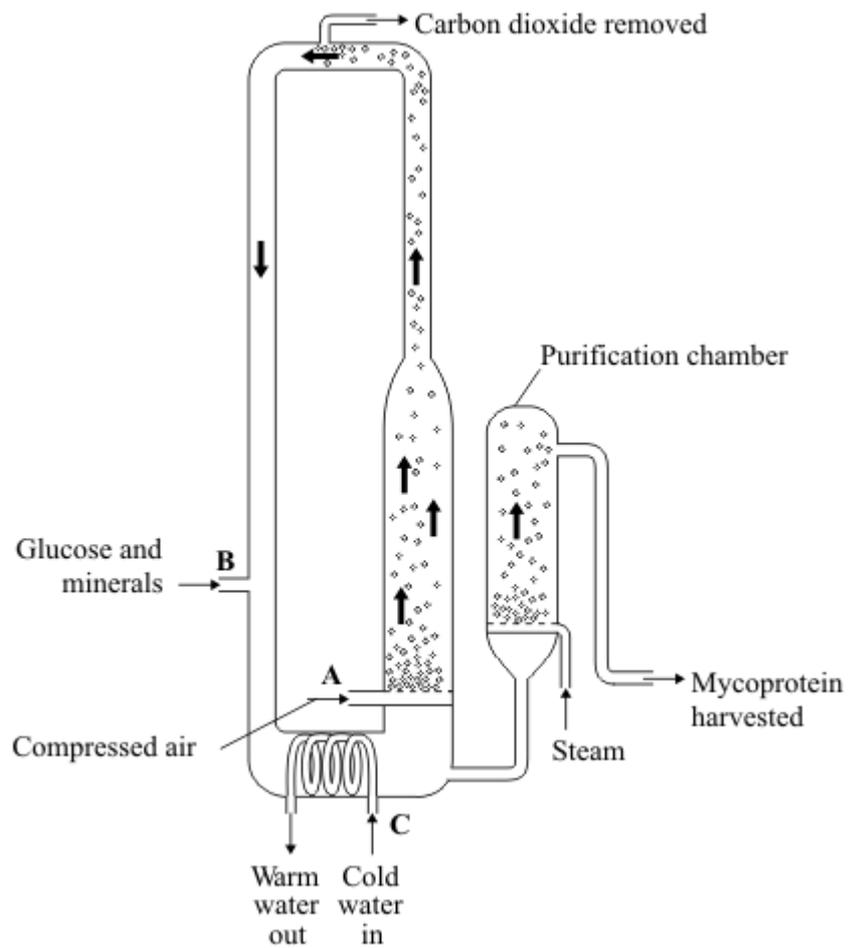
- limiting mesh size of nets,
- specifying maximum catch by each boat per year.
- prohibiting fishing in herring breeding grounds.
- prohibiting fishing at certain times of the year.

Evaluate their probable effects on both fish stocks and the fishermen, using the information given above.

(Total 9 marks)

Q18.

The diagram shows a fermenter. This fermenter is used for growing the fungus *Fusarium* which is used to make mycoprotein.



(a) Bubbles of air enter the fermenter at **A**.

Give **two** functions of the air bubbles.

1. _____
2. _____

(2)

(b) Glucose is added to the fermenter at **B**.

Explain why glucose is added.

(1)

(c) The fermenter is prevented from overheating by the cold water flowing in through the heat exchanger coils at **C**.

Explain what causes the fermenter to heat up.

(1)

(d) It is important to prevent microorganisms other than *Fusarium* from growing in the fermenter.

(i) Why is this important?

(1)

(ii) Suggest **two** ways in which contamination of the fermenter by microorganisms could be prevented.

1. _____

2. _____

(2)

(e) Human cells cannot make some of the amino acids which we need. We must obtain these amino acids from our diet.

The table shows the amounts of four of these amino acids present in mycoprotein, in beef and in wheat.

Name of amino acid	Amount of amino acid per 100 g in mg			Daily amount needed by a 70 kg human in mg
	Mycoprotein	Beef	Wheat	
Lysine	910	1600	300	840
Methionine	230	500	220	910
Phenylalanine	540	760	680	980
Threonine	610	840	370	490

A diet book states that mycoprotein is the best source of amino acids for the human diet.

Evaluate this statement.

Remember to include a conclusion in your evaluation.

(4)
(Total 11 marks)

ANSWERS to Practice GCSE Questions

Q1.

(a) Marks awarded for this answer will be determined by the Quality of Written Communication (QWC) as well as the standard of the scientific response. Examiners should also refer to the information in the [Marking guidance](#), and apply a 'best-fit' approach to the marking.

0 marks

No relevant content.

Level 1 (1-2 marks)

There is a brief description of at least one of the stages (pre-inoculation, inoculation, post-inoculation).

Level 2 (3-4 marks)

There is a simple description of at least two stages and an explanation of at least one of them.

Level 3 (5-6 marks)

There is a clear description of all three stages and an explanation of at least two of them.

Examples of Biology points made in the response:

Pre-inoculation

- Petri dish and agar sterilised before use
- to kill unwanted bacteria
- inoculating loop passed through flame / sterile swab
- to sterilise / kill (other) bacteria

Inoculation

- loop/swab used to spread/streak bacterium onto agar

Allow other correct methods, eg bacterial lawns

- lid of Petri dish opened as little as possible
- to prevent microbes from air entering

Post-inoculation

- sealed with tape
- to prevent microbes from air entering
- incubate
- to allow growth of bacteria

(b) (i) bacteria killed / destroyed
ignore fights / attacks / stops growth / got rid of

1

(ii) *Might be correct*

largest area / space where no bacteria are growing
allow most bacteria killed

1

Might not be correct

(need more evidence as) D may be harmful to people / animals / surfaces
ignore ref to cost / dangerous or harmful unqualified

1

or may work differently with different bacteria

or disinfectants may be different concentrations

ignore different amounts of disinfectant unless reference to different drop size

or may not last as long

ignore take longer to work

allow reference to anomalous result or not repeated

[9]

Q2.

(a) any **two** from:

- regular hand washing

or

use hand sanitiser / alcohol gel

- cover nose / mouth when coughing / sneezing

allow wear a face mask

- put used tissues (straight) in the bin
- don't kiss uninfected people

allow isolate patient from others

or

don't share cutlery / cups / drinks with uninfected people

- clean / disinfect / sterilise surfaces regularly

ignore responses referring to infected people

2

(b) any **three** from:

- stimulate (mouse) lymphocytes to produce antibody

for marking points 1 and 2 lymphocyte must be used at least once

- combine (mouse) lymphocyte with tumour cell

or

(create a) hybridoma

- clone (hybridoma) cell
- (hybridoma) divides rapidly **and** produces the antibody

3

(c) any **two** from:
• (monoclonal) antibody binds to virus **or** antibody binds to antigen on surface of virus
• (monoclonal) antibody is complementary (in shape) / specific to antigen (on surface of virus)
• white blood cells / phagocytes kill / engulf the virus(es)

2

(d) as a control
or
to see / compare the effects of the treatment (vs. no treatment)

1

(e) $(4.8 + 10.4) \div 2 \div 100 \times 1500$
or
 $(4.8 \div 100 \times 750) + (10.4 \div 100 \times 750)$

1

114
an answer of 114 scores 2 marks
allow 228 for 1 mark

1

(f) **(supports the conclusion because)**
over double the number / % of patients (in the trial) were hospitalised with the placebo (compared to MAB)

1

(does not support the conclusion because)
no information on patients not hospitalised / still unwell at home
or
other factors may have affected those admitted to hospital
allow correct named factor e.g. age / gender / other illness
or
don't know if it was a double blind trial

1

[12]

Q3.

(a) to kill virus
or
to prevent virus spreading

1

(b) take (stem) cells from meristem
or
tissue culture
allow take cuttings

1

(c) use Benedict's solution

1

glucoses turns solution blue to orange

1

(d) **Level 2 (3–4 marks):**

A detailed and coherent explanation is provided. The student makes logical links between clearly identified, relevant points that explain why plants with TMV have stunted growth.

Level 1 (1–2 marks):

Simple statements are made, but not precisely. The logic is unclear.

0 marks:

No relevant content.

Indicative content

- less photosynthesis because of lack of chlorophyll
- therefore less glucose made
- so
- less energy released for growth
- because glucose is needed for respiration
- and / or
- therefore less amino acids / proteins / cellulose for growth
- because glucose is needed for making amino acids / proteins / cellulose

4

[8]

Q4.

(a) pupils dilated (at **B**)

allow converse for A

1

in dim light / low light levels

1

because circular muscles (in iris) relax

1

(and) radial muscles contract

1

(b) figure 2 shows myopia where light does not focus on the retina

allow refraction

1

in figure 3 the lens bends the light so that light focuses on the retina

1

[6]

Q5.

(a) to prevent water affecting the direction of root growth

1

(b) gravity acts evenly on all sides

allow cancel out the effect of gravity

*do **not** accept there is no gravity*

1

(c) (mean) includes the (anomalous) result for seedling 4
allow (mean) includes the (anomalous) result which only grew 1 mm

1

(d) calculate (mean) from just seedlings 1, 2, 3 and 5
or
repeat the investigation **and** recalculate (a new mean)
allow omit seedling 4 from (mean) calculation

1

(e) uneven distribution of hormone in (root / seedling of) A
allow reference to auxin
allow more hormone at bottom
*do **not** accept more hormone at the top*

1

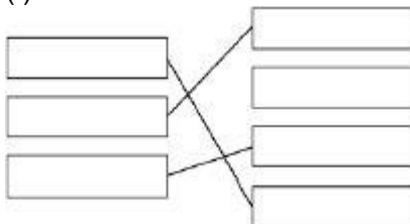
even distribution of hormone in B
allow B does not have an uneven distribution of hormone

1

(so) top grows fast(er) (than bottom) in (root / seedling of) A (and equal growth in B)
allow (more) cell elongation or cell division on top of A
allow converse for lower surface

1

(f)



extra line for a hormone cancels mark for that hormone

1
1
1

[10]

Q6.

(a) (i) gravitropism / geotropism
not '...trophism'
ignore 'positive' or 'negative'

1

(ii) any **two** from:

- anchorage
- takes in water
- takes in ions / minerals / salts / correct named example

allow nutrients

do not accept food

2

(iii) auxin

1

(b) Marks awarded for this answer will be determined by the Quality of Communication (QC) as well as the standard of the scientific response. Examiners should also refer to the information on page 5, and apply a best-fit approach to the marking.

0 marks

No relevant content.

Level 1 (1 – 2 marks)

There is a basic description of a simple method involving seedlings and light.

Level 2 (3 – 4 marks)

There is a description of a method involving seedlings in 1-sided light, and a control, with a correct observation.

Level 3 (5 – 6 marks)

There is a description of a method involving groups of seedlings in 1-sided light, and in control conditions. It includes some correct measurements or observations.

examples of Biology points made in the response:

- use of scissors to cut tips from some shoots / cut hole in box
- use of forceps for handling seedlings
- use of ruler to measure lengths of shoots at start and at end
- other factors controlled – eg temperature / water
- use of lamp + box re. one-sided lighting
- repetitions – each treatment ≥ 3 times
- control in total darkness / all-round light
- time taken = several hours to a few days
- sample results: tip exposed to 1-sided light \rightarrow bend to light, tip removed \rightarrow vertical, control \rightarrow vertical

6

[10]

Q7.

(a)

	statement is true for		
	mitosis only	meiosis only	both mitosis and meiosis
all cells produced are genetically identical	✓		

in humans, at the end of cell division each cell contains 23 chromosomes		✓	
involves DNA replication			✓

3 correct = 2 marks

2 correct = 1 mark

0 or 1 correct = 0 marks

2

(b) any **two** from:

ignore references to one parent only

- many offspring produced
- takes less time

allow asexual is faster

- (more) energy efficient
- genetically identical offspring

allow offspring are clones

- successful traits propagated / maintained / passed on (due to offspring being genetically identical)

- no transfer of gametes or seed dispersal

allow no vulnerable embryo stage

allow no need for animals

- not wasteful of flowers / pollen / seeds
- colonisation of local area

must imply local area

2

(c) genetic variation (in offspring)

1

(so) better adapted survive

allow reference to natural selection or survival of the fittest

1

(and) colonise new areas by seed dispersal

or

can escape adverse event in original area (by living in new area)

must imply new area

1

many offspring **so** higher probability some will survive

1

allow bluebell example described (max 3 if not bluebell)

[8]

Q8.

(a) gene / allele

1

(b) (in / on) ribosome(s)

1

(c) any **three** from:

- amino acids make up a protein
- (protein is) particular combination / sequence (of amino acids)
- bases form a code
- the bases work in threes or description
accept bases work in triplet
- (code / three bases) for one amino acid
accept eg (bases) WXZ for amino acid J for 2 marks

3

(d) (i) different / wrong amino acid (coded for) **or** different / wrong shape
ignore reference to amino acid 'made'
ignore change unqualified
ignore different protein

1

(ii) different / example of different eye colour
allow protein may / would not be made / function (normally)

1

[7]

Q9.

(a) (i) fusion / joining / combining of gametes / egg **and** sperm / sex cells
accept fertilisation
allow fusion / joining / combining DNA from two parents
ignore meeting / coming together / mixing of gametes etc

1

(ii) (mixture of) genes / DNA / genetic information / chromosomes
ignore nucleus / inherited information but allow second mark if given

1

from both parents / horse **and** zebra
dependent on sensible attempt at 1st mark

1

(b) Marks awarded for this answer will be determined by the Quality of Written Communication (QWC) as well as the standard of the scientific response. Examiners should apply a 'best-fit' approach to the marking.

0 marks

No relevant content

Level 1 (1-2 marks)

There is simple description of the early stages of adult cell cloning. However there is little other detail and the description may be confused or inaccurate.

Level 2 (3-4 marks)

There is an almost complete description of the early stages of the process and description of some aspects of the later stages. The description may show some confusion or inaccuracies.

Level 3 (5-6 marks)

There is a clear, detailed and accurate description of all the major points of how adult cell cloning is carried out.

Examples of Biology points made in the response could include:

- skin cell from zorse
- (unfertilised) egg cell from horse
- remove nucleus from egg cell
- take nucleus from skin cell
- put into (empty) egg cell
- (then give) electric shock
- (causes) egg cell divides / embryo formed
- (then) place (embryo) in womb / uterus

6

[9]

Q10.

(a)

Classification group	Name
Class	<i>Mammalia</i>
Order	<i>Primates</i>
Family	<i>Lemuroidea</i>
Species	<i>catta</i>

all 4 correct = 2 marks

2 or 3 correct = 1 mark

0 or 1 correct = 0 marks

2

(b) Lemur catta

ignore capitalisation / non-capitalisation of initial letters
ignore italics / non-italics
ignore underlining / non-underlining 1

(c) carried by (favourable) currents on masses of vegetation
allow description of currents from Figure 2
ignore swimming 1

(d) isolation of different populations 1

habitat variation between lemur populations
allow examples – biotic (e.g. food / predators) or abiotic (e.g. temperature) 1

genetic variation or mutation (in each population) 1

better adapted survive (reproduce) **and** pass on (favourable) allele(s) to offspring
*allow natural selection **or** survival of the fittest **and** pass on (favourable) allele(s) to offspring*
allow gene(s) / mutation as an alternative to allele(s) 1

(eventually) cannot produce fertile offspring with other populations
allow cannot reproduce 'successfully' with other populations
ignore cannot reproduce unqualified 1

[9]

Q11.

(a) reference to interbreeding 1

successfully between Island types
allow ref. to production of fertile offspring
allow ref. to DNA analysis / comparison for 1 mark
ignore ref. to grey fox 1

(b) (i) (two ancestral populations) separated / isolated (by geographical barrier / sea) 1

and genetic variation (in each population) **or** different / new alleles **or** mutations occur 1

under different environment / conditions
allow abiotic or biotic example
allow different selection pressures 1

natural selection occurs **or** better adapted survived to reproduce 1

so (favourable) alleles / genes / mutations passed on (in each population) 1

ignore they adapt to their environment

1

(ii) any **one** from:

- continued to mate with one another
- few beneficial mutations (between island varieties)
- similar conditions on each island so similar adaptations/features fit

1

[8]

Q12.

(a) Aa

*allow dominant **and** recessive*

allow heterozygous

1

(b) (i) gametes A, a **and** A, a

max 1 if gametes are incorrect (eg in punnet square)

1

correctly derived offspring from cross

allow ecf from their gametes

1

*identification of round **and** wrinkled offspring*

for this mark the phenotype of each different offspring genotype must be indicated

1

(ii) (due to) chance **or** expected ratio is only a probability

accept the idea of small numbers not representative

ignore anomaly / random / coincidence

*do **not** accept error*

1

(c) any **one** idea from:

- genes / chromosomes / alleles / DNA not discovered / known about
*do **not** accept religious theme (ie confusion with Darwin's difficulties with the church)*

- published in obscure journal / few scientists read his work

1

[6]

Q13.

(a)

	1960 – 1977	1977 – 2003	2003 – 2015
trend in carbon dioxide concentration		increasing	increasing
trend in air temperature	decreasing	increasing	constant / decreasing

1

1

allow synonyms e.g. level / goes up / goes down

(b) traps heat / energy or (long-wavelength / IR) radiation

do not accept light / UV

or

less loss of heat

allow stops (some) heat escaping

do not accept stops all heat escaping

or

insulates

ignore greenhouse effect

ignore reference to ozone layer

1

(c) **Level 2:** Some logically linked reasons are given. There may also be a simple judgement.

3–4

Level 1: Relevant points are made. They are not logically linked.

1–2

No relevant content

0

Indicative content

for the theory:

- (overall increased CO₂ parallels) overall increased temperature (e.g. by 0.4 (°C))
- CO₂ traps (long-wave) radiation / IR / heat

against the theory:

- in some years (e.g. 1960–1977) temperature falls (while CO₂ is rising)
- many (large and small) erratic rises and falls in temperature
- overall correlation does not necessarily mean a causal link
- other (unknown) factors may be involved in temperature change

to access level 2 there must be evidence both for and against the theory **and** use of data from the graph

(d) burning of (fossil) fuels

allow e.g. coal / oil / gas

allow driving cars
allow any activity which leads to burning fuels – e.g. using central heating

ignore power stations unqualified
ignore burning / fires unqualified
ignore deforestation

1

(e) photosynthesis
allow full description or full equation
allow a symbol equation which is not balanced

1

(f) any **two** from:
• (some) plants grow faster / higher yield
• loss of habitat
• migration **or** change in distribution*
• extinction*

*if neither is given allow alters biodiversity for 1 mark
allow (in terms of extinction) death due to e.g. lack of water / food or increased disease
ignore death unqualified

2

allow points made using examples

[11]

Q14.

(a) x-axis: scale + labelled, including units
scale $\geq \frac{1}{2}$ width of graph paper label: biomass in g/m^2

1

bar widths correct
 $\pm \frac{1}{2}$ -square each side
allow 1 mark if 3 correct

2

all 4 bars correctly labelled
large fish + small fish + invertebrate (animals) + algae
or
(trophic level) 4 + 3 + 2 + 1
or
tertiary consumer + secondary consumer + primary consumer
+ producer
ignore bar heights

1

(b) $\frac{840 - 10}{840} \times 100$

allow equivalent calculation

1

98.809523... / 98.810 / 98.81 / 98.8

99
allow answer given to two significant figures from an incorrect calculation in step 2

1

an answer of 99 scores **3** marks

1

(c) inedible parts / example
allow eaten by other animals **or** not all organisms eaten

or

egested / faeces
allow not digested
allow excretion / urine
ignore waste

or

respiration / as CO₂
ignore energy losses
ignore movement

1

(d) bacteria decay organic matter / sewage / algae / dead plants

1

(by) digestion
allow example such as starch broken down to sugar
or
protein broken down to amino acids

1

(and) bacteria respire aerobically
or
respire using oxygen

1

(which) lowers oxygen concentration (in water)
or
fish have less oxygen
allow reduced respiration of fish

1

(so) reduced energy supply causes death of fish
allow toxins in the sewage kill fish
ignore pathogens **or** (pathogenic) bacteria cause disease in fish and kills them

1

[13]

Q15.

(a) wear a face mask
allow wear gloves

1

(b) **Level 2 (3–4 marks):**

A detailed and coherent plan covering all the major steps. It sets out the steps needed in a logical manner that could be followed by another person to produce an outcome which will address the hypothesis.

Level 1 (1–2 marks):

Simple statements relating to steps are made but they may not be in a logical order. The plan may not allow another person to produce an outcome which will address the hypothesis.

0 marks:

No relevant content.

Indicative content

Plan:

- cut a specified number of pieces of bread to the same size
- place mould spores on the bread
- the number of mould spores needs to be the same quantity of mould spores on each piece of bread
- place bread in different sealable plastic bags
- place in different temperatures (minimum of three) eg fridge, room, incubator
- leave each for the same amount of time eg four days
- measure the percentage cover of mould on each piece of bread
- repeat experiment

additional examiner guidance:

- good level 2 answer will describe how the growth of mould can be measured and will give a range of different temperatures to be used
- allow equivalent levels of credit for alternative methodologies that would clearly produce a measurable outcome in terms of mould growth at various temperatures

4

(c) any **one** from:

- type of mould
- amount of mould (put on each piece of bread)
- amount of air in the plastic bags
- size of the pieces of bread
- type of bread
- amount of moisture / water added

1

(d) $(56 - 4 = 52) / 5$

1

10.4

allow 10.4 with no working shown for 2 marks

1

ecf for incorrectly read figures for 1 mark

(e) (decomposition occurs at a faster rate when the temperature is higher
or
amount of decomposition is higher when temperature is higher

1

Q16.

(a) $0.03 = \frac{\text{output}}{5950 + 50} \times 10$

an answer of 1.8 scores **3** marks

1

$$\text{output} = \frac{0.03 \times (590 + 50)}{100}$$

1

1.8

1

(b) indoor % efficiency = $\frac{40}{10000 + 6000} \times 100$

1

or
 $\frac{40}{16000} \times 100$

0.25(%)

an answer of 8.33 scores **3** marks

allow 8 / 8.3 / 8.333...

1

$$\left(\frac{0.25}{0.03} = \right) 8.33 \text{ (times)}$$

1

(c) any **two** from:

- in faeces / egestion

or

not all food is absorbed

- not all food is ingested
- in urine / excretion
- in respiration
- keeping warm
- movement

do **not** accept 'for respiration'

allow as 'heat'

2

(d) warmer indoors so less energy wasted in keeping warm

allow less energy lost as 'heat'

1

less movement indoors so less energy wasted

if no other mark awarded, allow it is warmer and there is less movement indoors for 1 mark

1
[10]

Q17.

ideas that:

large mesh

allows small fish to escape so they live long enough/grow big enough to breed
maintains stocks

close season

maintains stocks
unless catch more in rest of time
especially important in breeding season

closed areas

maintains stocks
especially important for breeding grounds
but can't make fish stay inside area

quotas

maintains stocks
plus difficulty of enforcement of any/all of above
any 7 for 1 mark each

fisherman (effect of controls on)

reduced catches/less income ∴ controls
harder to catch fish
but will ensure their future

any 3 for 1 mark each

to max. of 9

(credit other good but unanticipated reasons)

[9]

Q18.

(a) circulation / mixing / described

1

or

temperature maintenance

supply oxygen

do **not** allow oxygen for anaerobic respiration

or

for aerobic conditions

or

for faster respiration

1

(b) any **one** from:

- energy supply / fuel
or use in respiration
*do **not** allow just food / growth*
ignore reference to aerobic / anaerobic
- material for growth
or to make mycoprotein

1

(c) (heat / energy) from respiration
allow exothermic reactions
allow description eg breakdown of glucose / catabolism
ignore metabolism
ignore aerobic / anaerobic

1

(d) (i) any **one** from:

- compete (with Fusarium) for food / oxygen
or reduce yield of Fusarium
- make toxic waste products
or they might cause disease / pathogenic
or harmful to people / Fusarium
*do **not** allow harmful unqualified*

1

(ii) any **two** from:

- steam / heat treat / sterilise fermenter (before use)
***not** just clean*
*allow sterilisation unqualified for **1** mark*
- steam / heat treat / sterilise glucose / minerals / nutrients / water (before use)
***not** just use pure glucose*
- filter / sterilise air intake
- check there are no leaks

2

(e) any **three** from:

- beef is best **or** beef is better than mycoprotein(*)
- mycoprotein mainly better than wheat(*)
- more phenylalanine in wheat than in mycoprotein(*)

allow equivalent numerical statements()*

- but no information given on other amino acids / costs / foods

3

overall conclusion:

statement is incorrect

or

it would be the best source for vegetarians

or

for given amino acids, beef is the best source

or

three foods provide insufficient data to draw a valid conclusion

1

[11]

Examiners' Report on the Practice Questions

Q1.

- (a) The quality of the written communication of many students was pleasing. Many good descriptions of the procedures were seen and students had obviously been involved in practical work involving microorganisms. References to 'inoculating loops' (though not necessarily named as such) and 'pressure cookers' for sterilising, were seen. However sterilising the surface of agar with a hot inoculating loop would not be an efficient sterilising method. A few students suggested sterilisation of the loop after it had been used to collect the bacteria, in order to 'kill the bad bacteria'. Some students did not give reasons for the steps they described and so limited their mark to Level 1. Lengthy descriptions of safety precautions such as gloves, goggles and tying the hair back were not required. Common omissions included the tape used for sealing the prepared plate or an instrument for transferring the bacteria. Often the latter was done by being 'picked up carefully by the fingers'. Some students described practical work they had done, for example with fingerprints or bacteria from doorknobs, but unfortunately they did not match the question which was asked. However, it was possible to gain some marks for practical techniques and explanations appropriate to the question. Some students were unfamiliar with the topic and did no more than repeat the stem of the question.
- (b) (i) Many students knew that the bacteria had been killed or destroyed. Answers which described the disinfectant 'fighting' or 'attacking' the bacteria were insufficient. Stopping the growth of the bacteria was ignored, since bacteria must have been growing in that area before the disinfectant was added.
- (ii) Examiners were looking for the idea that the area around disinfectant D was the largest space where no bacteria were growing. Indication that this was only 'the largest clear area' was considered to be insufficient without qualification relating to the numbers or growth of bacteria. Answers which said most bacteria were stopped from growing were allowed in this part. The most common suggestion as to why the student might not be correct, was that the disinfectant might be harmful to people or animals or that it might work differently on other bacteria. The idea that the disinfectant was 'dangerous' needed qualification as to what the danger might be to gain the mark. The examiners were not surprised at the power of advertising, some students suggesting that the disinfectant might 'be too strong' and so kill 'good bacteria', too. A number of students gained a mark for pointing out that the investigation needed to be repeated.

Q5.

- (a) In the stem of the question students were told that both sets of apparatus were placed in a dark cupboard. However, many students thought that the purpose of the damp blotting paper in each set of apparatus was to prevent light affecting the direction of root growth.

57% of students selected the correct reason which was to prevent water affecting the direction of root growth.

- (b) 24% of students were able to explain that apparatus B acted as a control because it allowed gravity to act evenly on all sides or cancelled the effect of gravity.

Many students attempted to explain why a control was needed rather than how apparatus B acted as a control in the given situation. Many also misused the terms 'geotropism' or 'gravitropism' when they in fact meant gravity.

- (c) Lack of precision was an issue for many students here: while most realised there was an anomalous result for apparatus B, many did not point out that this was for seedling 4 whose increase in length was less than 10% of that of the other seedlings.

- (d) Two omissions were evident in the answers of most students. As in question 06.3, many forgot to mention seedling 4. Plus, although most thought the anomalous result should have been ignored or that the experiment should have been repeated, they did not state that the mean should have been recalculated. 31% of students achieved the mark.

- (e) Although the drawing of the root of a seedling from apparatus A showed a right-angle bend with the tip pointing vertically downwards, many students stated that the effect was due to a response to light.

34% of students gained partial credit and 13% achieved all three marks for stating that gravity had caused the hormone to be unevenly distributed in the root of seedling A resulting in more growth on the upper side. While in seedling B the hormone was evenly distributed.

- (f) 61% of students were able to link each of the plant hormones, auxin, ethene and gibberellin, to a correct example of its use in horticulture.

Q7.

- (a) 63% of students knew that genetically-identical cells were only produced in mitosis, that haploid cells were produced in meiosis and that DNA replication was necessary for both processes.

- (b) The advantages of asexual reproduction for bluebell plants most commonly cited by students were that it was a faster process than sexual reproduction and that it required less energy. Many stated that 'identical' plants were produced, but this required qualification in terms of the offspring being **genetically** identical.

50% of students achieved the two marks available.

- (c) Most students concentrated on just two points that related to sexual reproduction in general and did not amplify further in terms of the context of the question, i.e. sexual reproduction in a plant. Thus, variation in the offspring was given together with an attempt to describe some sort of selective advantage in terms of survival. The latter point was frequently made inadequately as students' answers implied that all would survive rather than just some which had the selective advantage.

Only a minority of students explained that sexual reproduction in plants involved seed production. And that seeds could be dispersed over a far wider area than bulbs, hence leading to potential colonisation of new areas giving a higher probability of survival should some unfortunate event overtake the original habitat.

32% of students scored no marks in this question, with 65% achieving one or two marks and 2% achieving three or four.

Q8.

The bulk of this question was aimed at testing potential grade A(students' ability to analyse unfamiliar information. These students rose to the challenge and there were some good responses throughout. Students operating at below this level still had the opportunity to gain some of the marks, using what they had learned from the specification.

- (a) Around two-thirds of students were able to identify 'gene' or 'allele' in part (a). Incorrect answers most frequently offered 'chromosomes'.
- (b) Slightly fewer students could then name the cellular component where proteins are synthesised, with all manner of organelles and cells being suggested, although 'mitochondria' was the most common incorrect response.
- (c) It was in part (c) where weaker students, not surprisingly, came unstuck. Students are expected to know that 'a gene codes for a particular combination of amino acids which make a specific protein'. Having been reminded in part (a) and in part (b) that this question was about making a specific protein (that for blue eye colour), students had only to convey the idea that 'proteins are composed of amino acids' for one mark and then describe 'a specific combination of amino acids' for the second mark. This second mark could be gained in a variety of ways, including quoting the amino acid sequence, 'J, K, L, M, K, N' from the diagram. A third mark could be acquired in a variety of ways, all derived from the diagram. This could have been derived from the idea that it is the 'bases that form the code', that the 'bases work in threes' or that 'this code or the three bases are involved in which amino acid goes to make the protein'. Some good students gave very succinct answers 'three bases code for one amino acid', and gained all three marks in only one line. A different and ultimately unsuccessful approach by some students was to describe what they knew of Mendelian inheritance, explaining how heterozygous parents might have a child with a recessive phenotype. Others homed in on the repeated amino acid 'K' and decided that this must be the recessive allele and that this sequence therefore 'caused blue eyes'.

- (d) (i) Many responses got no further than suggesting that a 'different protein' would be synthesised. Unfortunately this was implied in the question, so gained no mark. Students who recognised that the base code varied for each different amino acid were able to suggest that the change in this code would alter the amino acid sequence and were justly rewarded. Others suggested that the protein would have a different shape and were also credited.
- (ii) Although many students picked up the mark in part (d)(ii) for reference to 'a different eye colour', good students showed excellent understanding of the potential effects of synthesising a different protein. Answers from such students often referred to the possibility of disruption of all manner of characteristics and processes in the body, including the potential that the change may confer advantages or disadvantages on the organism.

Q9.

- (a) (i) The examiners had hoped that students would be well-versed in a definition of 'sexual reproduction'. Unfortunately, this was not the case and there were only a small number of very good answers which included reference to the fusion of gametes or fertilisation. Instead, answers more often referred to the need for 'two parents', 'sexual intercourse' or 'producing a baby', and no mark was awarded. A significant number of students referred to gametes which 'met' or 'mixed', rather than 'fused', and these ideas were not credited.
- (ii) Students fared better in this part, where many described the significance of the 'genes' of the two parents resulting in the characteristics of the zorse, and so gained both marks. A common error was simply to rephrase the question and provide no extra information, for example 'it has the characteristics of the horse and zebra'. It should be noted that acquisition of the second mark, in the mark scheme, was dependent upon a sensible attempt at identifying what was responsible for the characteristics.
- (b) Many students were able to use the diagram to help them to describe some of the early stages of adult cell cloning, though the origin of the cells was not always given. Others managed to go on to describe some or all of the later stages and gain more credit. A common error was poor observation of the diagram which showed the nucleus of the skin cell being transferred, thus many answers referred to the whole zorse skin cell being put into the egg cell, rather than just the nucleus. Some confused students described this as fertilisation, while others included sperm. Many students placed embryos into horses but failed to point out the uterus and only a small minority included ideas about electric shock treatment, often at the wrong stage. Students should be reminded that good quality QWC skills will affect the mark they gain for their biological knowledge in these questions and it was apparent that the majority paid scant attention to this. The lack of sentences, capital letters, full stops and correct spellings meant that some students were penalised. Marks were spread across the range from 0 to 6, however very few students reached the higher level.

Q10.

- (a) 37% of students knew that the four missing taxa in the hierarchy were class, order, family and species. Some demonstrated the use of mnemonics to enable them to recall these technical terms. Unfortunately, some could only remember the mnemonic, not what it represented.
- (b) 48% of students knew the binomial name of an organism was composed of the genus plus species: here, *Lemur catta*. Many incorrect answers included the family name from the table, '*Lemuroidea*'. Many gave a single word for the binomial name.
- (c) Most students appeared not to make use of the scale given on the map. Therefore, did not realise that the ancestral lemur would have had to swim 400 kilometres to get to Madagascar.

Others did not seem to appreciate how long ago 60 million years was and stated that the ancestral lemurs might have been stowaways on boats. 3% of students described how lemurs would have likely been carried on rafts of vegetation (or tree trunks) which would have floated and been propelled by the favourable water currents.

- (d) The ideas required to answer this question were that several populations of ancestral lemurs would have been isolated from one another, perhaps by mountains, deserts or rivers, and found themselves in different types of habitat. Genetic variation, or mutation, within each population then led to the better adapted surviving long enough to reproduce and pass on their beneficial alleles to their offspring, eventually producing different groups of lemurs that could not reproduce with members of another group to produce fertile offspring. Such a complete explanation was given by 4% of students. Although 53% of students were able to achieve at least two of the five available marks, usually for the first two marking points given above.

Weaker explanations gave ideas such as 'the lemurs were in different parts of Madagascar', 'the lemurs survived and passed on their characteristics', 'the lemurs could no longer reproduce together'.

Q11.

This question was about the geographical isolation of foxes on offshore islands and their development into a new species, and varieties of that species between the different islands.

- (a) Over half of the students were able to make at least one sensible suggestion about how scientists could tell if the six types of Island Fox belonged to the same species. This usually involved an attempt to interbreed them, although some suggested DNA analysis as an alternative strategy and this was accepted by examiners. However, only around a quarter could amplify upon their suggested breeding programme and state that the outcome would be successful (or that the offspring would be fertile) if all of the foxes belonged to the same species.
- (b) (i) This section, on speciation by natural selection was answered well by the majority of students, with nearly two thirds scoring at least two of the five marks available and only those capable of the highest grades

being able to gain access to four or five marks. Thus good differentiation between students of differing abilities was achieved. Most students realised that geographical *isolation* had occurred on the islands and that *environmental conditions* might be *different* here compared to the mainland. *Natural selection* was often mentioned but relatively few students wrote about *genetic variation / mutation* and the passing on of advantageous alleles to the offspring (all too often, the 'feature' or 'adaptation' was inherited). Weaker students seemed to think that the environment 'caused' mutation or that organisms 'adapted' to their environments.

- (ii) This question caused much difficulty and very few students were able to suggest why the Island Foxes had only developed into different varieties of the same species rather than into different species. Less than a quarter were able to suggest that the foxes may have continued to mate with one another or that similar adaptations would have persisted as the conditions on the islands were very similar to each other.

Q12.

- (a) It was expected that the great majority of candidates would be able to correctly offer 'Aa' in part (a), which was a precursor to part (b)(i). However this was not the case and little more than half did so. The most common errors involved giving only one allele, usually 'A' or giving the phenotype 'round', despite the question asking for alleles. Other candidates offered the examiners the unacceptable choice of at least two genotypes.
- (b) (i) The consequences of the omissions in part (a) were frequently not manifested in part (b)(i). Many candidates who gave the wrong answer in (a) went on to show the correct cross here. Although many candidates gained at least one of the three marks, less than one in five were awarded all three. The context of the question was Mendel's second cross, which involved plants from the seeds of the original offspring. Candidates were asked to explain the results obtained from this cross only, by using a genetic diagram. It was impossible, therefore, to award more than one mark (for correct derivation of offspring) if answers included more than one option and gave no guidance to the examiner as to which to select; perhaps by indicating 'first cross' and 'second cross'. The high numbers of seeds referred to seemed to distract some students. They failed to spot the 3:1 ratio and then gave what they believed to be a cross which could result in the largest proportion of wrinkled to round seeds. It was, therefore, common to see answers which assumed the parental genotypes had been AA and Aa. Correct derivation of offspring from the gametes in such a cross gained the maximum of one mark only. Other mistakes included the occasional use of two alleles in gametes. The mark that many failed to pick up, however, was the final one for the identification of both round and wrinkled offspring. Candidates often thought that acknowledging the wrinkled outcomes was enough. They were perhaps thinking of recent exam questions which have asked for an indication of the one child who had a genetic disorder. Some answers here did, in fact, refer to the 'aa'

outcome as 'the sufferer'. Students should be encouraged to match all genotypes and phenotypes in genetic diagrams. It is also important to emphasise the need for clarity in answers of this kind. Gametes should be obvious; casually drawn lines from parental genotypes may not be sufficient and the use of a Punnett square may prove to be a safer option. In addition, it is better to rewrite answers rather than try to alter letters given in a diagram; examiners cannot be left to decide whether a candidate means 'A' or 'a' in such cases. Only a very few candidates used alternative letters, these were only given credit when a key was also given.

- (ii) Many candidates implied that Mendel had made errors in his cross 'he used AA and Aa by mistake', had 'crossed the wrong plants' or had cheated to get his final 3:1 ratio and that this result had 'found him out'. Other answers suggested the misconception that 'some of the wrinkled genes became dominant', presumably misunderstanding the term 'dominant' or the infrequency of mutation. Some candidates carried their experience in coursework tasks into this question, suggesting that the results were an 'anomaly'. Other responses got closer to the essence, but were too vague. Neither 'the ratio is not always exact' nor 'we cannot accurately predict the outcome' or 'fertilisation is random', explained exactly why the numbers failed to match. Good candidates showed clear appreciation of the ideas of chance and probability.
- (c) A number of candidates gained the mark by answering in terms of genes and/or DNA being unknown at the time, so Mendel lacked supporting evidence for his theory. Some candidates missed out by only stating that the technology was not sufficiently developed, or incorrectly that microscopes had not been invented. Others said that at this time inheritance was not recognised, although the "blending theory" had been used in selection for quite some time. Very few referred to his publication being restricted in circulation. The most frequent incorrect response was that Mendel was 'not a scientist', which he certainly was or that he was 'only a monk' (or, according to one candidate, 'only a nun!').

Q13.

Foundation

- (a) Students had to decide whether the trend in carbon dioxide concentration and air temperature, as shown in the graph, was to stay constant, to decrease or to increase during each of three given date ranges. 50% of students were completely successful, the main errors being in deciding which trend was applicable to the air temperature.
- (b) 13% of students were able to explain how an increase in carbon dioxide concentration might cause an increase in temperature. Answers needed to be in terms of reducing the loss of heat / long-wavelength radiation / infra-red radiation from the Earth or acting as an 'insulator'.

Errors included the mention of ultra-violet radiation, the ozone layer and the fact that heat was released in the process of combustion which was also the process that released carbon dioxide. There were also many references to 'global warming' offered as an explanation rather than as a

phenomenon in need of explanation.

- (c) This 'extended response' question was marked using a 'level of response' mark scheme. An answer at level 2 (3–4 marks) required students to give evidence both for and against the proposition that an increase in carbon dioxide in the atmosphere was the cause of an increase in air temperature. The inclusion of numerical data (as stated in the question) was required to back up their argument.

One approach was to make use of the trends already worked out in answer to question (a), possibly adding on numerical values from the graph to illustrate the point being made. For example, from 1960–1977 the concentration of carbon dioxide rose by about 20 ppm (from 320–340 ppm) while the temperature decreased by around 0.4 °C.

Since there was no grid on the graph, approximate numerical values were allowed. However, many students misread or misunderstood the scales on the graph. For the given example, they stated that carbon dioxide concentration rose from 0.1 to 0.3 (ppm or °C), or that the temperature changed from 0 °C to –0.4 °C or even from 320 °C to 280 °C. 26% of students gave level 2 answers.

Many students did not use data from the graph and / or only gave evidence for one side of the argument, usually in favour of the proposition.

- (d) 55% of students were able to give the burning of some sort of fuel (e.g. a fossil fuel or wood) as a human activity that would cause higher concentrations of carbon dioxide in the atmosphere in the winter than in the summer. This could have been described indirectly in terms of examples such as driving cars or the use of home heating systems.
- (e) 24% of students could state that 'photosynthesis' was the biological process that lowered the concentration of carbon dioxide in the summer. Many attempted to answer in terms of human activities.
- (f) Loss of habitat, usually in terms of polar bears in the Arctic, changes in migration patterns, and extinction, were the main examples given as effects of rising global temperatures on living organisms. 43% of students were able to give at least one of these. Quite commonly, answers were too vague, such as organisms dying.

Higher

- (a) In this question, students had to decide whether the trend in carbon dioxide concentration and air temperature, as shown in the graph, was to stay constant, to decrease or to increase during each of three given date ranges. 75% of students were completely successful, the main errors being in deciding which trend was applicable to the air temperature.
- (b) 49% of students were able to explain how an increase in carbon dioxide concentration might cause an increase in temperature in terms of reducing the loss of heat / long-wavelength radiation / infra-red radiation from the earth or acting as an 'insulator'.

Errors included the mention of ultra-violet radiation, the ozone layer and

the fact that heat was released in the process of combustion which was also the process that released carbon dioxide. There were also many references to 'global warming' offered as an explanation rather than as a phenomenon in need of explanation.

- (c) This 'extended response' question was marked using a 'level of response' mark scheme. An answer at level 2 (3–4 marks) required students to give evidence both for and against the proposition that an increase in carbon dioxide in the atmosphere was the cause of an increase in air temperature, together with the inclusion of numerical data (as stated in the question) to back up their argument.

One approach was to make use of the trends already worked out in answer to question (b), possibly adding on numerical values from the graph to illustrate the point being made. For example, between 1960–1977 the concentration of carbon dioxide rose by about 20 ppm (from 320–340 ppm) while the temperature decreased by around 0.4 °C.

Since there was no grid on the graph, approximate numerical values were allowed. However, some students misread or misunderstood the scales on the graph and stated, for the given example, that carbon dioxide concentration rose from 0.1–0.3 (ppm or °C), or that the temperature changed from 0 °C to –0.4 °C or even from 320–280°C. 61% of students gave level 2 answers.

Some students did not follow the instruction to use data from the graph and / or only gave evidence for one side of the argument, usually in favour of the proposition.

- (d) 79% of students were able to give the burning of some sort of fuel (e.g. a fossil fuel or wood) as a human activity that would cause higher concentrations of carbon dioxide in the atmosphere in the winter than in the summer. In some instances this was described indirectly in terms of examples such as driving cars or the use of home heating systems.
- (e) 77% of students knew that 'photosynthesis' was the biological process that lowered the concentration of carbon dioxide in the summer. Some attempted to answer in terms of human activities.
- (f) Loss of habitat, usually in terms of polar bears in the Arctic, changes in migration patterns and extinction were the main examples given as effects of rising global temperatures on living organisms. 80% of students were able to give at least one of these. Quite commonly, answers were too vague, such as 'organisms dying'.

Q14.

- (a) Students were required to draw a pyramid of biomass on the graph paper, to scale, using figures given in the food chain. 32% of students were completely successful, but the following errors were common among the remainder:
- Forgetting to label the x-axis as 'Biomass in g/m²'.
 - A scale ranging from 0 to 900 in both directions from the mid-point. Consequently, the plotted bars that were twice the width they should

have been (e.g. 840 units for the algae was plotted as 1680). Thus all the plotted bars were incorrect as none of them matched the student's chosen scale.

- (b) There were two possible routes for the calculation of the percentage of biomass lost between the algae and the large fish, given that their biomasses were 840 and 10 g/m² respectively.

Allowance was made for arithmetic errors in that one mark was available for an answer given to two significant figures, correctly derived from an incorrect answer to the calculation. Many students did not give their answer correct to two significant figures e.g. '98.8' was a common answer. This scored two of the three marks available, provided it was evident that an appropriate method had been used to produce this figure. 51% of students achieved full marks, with a further 13% achieving two marks.

- (c) 63% of students knew a method by which biomass could be lost between trophic levels in a food chain, such as inedible or indigestible material, or by the process of respiration. Many students suggested 'movement' but this was ignored unless respiration was also mentioned.

- (d) Students had to be able to link concepts from various sections of the specification: 4.7.3.2 (pollution of water by sewage), 4.7.2.3 (the decay of biological material, including the use of oxygen), 4.2.2.1 (digestion) and 4.4.2.1 (aerobic respiration). Students were also prompted by the sentence in the stem of the question: 'Untreated sewage contains organic matter and bacteria.'

Most students did not link the decay of organic matter by bacteria, involving digestion and aerobic respiration, to depletion of oxygen dissolved in the river water, leaving insufficient oxygen for the fish to respire, and hence the fish being deprived of the energy necessary to sustain life.

The vast majority of students associated bacteria with disease in the fish which was insufficient at this level and for which no marks were awarded. Some suggested toxins in the sewage might kill the fish, which was allowed as an alternative to lack of energy as a cause of the fishes' death.

42% of students achieved any marks and 0.2% students achieved full marks in this high demand question.

Q17.

Few candidates failed to gain around half marks for this question, though very good responses were also few and far between. Common errors, particularly amongst weaker candidates, were:

- taking the limiting of the mesh size of nets to mean limiting the overall size of nets or of insisting on a small mesh (which is obviously not a sensible way to conserve fish populations);
- interpreting fish stocks as the amount of fish available in shops.

Q18. In this question about the growth of *Fusarium* in an industrial fermenter, most made the point, in part (a), that the air would supply the fungus with oxygen. Fewer went on to explain that it would also circulate or mix the contents of the fermenter or that it would contribute to temperature maintenance. Only around a third of candidates were able to give two valid points and relatively few, who had mentioned oxygen, went on to explain that this could be used in *aerobic* respiration.

In part (b) just under three quarters of candidates were able to explain why the fungus required glucose, generally as a supply of energy or for respiration. Answers such as for growth were considered too weak without further qualification, for example to make cell components.

In part (c) 62% of candidates appreciated that respiration, or exothermic reactions in the fungus generated heat and hence warmed the fermenter.

Responses to part (d)(i) were somewhat disappointing, with less than half of candidates being able to explain that contaminating microorganisms might either compete with the *Fusarium* for resources or might make toxic products which had an adverse effect either on the *Fusarium* or on the human consumer. Answers such as, other microorganisms might be harmful, without further qualification, for example to human health, were discounted as being too vague.

In part (d)(ii), the vast majority of candidates were able to suggest at least one way that contamination of the fermenter could be prevented, either by sterilisation of apparatus or materials before use or by ensuring the apparatus had no leaks. However, less than a third of candidates were able to suggest *two* precautions. Some, presumably having practised on the January paper, thought that bent tubes on the supply lines, as in Pasteur's flasks, might have been helpful!

Around 30% of candidates were unable to make any valid deductions from the data for part (e), but most could give at least one or two points. Most noticed that beef had the highest content of each of the four given amino acids and hence deduced that the statement suggesting mycoprotein was the best source was incorrect, these were the two most common valid points made by candidates. Some pointed out that mycoprotein would be a good source for vegetarians and a few noticed that mycoprotein was a better source than wheat for just three of the amino acids, perhaps naming phenylalanine as the one exception. Too much value was often placed on the relationship between the absolute amounts of the different amino acids per 100 grams of each food compared to the human daily needs – forgetting that a person is not obliged to eat merely 100 grams and that any excess amino acids are generally deaminated in the human body, the waste excreted and the residue used for other aspects of metabolism. There was also much irrelevant use of the given numbers, with candidates adding up columns of figures for no apparent reason. Better candidates were able to extract more *relevant* information from the data. Others introduced their own ideas that went beyond the data, such as discussing the fat content of beef, which they then often used to contradict themselves, having already stated that beef was the best source. Such considerations were entirely irrelevant to the question which was restricted to *source(s) of amino acids*.

To gain full marks it was essential to give either a conclusion based on the evidence or to state that information for just three foodstuffs provided insufficient evidence upon which to base a valid conclusion. Only the more able candidates had the courage of their convictions in this latter respect.

Task 2
Optional
Applying mathematical skills in a biological context

In Biology analysis of data is key, this task shows how Biologists use data to make links.

You may have carried out a practical investigation in the past, during which you calculated your heart rate by taking your pulse. Heart rate can be used to calculate cardiac output – provided that you have a value for the individuals' stroke volume – using the equation:

$$\text{cardiac output} = \text{heart rate} \times \text{stroke volume}$$

- a) Define the terms 'cardiac output' and 'stroke volume' (you may need to use the Internet or other research to help you).
- b) Cardiac output is measured in $\text{cm}^3\text{min}^{-1}$ (cm^3/min). Heart rate is measured in beats per minute. Suggest what units stroke volume is measured in.
- c) Rearrange the equation so that stroke volume is the subject of the equation. Use your rearranged equation to calculate the athlete's stroke volume after training, using the data below:

The table shows the cardiac output and resting heart rate of an athlete before and after completing a training programme.

	Before training	After training
Cardiac output / cm^3	5000	5000
Resting heart rate / beats per minute	70	55

- d) Using the data above, calculate the percentage decrease in the athlete's resting heart rate after training.
- e) As well as the heart rate, breathing rate also increases during and following exercise. What units are used to express breathing rate?
- f) Measure your breathing rate at rest fifteen times. Calculate the mean, median and mode of your data. **Extension:** Can you also define and calculate standard deviation?
- g) Following practical activities, you will need to construct tables in which to put your results. Watch the following video by typing this URL into your web browser:
<http://ed.ted.com/on/x1a7JDW4>. Then look at the guidelines below and use them to evaluate the table drawn in the video.

- All raw data in a single table with ruled lines and border.
- Independent variable (IV) in the first column; dependent variable (DV) in columns to the right (for quantitative observations) OR descriptive comments in columns to the right (for qualitative observations).
- Processed data (e.g. means, rates, standard deviations) in columns to the far right.
- No calculations in the table, only calculated values.
- Each column headed with informative description (for qualitative data) or physical quantity and correct SI units (for quantitative data); units separated from physical quantity using either brackets or a solidus (slash).
- No units in the body of the table, only in the column headings.
- Raw data recorded to a number of decimal places and significant figures appropriate to the least accurate piece of equipment used to measure it.
- All raw data recorded to the same number of decimal places and significant figures.
- Processed data recorded to up to one decimal place more than the raw data.

h) Then, use the guidelines to construct a results table for an investigation into the effect of temperature upon the time taken for the enzyme trypsin to break down a protein in milk (hint: to ensure your column heading are clear, you will need to find out, perhaps using Internet research, how the breakdown of milk protein by trypsin can be observed). State the type of graph that should be drawn to analyse the results from the practical investigation described above. Explain your answer. The video at <http://ed.ted.com/on/GV5hkNIA> may be useful.

Task 3
Optional
Extending understanding

In Biology we have to write essays where we link lots of information together. This task is designed to help build up your essay skills.

Print off the image displaying the variety of functions of water, which is included at the end of this booklet.

Pathway A – complete the table below using examples from the image:

Function	Examples/Explanations
Transport	
Chemical reactions (metabolism)	
Temperature control	
Support	
Movement	
Reproduction	

Pathway B – using Internet research to help you, explain the biological importance of water.

The following websites may be helpful:

<https://alevelbiology.co.uk/notes/the-biological-importance-of-water/>

<https://www.s-cool.co.uk/a-level/biology/biological-molecules-and-enzymes/revise-it/water>

Wider reading (Optional)

Other Minds: The Octopus and the Evolution of Intelligent Life

OTHER
MINDS / THE OCTOPUS AND
THE EVOLUTION
OF INTELLIGENT
LIFE

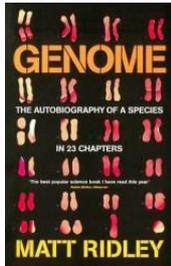


PETER GODFREY-SMITH

This is one of my favourite books and a must for those interested in evolutionary Biology (Mrs Lea)

News paper reviews say: 'Brilliant' Guardian 'Fascinating and often delightful' The Times What if intelligent life on Earth evolved not once, but twice? The octopus is the closest we will come to meeting an intelligent alien. What can we learn from the encounter?

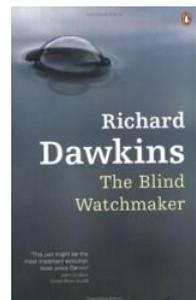
Genome



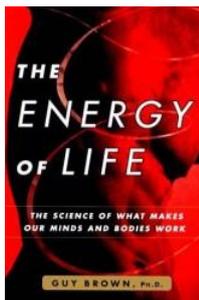
Probably the BEST popular introduction to modern genetics. Ridley's structure is wonderfully simple – 23 chapters to cover the 23 human chromosomes – but he uses it brilliantly. We start with Chromosome number 1 and a gene that we share with every other life form, including, probably, the very first living organism.

The Blind Watchmaker

Every A-level Biology student should read at least one of Dawkins' books, and this may be the best place to start. Readable and provocative, you can accuse Dawkins of many things, but he is never dull.



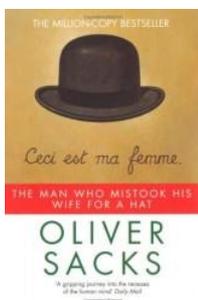
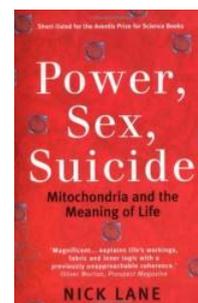
The Energy of Life



An enthralling account of the electricity that keeps you alive and one of the best popular science books ever written. It complements the A2 Respiration topic perfectly and makes all kinds of complex issues immediately accessible.

Power, sex, suicide: mitochondria and the meaning of life

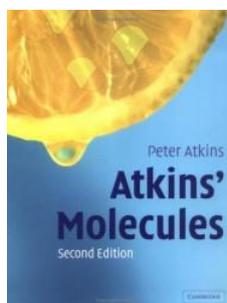
Not an easy read, but awesome in scope and mind-boggling in its implications. From the very origins of mitochondria in the murky bacterial soup, to the dangers of keeping DNA next to this bubbling furnace of free radicals, and the role of mitochondria in apoptosis. Includes all the latest research and ideas in the field, and is essential reading for anyone who's serious about Oxbridge.



The Man Who Mistook His Wife For a Hat

Sacks's case studies make fascinating reading and this is the most famous, and probably the most accessible, of his books. The chapters are interesting for what they reveal about the human brain and how it works, but the stories are so much more than just dry case histories. Sacks never loses sight of the fact that his patients, for all their bizarre symptoms, are human beings, and his compassion is evident throughout. Extraordinary and moving, this book may change the way you view the world.

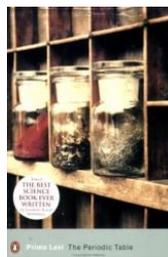
Atkin's Molecules



This sounds terribly dry. A book about molecules? Ugh. But try this extract from the section of pheromones:

“Another component of male underarm sweat provides an engaging story. This component is a hormone molecule that closely resembles one secreted by a male pig encouraging mating behaviour in a sow. The same pheromone is also secreted by the fungus we know as the truffle. Because truffles do not appear above ground, they must be sought out by pigs, who end up frustrated. Whether our enjoyment of truffles is related to our perhaps unconscious enjoyment of our own underarm sweat is a matter of conjecture.” Could make you fall in love with Biochemistry...

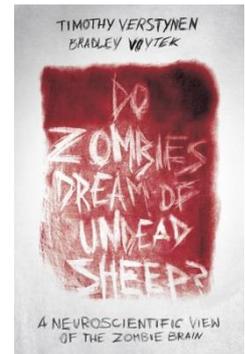
The Periodic Table



Primo Levi is best known for his extraordinary accounts of his time in Auschwitz as a prisoner of the Nazis, how he lived, how he survived, and how he finally found his way home. These books, *If This Is A Man*, and *The Truce*, should be read by anyone and everyone. But Levi was an industrial chemist by training, and another of his books, the unpromisingly titled *The Periodic Table*, celebrates this first love. Forget the title. Each chapter has the name of an element, and each is a self-contained story. These vary hugely, from pure fantasy to historical fable to autobiographical snippets. Vanadium describes how his knowledge of that element's properties helped him survive the concentration camp. Lead tells the story of a mediaeval lead worker. Carbon, the best of all, narrates the journey of a carbon atom as it travels into and out of the living world. These are wonderful stories, wholly original and utterly compelling.

Do zombies dream of undead sheep?

Interesting for those studying Biology and Psychology: Even if you've never seen a zombie movie or television show, you could identify an undead ghoul if you saw one. With their endless wandering, lumbering gait, insatiable hunger, antisocial behavior, and apparently memory-less existence, zombies are the walking nightmares of our deepest fears. What do these characteristic behaviors reveal about the inner workings of the zombie mind? Could we diagnose zombism as a neurological condition by studying their behavior? In *Do Zombies Dream of Undead Sheep?*, neuroscientists and zombie enthusiasts Timothy Verstynen and Bradley Voytek apply their neuro-know-how to dissect the puzzle of what has happened to the zombie brain to make the undead act differently than their human prey. Combining tongue-in-cheek analysis with modern neuroscientific principles, Verstynen and Voytek show how zombism can be understood in terms of current knowledge.



Other suggested reading

The Greatest Show on Earth by Richard Dawkins. Bang up to date on the evidence for evolution- a great introduction to evolution.
The Origin of Species by Charles Darwin (the final chapter- although it is all very well written).
Why Evolution is True by Jerry Coyne (an introduction to evolutionary theory)
Bad Science by Ben Goldacre- very good on the scientific method and how science works.
Bad Pharma: How Drug Companies Mislead Doctors and Harm Patients is a book by British physician and academic [Ben Goldacre](#) about the [pharmaceutical industry](#), its relationship with the medical profession, and the extent to which it controls academic research into its own products.

Additional Reading

The Selfish Gene by Richard Dawkins (a classic, if difficult read).
River out of Eden by Richard Dawkins.
Life by Richard Fortey (excellent on fossil evidence and the history of life).
A Short History of Nearly Everything by Bill Bryson.
Mapping the Deep by Robert Kunzig.
Silent Spring by Rachel Carson.
Almost Like A Whale by Steve Jones.

Websites

<http://www.bbc.co.uk/nature/>
<http://www.bbc.co.uk/radio4/programmes/genres/factual/scienceandnature>
<http://www.newscientist.com/>
<http://www.guardian.co.uk/science>

Ted Talks (Optional but interesting)

If you have 30 minutes to spare, here are some great presentations (and free!) from world leading scientists and researchers on a variety of topics. They provide some interesting answers and ask some thought-provoking questions. Use the link or scan the QR code to view:

A New Superweapon in the Fight Against Cancer

Available at :

http://www.ted.com/talks/paula_hammond_a_new_superweapon_in_the_fight_against_cancer?language=en

Cancer is a very clever, adaptable disease. To defeat it, says medical researcher and educator Paula Hammond, we need a new and powerful mode of attack.



Why Bees are Disappearing

Available at :

http://www.ted.com/talks/marla_spivak_why_bees_are_disappearing?language=en

Honeybees have thrived for 50 million years, each colony 40 to 50,000 individuals coordinated in amazing harmony. So why, seven years ago, did colonies start dying en-masse?

Why Doctors Don't Know About the Drugs They Prescribe

Available at :

http://www.ted.com/talks/ben_goldacre_what_doctors_don_t_know_about_the_drugs_they_prescribe?language=en

When a new drug gets tested, the results of the trials should be published for the rest of the medical world — except much of the time, negative or inconclusive findings go unreported, leaving doctors and researchers in the dark.



Growing New Organs

Available at :

http://www.ted.com/talks/anthony_atalla_growing_organs_engineering_tissue?language=en

Anthony Atalla's state-of-the-art lab grows human organs — from muscles to blood vessels to bladders, and more.