AQA A-LEVEL · 7402

BIOLOGY



EXAM QUESTION PACK

3.5.2 RESPIRATION

SCORE	PERCENTAGE
/506	%

STEMUP

These questions belong to AQA, not to us.

The examination questions, mark schemes and examiner reports in this pack were written and published by AQA. They are past assessment materials, reproduced here so that students can revise from them.

What we do not own

STEMUP is not affiliated with AQA and does not own, and makes no claim to own, any of the question, mark scheme or examiner report material in this pack. AQA has not endorsed, approved or been involved in the production of it. AQA and the qualification titles used here belong to their respective owners and appear for identification only.

Where to find the originals

AQA publishes its past papers, mark schemes and examiner reports free of charge. Always check the current specification at aqa.org.uk before you revise, because content and wording can change between series.

If you hold the rights to any material in this pack and would like it amended or removed, contact admin@stemup.co.uk and we will act on it.

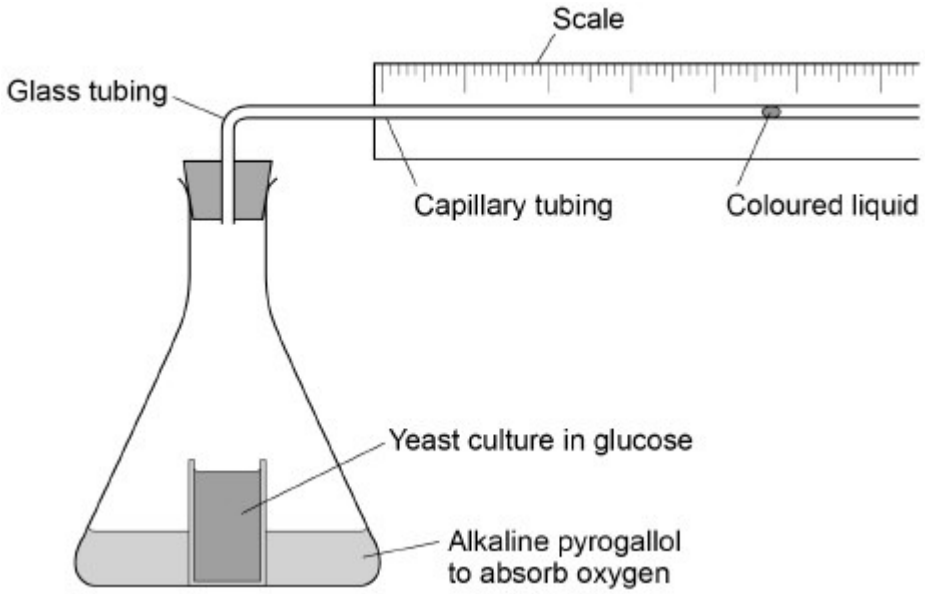
Q1.

Yeast cells can respire aerobically or anaerobically. A student used the apparatus shown in **Figure 1** to measure the rate of respiration in yeast.

She:

- positioned the flask in a water bath so that the yeast culture reached a constant temperature
- then left the apparatus for one hour before starting her investigation.

Figure 1



(a) Suggest **one** reason why it was important that the student left the apparatus for one hour after the yeast culture reached a constant temperature.

_____

_____

(1)

(b) During her investigation, the coloured liquid moved to the right.

Explain why it moved to the right.

_____

_____

_____

_____

_____

_____

_____

_____

(2)

(c) The student found that the coloured liquid moved 1.5 cm in 24 hours. The diameter of the lumen (hole) of the capillary tubing was 1 mm.

The volume of a capillary tubing is given by $\pi r^2 l$, where π is 3.14 and l = length.

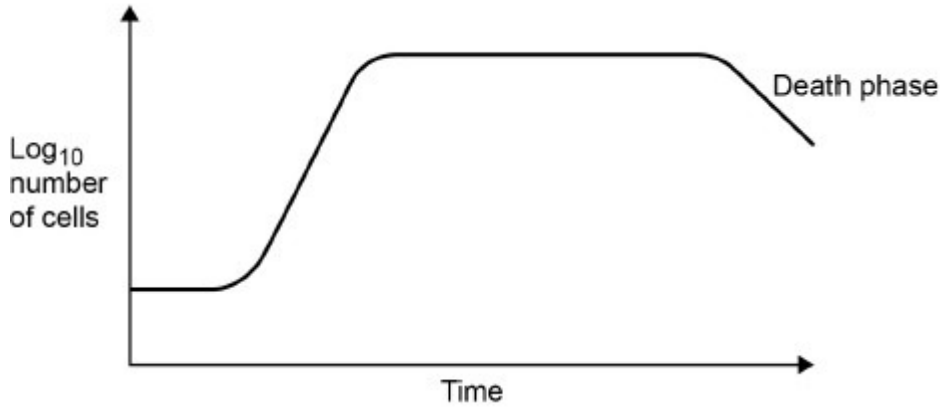
Calculate the volume of gas produced in $cm^3\ hour^{-1}$.
Show your working.

Answer = _____ $cm^3\ hour^{-1}$

(2)

Figure 2 shows a typical population growth curve for yeast under laboratory conditions.

Figure 2



(d) Explain why a log scale is used to record the number of cells.

_____

_____

_____

(1)

(e) Many yeast cells die during the death phase.

Suggest **one** reason why.

_____

_____

_____

_____

(1)

(f) The following equation can be used to make predictions of the growth in the population of yeast cells under ideal laboratory conditions.

$$\mathbf{X_t = X_0\ e^{rt}}$$

X_t = the population after a certain time
X_0 = the population at the start
e = 2.72 (base of natural logarithm)
r = growth rate
t = time period in hours over which r applies

A population of 2000 yeast cells was left for 10 hours.
The value for the growth rate was 0.5

Assuming no yeast cells died, calculate the predicted size of the population after 10 hours. Show your working.

Answer = _____

(2)

(Total 9 marks)

Q2.

(a) Exercise causes an increase in heart rate.

Describe the role of receptors and of the nervous system in this process.

_____

_____

_____

_____

_____

_____

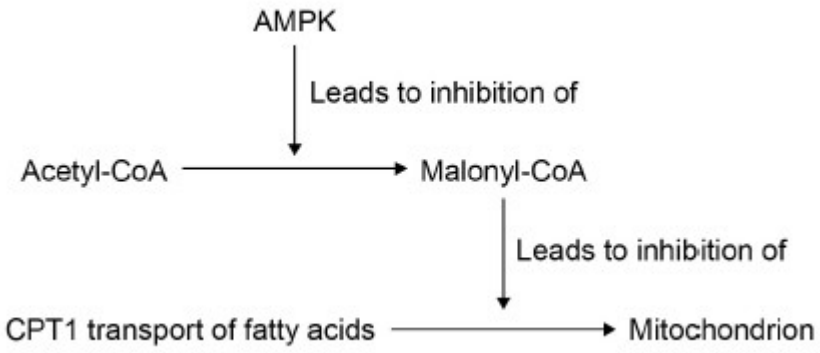
_____

_____

(4)

(b) AMP-activated protein kinase (AMPK) is an enzyme that regulates a number of cellular processes. Exercise leads to activation of AMPK.

The diagram shows one effect of activation of AMPK during exercise.



CPT1 is a channel protein that transports fatty acids into mitochondria.

Using the diagram above, explain the benefit of activation of AMPK during exercise.

_____

_____

_____

_____

_____

_____

_____

_____

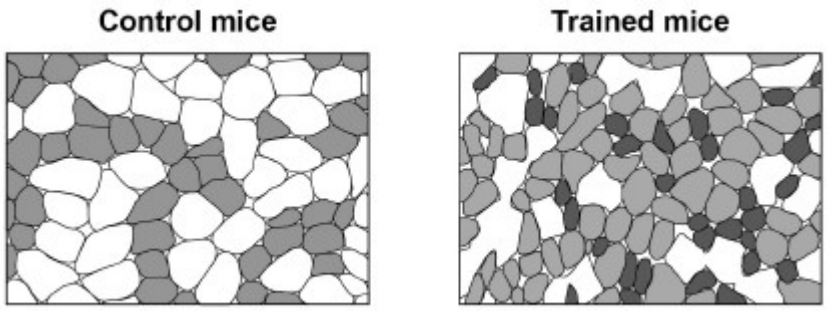
(3)

(Total 7 marks)

Q3.

Scientists investigated the effect of regular exercise on skeletal muscle fibres in mice. The scientists compared the muscle fibres of mice after six weeks of regular exercise (trained mice) with those of mice that had not exercised (control mice). The scientists stained the muscle fibres from both sets of mice to show succinic acid dehydrogenase activity. The darker the stain the greater the succinic acid dehydrogenase activity.

The diagram below shows a typical set of results they obtained.



(a) Succinic acid dehydrogenase is an enzyme used in the Krebs cycle.

Suggest **one** reason for the difference in the staining between the muscle fibres of the control mice and the trained mice.

_____

_____

_____

(1)

(b) The scientists then compared the length of time that the control mice and the trained mice could carry out prolonged exercise. The trained mice were able to exercise for a longer time period than control mice.

Explain why.

_____

_____

_____

_____

_____

_____

_____

_____

(3)

(c) The scientists determined the mean diameter of muscle fibres in trained mice using an optical microscope to examine sections of muscle tissue. The circular area (πr^2) of one field of view was 1.25 mm^2. The diameter of this area was equal to the

diameter of 15 muscle fibres.

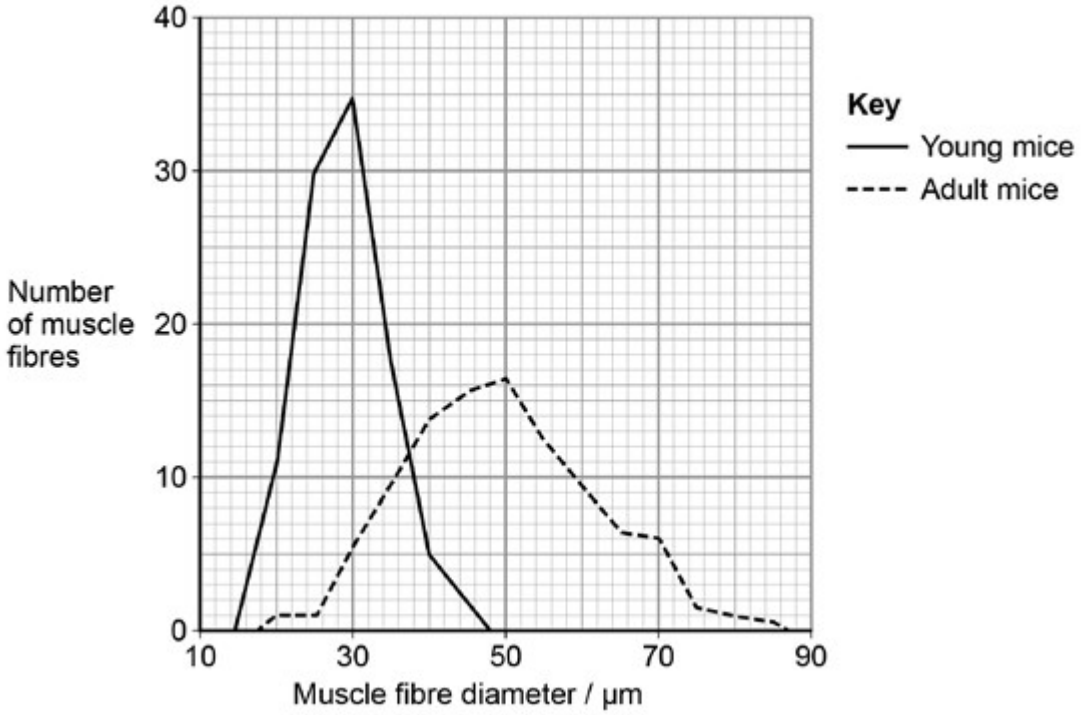
Using this information, calculate the mean diameter in μm (micrometres) of muscle fibres in this section of tissue.

Answer _____ μm

(2)

(d) The scientists also compared the diameter of samples of muscle fibres taken from young mice and adult mice.

Some of their results are shown in the graph.



Describe **two** differences between these samples of muscle fibres.

1. _____

_____

_____

2. _____

_____

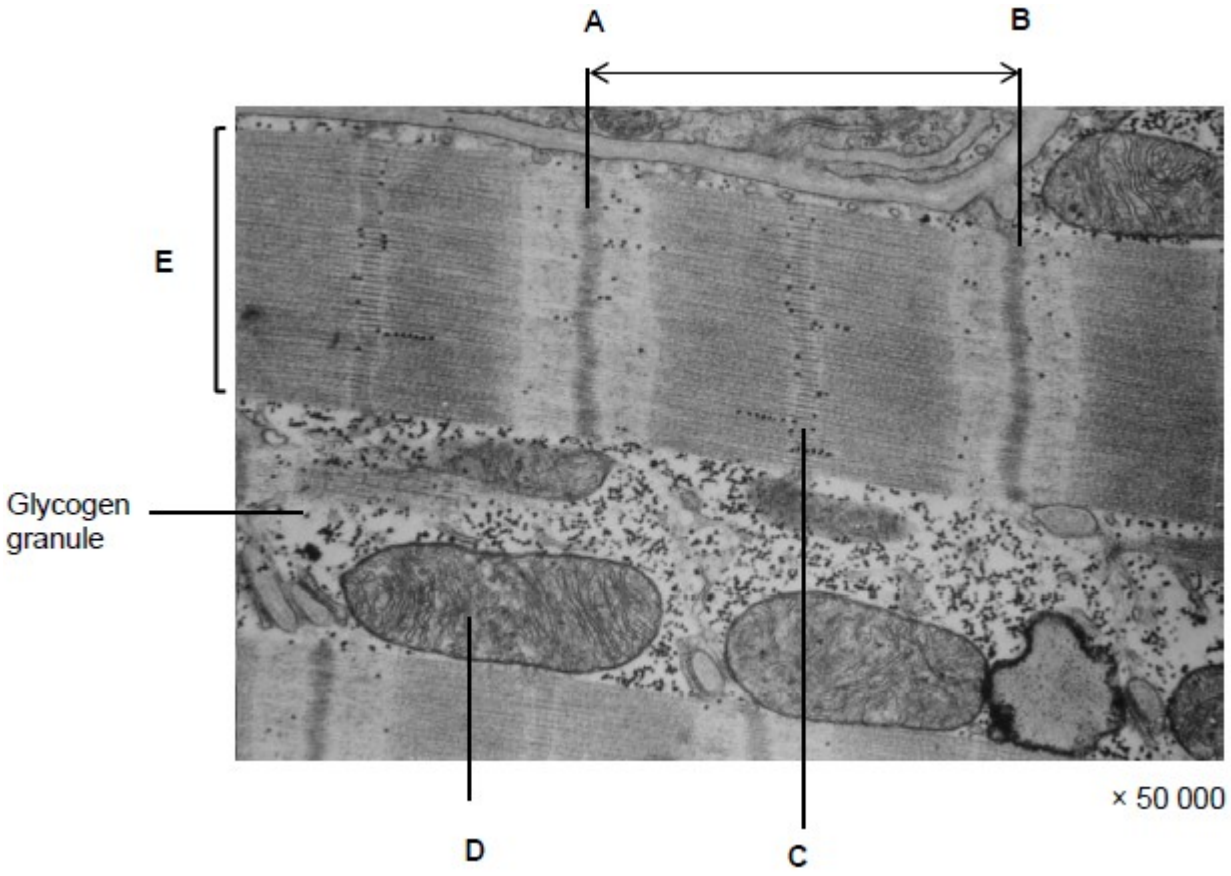
_____

(2)

(Total 8 marks)

Q4.

The image below shows a transmission electron micrograph of a longitudinal section of skeletal muscle.



(a) Name structures **C**, **D** and **E**.

C _____

D _____

E _____

(3)

(b) Give the name of the structure shown between points **A** and **B**.

_____

(1)

(c) Calculate the actual distance between points **A** and **B**. Give your answer in micrometres (μm).

Answer = _____ μm

(1)

(d) The image shows glycogen granules present in skeletal muscle.

Explain their role in skeletal muscle.

_____

_____

_____

_____

_____

(2)

(e) During vigorous exercise, the pH of skeletal muscle tissue falls. This fall in pH leads to a reduction in the ability of calcium ions to stimulate muscle contraction.

Suggest how.

_____

_____

_____

_____

_____

_____

_____

(3)

(Total 10 marks)

Q5.

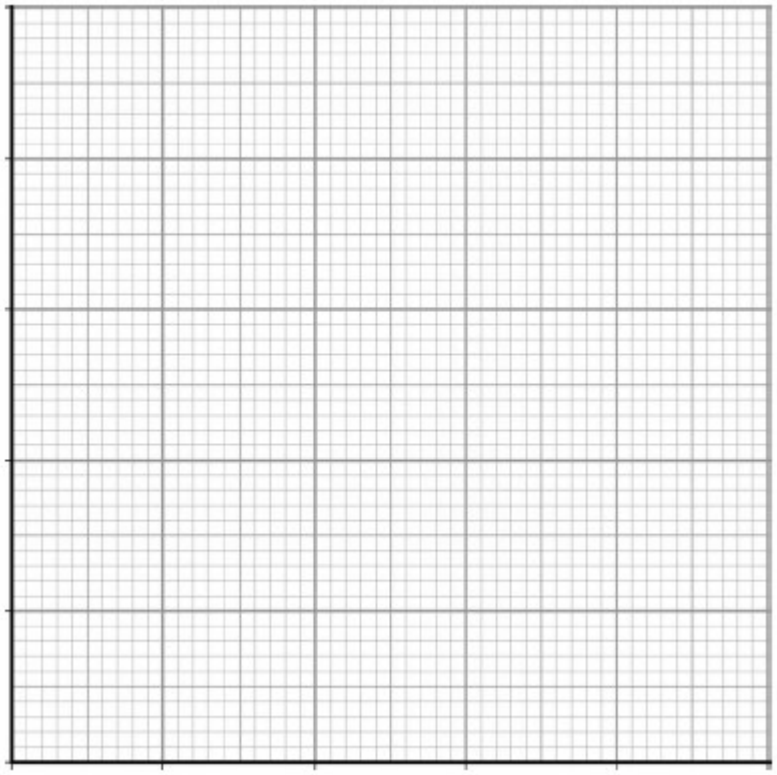
Scientists measured the rate of carbon dioxide release by three groups of insects of the same species at 10 °C, 20 °C and 30 °C. They also determined the mean mass of each group of insects.

The scientists results are shown in the table.

Temperature / °C	**Mean mass / g**	**Rate of carbon dioxide release / μdm^3 $minute^{-1}$**	**Rate of carbon dioxide release per gram / μdm^3 g^{-1} $minute^{-1}$**
10	0.047	0.12	
20	0.046	0.33	
30	0.048	0.56	

(a) Complete the table above and plot a graph of your calculated values against temperature on the graph paper. Express your calculated rates with the appropriate

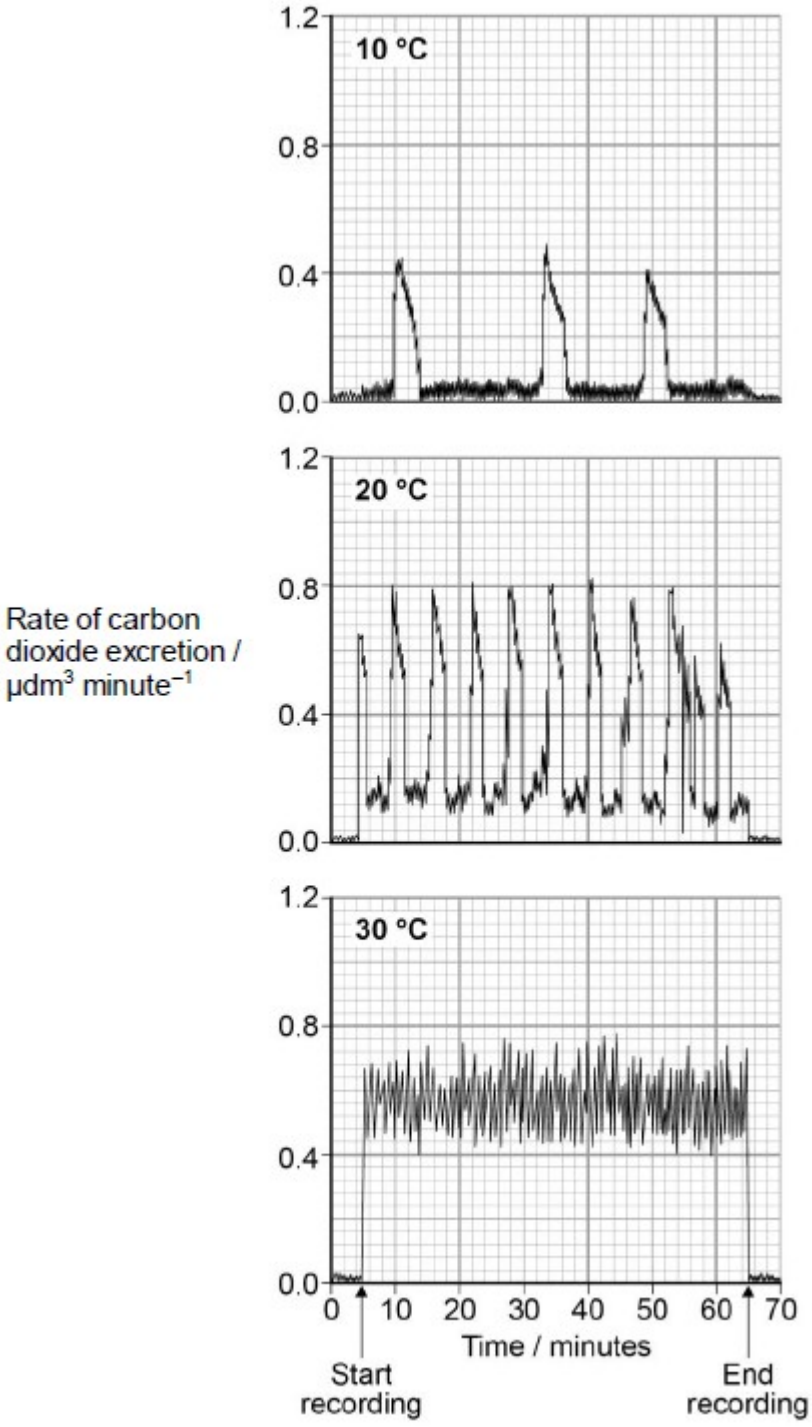
number of significant figures.



(3)

The body temperature of the insects was largely determined by the temperature they were kept at. At each temperature, the scientists recorded rate of carbon dioxide release by individual insects over time. This rate depends upon spiracles opening or closing.

The graphs below show results for three insects.



(b) Calculate the change in the rate per hour of opening of the spiracles between 10 °C and 20 °C.

_____

_____

(1)

(c) Explain how you could determine the total amount of carbon dioxide secreted at 30 °C during the period of recording.

_____

_____

(1)

(d) Suggest an explanation for the effect of temperature on the rate of carbon dioxide release.

_____

_____

_____

_____

_____

_____

_____

(3)

(Total 8 marks)

Q6.

Scientists have investigated the use of different types of stem cell to treat damage to the heart after a myocardial infarction. During a myocardial infarction, a number of different cell types in the heart die. This includes cardiomyocytes which are heart-muscle cells.

Embryonic pluripotent stem cells (ESCs) can divide and differentiate into a wide range of different cell types.

(a) Using the information given, suggest **one** reason why ESCs might be suitable to treat damage to the heart.

_____

_____

_____

(1)

(b) ESCs have not yet been used to treat people who have had a myocardial infarction. This is because of concern that the use of ESCs might lead to more harm to the person. One way that ESCs might lead to more harm is by differentiating into the wrong types of cells.

Suggest **one** other way that putting ESCs into a person's heart might lead to more harm to the person.

_____

_____

_____

_____

_____

(2)

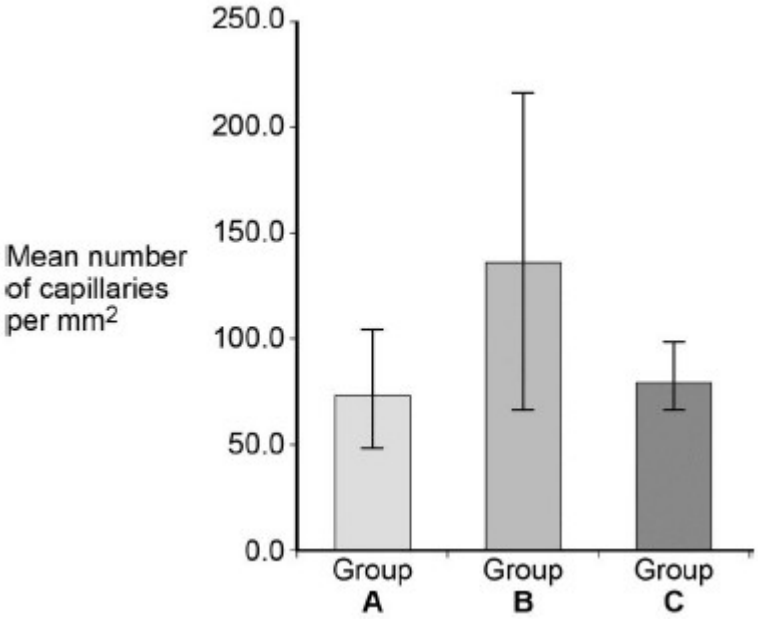
(c) Transplants of cardiomyocytes have been shown to increase the repair of heart tissue damaged by myocardial infarction.

One group of scientists investigated the hypothesis that these transplants work by stimulating growth of new blood vessels into damaged heart tissues. They obtained three groups of mice, **A**, **B** and **C** that had suffered myocardial infarctions.

- **Group A** were operated on but no transplant was given.
- **Group B** were operated on and given transplants containing cardiomyocytes and two other types of heart cell.
- **Group C** were operated on and given transplants containing the two other types of heart cells but no cardiomyocytes.

After a suitable time, the scientists measured the mean number of capillaries per mm^2 in sections taken from areas of the hearts of the mice affected by myocardial infarction.

Their results are shown in the graph below. The bars show ±2 standard deviations, which includes 95.4% of the data.



Group **A** was a control group. Explain **two** ways in which Group **A** acts as a control.

1. _____

_____

_____

2. _____

_____

_____

(2)

(d) What can you conclude from these data about the stimulation by cardiomyocytes on

growth of new blood vessels into damaged heart tissues?

(3)

(e) Suggest how the growth of new blood vessels into damaged heart tissues could increase the rate of repair of tissues.

(3)

(f) The scientists used an optical microscope to measure the number of capillaries in thin sections cut from samples of heart muscle.

Describe the method they would have used to find the mean number of capillaries per mm^2.

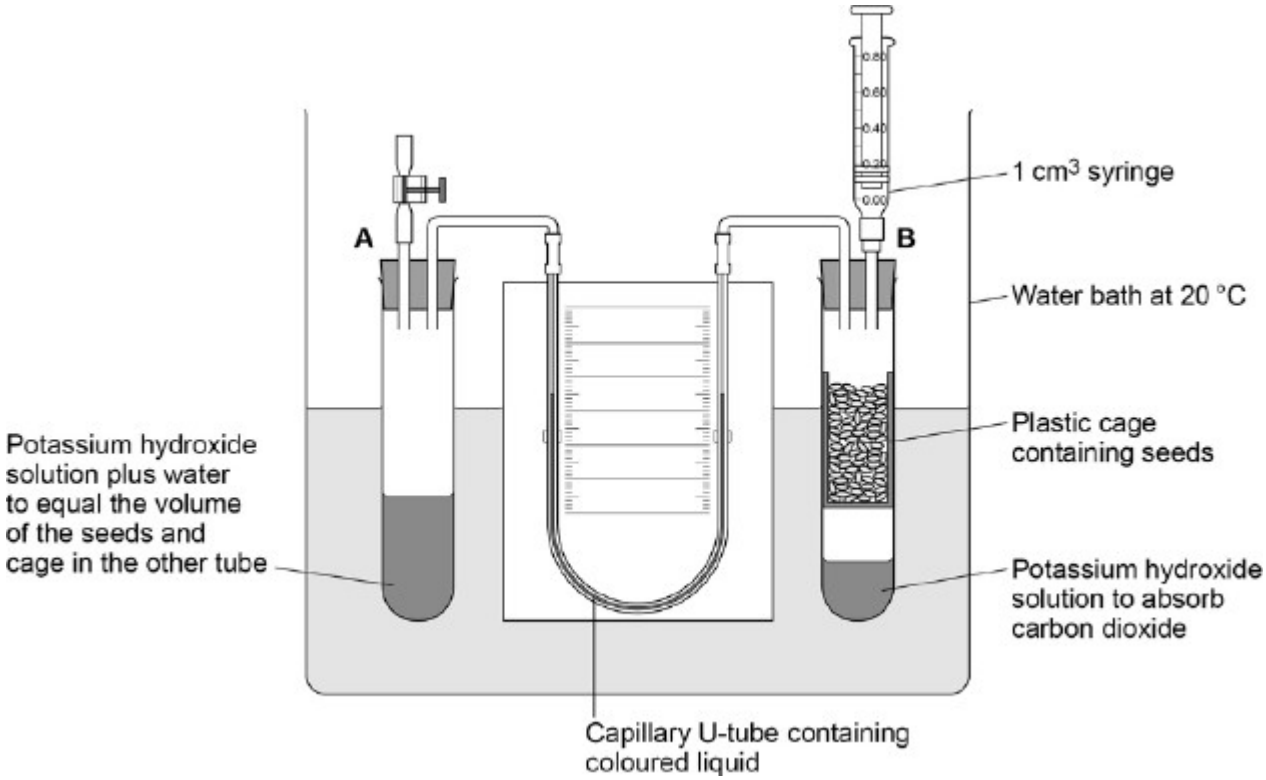
_____

(4)

(Total 15 marks)

Q7.

The figure below shows the apparatus used for measuring the rate of oxygen consumption in aerobic respiration by seeds.



(a) For the first 10 minutes, the tap attached to tube **A** was left open and the syringe from tube **B** was removed.

Suggest **three** reasons why the apparatus was left for 10 minutes.

1. _____

_____

2. _____

_____

3. _____

_____

(3)

(b) Suggest and explain why the chosen temperature was 20 °C for this experiment.

_____

_____

_____

_____

(2)

After 10 minutes, the tap attached to tube **A** was closed and the syringe was attached to tube **B**. Every minute, the syringe plunger was moved until the levels in the U-tube were the same. The reading on the syringe volume scale was then recorded.

The results are shown in the table below.

Time / minutes	Reading on syringe volume scale / cm^3
0	0.84
1	0.81
2	0.79
3	0.76
4	0.73
5	0.70
6	0.68
7	0.66
8	0.63
9	0.62
10	0.58

(c) During the experiment, the coloured liquid in the tubing moved towards tube **B**. Explain what caused this.

_____

_____

_____

_____

_____

_____

(3)

(d) The mass of the seeds was 1.6 g. Use the information in the table above to calculate the rate of oxygen consumption in $cm^3\ g^{-1}\ hour^{-1}$ by the seeds.

Show your working.

Rate = _____ $cm^3\ g^{-1}\ hour^{-1}$

(2)

(Total 10 marks)

Q8.

Read the following passage carefully.

A large and growing number of disorders are now known to be due to types of mitochondrial disease (MD). MD often affects skeletal muscles, causing muscle weakness.

We get our mitochondria from our mothers, via the fertilised egg cell. Fathers do not pass on mitochondria via their sperm. Some mitochondrial diseases are caused by mutations of mitochondrial genes inside the mitochondria. Most mitochondrial diseases are caused by mutations of genes in the cell nucleus that are involved in the functioning of mitochondria. These mutations of nuclear DNA produce recessive alleles.

One form of mitochondrial disease is caused by a mutation of a mitochondrial gene that codes for a tRNA. The mutation involves substitution of guanine for adenine in the DNA base sequence. This changes the anticodon on the tRNA. This results in the formation of a non-functional protein in the mitochondrion.

There are a number of ways to try to diagnose whether someone has a mitochondrial disease. One test involves measuring the concentration of lactate in a person's blood after exercise. In someone with MD, the concentration is usually much higher than normal. If the lactate test suggests MD, a small amount of DNA can be extracted from mitochondria and DNA sequencing used to try to find a mutation.

Use information in the passage and your own knowledge to answer the following questions.

(a) Mitochondrial disease (MD) often causes muscle weakness (lines 1–3). Use your knowledge of respiration and muscle contraction to suggest explanations for this effect of MD.

_____

_____

_____

_____

_____

_____

(3)

Two couples, couple **A** and couple **B**, had one or more children affected by a mitochondrial disease. The type of mitochondrial disease was different for each couple.

None of the parents showed signs or symptoms of MD.

- Couple **A** had four children who were all affected by an MD.
- Couple **B** had four children and only one was affected by an MD.

(b) Use the information in lines 5–9 and your knowledge of inheritance to suggest why:

- all of couple **A**'s children had an MD
- only one of couple **B**'s children had an MD.

Couple **A** _____

_____

_____

_____

Couple **B** _____

_____

_____

_____

(4)

(c) Suggest how the change in the anticodon of a tRNA leads to MD (lines 10–13).

_____

_____

_____

_____

_____

_____

(3)

(d) If someone has MD, the concentration of lactate in their blood after exercise is usually much higher than normal (lines 15–17). Suggest why.

_____

_____

_____

_____

_____

_____

(3)

(e) A small amount of DNA can be extracted from mitochondria and DNA sequencing used to try to find a mutation (lines 18–19).

From this sample:

- how would enough DNA be obtained for sequencing?
- how would sequencing allow the identification of a mutation?

_____

_____

_____

_____

(2)

(Total 15 marks)

Q9.

In mammals, the mesenteric artery connects the aorta to blood vessels of the small intestine.

Sport scientists recorded increases in blood flow in the mesenteric artery after different types of meal. The types of meal were:

- carbohydrate only
- fat only
- protein only.

Typical results are shown in the table.

Type of meal	Maximum percentage increase in blood flow in mesenteric artery	Time taken to reach maximum increase in blood flow in mesenteric artery / minutes
Carbohydrate only	64	15
Fat only	60	30
Protein only	57	45

(a) The sport scientists concluded that the three types of meal had no major effect on maximum percentage increase in blood flow in the mesenteric artery.

What else can be concluded from their results?

_____

_____

_____

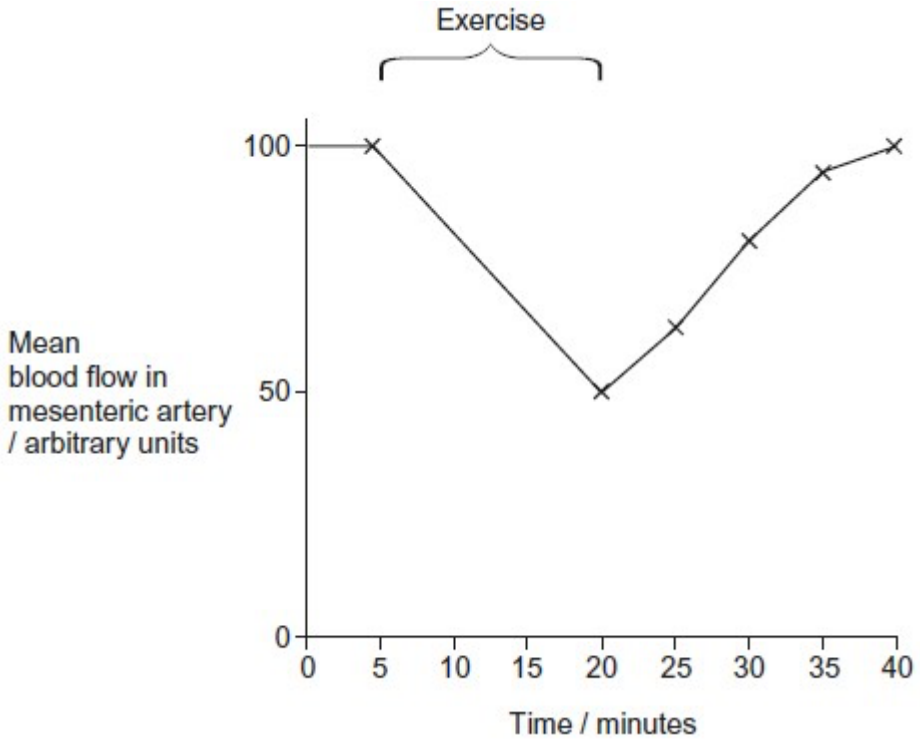
_____

_____

(2)

In another investigation, the sport scientists recorded blood flow in the mesenteric artery before and after vigorous exercise.

The graph shows their results for a large group of volunteers.



(b) Suggest the advantage of the change in blood flow in the mesenteric artery during exercise.

_____

_____

_____

_____

_____

_____

_____

(3)

(c) The sport scientists concluded people should **not** do vigorous exercise after a meal. Does the information from the table and the graph support this conclusion?

_____

_____

_____

_____

_____

_____

_____

_____

_____

_____

_____

(4)

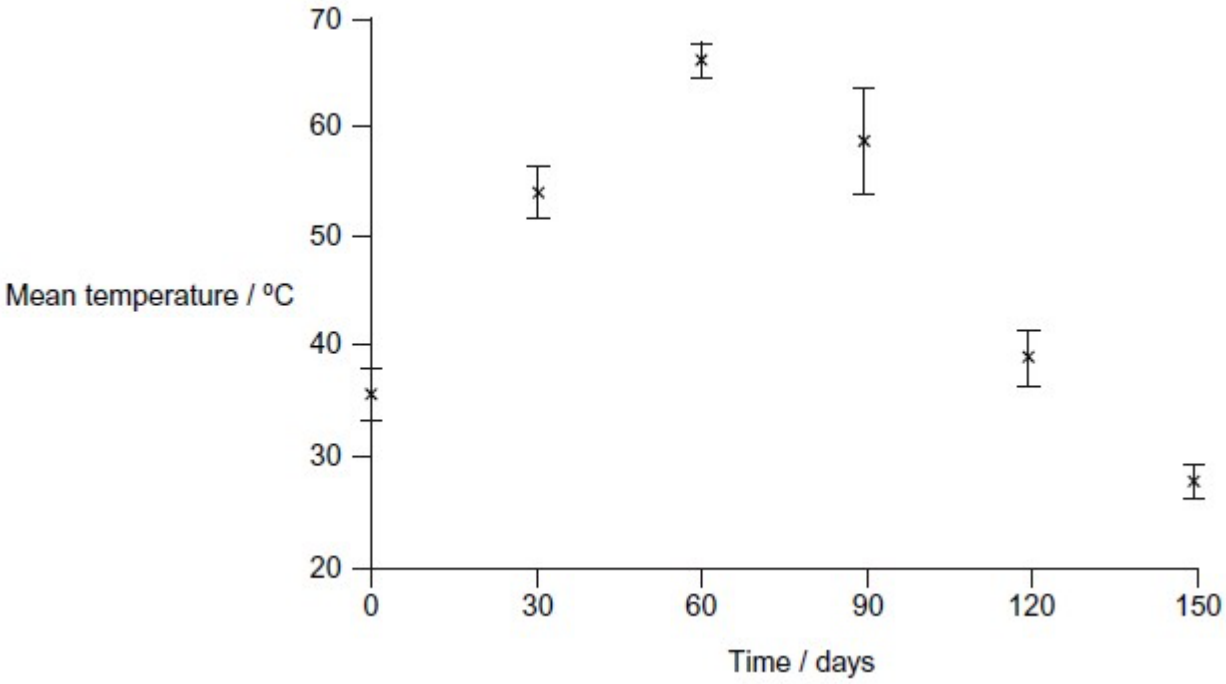
(Total 9 marks)

Q10.

The organic material in household waste can be used to make compost for use as a fertiliser. Scientists investigated changes during one process used to make this compost. The method involved placing the waste in large containers for 150 days. At regular intervals the containers were rotated. The scientists measured the temperature of samples of waste during the investigation.

Figure 1 shows the results they obtained. The vertical bars show standard deviations.

Figure 1



(a) Explain how microorganisms contributed to the increase in temperature during processing of organic waste.

_____

_____

_____

_____

(2)

(b) Explain the advantage of showing the data using standard deviations rather than ranges.

_____

_____

_____

_____

(2)

(c) Suggest **two** advantages of rotating the containers during the process.

1. _____

_____

2. _____

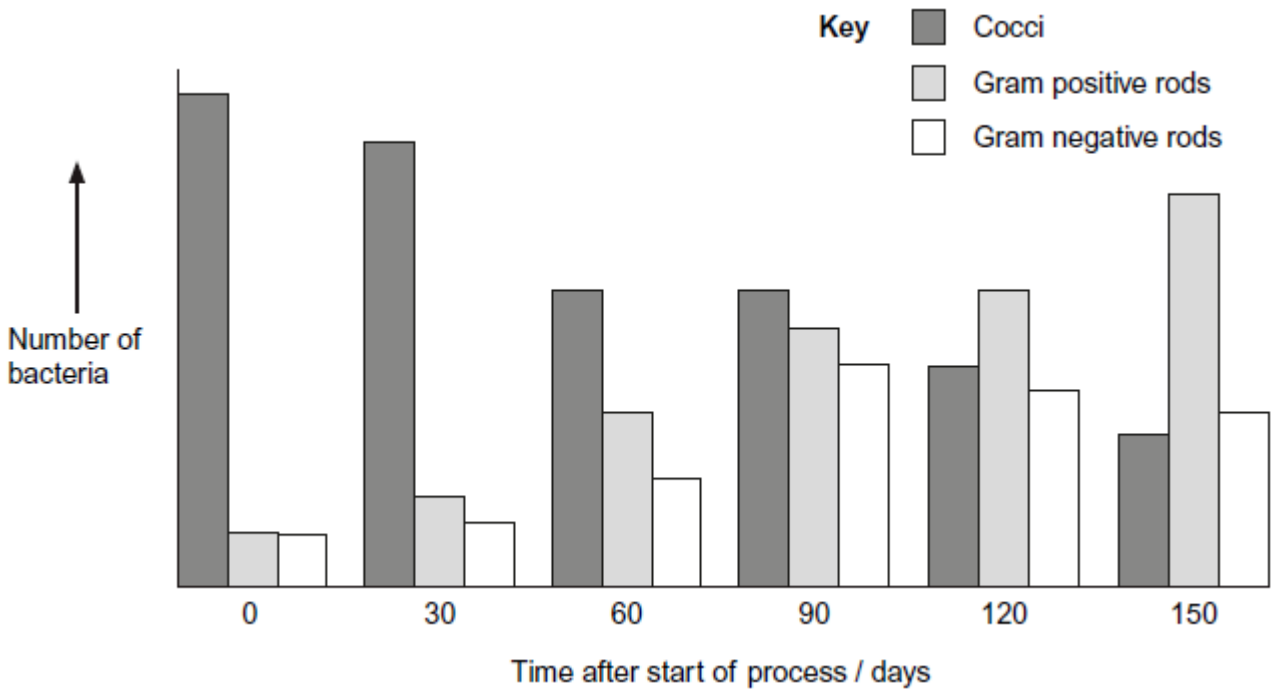
_____

(2)

(d) The scientists took a sample of the waste at the start of the process. They then took

samples every 30 days. In each sample, they determined the numbers of particular types of bacteria.
Figure 2 shows the changes in the number of three types of bacteria during the process.

Figure 2



The scientists concluded that the results in **Figure 1** and **Figure 2** are evidence for a form of succession during the process.

Use the information to suggest how they reached this conclusion.

_____

_____

_____

_____

_____

_____

_____

_____

(3)

(Total 9 marks)

Q11.

Some plant seeds can respire aerobically and anaerobically. A summary of the process of anaerobic respiration is shown below.



(a) (i) Where in a cell does **stage 1** occur?

_____

(1)

(ii) Explain how **stage 2** enables **stage 1** to continue.

_____

_____

_____

_____

(2)

(b) The Respiratory Quotient (RQ) can provide information on the type of respiration taking place in an organism. The following equation is used to calculate the RQ.

$$RQ = \frac{\text{volume of carbon dioxide produced during respiration}}{\text{volume of oxygen used during respiration}}$$

(i) What would be the RQ for aerobic respiration of glucose?

☐

(1)

(ii) A student calculated that the RQ of germinating seeds was 1.8.

Use the information provided to explain this result.

_____

_____

_____

_____

(2)

(c) Aerobic respiration produces more ATP per molecule of glucose than anaerobic respiration.

Explain why.

_____

_____

_____

_____

(2)

(Total 8 marks)

Q12.

Multiple sclerosis (MS) is a condition caused when the body's own immune system attacks the myelin sheath around axons. The cell bodies of the neurones themselves can also be damaged or destroyed. People with MS usually have periods of time when their MS gets no worse, followed by relapses when it gets worse.

Scientists investigated the effects on neurones of damage to myelin. The scientists obtained a modified antigen from the myelin sheath of humans and injected it into mice. After a number of days, this injection of antigen resulted in the myelin sheaths in the mice being damaged. Some cell bodies of neurones were also damaged.

(a) Suggest how the injection of the antigen resulted in the myelin sheaths being damaged.

_____

_____

_____

_____

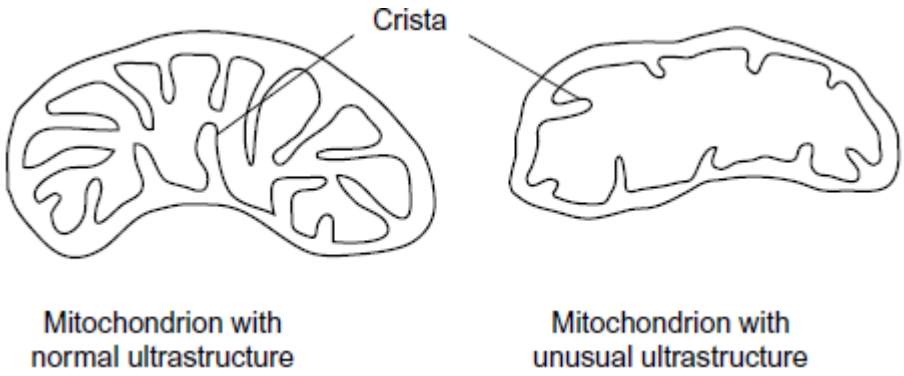
_____

_____

(3)

(b) The scientists compared the ultrastructure of normal and damaged neurones. They found that damaged neurones contained many mitochondria with an unusual ultrastructure.

The diagram shows a mitochondrion with normal ultrastructure and one with the unusual ultrastructure.



Suggest why having a large number of mitochondria with this unusual ultrastructure could lead to neurones dying.

_____

_____

_____

_____

_____

_____

(3)

(c) The scientists took a large number of photographs of thin sections through neurones.
Using these photographs, they found that 40% of mitochondria had the unusual ultrastructure in damaged neurones.

(i) What sort of microscope would the scientists use to take the photographs? Give **one** reason for your answer.

Type of microscope_____

Reason _____

_____

_____

(1)

(ii) Suggest how the scientists found the percentage of mitochondria with the unusual ultrastructure.

_____

_____

_____

_____

_____

_____

(3)

(Total 10 marks)

Q13.

(a) Describe how acetylcoenzyme A is formed in the link reaction.

_____

_____

_____

_____

_____

(2)

(b) In the Krebs cycle, acetylcoenzyme A combines with four-carbon oxaloacetate to form six-carbon citrate. This reaction is catalysed by the enzyme citrate synthase.

(i) Oxaloacetate is the first substrate to bind with the enzyme citrate synthase. This induces a change in the enzyme, which enables the acetylcoenzyme A to bind.

Explain how oxaloacetate enables the acetylcoenzyme A to then bind to the enzyme.

_____

_____

_____

_____

_____

(2)

(ii) Another substance in the Krebs cycle is called succinyl coenzyme A. This substance has a very similar shape to acetylcoenzyme A.

Suggest how production of succinyl coenzyme A could control the rate of the reaction catalysed by citrate synthase.

_____

_____

_____

_____

_____

(2)

(c) In muscles, pyruvate is converted to lactate during anaerobic respiration.

(i) Explain why converting pyruvate to lactate allows the continued production of ATP during anaerobic respiration.

_____

_____

_____

_____

_____

(2)

(ii) In muscles, some of the lactate is converted back to pyruvate when they are well supplied with oxygen. Suggest **one** advantage of this.

_____

_____

_____

_____

(1)

(Total 9 marks)

Q14.

(a) On islands in the Caribbean, there are almost 150 species of lizards belonging to the genus *Anolis*. Scientists believe that these species evolved from two species found on mainland USA. Explain how the Caribbean species could have evolved.

_____

_____

_____

_____

_____

_____

_____

_____

_____

_____

_____

(6)

(b) *Anolis sagrei* is a species of lizard that is found on some of the smallest Caribbean islands. Describe how you could use the mark-release-recapture method to estimate the number of *Anolis sagrei* on one of these islands.

_____

_____

_____

_____

_____

_____

_____

_____

(4)

(c) Large areas of tropical forest are still found on some Caribbean islands. The concentration of carbon dioxide in the air of these forests changes over a period of 24 hours and at different heights above ground.

Use your knowledge of photosynthesis and respiration to describe and explain how the concentration of carbon dioxide in the air changes:

- over a period of 24 hours
- at different heights above ground.

_____

_____

_____

_____

_____

_____

_____

_____

_____

_____

(5)

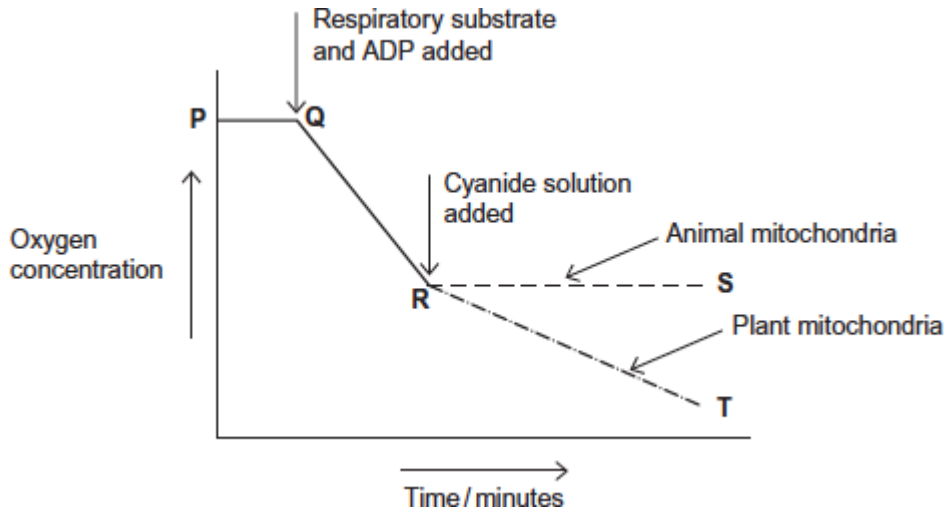
(Total 15 marks)

Q15.

Researchers investigated the effect of cyanide on oxygen uptake by mitochondria. They prepared a suspension of mitochondria from animal cells and a suspension of mitochondria from plant cells. They placed the suspensions in separate flasks containing isotonic solution, started the timer and began recording the concentration of oxygen in each flask.

- After 5 minutes, they added a respiratory substrate and ADP to each flask.
- After 13 minutes, they added cyanide solution to each flask.

The graph below shows their results. From **P** to **R** the curves for animal and plant mitochondria overlap.



(a) Explain the line between **P** and **Q**.

_____

_____

_____

_____

(2)

(b) (i) Explain the line between **Q** and **R**.

_____

_____

_____

_____

(2)

(ii) The respiratory substrate and ADP added after 5 minutes (**Q**) were part of a buffered isotonic solution.

What other substance would the buffer or solution have to contain?

_____

_____

(1)

(c) Describe and explain the difference between line **R** to **S** (animal mitochondria) and line **R** to **T** (plant mitochondria).

_____

_____

_____

_____

_____

_____

_____

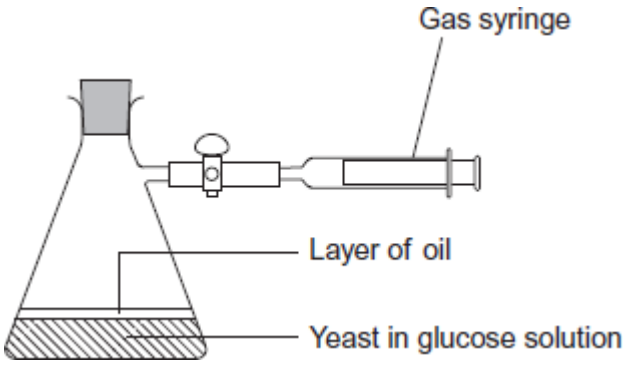
_____

(4)

(Total 9 marks)

Q16.

A student investigated the rate of anaerobic respiration in yeast. She put 5 g of yeast into a glucose solution and placed this mixture in the apparatus shown in the figure below. She then recorded the total volume of gas collected every 10 minutes for 1 hour.



(a) Explain why a layer of oil is required in this investigation.

_____

_____

(1)

(b) The student's results are shown in the following table.

Time / minutes	Total volume of gas collected / cm^3
10	0.3
20	0.9
30	1.9
40	3.1
50	5.0
60	5.2

(i) Calculate the rate of gas production in $cm^3\ g^{-1}\ min^{-1}$ during the first 40 minutes of this investigation. Show your working.

Answer = _____ $cm^3\ g^{-1}\ min^{-1}$

(2)

(ii) Suggest why the rate of gas production decreased between 50 and 60 minutes.

_____

_____

(1)

(iii) Yeast can also respire aerobically. The student repeated the investigation with a fresh sample of yeast in glucose solution, but without the oil. All other conditions remained the same.
Explain what would happen to the volume of gas in the syringe if the yeast were only respiring aerobically.

_____

_____

_____

_____

(2)

(c) Respiration produces more ATP per molecule of glucose in the presence of oxygen than it does when oxygen is absent. Explain why.

_____

_____

_____

_____

(2)

(Total 8 marks)

Q17.

CREB is a transcription factor in the mitochondria of neurones.

(a) What is a **transcription factor**?

_____

_____

_____

_____

(2)

(b) CREB leads to the formation of a protein that removes electrons and protons from reduced NAD in the mitochondrion.

Huntington's disease (HD) causes the death of neurones. People with HD produce a substance called huntingtin. Some scientists have suggested that binding of huntingtin to CREB may lead to the death of neurones.

Suggest how binding of huntingtin to CREB may lead to the death of neurones.

_____

_____

_____

_____

_____

_____

(3)

(c) CREB is a protein synthesised in the cytoplasm of neurones. Transport of CREB from the cytoplasm into the matrix of a mitochondrion requires two carrier proteins.

Use your knowledge of the structure of a mitochondrion to explain why transport of CREB requires **two** carrier proteins.

_____

_____

_____

_____

(2)

(Total 7 marks)

Q18.

Scientists measured the rate of respiration in **three** parts of an ecosystem.

They did this by measuring carbon dioxide released into the air by:

- leaves of plants
- stems and roots of plants
- non-photosynthetic soil organisms.

The table below shows the scientists' results for these three parts of the ecosystem.

Part of ecosystem	Mean rate of carbon dioxide	Percentage of total carbon dioxide

	production / $cm^3\ m^{-2}\ s^{-1}$	production measured by the scientists
Leaves of plants	0.032	25.0
Stems and roots of plants	0.051	
Non-photosynthetic soil organisms	0.045	

(a) Complete the table to show the percentage of total carbon dioxide production by each part of the ecosystem.

Show your working.

(2)

(b) A student who looked at the data in the table concluded that plants carry out more respiration than non-photosynthetic organisms in the ecosystem.

Use the information provided to suggest why these data may **not** support the student's conclusion.

_____

_____

_____

_____

(2)

(c) What measurements would the scientists have made in order to calculate the rate of carbon dioxide production?

_____

_____

_____

_____

(2)

(d) The scientists calculated the mean rate of carbon dioxide production of the leaves

using measurements of carbon dioxide release in the dark.

Explain why they did **not** use measurements taken in the light.

_____

_____

_____

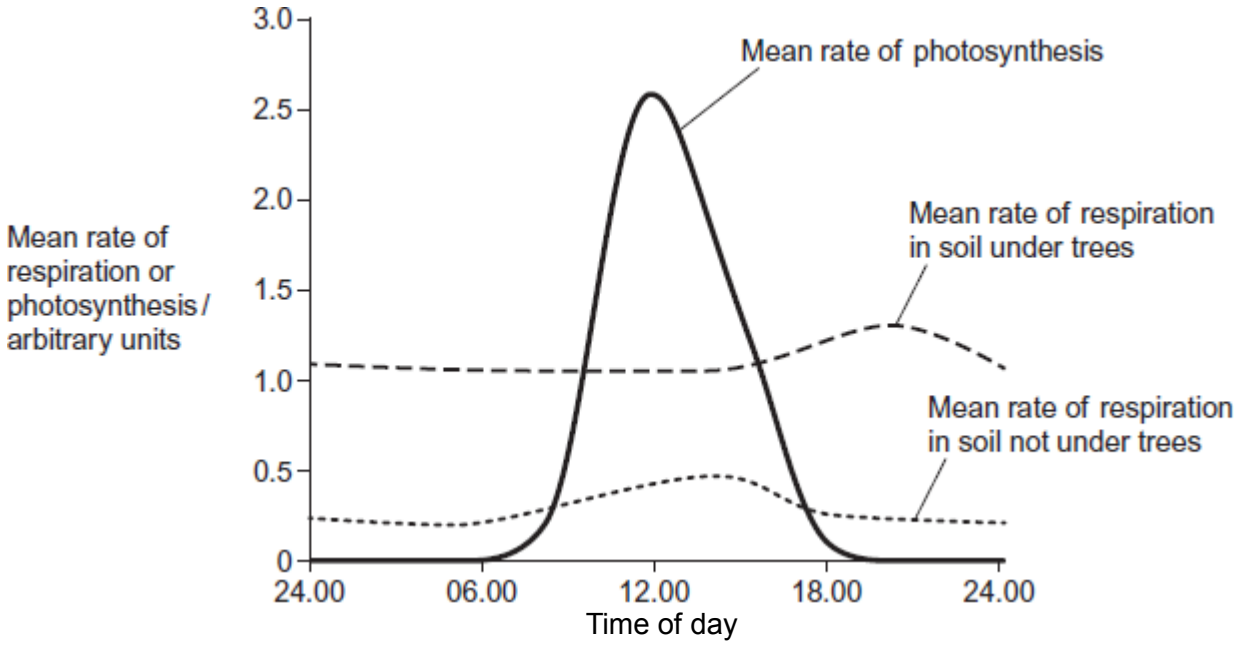
_____

(2)

Another group of scientists measured the mean rate of respiration in soil under trees and soil not under trees in the same wood. They also measured the mean rate of photosynthesis in the trees.

They took measurements at different times of day during the summer.

The figure below shows the scientists' results.



(e) (i) Describe **two** ways in which the mean rate of respiration in soil under trees is different from soil not under trees.

1. _____

_____

2. _____

_____

(2)

(ii) Suggest **one** explanation for the differences in the mean rate of respiration in soil under trees and soil not under trees between 06.00 and 12.00.

_____

_____

_____

_____

(2)

(f) The scientists suggested that the rise in the mean rate of photosynthesis was the cause of the rise in the mean rate of respiration in soil under trees.

(i) Suggest how the rise in the mean rate of photosynthesis could lead to the rise in the mean rate of respiration in soil under trees.

_____

_____

_____

_____

(2)

(ii) Suggest why there is a delay between the rise in the mean rate of photosynthesis and the rise in the mean rate of respiration.

_____

_____

(1)

(Total 15 marks)

Q19.

Many sports drinks contain water, sodium chloride and carbohydrates. The manufacturers of the sports drinks claim that carbohydrates provide an energy boost. The sodium chloride is used to increase absorption of glucose in the small intestine.

Scientists investigated the effect of a sports drink on the performance of runners in 5 km races.
They recruited 100 runners who had previously run a 5 km race in similar times. During this race, Race 1, they had water they could drink.

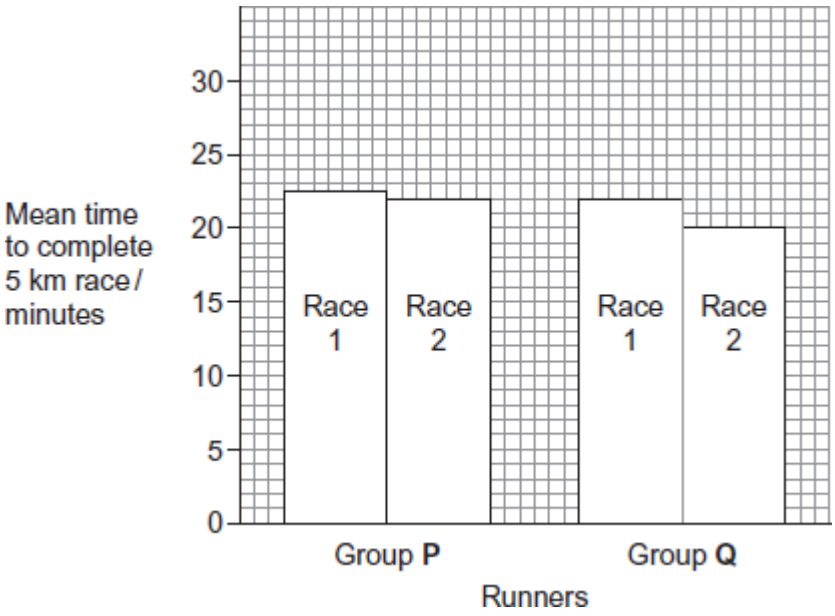
The scientists divided the runners into two equal groups, **P** and **Q**. Both groups ran a second 5 km race, Race 2. During this race:

- group **P** had water available
- group **Q** had the sports drink available.

The scientists recorded the mean time for each group to complete this race.

Figure 1 shows their results.

Figure 1

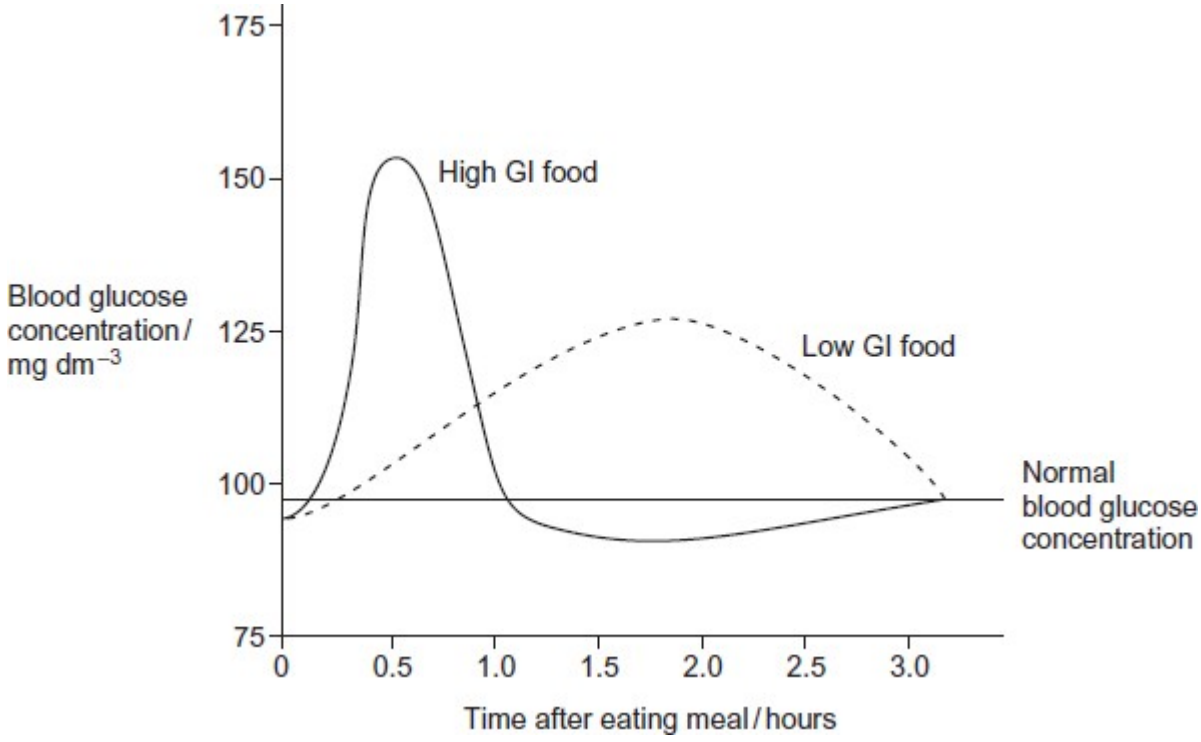


The glycaemic index (GI) is a measure of the increase in blood glucose concentration after eating a given mass of a food compared with eating the same mass of pure glucose. The GI of pure glucose has a value of 100.

The GI of a food depends on several factors such as how much starch and sugars it contains. High GI foods include those containing lots of simple sugars or white flour. The carbohydrates in these foods are rapidly digested and absorbed. Low GI foods include wholegrain bread and breakfast cereals that contain a lot of fibre. The carbohydrates in these foods are digested and absorbed more slowly.

Figure 2 shows changes in blood glucose concentration after eating meals of high GI food and meals of low GI food.

Figure 2



Explain how a sports drink could provide an energy boost when running.

_____

_____

_____

_____

_____

_____

(Total 3 marks)

Q20.

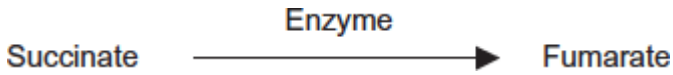
(a) The table contains statements about three stages of respiration.

Complete the table with a tick if the statement in the first column is true for each stage of respiration in an animal.

	Glycolysis	Link reaction	Krebs cycle
Occurs in mitochondria			
Carbon dioxide produced			
NAD is reduced			

(3)

(b) The following reaction occurs in the Krebs cycle.



A scientist investigated the effect of the enzyme inhibitor malonate on this reaction. The structure of malonate is very similar to the structure of succinate. The scientist added malonate and the respiratory substrate, pyruvate, to a suspension of isolated mitochondria. She also bubbled oxygen through the suspension.

(i) Explain why the scientist did not use glucose as the respiratory substrate for these isolated mitochondria.

_____

_____

_____

_____

_____

(2)

(ii) Explain how malonate inhibits the formation of fumarate from succinate.

_____

_____

_____

_____

_____

(2)

(iii) The scientist measured the uptake of oxygen by the mitochondria during the investigation. The uptake of oxygen decreased when malonate was added. Explain why.

_____

_____

_____

_____

_____

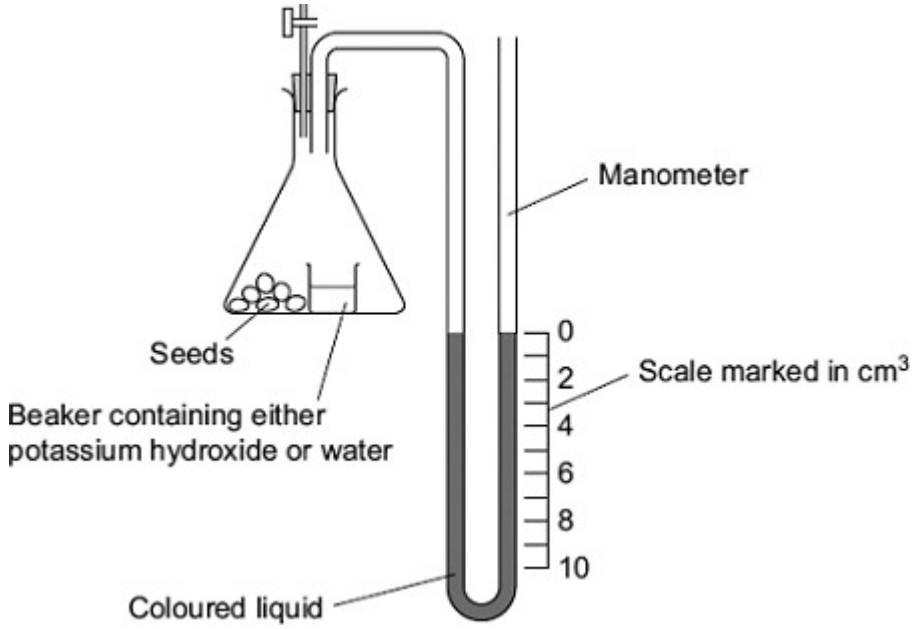
(2)

(Total 9 marks)

Q21.

A student investigated the rate of gas exchange in aerobically respiring seeds using the apparatus shown in the diagram. She carried out two experiments.

- In Experiment **1**, she put potassium hydroxide solution in the beaker. Potassium hydroxide solution absorbs carbon dioxide.
- In Experiment **2**, she put water in the beaker.



(a) Both experiments were carried out at the same temperature. Explain why.

_____

_____

_____

_____

_____

(2)

(b) (i) The level of coloured liquid in the right-hand side of the manometer tube went down during Experiment **1**. Explain why.

_____

_____

_____

_____

_____

_____

(3)

The results from both experiments are shown in the table.

Experiment	Solution in beaker	Fall in volume of coloured liquid in right-hand side of manometer / cm^3
1	Potassium hydroxide	5
2	Water	1

(ii) Use these results to calculate the volume of carbon dioxide produced during Experiment **1**.

Answer = _____ cm^3

(1)

(c) The student repeated Experiment 1 using seeds which were respiring anaerobically. What would happen to the level of coloured liquid in the right-hand side of the manometer tube? Explain your answer.

_____

_____

_____

_____

_____

(2)

(Total 8 marks)

Q22.

A student investigated the rate of respiration of yeast cells. He set up a conical flask with a suspension of yeast in some apple juice. He took samples of the mixture at different times and found the number of yeast cells.

His results are recorded in the table below.

Time from start of investigation/days	Mean number of yeast cells ($\times 10^6$) per cm^3
3	7.413
4	8.912
8	16.595
9	19.952
10	23.442
11	23.703

(a) The student set up a suspension of yeast in apple juice. Apple juice contains all the nutrients that yeast requires for growth. Name **two** types of nutrients present in the apple juice that are essential for the growth and reproduction of yeast cells.

1. _____

2. _____

(2)

(b) The student counted the yeast cells in a sample of the suspension.
Give **one** precaution the student should have taken to make sure he obtained a representative sample. Explain how this precaution would result in a representative sample.

_____

_____

_____

_____

_____

(2)

(c) Calculate the percentage increase of yeast cells between day 3 and day 4. *Show your working.*

Answer _____

(2)

(d) The increase in the number of yeast cells was less between days 10 and 11 than it was between days 3 and 4.
Give **two** reasons why.

1. _____

_____

2. _____

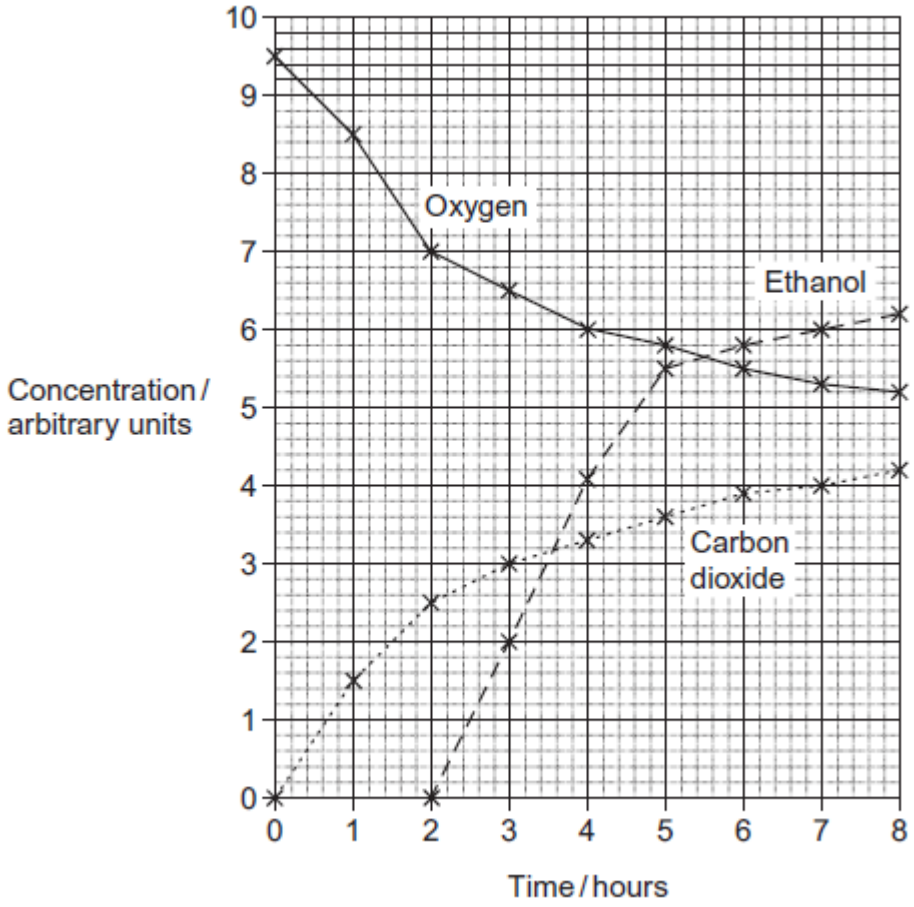
_____

(2)

(Total 8 marks)

Q23.

A scientist investigated the use of a new source of carbohydrate in the production of ethanol for biofuel. He wanted to find the optimum time to leave a mixture of yeast and this carbohydrate to produce ethanol. The scientist set up an airtight container containing yeast and this carbohydrate. He then measured the oxygen, carbon dioxide and ethanol concentrations over 8 hours.
The results of his investigation are shown in the graph below.



(a) The scientist used a container that was airtight.
Give **two** explanations why the container had to be airtight.

1. _____

_____

_____

_____

2. _____

_____

_____

_____

(4)

(b) Explain the relationship between the concentration of oxygen and the concentration of carbon dioxide between 0 and 3 hours.

_____

_____

_____

_____

_____

_____

(2)

(c) The scientist concluded that yeast starts to respire anaerobically when the oxygen concentration falls below a certain concentration. What is the oxygen concentration when the yeast starts to respire anaerobically? Explain your answer.

_____

_____

_____

_____

_____

(2)

(d) (i) The scientist worked for a biofuel company. Give **two** suggestions for further work he should do to make sure that the results he presented to the company were reliable.
Explain how each of your suggestions would make the results more reliable.

Suggestion_____

_____

Explanation _____

_____

Suggestion_____

_____

Explanation _____

_____

(4)

(ii) The scientist recommended that when the ethanol is produced commercially as biofuel the reaction should be stopped at 6 hours. Use the graph to suggest why.

_____

_____

_____

_____

_____

(2)

(iii) The scientist's work was funded by a biofuel company. Explain why the source of funding can cause problems with scientific work.

_____

_____

_____

_____

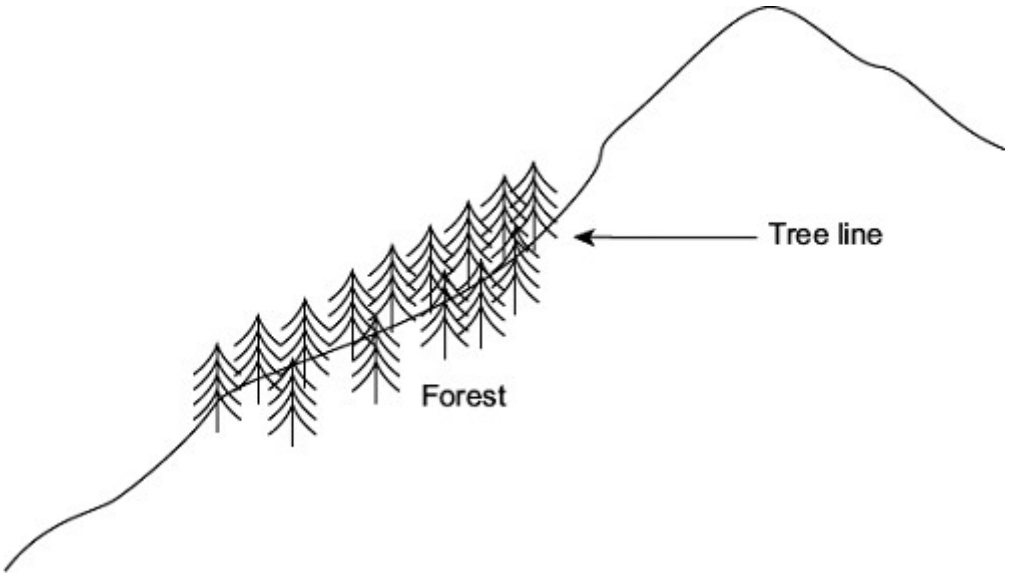
_____

(2)

(Total 16 marks)

Q24.

Mountains are harsh environments. The higher up the mountain, the lower the temperature becomes. The diagram shows a forest growing on the side of a mountain. The upper boundary of the forest is called the tree line. Trees do not grow above the tree line.



(a) (i) The position of the tree line is determined by abiotic factors.
What is meant by an abiotic factor?

_____

_____

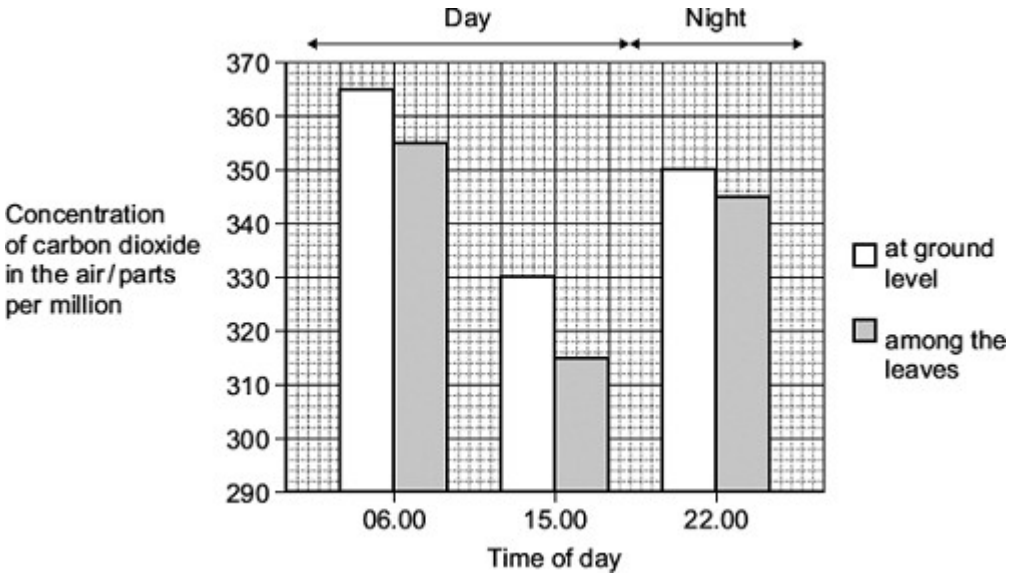
(1)

(ii) Other than temperature, suggest **one** abiotic factor that is likely to affect the position of the tree line on the mountain.

_____

(1)

(b) Scientists measured the concentration of carbon dioxide in the air in one part of the forest. They took measurements at different times of day and at two different heights above the ground. Their results are shown in the bar chart.



Use your knowledge of photosynthesis and respiration to explain the data in the bar chart.

(4)

(c) The population of trees in the forest evolved adaptations to the mountain environment.
Use your knowledge of selection to explain how.

(3)

(Total 9 marks)

Q25.

(a) ATP is useful in many biological processes. Explain why.

(4)

(b) Describe how ATP is made in mitochondria.

(6)

(c) Plants produce ATP in their chloroplasts during photosynthesis. They also produce ATP during respiration. Explain why it is important for plants to produce ATP during respiration in addition to during photosynthesis.

_____

_____

_____

_____

_____

_____

(5)

(Total 15 marks)

Q26.

(a) The table contains statements about three biological processes.

Complete the table with a tick if the statement in the first column is true, for each process.

	Photosynthesis	**Anaerobic respiration**	**Aerobic respiration**
ATP produced			
Occurs in organelles			
Electron transport chain involved			

(3)

(b) Write a simple equation to show how ATP is synthesised from ADP.

_____

(1)

(c) Give **two** ways in which the properties of ATP make it a suitable source of energy in biological processes.

1. _____

_____

2. _____

_____

(2)

(d) Humans synthesise more than their body mass of ATP each day. Explain why it is necessary for them to synthesise such a large amount of ATP.

_____

_____

_____

_____

_____

(2)

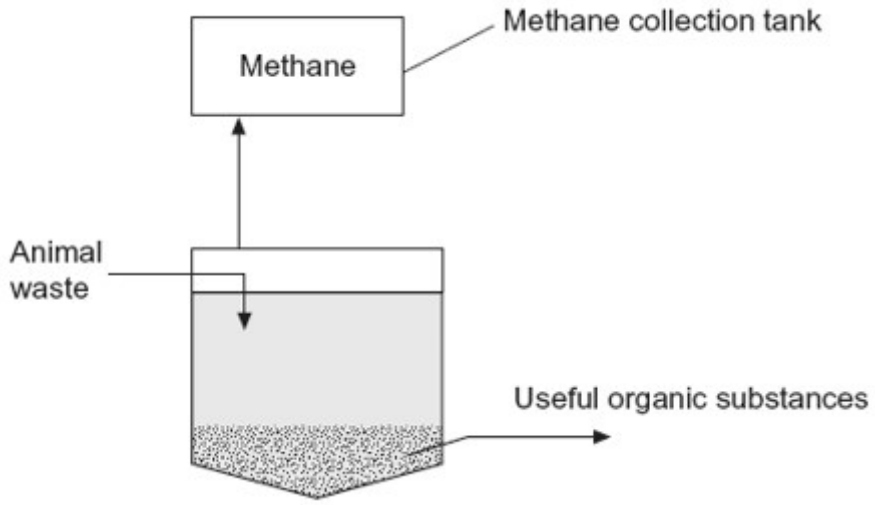
(Total 8 marks)

Q27.

Intensive rearing of livestock produces large quantities of waste. Some farmers use an anaerobic digester to get rid of the waste.

In an anaerobic digester, microorganisms break down the large, organic molecules in the waste. This produces methane, which is a useful fuel. It also produces organic substances that can be used as a natural fertiliser.

The diagram shows an anaerobic digester.



(a) (i) Suggest **two** advantages of processing waste in anaerobic digesters rather than in open ponds.

1. _____

_____

2. _____

_____

(2)

(ii) The anaerobic digester has a cooling system, which is not shown in the diagram.

Without this cooling system the digester would soon stop working. Explain why.

_____

_____

_____

_____

_____

(2)

(b) (i) The over-application of fertiliser increases the rate of leaching. Explain the consequences of leaching of fertiliser into ponds and lakes.

_____

_____

_____

_____

_____

_____

(3)

(ii) Give **one** advantage of using natural fertiliser produced in the digester rather than an artificial fertiliser.

_____

_____

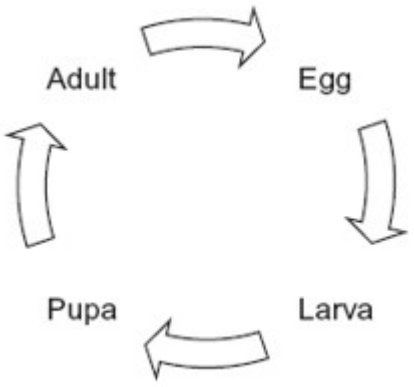
_____

(1)

(Total 8 marks)

Q28.

The diagram shows the life cycle of a fly.



When the larva is fully grown, it changes into a pupa. The pupa does not feed. In the pupa, the tissues that made up the body of the larva are broken down. New adult tissues are formed from substances obtained from these broken-down tissues and from substances that were stored in the body of the larva.

(a) Hydrolysis and condensation are important in the formation of new adult proteins.

Explain how.

_____

_____

_____

_____

(2)

(b) Most of the protein stored in the body of a fly larva is a protein called calliphorin. Explain why different adult proteins can be made using calliphorin.

_____

_____

(1)

The table shows the mean concentration of RNA in fly pupae at different ages.

Age of pupa as percentage of total time spent as a pupa	Mean concentration of RNA / µg per pupa
0	20
20	15
40	12
60	17
80	33
100	20

(c) Describe how the concentration of RNA changes during the time spent as a pupa.

_____

_____

_____

_____

(2)

(d) (i) Describe how you would expect the number of lysosomes in a pupa to change with the age of the pupa. Give a reason for your answer.

_____

_____

_____

_____

(2)

(ii) Suggest an explanation for the change in RNA concentration in the first 40% of the time spent as a pupa.

_____

_____

_____

_____

_____

(2)

(e) Suggest an explanation for the change in RNA concentration between 60 and 80% of the time spent as a pupa.

_____

_____

_____

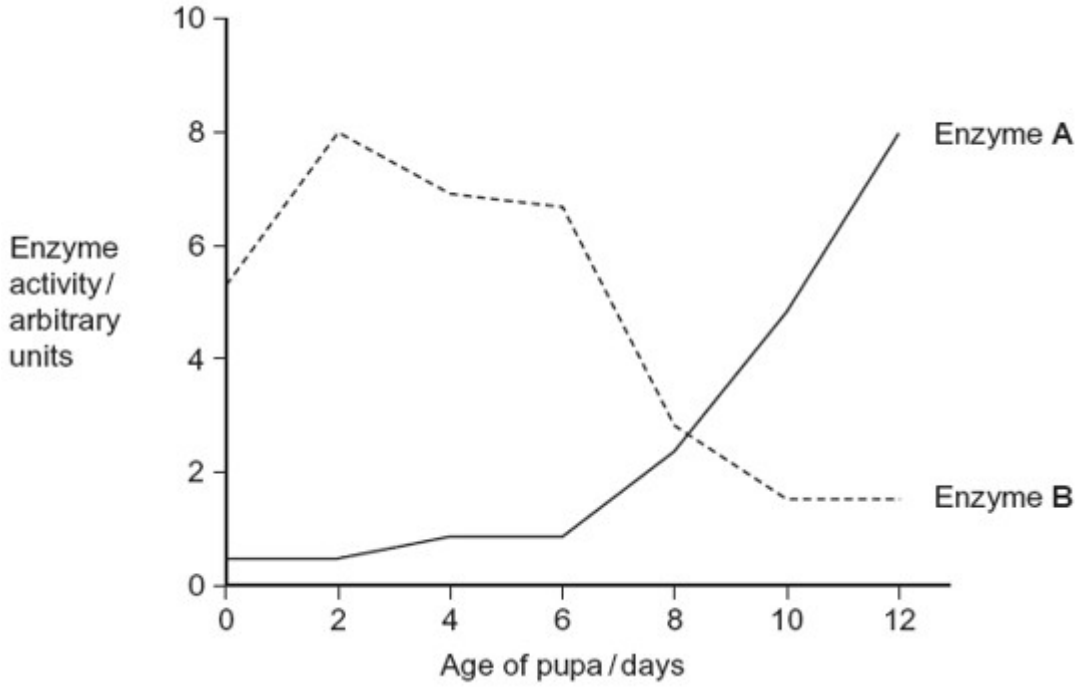
_____

_____

(2)

(f) The graph shows changes in the activity of two respiratory enzymes in a fly pupa.

- Enzyme **A** catalyses a reaction in the Krebs cycle
- Enzyme **B** catalyses the formation of lactate from pyruvate



During the first 6 days as a pupa, the tracheae break down. New tracheae are formed after 6 days. Use this information to explain the change in activity of the two enzymes.

_____

_____

_____

_____

_____

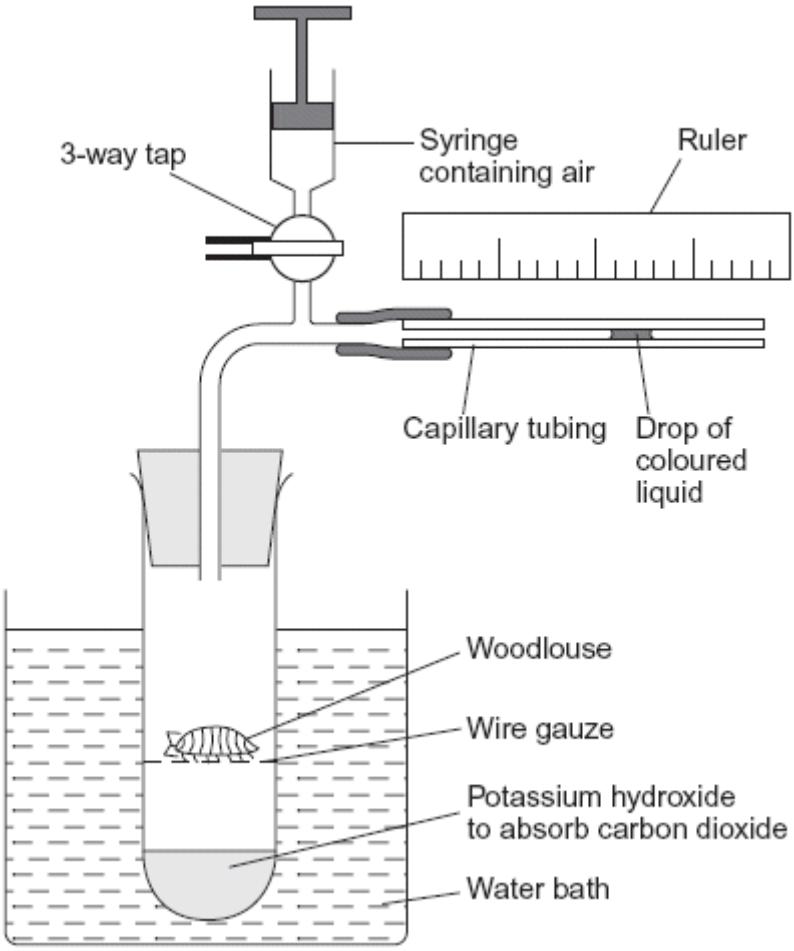
_____

(4)

(Total 15 marks)

Q29.

(a) A student measured the rate of aerobic respiration of a woodlouse using the apparatus shown in the diagram.



(i) The student closed the tap. After thirty minutes the drop of coloured liquid had moved to the left. Explain why the drop of coloured liquid moved to the left.

_____

_____

_____

_____

_____

_____

(3)

(ii) What measurements should the student have taken to calculate the rate of aerobic respiration in mm^3 of oxygen g^{-1} h^{-1}?

_____

_____

_____

_____

_____

_____

(3)

(b) DNP inhibits respiration by preventing a proton gradient being maintained across membranes. When DNP was added to isolated mitochondria the following changes were observed

- less ATP was produced
- more heat was produced
- the uptake of oxygen remained constant.

Explain how DNP caused these changes.

_____

_____

_____

_____

_____

_____

(3)

(Total 9 marks)

Q30.

(a) Describe the part played by the inner membrane of a mitochondrion in producing ATP.

_____

_____

_____

_____

_____

_____

(3)

(b) A scientist investigated ATP production in a preparation of isolated mitochondria. He suspended the mitochondria in an isotonic solution and added a suitable respiratory substrate together with ADP and phosphate. He bubbled oxygen through the preparation.

(i) Why was the solution in which the mitochondria were suspended isotonic?

_____

_____

(1)

(ii) Explain why the scientist did **not** use glucose as the respiratory substrate.

_____

_____

_____

_____

_____

(2)

(iii) Explain why the oxygen concentration would change during this investigation.

_____

_____

(1)

(Total 7 marks)

Q31.

Doctors compared two tests for lactase deficiency.

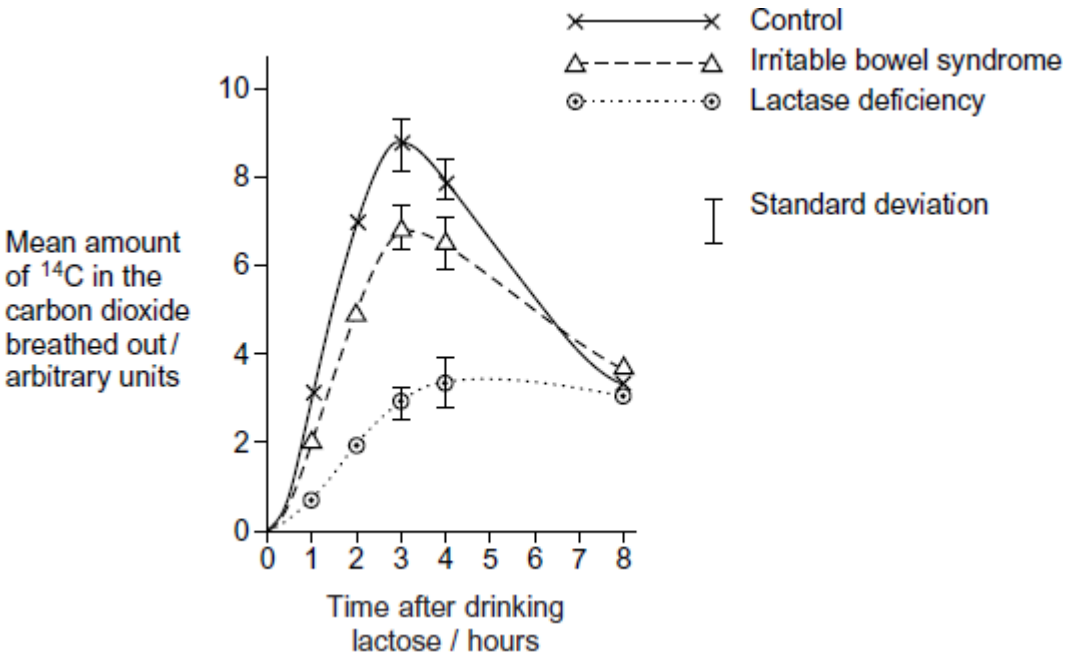
Doctors investigated three groups of people. The people in all three groups were not allowed to eat or drink for 8 hours before the test. They each then drank a solution containing 50 g of lactose made with a radioactive form of carbon called ^{14}C.

- Group **A** were the control group
- Group **B** were lactase deficient
- Group **C** had irritable bowel syndrome (IBS)

Both lactase deficiency and irritable bowel syndrome have similar symptoms.

The carbon dioxide breath test

In this test the doctors measured the amount of ^{14}C in the carbon dioxide breathed out. The doctors took measurements at intervals for 8 hours after each volunteer had drunk the lactose solution. The following figure shows the mean results for each group.



(a) Describe the common trend shown by **all** the curves in the figure.

_____

_____

_____

(1)

(b) Explain why the doctors stopped measuring the amounts of ^{14}C in the carbon dioxide breathed out after 8 hours.

_____

_____

_____

_____

(2)

(c) Carbon dioxide in the breath contained the radioactive form of carbon, ^{14}C. Explain how ^{14}C in carbon dioxide came from ^{14}C in glucose in the blood.

_____

_____

_____

_____

(2)

(d) The doctors concluded that measuring the amount of ^{14}C in the carbon dioxide in the breath after 3 hours was a better way of diagnosing lactase deficiency than the lactose tolerance test. Do you agree with the doctors' conclusion? Give the reasons for your answer.

_____

_____

_____

_____

_____

(2)

(Total 7 marks)

Q32.

Introduction

Resource A – D relate to a single investigation.

Scientists investigated the effect of supplying extra carbon dioxide on the yield of tomatoes growing in a glasshouse. They compared the mean yield of tomatoes from 1995 to 1997 when no extra carbon dioxide was supplied with the mean yield of tomatoes from 1998 to 2000 when extra carbon dioxide was supplied.

Resource A

Tomato plants were grown in two glasshouses, each with an area of 2000 m^2. Figure 1 shows the mean number of hours of sunshine per month during fruit production.

Figure 1

	1995 - 1997 (no extra carbon dioxide)	**1998 - 2000 (extra carbon dioxide)**
Mean number of hours of sunshine per month	148.91	147.00

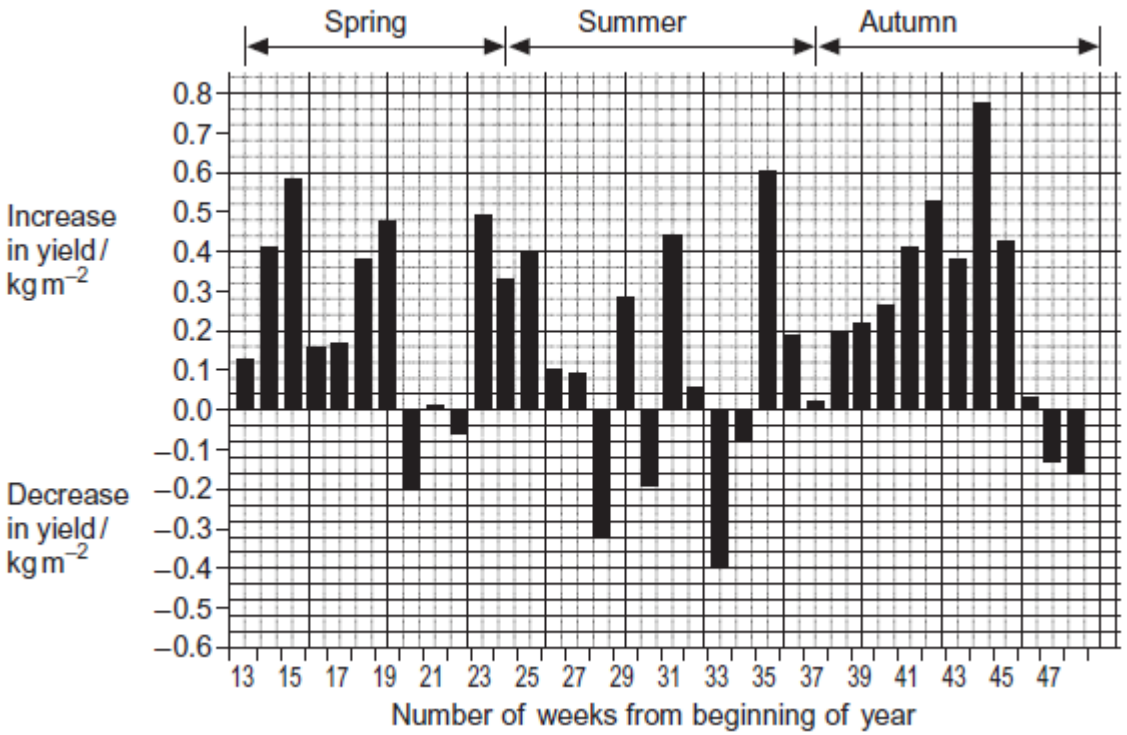
- The scientists used heating to maintain the tempera ture inside the glasshouses above 18 °C. They opened the windows to keep the tempera ture below 30 °C.
- From 1998 to 2000 they maintained the carbon dioxide concentration between 0.06 % and 0.08 % when the windows were closed and between 0.04 % and 0.05 % when the windows were open.
- The carbon dioxide concentration in the air outside the glasshouse was 0.04 %.

Resource B

Figure 2 shows the mean difference between the yield of tomatoes with extra carbon dioxide and the yield with no extra carbon dioxide for each week during the harvesting period.

If the yield is greater when extra carbon dioxide is supplied, the difference in yield is shown as an increase. If the yield is lower when extra carbon dioxide is supplied, the difference is shown as a decrease.

Figure 2



Resource C

Figure 3 shows the relationship between the time when the tomatoes were harvested and the yield.

Figure 3

Number of weeks from beginning of year	Mean yield per week with extra carbon dioxide / kg m^{-2}	Mean yield per week without extra carbon dioxide / kg m^{-2}
13 – 19	1.25	0.83
20 – 25	1.62	1.47
26 – 48	1.23	1.06

The commercial price for tomatoes varies with the time of year. The highest price is paid for tomatoes between weeks 13 and 19. The lowest price is paid between weeks 26 and 48.

Resource D

Whiteflies are an important insect pest of tomatoes. The adults can fly from plant to plant. Their young do not have wings. The adults and young feed on the plant sap and introduce viruses into the tomato plants. Feeding and the introduction of viruses both reduce the yield of tomatoes. The scientists controlled the number of whitefly in the glasshouses by releasing parasitic wasps. The wasps lay their eggs in the young of the whitefly. The wasp eggs hatch and feed on the young whitefly, killing them.

(a) (i) An increase in carbon dioxide concentration affected the yield of tomatoes in week 35. Use **Figure 2** to describe how.

_____

_____

(1)

(ii) There was a decrease in yield when extra carbon dioxide was supplied during some weeks of the year. Use information from **Resource A** to suggest why.

_____

_____

(1)

(b) Using **Figure 3**, calculate the percentage increase in yield when extra carbon dioxide was added for weeks 13 to 19. Show your working.

Percentage increase _____

(2)

(c) Additional information is required for tomato growers to decide whether it is economically profitable to add extra carbon dioxide to produce very early tomatoes.

Give **two** pieces of information that the growers would require.

1. _____

_____

2. _____

_____

(2)

(d) Adding extra carbon dioxide during the summer (weeks 24 – 36) is unlikely to be profitable. Use data from the resource sheet explain why.

_____

_____

_____

_____

(2)

(e) The control experiment in this investigation was when data were collected with no extra carbon dioxide added. Some scientists said this control experiment was not satisfactory. Explain how you could improve the control experiment.

_____

_____

_____

_____

(2)

(Total 10 marks)

Q33.

(a) Gas exchange in fish takes place in gills. Explain how **two** features of gills allow efficient gas exchange.

1. _____

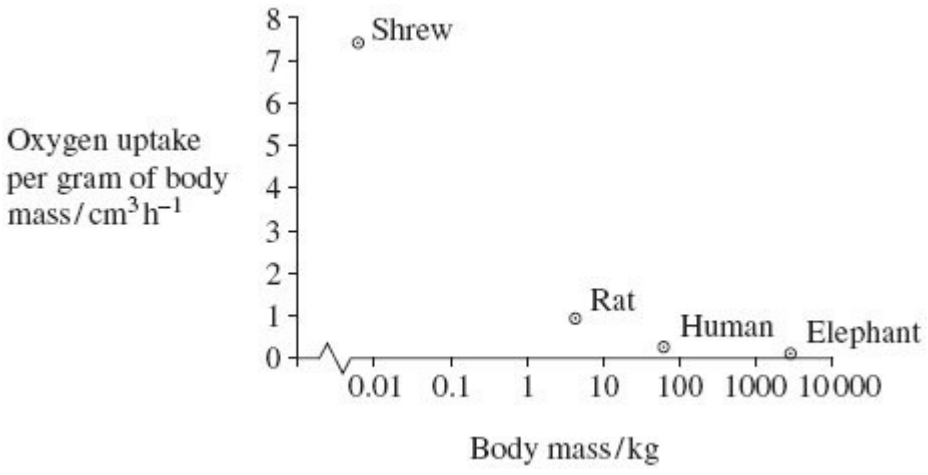
_____

2. _____

_____

(2)

(b) A zoologist investigated the relationship between body mass and rate of oxygen uptake in four species of mammal. The results are shown in the graph.



(i) The scale for plotting body mass is a logarithmic scale. Explain why a logarithmic scale was used to plot body mass.

_____

_____

(1)

(ii) Describe the relationship between body mass and oxygen uptake.

_____

_____

(1)

(iii) The zoologist measured oxygen uptake per gram of body mass. Explain why he measured oxygen uptake per gram of body mass.

_____

_____

_____

_____

(2)

(Total 6 marks)

Q34.

(a) The biochemical pathway of aerobic respiration involves a number of different steps.

Name **one** step in which carbon dioxide is produced.

_____

(1)

In an investigation, scientists transferred slices of apple from air to anaerobic conditions in pure nitrogen gas. They measured the rate of carbon dioxide production.

(b) The scientists kept the temperature constant throughout the investigation. Explain how a decrease in temperature would affect the rate of carbon dioxide production.

_____

_____

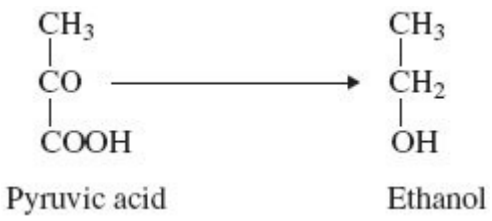
_____

_____

_____

(2)

(c) When the apple slices were transferred to nitrogen, the following biochemical pathway took place.



Pyruvic acid Ethanol

Use this pathway to explain the part played by reduced NAD when the apple slices were transferred to nitrogen.

_____

_____

_____

_____

(2)

(d) The rate of carbon dioxide production was higher when the apple slices were in nitrogen than when they were in the air. Explain why.

_____

_____

_____

_____

_____

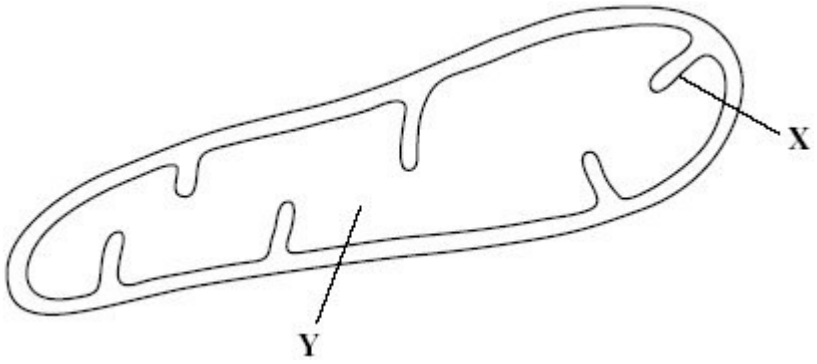
_____

(3)

(Total 8 marks)

Q35.

The diagram shows a mitochondrion.



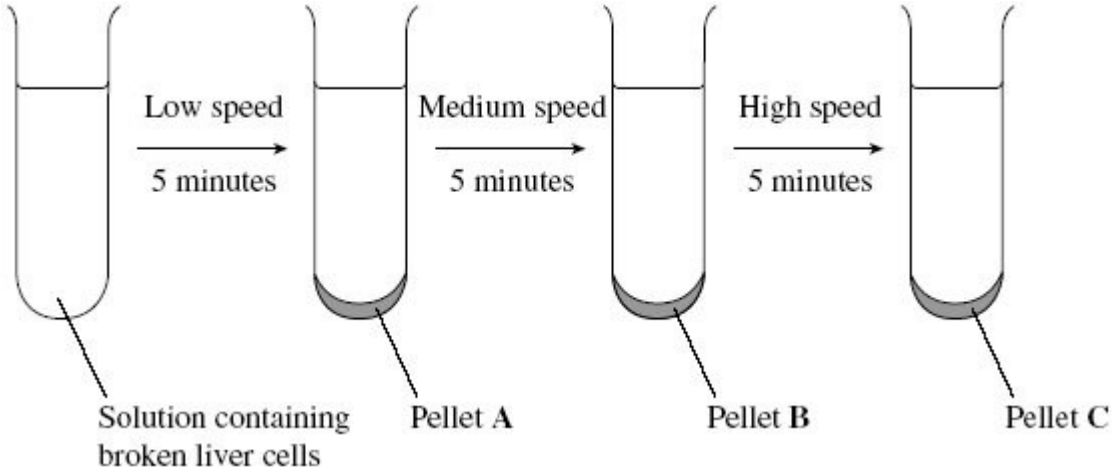
(a) Name the parts labelled **X** and **Y**.

(i) **X** _____

(ii) **Y** _____

(2)

Scientists isolated mitochondria from liver cells. They broke the cells open in an ice-cold, isotonic solution. They then used a centrifuge to separate the cell organelles. The diagram shows some of the steps in the process of centrifugation.



(b) Suggest which pellet, **A**, **B** or **C** contained the mitochondria.

(1)

(c) Explain why the solution used was

(i) ice-cold

(1)

(ii) isotonic.

(2)

(d) People with mitochondrial disease have mitochondria that do not function properly.

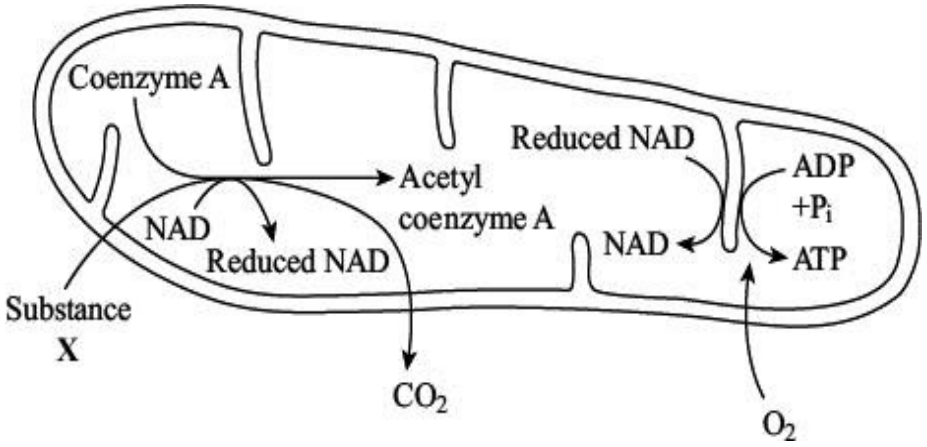
Some people with mitochondrial disease can only exercise for a short time. Explain why a person with mitochondrial disease can only exercise for a short time.

(2)

(Total 8 marks)

Q36.

The diagram represents two of the stages of aerobic respiration that take place in a mitochondrion.



(a) Name substance **X**.

_____

(1)

(b) Which stage of aerobic respiration takes place inside a mitochondrion and is **not** represented on the diagram?

_____

(1)

(c) Explain why oxygen is needed for the production of ATP on the cristae of the mitochondrion.

_____

_____

_____

_____

_____

_____

(3)

(Total 5 marks)

Q37.

The kangaroo rat is a small desert mammal. It takes in very little water in its food and it rarely drinks. Its core body temperature is 38 °C.

The kangaroo rat takes in some water by feeding and drinking. Describe another method by which the kangaroo rat could obtain water.

_____

_____

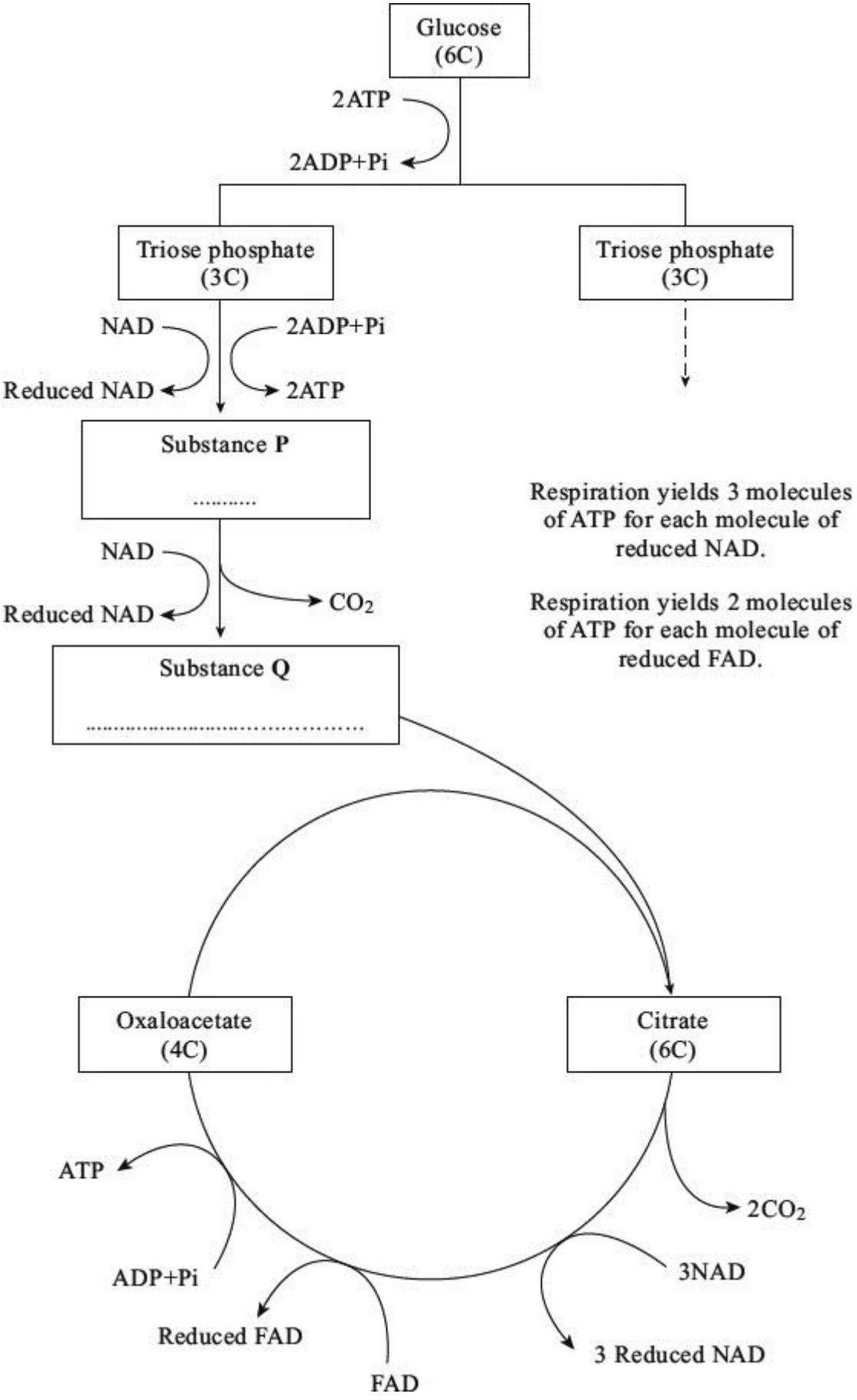
_____

_____

(Total 2 marks)

Q38.

(a) The flow chart shows the main stages in aerobic respiration.



(i) Complete the flow chart by writing, in the appropriate boxes, the number of carbon atoms in substance **P** and the name of substance **Q**.

(2)

(ii) Some ATP is formed in the cytoplasm and some in the mitochondria. Use the information given to calculate the number of molecules of ATP formed in a mitochondrion from one molecule of glucose in aerobic respiration. Show how you arrived at your answer.

Answer_____

(2)

(iii) In the presence of oxygen, respiration yields more ATP per molecule of glucose than it does in the absence of oxygen. Explain why.

_____

_____

_____

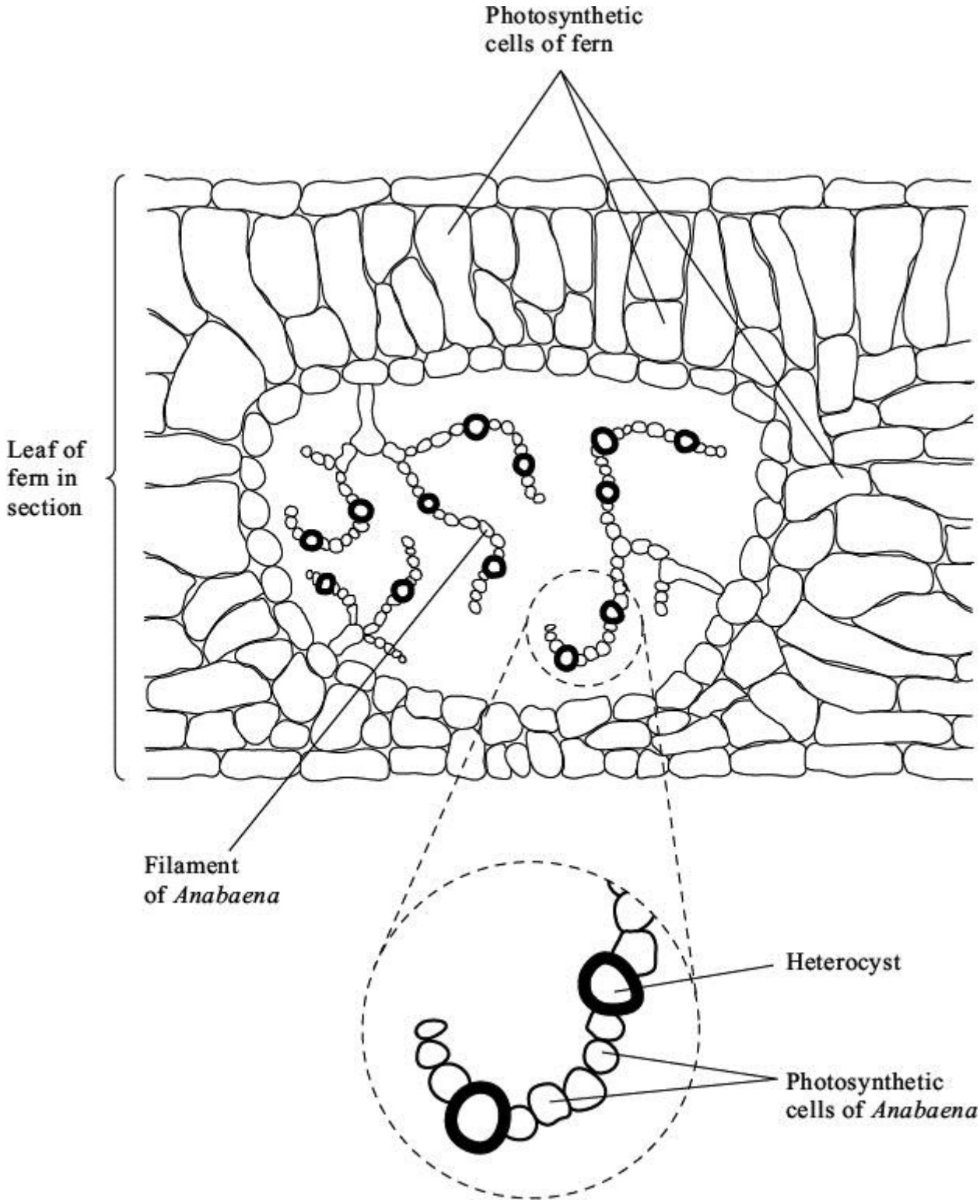
_____

_____

_____

(3)

(b) Anabaena is a prokaryote found inside the leaves of a small fern. Anabaena can produce ammonia from nitrogen (nitrogen fixation). This reaction only takes place in the anaerobic conditions found in cells called heterocysts. Heterocysts are thick-walled cells that do not contain chlorophyll. The drawing shows the relationship between *Anabaena* and the fern.



(i) Suggest how the features of the heterocysts improve the efficiency of the process of nitrogen fixation.

_____

_____

_____

_____

_____

_____

(3)

(ii) In China, the fern is cultivated and ploughed into fields to act as an organic fertiliser. Explain how ploughing the fern plants into the soil results in an improvement in the growth of the rice crop grown in these fields.

_____

_____

_____

_____

_____

_____

_____

_____

_____

_____

(5)

(Total 15 marks)

Q39.

(a) Discs of carrot were placed in a solution containing potassium ions (K^+). The concentration of oxygen in air bubbled through the solution was changed and the rates of respiration and uptake of potassium ions were measured. The results are shown in the table.

Concentration of oxygen / %	Rate of respiration / arbitrary units	Rate of uptake of potassium ions / arbitrary units
2.7	31	29
12.2	69	72
20.8	90	80

Describe and explain the link between oxygen concentration, rate of respiration and rate of uptake of potassium ions.

_____

_____

_____

_____

_____

_____

_____

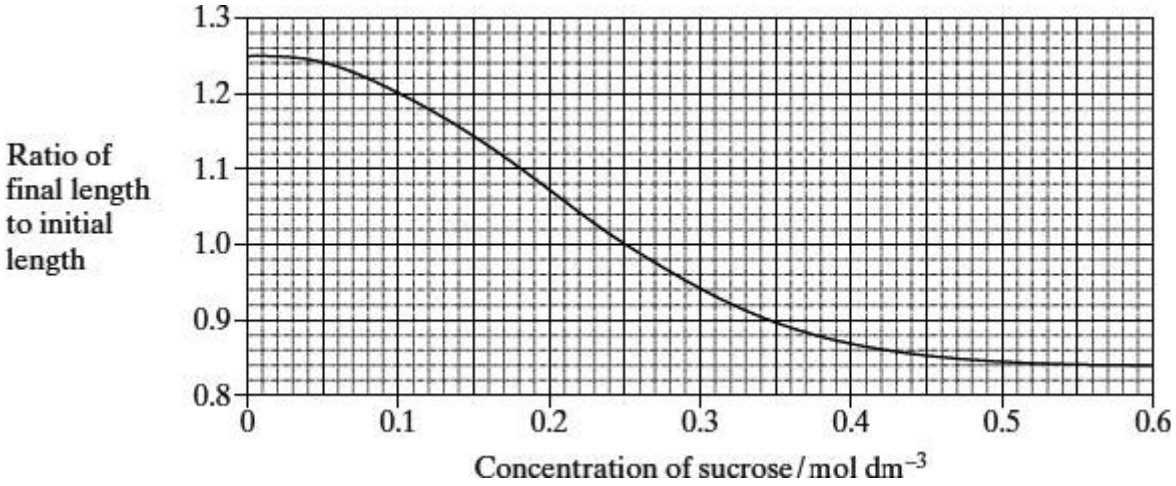
_____

_____

_____

(4)

(b) Cylinders of potato were cut using a cork borer. Their initial lengths were measured. Each cylinder was then put in a different concentration of sucrose solution for 12 hours. The graph shows the changes in length of the potato cylinders in the different sugar solutions.



(i) In what concentration of sucrose did the length of the potato cylinder remain the same?

_____

(1)

(ii) The initial length of the potato cylinder in the solution of concentration 0.1 mol dm^{-3} was 90 mm. Calculate its final length. Show your working.

Final length = _____ mm

(2)

(iii) Explain the change in length which occurs in a sucrose solution of concentration 0.5 mol dm^{-3}.

_____

_____

_____

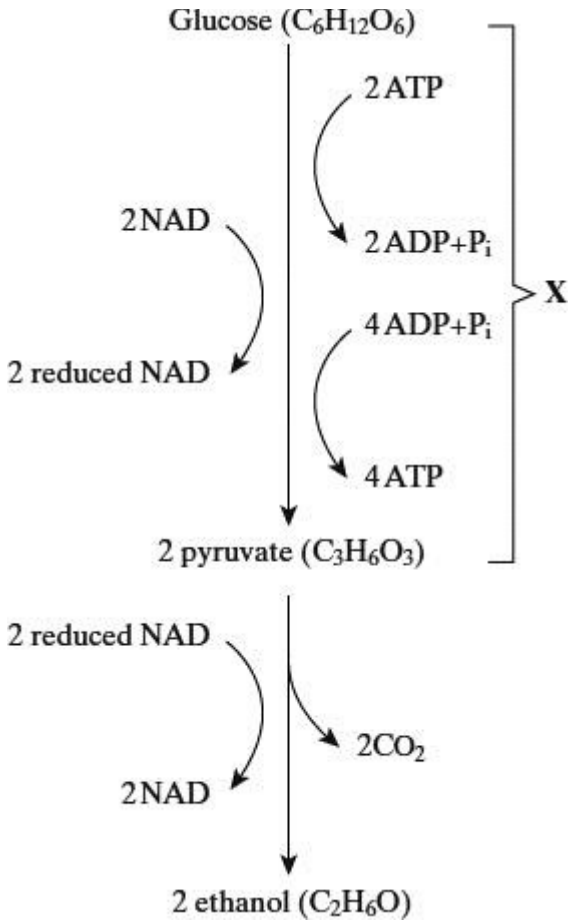
_____

(2)

(Total 9 marks)

Q40.

(a) The main stages in anaerobic respiration in yeast are shown in the diagram.



(i) Name process **X**.

_____

(1)

(ii) Give **one** piece of evidence from the diagram which suggests that the conversion of pyruvate to ethanol involves reduction.

_____

_____

(1)

(iii) Explain why converting pyruvate to ethanol is important in allowing the continued production of ATP in anaerobic respiration.

_____

_____

_____

_____

(2)

(b) Give **two** ways in which anaerobic respiration of glucose in yeast is

(i) similar to anaerobic respiration of glucose in a muscle cell;

1. _____

_____

2. _____

_____

(2)

(ii) different from anaerobic respiration of glucose in a muscle cell.

1. _____

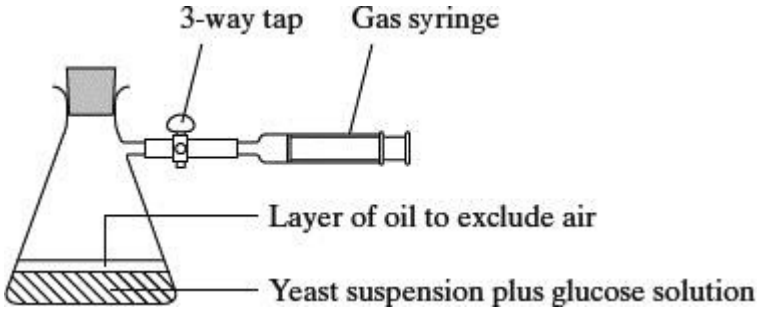
_____

2. _____

_____

(2)

(c) Some students investigated the effect of temperature on the rate of anaerobic respiration in yeast. The apparatus they used is shown in the diagram. The yeast suspension was mixed with glucose solution and the volume of gas collected in five minutes was recorded.



(i) Each student repeated the experiment and the results were pooled. Explain the advantages of collecting a large number of results.

_____

_____

_____

_____

(2)

(ii) At 30 °C, one student obtained the following results.

Volume of gas collected in 5 minutes / cm^3	Result 1	Result 2	Result 3
	38.3	27.6	29.4

Calculate the mean rate of gas production. Give your answer in $cm^3\ s^{-1}$.

Answer _____ $cm^3\ s^{-1}$

(2)

(iii) If aerobic respiration had been investigated rather than anaerobic respiration, how would you expect the volumes of gas collected at 30°C to differ from these results?

Explain your answer.

_____

_____

_____

_____

_____

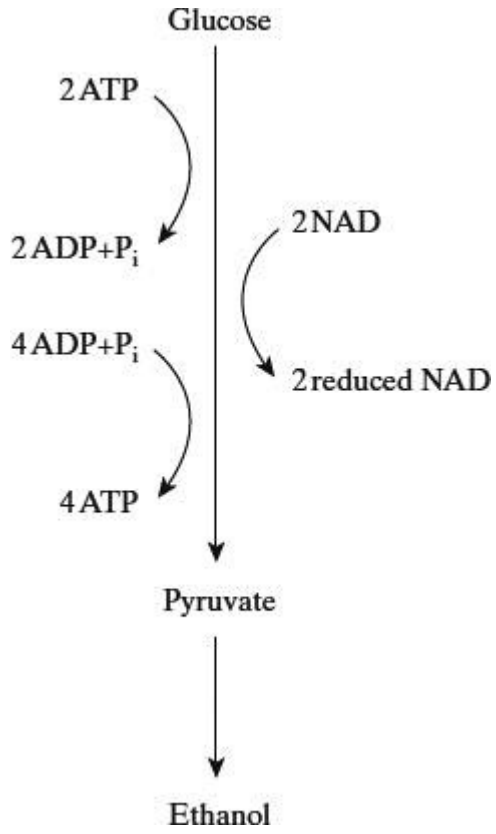
_____

(3)

(Total 15 marks)

Q41.

The diagram summarises the process of anaerobic respiration in yeast cells.



(a) (i) In anaerobic respiration, what is the net yield of ATP molecules per molecule of glucose?

_____

(1)

(ii) Give **two** advantages of ATP as an energy-storage molecule within a cell.

1. _____

_____

2. _____

_____

(2)

(b) Describe how NAD is regenerated in anaerobic respiration in yeast cells.

_____

_____

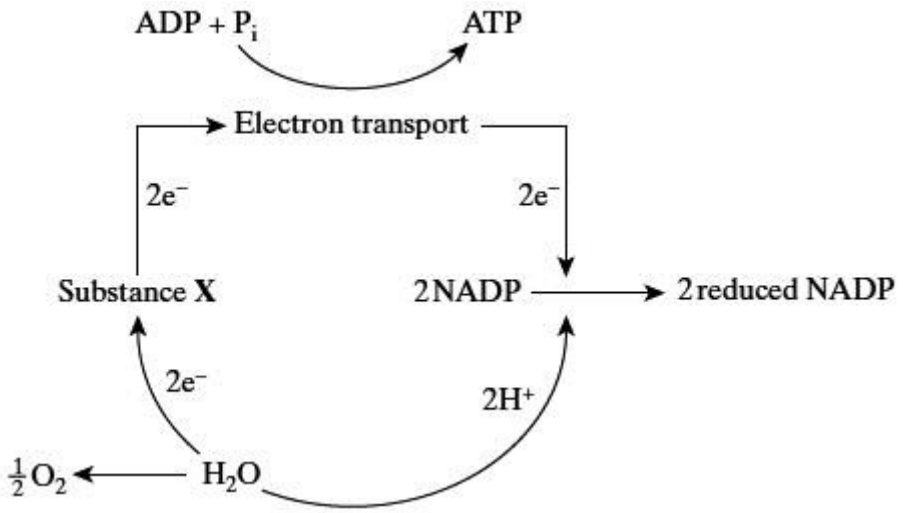
(1)

(Total 4 marks)

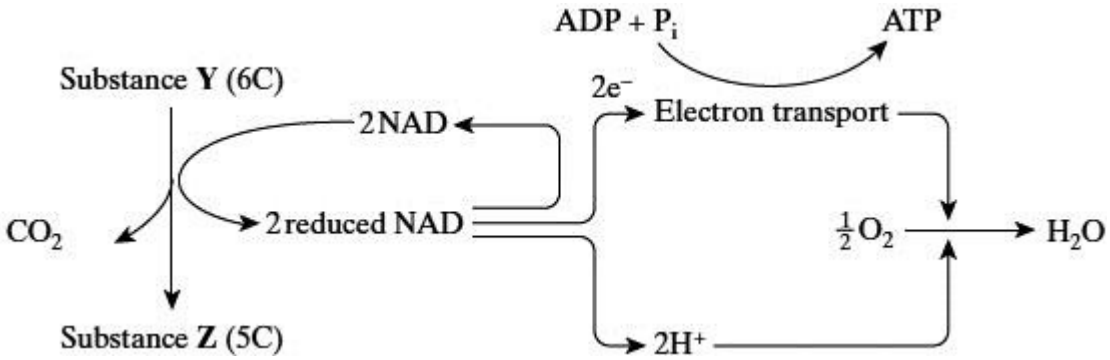
Q42.

The diagram shows some of the stages in two processes that produce ATP.

Process 1



Process 2



(a) In **Process 1**, what causes substance **X** to lose electrons (e^-)?

_____

_____

(1)

(b) Where precisely, within a cell, does electron transport take place in **Process 2**?

_____

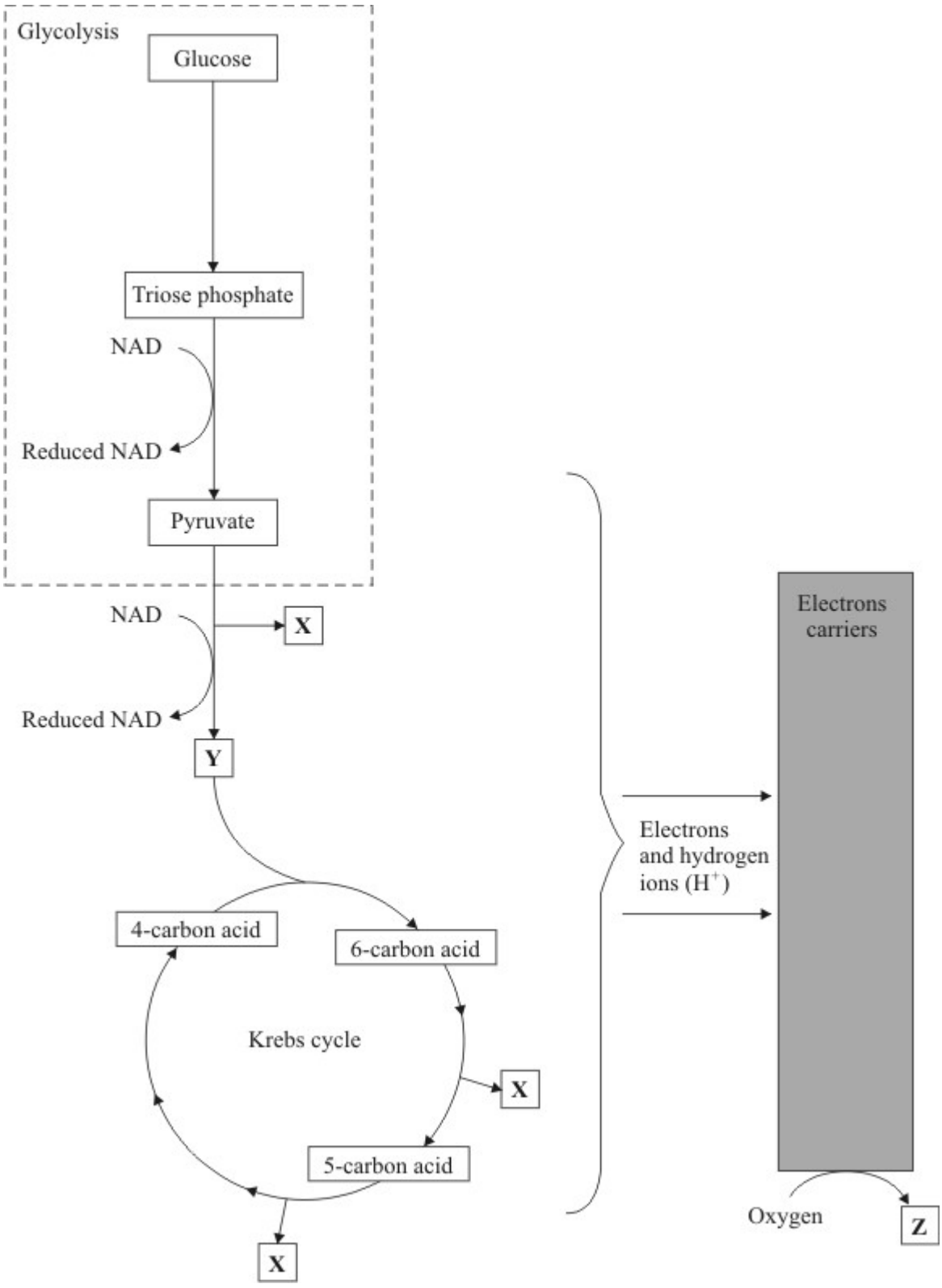
_____

(1)

(Total 2 marks)

Q43.

The diagram gives an outline of the process of aerobic respiration.



(a) Name substances **X**, **Y** and **Z**.

X _____

Y _____

Z _____

(3)

(b) Give the location of each of the following in a liver cell.

(i) Glycolysis _____

(ii) The Krebs cycle _____

(2)

(c) (i) Write the letter **A** on the diagram to show **one** step where ATP is used.

(ii) Write the letter **B** on the diagram at **two** steps where ATP is produced.

(3)

(d) Apart from respiration, give **three** uses of ATP in a liver cell.

1. _____

2. _____

3. _____

(3)

(e) Human skeletal muscle can respire both aerobically and anaerobically. Describe what happens to pyruvate in anaerobic conditions and explain why anaerobic respiration is advantageous to human skeletal muscle.

_____

_____

_____

_____

_____

_____

_____

_____

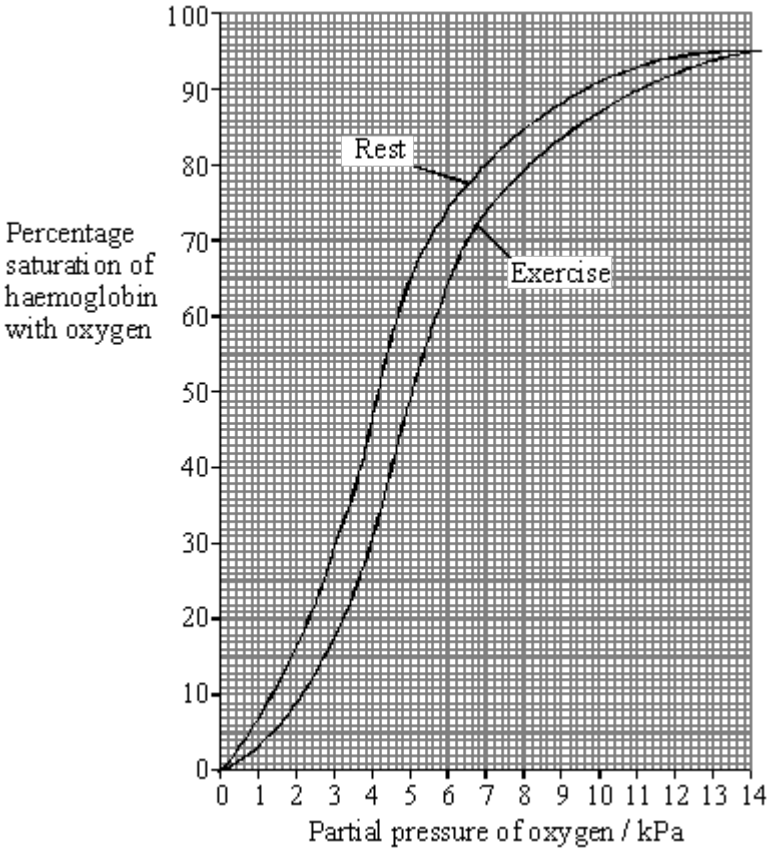
(4)

(Total 15 marks)

Q44.

The graph shows dissociation curves for human oxyhaemoglobin at rest and during exercise.

Table 1 gives information about conditions in the body at rest and during exercise.



	Rest	Exercise
Plasma pH	7.4	7.2
Blood temperature / °C	37.0	39.0
Alveolar partial pressure of oxygen / kPa	13.3	13.3
Tissue partial pressure of oxygen / kPa	5.0	4.0

Table 1

(a) What is meant by the term *partial pressure*?

_____

_____

(1)

(b) Use **Table 1** and the graph to calculate the difference in the percentage saturation of haemoglobin in the tissues between rest and exercise.

Answer _____ %

(1)

(c) Explain the differences between the figures shown in **Table 1** for rest and exercise.

_____

_____

_____

_____

_____

_____

_____

_____

(4)

(d) Explain the advantage of the difference in position of the dissociation curve during exercise.

_____

_____

_____

_____

(2)

Table 2 shows how the oxygen concentration in the blood going to and from a muscle changes from rest to heavy exercise.

		Oxygen concentration / cm^3 per 100 cm^3 blood	
		Blood in arteries	**Blood in veins**
At rest	**In solution**	0.3	0.2
	As oxyhaemoglobin	19.5	15.0
	Total oxygen	19.8	15.2
During heavy exercise	**In solution**	0.3	0.1
	As oxyhaemoglobin	20.9	5.3
	Total oxygen	21.2	5.4

Table 2

(e) By how many times is the volume of oxygen removed from the blood by the muscle in **Table 2** during heavy exercise greater than the volume removed at rest?

Show your working.

Answer _____ times

(2)

(f) Does enriching inspired air with oxygen have any effect on the amount of oxygen reaching the tissues? Support your answer with evidence from the graph and **Table 2**.

_____

_____

_____

_____

_____

_____

(3)

(g) The change to the dissociation curve is one of a number of ways in which the total oxygen supplied to muscles is increased during exercise. Give **two** other ways in which the total oxygen supplied to muscles during exercise is increased.

1. _____

_____

2. _____

_____

(2)

(Total 15 marks)

Q45.

(a) Pyruvate is formed in the breakdown of glucose during respiration. When there is sufficient oxygen, this pyruvate is fully broken down. Name **two** substances formed from the pyruvate.

1. _____

2. _____

(1)

(b) (i) If there is a shortage of oxygen in muscle cells during exercise, some pyruvate is converted into lactate. Explain why muscles become fatigued when insufficient oxygen is available.

_____

_____

_____

_____

(2)

(ii) Some of the lactate is oxidised to pyruvate by muscles when they are well-supplied with oxygen. Suggest an advantage of the lactate being oxidised in the muscles.

_____

_____

_____

_____

(2)

(Total 5 marks)

Q46.

(a) The table contains some statements relating to biochemical processes in a plant cell. Complete the table with a tick if the statement is true or a cross if it is not true for each biochemical process.

Statement	Glycolysis	Krebs cycle	Light-dependent reaction of photosynthesis
NAD is reduced			
NADP is reduced			
ATP is produced			
ATP is required			

(4)

(b) An investigation was carried out into the production of ATP by mitochondria. ADP, phosphate, excess substrate and oxygen were added to a suspension of isolated mitochondria.

(i) Suggest the substrate used for this investigation.

_____

(1)

(ii) Explain why the concentration of oxygen and amount of ADP fell during the investigation.

_____

_____

_____

_____

(2)

(iii) A further investigation was carried out into the effect of three inhibitors, **A**, **B** and **C**, on the electron transport chain in these mitochondria. In each of three experiments, a different inhibitor was added. The table shows the state of the electron carriers, **W–Z**, after the addition of inhibitor.

Inhibitor added	Electron carrier			
	W	**X**	**Y**	**Z**
A	oxidised	reduced	reduced	oxidised
B	oxidised	oxidised	reduced	oxidised
C	reduced	reduced	reduced	oxidised

Give the order of the electron carriers in this electron transport chain. Explain your answer.

Order _____ _____ _____ _____

Explanation _____

_____

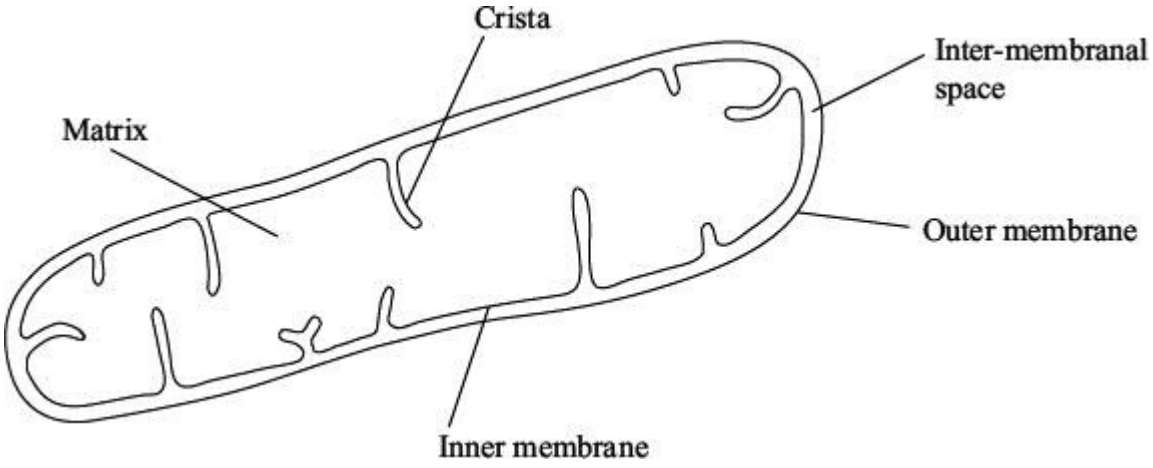
_____

(2)

(Total 9 marks)

Q47.

The diagram shows the structure of a mitochondrion.



(a) In which part of the mitochondrion does the Krebs cycle take place?

_____

(1)

(b) Name **two** substances for which there would be net movement into the

mitochondrion.

1. _____

2. _____

(2)

(c) The mitochondria in muscles contain many cristae. Explain the advantage of this.

_____

_____

_____

_____

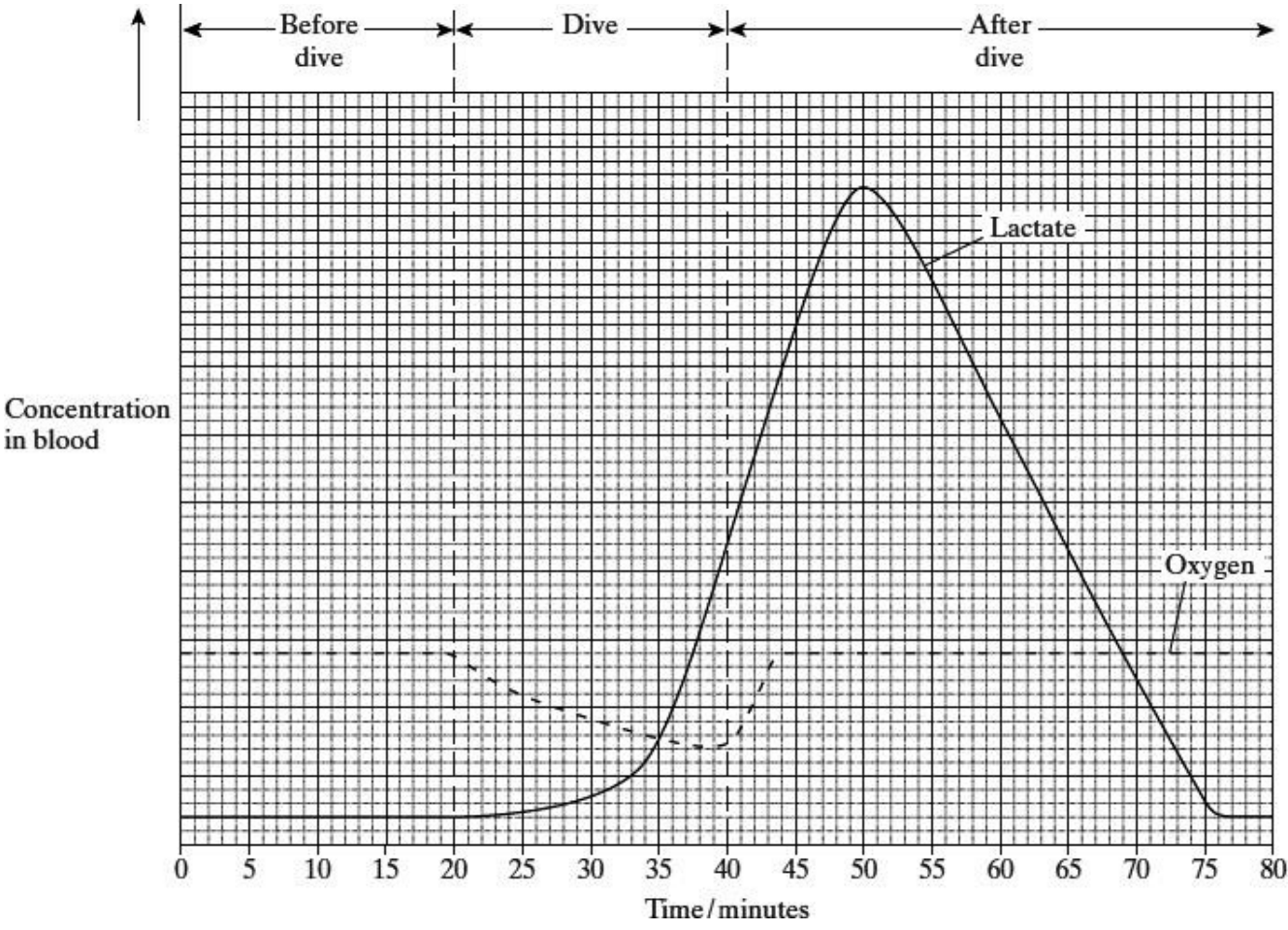
(2)

(Total 5 marks)

Q48.

Seals are aquatic mammals. They use lungs as organs of gas exchange so they do not breathe when they are under water during a dive.

The graph shows changes in oxygen and lactate concentration in the blood of a seal before, during and after a dive.



(a) The concentration of oxygen in the blood fell during the dive. Explain why.

_____

_____

(1)

(b) Use information in the graph to calculate how long it took from the end of the dive for the seal to recover fully.

Answer _____ minutes

(1)

(c) Explain what causes the concentration of blood lactate to fall after a dive.

_____

_____

_____

_____

(2)

(d) Reducing the volume of blood pumped out by the heart reduces the rate of blood flow to the diaphragm muscles.

(i) Give **one** other way in which blood flow into the diaphragm muscles may be reduced.

_____

_____

(1)

(ii) During a dive, blood flow to the diaphragm muscles of a seal is reduced. Suggest the advantage to the seal of maintaining some blood supply to the diaphragm muscles during a dive.

_____

_____

_____

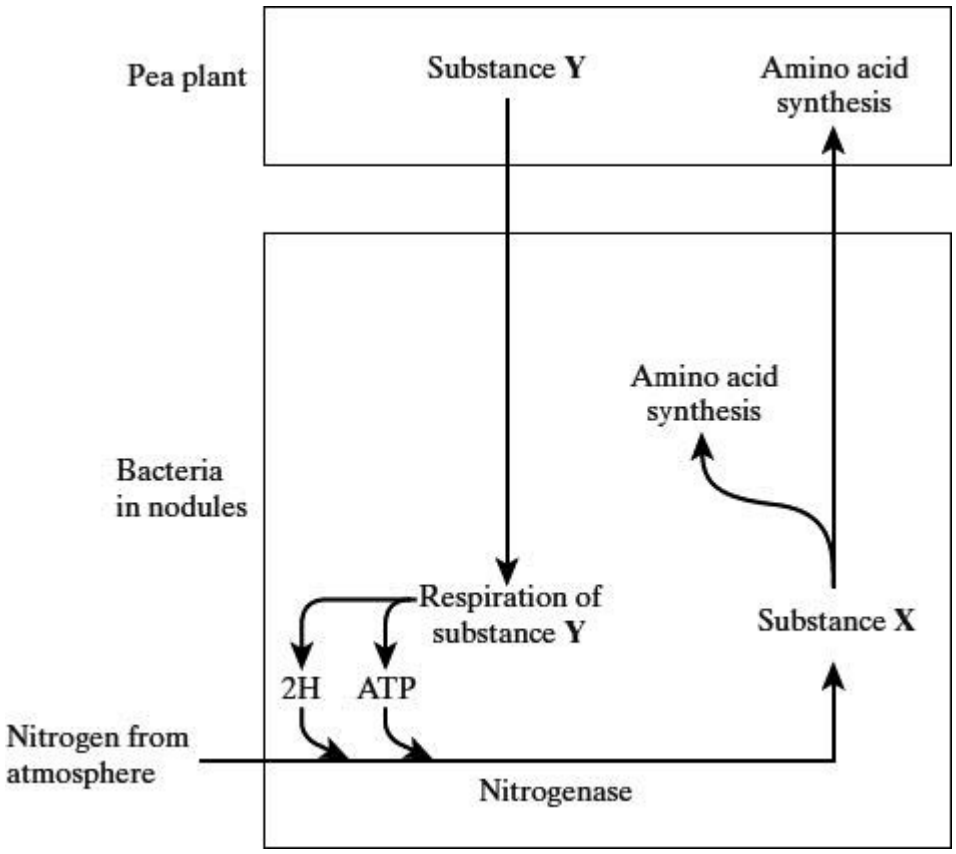
_____

(2)

(Total 7 marks)

Q49.

Pea plants are leguminous and have nodules on their roots which contain bacteria that are able to fix nitrogen. The diagram shows some of the processes involved in nitrogen fixation by these bacteria.



(a) Name

(i) substance **X**;

_____

(1)

(ii) substance **Y**.

_____

(1)

(b) Pea plants respire aerobically, producing ATP which can be used for amino acid synthesis. Describe the role of oxygen in aerobic respiration.

_____

_____

_____

_____

(2)

(c) The bacteria respire anaerobically. This produces hydrogen and ATP used in nitrogen fixation. The hydrogen comes from reduced NAD. Explain how the regeneration of NAD in this way allows ATP production to continue.

_____

_____

_____

_____

(2)

(d) The enzyme nitrogenase is specific to the reaction shown. Explain how **one** feature of the enzyme would contribute to this specificity.

Feature

_____

Explanation

_____

_____

_____

(2)

(e) Sodium ions act as a non-competitive inhibitor of the enzyme nitrogenase. Explain how the presence of a non-competitive inhibitor can alter the rate of the reaction catalysed by nitrogenase.

_____

_____

_____

_____

_____

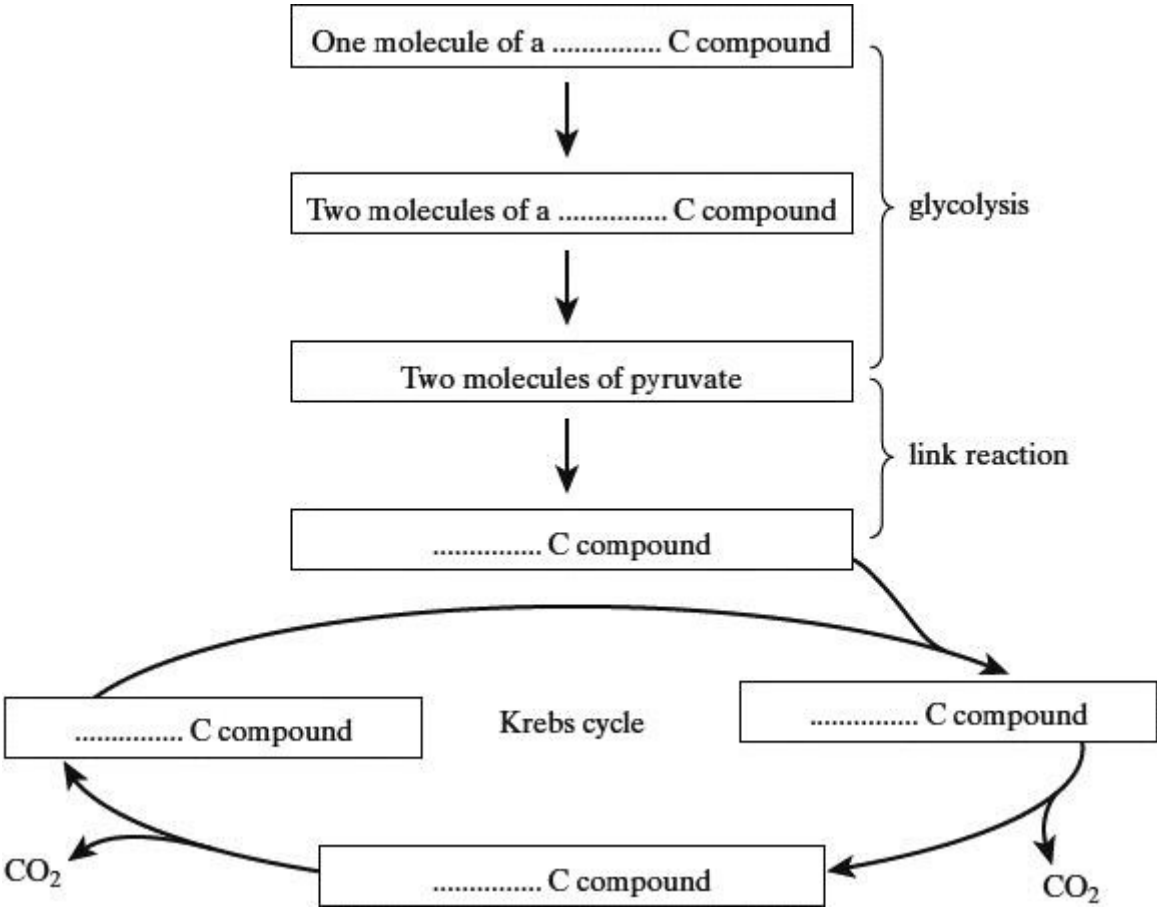
_____

(3)

(Total 11 marks)

Q50.

The boxes in the diagram represent substances in glycolysis, the link reaction and the Krebs cycle.



(a) Complete the diagram to show the number of carbon atoms present in **one** molecule of each compound.

(2)

(b) Other substances are produced in the Krebs cycle in addition to the carbon compounds shown in the diagram. Name **three** of these other products.

1. _____

2. _____

3. _____

(3)

(Total 5 marks)

Q51.

In an investigation, the effects of caffeine on performance during exercise were measured. One group of athletes (**A**) was given a drink of decaffeinated coffee. Another group (**B**) was given a drink of decaffeinated coffee with caffeine added. One hour later the athletes started riding an exercise bike and continued until too exhausted to carry on. Three days later the same athletes repeated the experiment, with the drinks exchanged.

(a) (i) The researchers added caffeine to decaffeinated coffee. Explain why they did not just use normal coffee.

_____

_____

(1)

(ii) The performance of the athletes might have been influenced by how they expected the caffeine to affect them. How could the researchers avoid this possibility?

_____

_____

(1)

During the exercise the concentrations of glycerol and fatty acids in the blood plasma were measured. The results are shown in the table.

Drink	Mean time to exhaustion /minutes	Mean concentration of blood glycerol/ mmol dm^{-3}	Mean concentration of blood fatty acids/ mmol dm^{-3}
With caffeine	90.2	0.20	0.53
Without caffeine	75.5	0.09	0.31

(b) (i) Describe the effect of caffeine on exercise performance.

_____

_____

(1)

(ii) Suggest **one** explanation for the higher glycerol and fatty acid concentrations in the blood plasma of the athletes after they were given caffeine.

_____

_____

_____

_____

(2)

(c) The researchers measured the volumes of carbon dioxide exhaled and oxygen inhaled during the exercise. From the results they calculated the respiratory quotient (RQ), using the formula

$$RQ = \frac{\text{volume of carbon dioxide exhaled per minute}}{\text{volume of oxygen inhaled per minute}}$$

When a person is respiring carbohydrate only, RQ = 1.0

When a person is respiring fatty acids only, RQ = 0.7

(i) The basic equation for the respiration of glucose is

$C_6H_{12}O_6 + 6O_2 \rightarrow 6CO_2 + 6H_2O$

Explain why the RQ for glucose is 1.0.

_____

_____

_____

_____

(2)

(ii) The researchers found that, when the athletes were given the drink containing caffeine, their mean RQ was 0.85. When given the drink without caffeine their mean RQ was 0.92.

The researchers concluded that when the athletes had caffeine they used glycogen more slowly than when they did not have caffeine, and that the store of glycogen in their muscles was used up less quickly during the exercise.

Explain the evidence from the information above and from the table which supports these conclusions.

_____

_____

_____

_____

_____

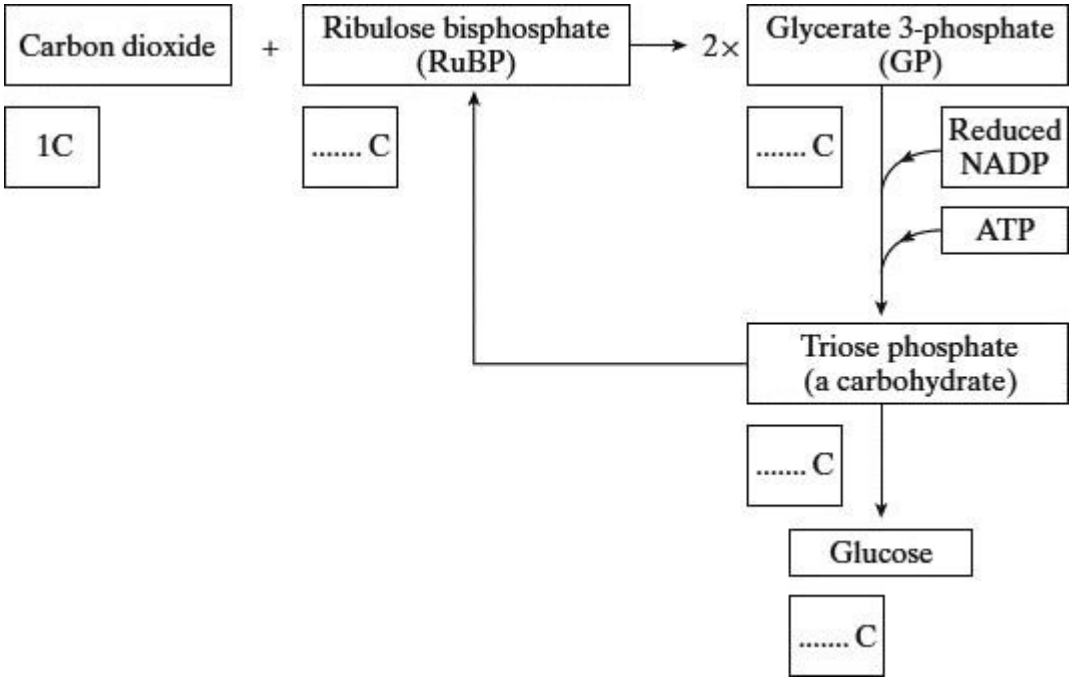
_____

(3)

(Total 10 marks)

Q52.

The diagram shows a summary of the light-independent reaction of photosynthesis.



(a) (i) Complete the boxes to show the number of carbon atoms in the molecules.

(2)

(ii) In which part of a chloroplast does the light-independent reaction occur?

_____

(1)

(iii) Which process is the source of the ATP used in the conversion of glycerate 3-phosphate (GP) to triose phosphate?

_____

(1)

(iv) What proportion of triose phosphate molecules is converted to ribulose bisphosphate (RuBP)?

_____

(1)

(b) Lowering the temperature has very little effect on the light-dependent reaction, but it slows down the light-independent reaction. Explain why the light-independent reaction slows down at low temperatures.

_____

_____

_____

_____

(2)

(Total 7 marks)

Q53.

(a) Mitochondria in muscle cells have more cristae than mitochondria in skin cells. Explain the advantage of mitochondria in muscle cells having more cristae.

_____

_____

_____

_____

(2)

(b) Substance **X** enters the mitochondrion from the cytoplasm. Each molecule of substance **X** has three carbon atoms.

(i) Name substance **X**.

_____

(1)

(ii) In the link reaction substance **X** is converted to a substance with molecules effectively containing only two carbon atoms. Describe what happens in this process.

_____

_____

_____

_____

(2)

(c) The Krebs cycle, which takes place in the matrix, releases hydrogen ions. These hydrogen ions provide a source of energy for the synthesis of ATP, using coenzymes and carrier proteins in the inner membrane of the mitochondrion.

Describe the roles of the coenzymes and carrier proteins in the synthesis of ATP.

_____

_____

_____

_____

_____

_____

(3)

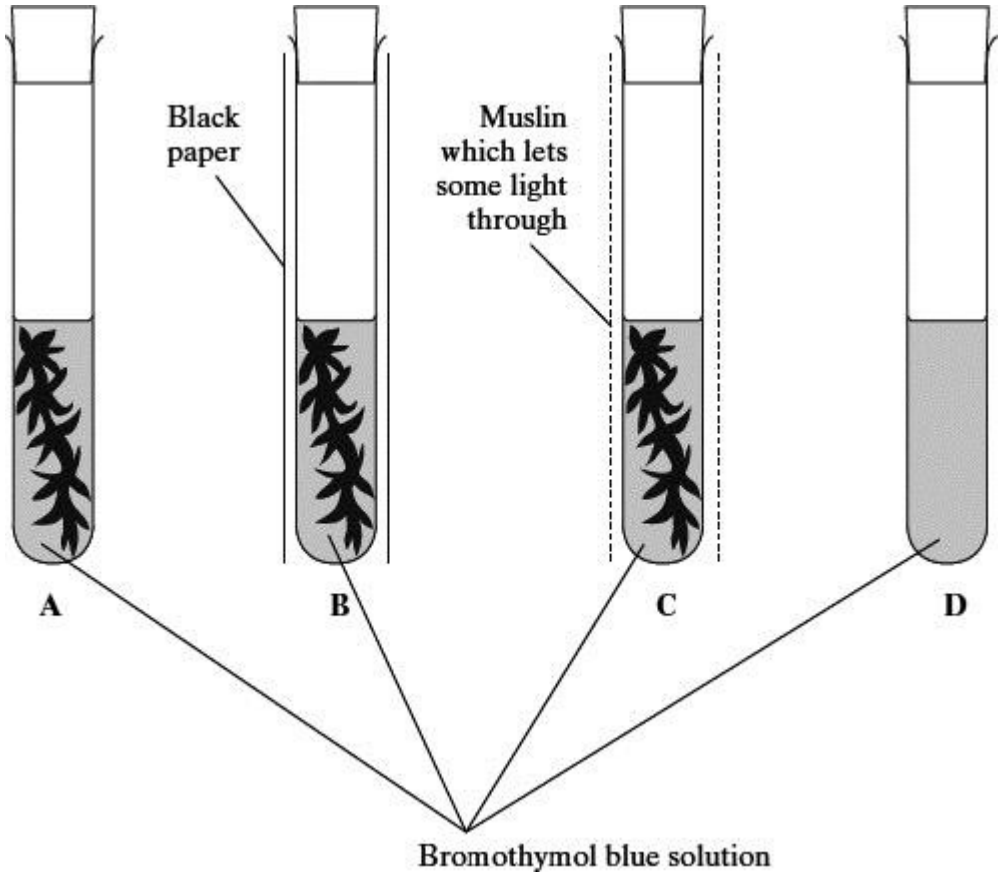
(Total 8 marks)

Q54.

Gas exchange in an aquatic plant was investigated by placing shoots in tubes containing bromothymol blue indicator solution. Bromothymol blue indicator is yellow below pH 6,

green between pH 6.1 and 7.5, and blue at pH 7.6 and above. Into each of four tubes, **A**, **B**, **C** and **D**, 10 cm^3 of bromothymol blue solution were placed. Each tube was closed with a bung and left for 10 minutes. Similar-sized shoots of an aquatic plant were then placed into each of tubes **A**, **B** and **C**. The tubes were treated as shown in the diagram.

They were then placed at equal distances from a 60 watt lamp and left for one hour.



The table shows the initial and final colours of the indicator in the four tubes.

Tube	Treatment	Initial colour of indicator	Colour of indicator after one hour
A	Uncovered	Green	Blue
B	Covered with black paper	Green	Yellow
C	Covered with muslin	Green	Green
D	Uncovered	Green	Green

(a) Explain the results for

tube **A**;

_____

_____

_____

_____

tube **B**;

_____

_____

_____

_____

tube **C**.

_____

_____

_____

_____

(4)

(b) (i) Explain how the results from tube **D** help to confirm that the explanations for the other tubes are valid.

_____

_____

(1)

(ii) Explain why all the tubes were placed the same distance from the lamp.

_____

_____

(1)

(Total 6 marks)

Q55.

When one mole of glucose is burned, 2800 kJ of energy are released. However, when one mole of glucose is respired aerobically, only 40% of the energy released is incorporated into ATP. Each mole of glucose respired aerobically produces 38 moles of ATP.

(a) (i) Calculate how much energy is incorporated into each mole of ATP. Show your working.

Answer _____ kJ

(2)

(ii) When glucose is respired what happens to the energy which is **not** incorporated into ATP?

_____

(1)

(b) (i) When one mole of glucose is respired anaerobically, only 2 moles of ATP are produced. Explain why less energy is released in anaerobic respiration.

_____

_____

(1)

(ii) At the end of a sprint race, a runner continues to breathe rapidly for some time. Explain the advantage of this.

_____

_____

_____

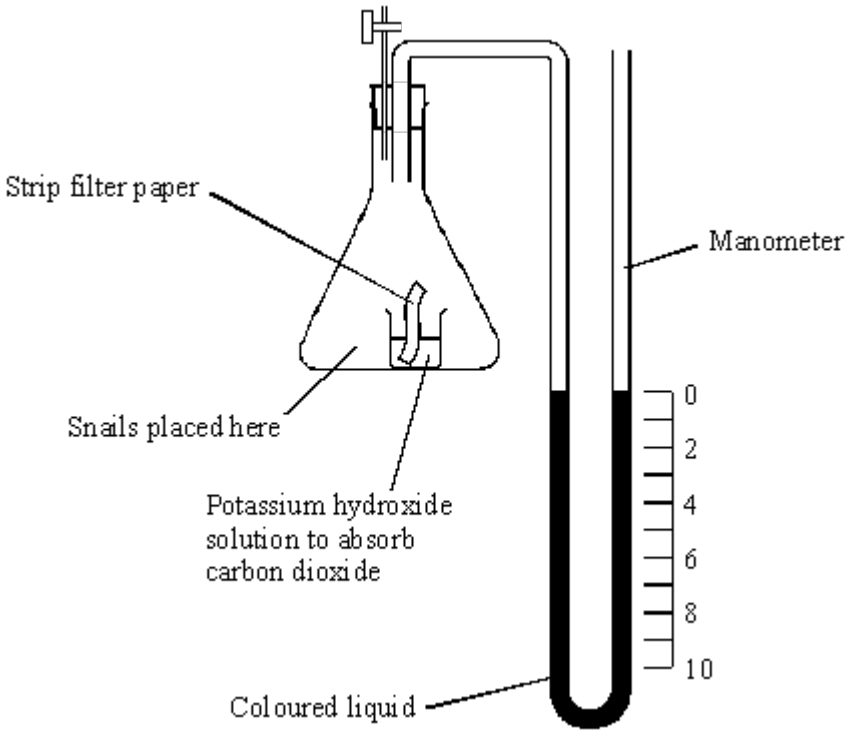
_____

(2)

(Total 6 marks)

Q56.

The diagram shows apparatus used to measure the oxygen uptake of snails that live on the seashore. The apparatus was kept at a constant temperature.



(a) (i) Explain the purpose of the strip of filter paper in the potassium hydroxide solution.

_____

_____

(1)

(ii) The level of liquid in the right-hand side of the manometer went down during the experiment. Explain why.

_____

_____

_____

_____

(2)

(iii) What measurements are needed to calculate the rate of oxygen uptake by the snails in $mm^3\ g^{-1}\ h^{-1}$?

_____

_____

_____

(3)

(b) Two experiments were carried out using the apparatus shown in the diagram.

1 The oxygen uptake of batches of 10 seashore snails kept in moist air was measured at temperatures between 5 °C and 35 °C.

2 Experiment 1 was repeated but with batches of 10 seashore snails covered by aerated seawater.

The experiments were repeated several times and means and standard deviations calculated. The results are shown in the table. The values given are means plus or minus one standard deviation.

Temperature / °C	**Oxygen uptake of snails kept in moist air / $mm^3\ g^{-1}\ h^{-1}$**	**Oxygen uptake of snails kept in seawater / $mm^3\ g^{-1}\ h^{-1}$**
5	35 ± 2	28 ± 8
10	34 ± 6	32 ± 3
15	36 ± 3	35 ± 3
20	86 ± 8	52 ± 10
25	141 ± 13	96 ± 15
30	132 ± 14	108 ± 9

35	120 ± 16	79 ± 21

(i) Describe **one** similarity and **one** difference between the pattern of mean oxygen uptake of the snails kept in moist air and those covered by seawater.

_____

_____

_____

_____

(2)

(ii) Explain why valid conclusions cannot be drawn about the trends in oxygen uptake at temperatures of 25 °C and above.

_____

_____

_____

_____

(2)

(Total 10 marks)

Mark schemes

Q1.

(a) (So the) oxygen is used/absorbed/respired;

1

(b) 1. Anaerobic respiration produces carbon dioxide;

2. Increase in pressure/volume (of gas);

Reference to either volume or pressure required for the mark

2

(c) 1. Correct answer in range of
4.9×10^{-4} to 4.91×10^{-4} = **2 marks**;;