CAMBRIDGE INTERNATIONAL AS & A LEVEL BIOLOGY · 9700

BIOLOGY



EXAM QUESTION PACK

12 ENERGY AND RESPIRATION

SCORE	PERCENTAGE
/	%

STEMUP

These questions belong to CIE, not to us.

The examination questions, mark schemes and examiner comments in this pack were written and published by Cambridge International (CIE). They are past assessment materials, reproduced here so that students can revise from them.

What we do not own

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

Where to find the originals

CIE publishes its past papers, mark schemes and examiner reports. Always check the current syllabus at cambridgeinternational.org before you revise.

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.

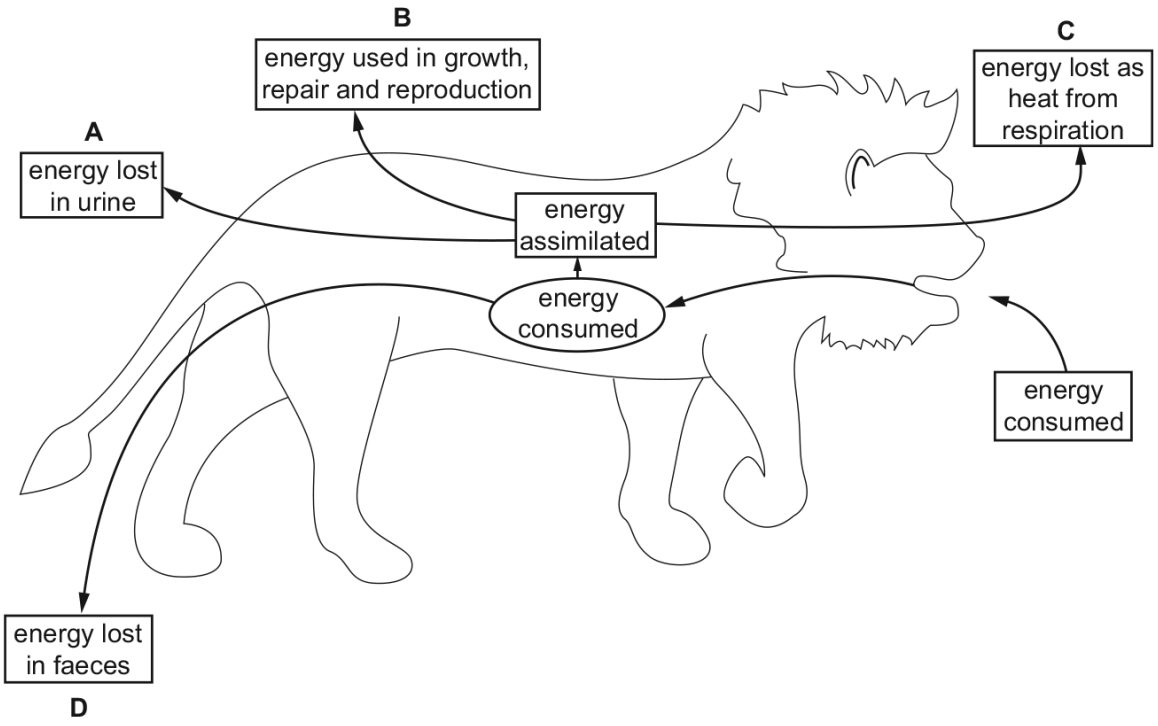
Chapter 12

Energy and respiration

12.1 Energy

1602. 9700_s15_qp_12 Q: 40

Of the prey consumed by the lion, into which box does the largest amount of energy go?

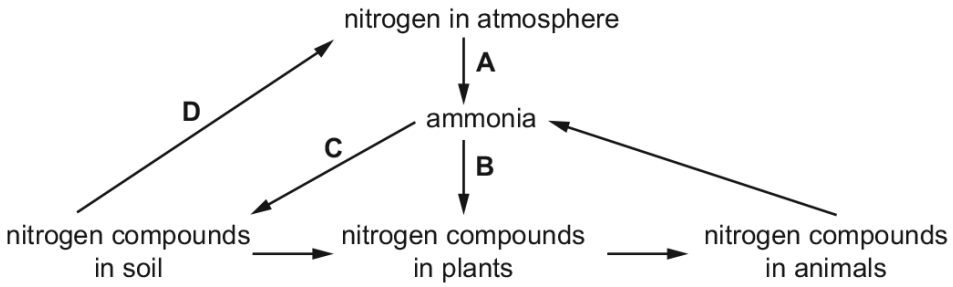


STEMUP.CO.UK

1603. 9700_s15_qp_13 Q: 38

The diagram represents part of the nitrogen cycle.

Which process is carried out by nitrifying bacteria?

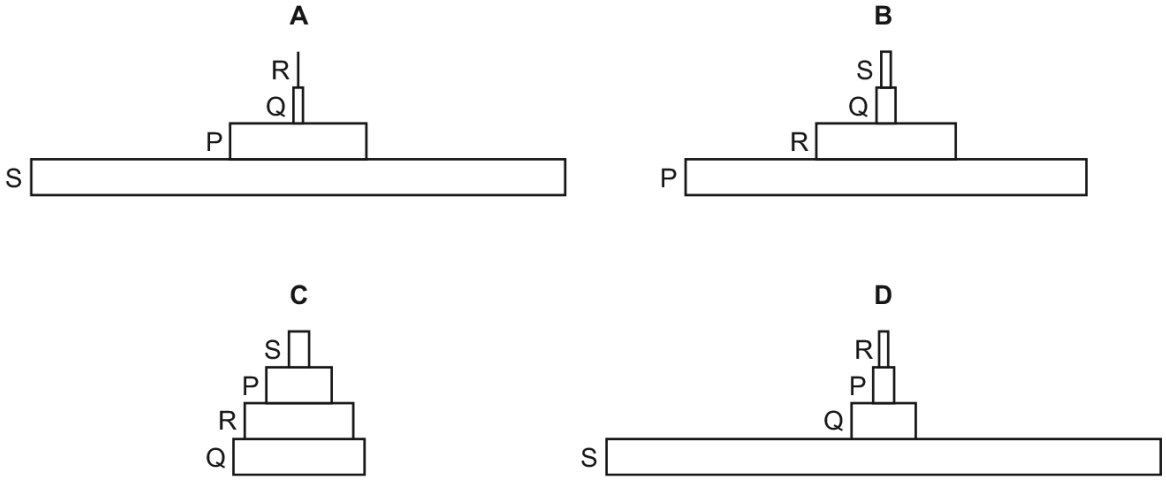


1604. 9700_s15_qp_13 Q: 40

The table shows the results of a field study of four species in a food chain in an area of woodland.

species	number of individuals	biomass of one individual / arbitrary units	energy value per unit mass / arbitrary units
P	10 000	0.100	1.0
Q	5	10.000	2.0
R	500	0.002	1.8
S	3	300 000.000	0.5

Which is the correct pyramid of energy from these data?



12.2 Respiration

1605. 9700_w15_qp_12 Q: 40

Anaerobic bacteria are found in large numbers in waterlogged soils.

Which effect does this have on soil fertility and why?

	soil fertility	reason
A	decreased	bacteria convert nitrate to ammonia
B	decreased	bacteria convert nitrate to nitrogen gas
C	increased	bacteria cause decomposition
D	increased	bacteria cause nitrogen fixation

Q1.

2 (a) Describe the importance of ATP in cells, giving **two** examples of processes in which it is used.

.....

.....

.....

.....[3]

Cells generate ATP by adding a phosphate group (P_i) to ADP.
During the complete oxidation of glucose, cells have two ways of doing this:

- substrate level phosphorylation
- oxidative phosphorylation

Figs 2.1 and 2.2 are diagrams that show the main details of these two processes (not drawn to the same scale).

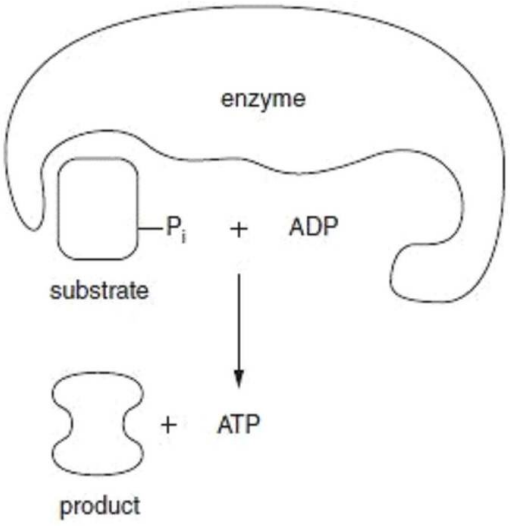


Fig. 2.1

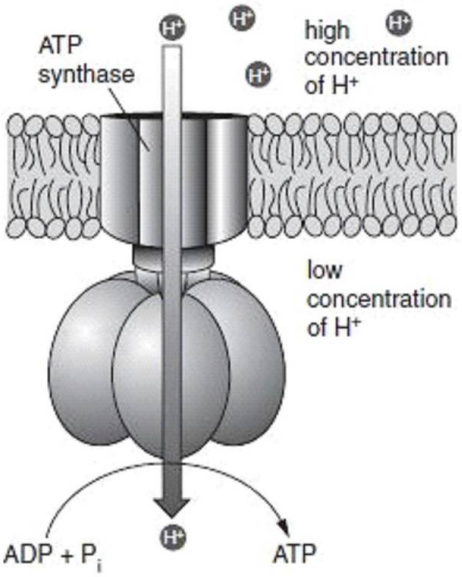


Fig. 2.2

STEMUP.CO.UK

(b) State precisely where these two processes occur in a cell.

substrate level phosphorylation

.....

.....

oxidative phosphorylation

.....

.....
[2]

(c) Compare the relative amounts of ATP produced by the two processes when a molecule of glucose is completely oxidised.

.....

.....

.....[2]

(d) Only substrate level phosphorylation is possible in the absence of oxygen.
Explain why oxidative phosphorylation is **not** possible in the absence of oxygen.

.....

.....

.....

.....[3]

[Total : 10]

Q2.

STEMUP.CO.UK

2 Fig. 2.1 is an electron micrograph showing the main structural features of a mitochondrion in section.



Fig. 2.1

(a) Indicate clearly on the diagram where:

(i) oxidative phosphorylation occurs;

(ii) Krebs cycle occurs.

[2]

(b) Describe two ways in which the structure of the mitochondrion is adapted for oxidative phosphorylation.

1. .....

.....

.....

2. .....

.....

.....[4]

STEMUP.CO.UK

(c) Explain how the lack of oxygen will affect the respiratory processes **in the mitochondria**. References to processes in the cytoplasm are not required.

.....

.....

.....

.....

.....[3]

[Total: 9]

Q3.

1 Fig. 1.1 shows the molecular structure of ATP.

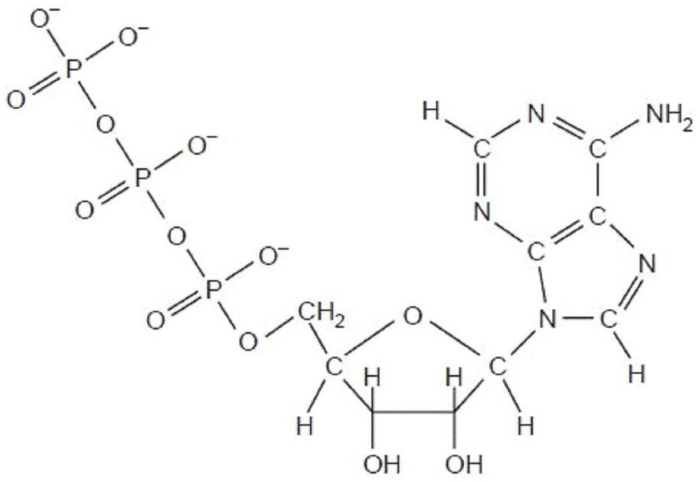


Fig. 1.1

STEMUP.CO.UK

(a) Describe the main structural features of the molecule.

.....

.....

.....

.....

.....[3]

(b) Explain how ATP is able to transfer energy in cells.

.....

.....

.....

.....

.....[3]

(c) State how ATP is synthesized in mitochondria.

.....

.....

.....

.....

.....

.....[4]

[Total: 10]

Q4.

STEMUP.CO.UK

1 The metabolic pathway in which a hexose sugar, such as glucose, is broken down in respiration by cells starts with glycolysis. Fig. 1.1 outlines the key stages of glycolysis.

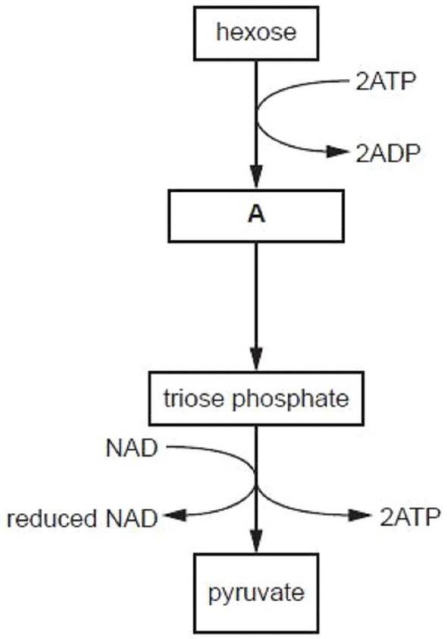


Fig. 1.1

(a) State where in the cell glycolysis takes place.

.....[1]

(b) Name substance **A**.

.....[1]

(c) Explain why the hexose is converted to substance **A**.

.....

.....

.....

.....[2]

STEMUP.CO.UK

(d) Briefly describe what happens to pyruvate if **yeast** is deprived of oxygen.

.....

.....

.....

.....

.....

.....

.....

.....[4]

[Total: 8]

Q5.

2 Aerobic respiration consists of three main processes.

Fill in the table to show the major products of each process.

process	major products
glycolysis	....
Krebs cycle	....
oxidative phosphorylation	....

[8]

[Total: 8]

STEMUP.CO.UK

Q6.

1 **(a)** The respiratory quotient (RQ) is used to show what substrates are being metabolised in respiration.

The RQ of a substrate may be calculated using the formula below:

$$RQ = \frac{\text{molecules of } CO_2 \text{ given out}}{\text{molecules of } O_2 \text{ taken in}}$$

When the unsaturated fatty acid linoleic acid is respired aerobically the equation is:

$$C_{18}H_{32}O_2 + 25O_2 \rightarrow \ldots\ldots\ldots CO_2 + 16H_2O + \text{energy}$$

(i) Calculate how many molecules of carbon dioxide are produced when one molecule of linoleic acid is respired aerobically.

answer ..... [1]

(ii) Calculate the RQ for linoleic acid.

answer ..... [1]

(b) Hummingbirds feed on nectar from flowers only during daylight hours. Nectar is rich in sugars.

Fig. 1.1 shows a hummingbird.



Fig. 1.1

STEMUP.CO.UK

A study of aerobic respiration in captive hummingbirds was carried out. The hummingbirds were allowed to feed freely and then made to fast for four hours in constant conditions. During this time their RQ values were calculated every 40 minutes.

For Examiner's Use

Fig. 1.2 shows the results from this study.

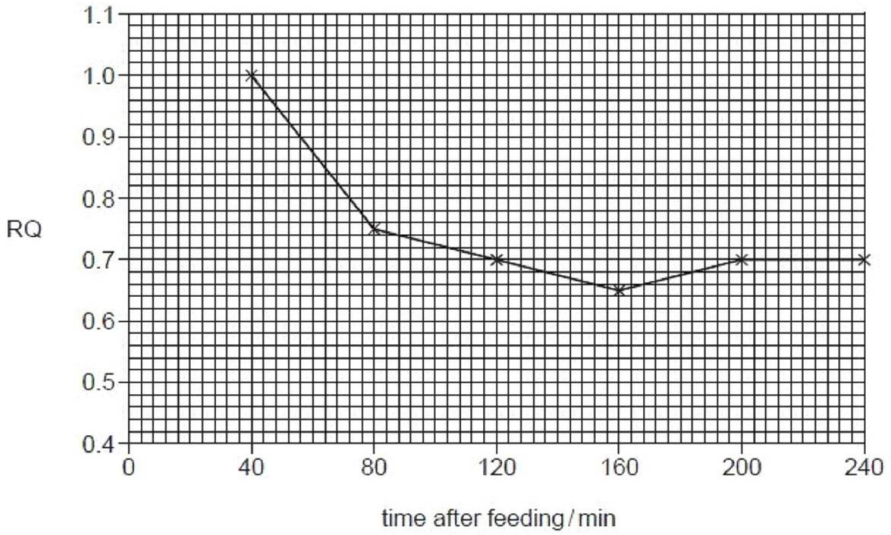


Fig. 1.2

Describe **and** explain the results shown in Fig. 1.2.

.....

.....

.....

.....

.....

.....

..... [4]

STEMUP.CO.UK

(c) Hummingbirds regulate their body temperature whereas butterflies do not regulate their body temperature.

Explain briefly the effect of an increase in temperature on the rate of respiration of a butterfly.

.....

.....

.....

..... [2]

[Total: 8]

Q7.

7 **(a)** The initial stages of respiration convert one molecule of glucose into two molecules of a 3C compound.

State

(i) the name given to these initial stages

..... [1]

(ii) where these stages occur in cells

..... [1]

(iii) the **total** number of ATP molecules formed during these stages.

..... [1]

(b) Most of the ATP formed in respiration is produced within the mitochondria by oxidative phosphorylation.

(i) State the location, in the mitochondrion, of oxidative phosphorylation.

..... [1]

STEMUP.CO.UK

(ii) Outline the process of oxidative phosphorylation.

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

..... [5]

(c) In an investigation, mammalian liver cells were homogenised (broken up) and the resulting homogenate centrifuged. Samples of the complete homogenate and samples containing only nuclei, only ribosomes, only mitochondria or only the remaining cytosol were incubated with:

1 glucose

2 pyruvate

3 glucose and cyanide

4 pyruvate and cyanide

Cyanide inhibits oxidative phosphorylation.

After incubation the presence or absence of carbon dioxide and lactate in each sample was determined.

The results are summarised in Table 7.1.

STEMUP.CO.UK

Table 7.1

	samples of homogenate									
	complete		only nuclei		only ribosomes		only mitochondria		only cytosol	
	carbon dioxide	lactate	carbon dioxide	lactate	carbon dioxide	lactate	carbon dioxide	lactate	carbon dioxide	lactate
1 glucose	✓	✓	✘	✘	✘	✘	✘	✘	✘	✓
2 pyruvate	✓	✓	✘	✘	✘	✘	✓	✘	✘	✓
3 glucose and cyanide	✘	✓	✘	✘	✘	✘	✘	✘	✘	✓
4 pyruvate and cyanide	✘	✓	✘	✘	✘	✘	✘	✘	✘	✓

✘ = absent ✓ = present

(i) With reference to Table 7.1, name the two organelles not involved in respiration.

1. .....

2. ..... [1]

STEMUP.CO.UK

(ii) Explain why carbon dioxide is produced when mitochondria are incubated with pyruvate but **not** when they are incubated with glucose.

For Examiner's Use

.....

.....

.....

.....

.....

..... [3]

(iii) Explain why, in the presence of cyanide, lactate is produced but carbon dioxide is not.

.....

.....

.....

.....

.....

..... [3]

[Total: 16]

Q8.

STEMUP.CO.UK

7 Fig. 7.1 is an outline diagram of the Krebs cycle. A two carbon acetyl group enters the cycle by combining with a molecule of oxaloacetate. A molecule of citrate is formed which is decarboxylated and dehydrogenated to regenerate the oxaloacetate.
The letters **P** to **V** are steps in the cycle.

For Examine Use

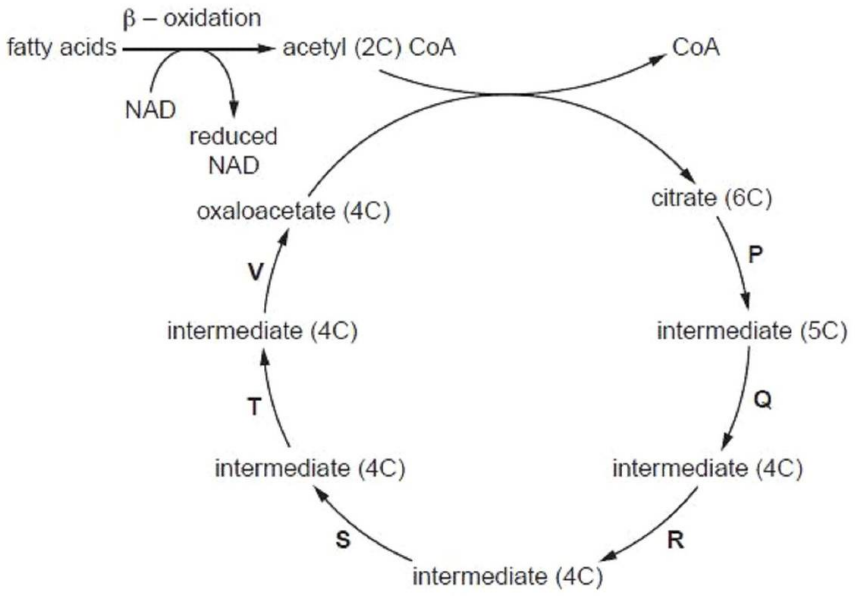


Fig. 7.1

(a) (i) Explain what is meant by the following terms:

decarboxylation .....

dehydrogenation ..... [2]

(ii) Using the letters in the cycle, state where decarboxylation is taking place.

..... [1]

(b) Fig. 7.1 shows that fatty acids can be converted into acetyl coenzyme A (acetyl CoA) by a process known as oxidation. Both this process and the Krebs cycle require NAD. The hydrogen atoms released reduce the NAD molecules.

(i) State the number of reduced NAD molecules that are formed in the Krebs cycle from one acetyl group that enters the cycle from acetyl CoA.

..... [1]

STEMUP.CO.UK

(ii) State where the reduced NAD molecules are re-oxidised **and** describe what happens to the hydrogen atoms.

.....

.....

.....

.....

.....

.....

.....

.....

..... [5]

(c) Describe the role of reduced NAD in respiring yeast cells in the absence of oxygen.

.....

.....

.....

.....

.....

.....

.....

..... [4]

STEMUP.CO.UK

(d) Describe how the production of lactate in muscle tissue **differs** from anaerobic respiration in yeast.

.....

.....

.....

.....

.....

..... [3]

[Total: 16]

Q9.

7 **(a)** Complete the following passage about ATP by writing in the missing words.

For Examiner's Use

All living organisms use energy. The most common immediate source of energy is adenosine triphosphate (ATP) which is used in every cell for the movement of ions against a concentration gradient, known as ..... .

ATP is known as the universal currency of energy.

ATP is a phosphorylated nucleotide which is known as a 'high energy' molecule. It is made of an organic base, adenine, a 5 carbon sugar named ..... and three phosphate groups. ATP is very soluble in ..... and easily transported within the cell. The removal of the outer phosphate group by the process of ..... releases energy. The energy released as a result of this reaction can be channelled directly into other reactions in the cell.

A certain proportion of this energy is lost as ..... .

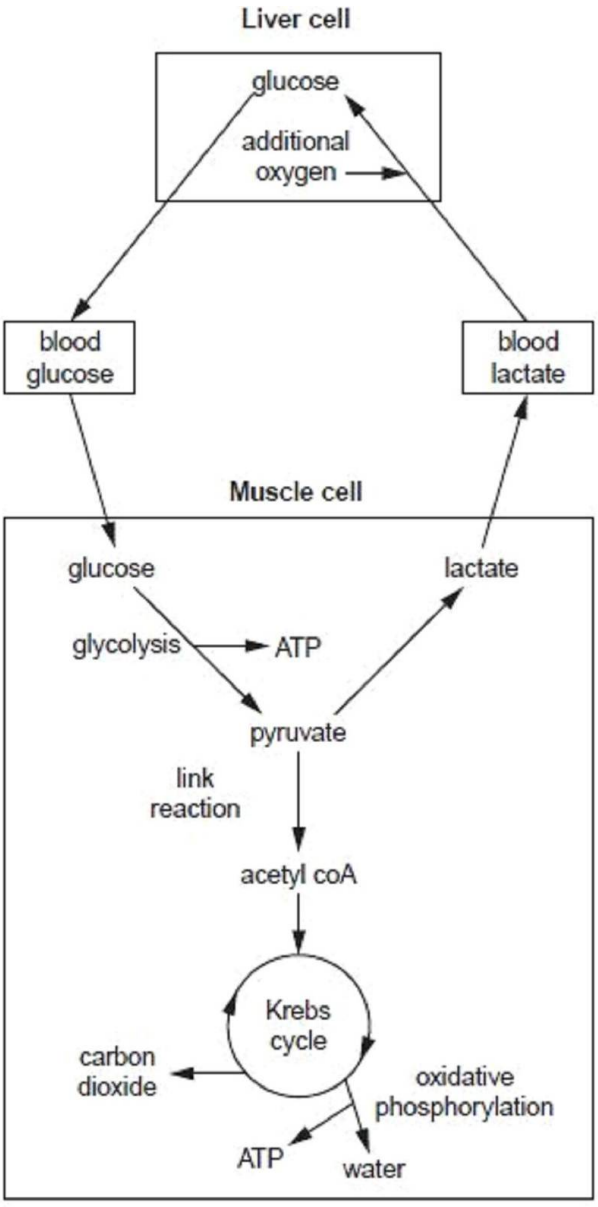
ATP is continually broken down and is reformed at a fast rate by the process of respiration. [5]

(b) During a sporting event an athlete may have to carry out anaerobic respiration in addition to aerobic respiration to produce sufficient ATP.

Ex

Fig. 7.1 outlines both processes in a muscle cell and shows how a liver cell is linked to these processes.

STEMUP.CO.UK


Liver cell
glucose
additional oxygen
blood glucose
blood lactate
Muscle cell
glucose
lactate
glycolysis
ATP
pyruvate
link reaction
acetyl coA
Krebs cycle
carbon dioxide
oxidative phosphorylation
ATP
water

STEMUP.CO.UK

You may refer to Fig. 7.1 in answering questions **(i)** to **(v)** below.

Fo
Exami
Us

(i) Glucose produced in the liver cell can be released into the blood to maintain blood glucose concentration.

State one use of glucose **within** the liver cell.

.....

..... [1]

(ii) Suggest why anaerobic respiration is said to be less efficient than aerobic respiration.

.....

.....

.....

..... [2]

(iii) Complete the table to indicate, within the muscle cell, the precise locations of glycolysis, the link reaction, the Krebs cycle and oxidative phosphorylation.

process	precise location
glycolysis	
link reaction	
Krebs cycle	
oxidative phosphorylation	

[4]

STEMUP.CO.UK

(iv) Glucose is phosphorylated at the start of glycolysis in the muscle cell.

Suggest why this phosphorylated glucose does **not** diffuse out of the cell into the surrounding tissue fluid.

.....

.....

.....

..... [2]

(v) Additional oxygen is required in the metabolic pathways involved in the conversion of lactate to glucose.

State the term given to this additional oxygen.

..... [1]

[Total: 15]

Q10.

STEMUP.CO.UK

6 The Krebs cycle occurs in the matrix of the mitochondrion.

Fig. 6.1 outlines the steps of the Krebs cycle.

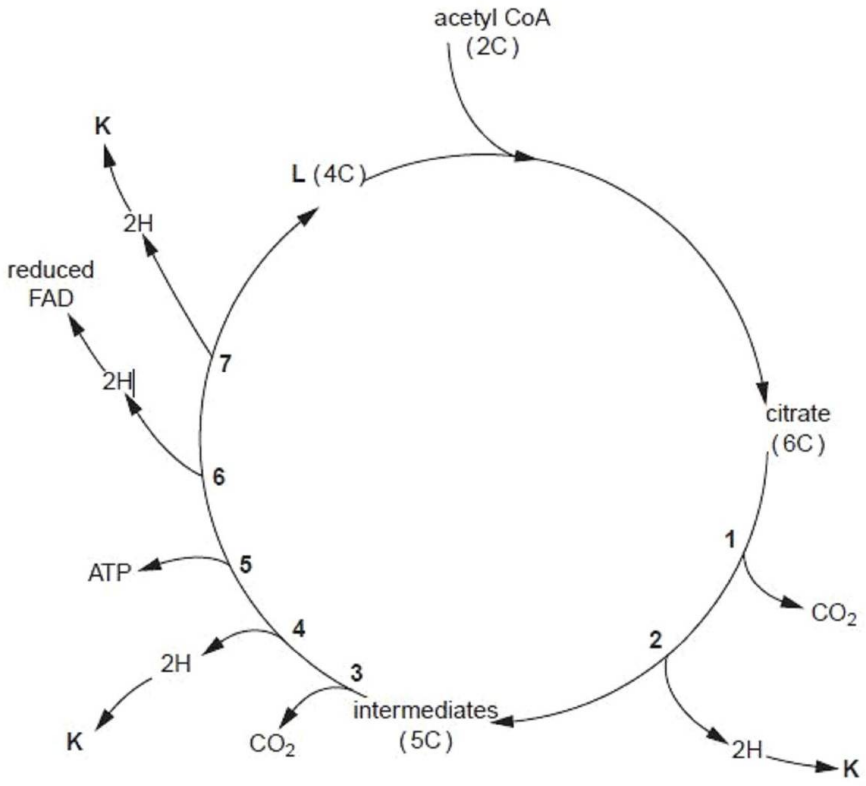


Fig. 6.1

(a) With reference to Fig. 6.1 name the process occurring at:

(i) **1** and **3** ..... [1]

(ii) **2**, **4**, **6** and **7** ..... [1]

(iii) **5** ..... [1]

(b) Name the compounds **K** and **L**.

K .....

L ..... [2]

STEMUP.CO.UK

(c) Most of the hydrogen atoms that are released by the Krebs cycle will take part in oxidative phosphorylation on the cristae of the mitochondria.

Outline the process of oxidative phosphorylation.

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....[5]

[Total: 10]

Q11.

4 **(a)** An experiment was carried out to investigate the effect of temperature on the rate of oxygen consumption of the lizard, *Sauromalus hispidus*. The body temperature of a lizard varies with environmental temperature.

Several lizards were fitted with small, airtight masks that covered their heads. Air was supplied inside the mask through one tube, and collected through another. The differences between oxygen concentrations in the air supplied for inhalation and the exhaled air enabled the researchers to measure the rate of oxygen consumption of the lizards.

The rate of oxygen consumption of each lizard was measured when it was at rest and when it was running. Measurements were made at different temperatures ranging from 15 °C to 40 °C.

Fig. 4.1 shows the results.

STEMUP.CO.UK

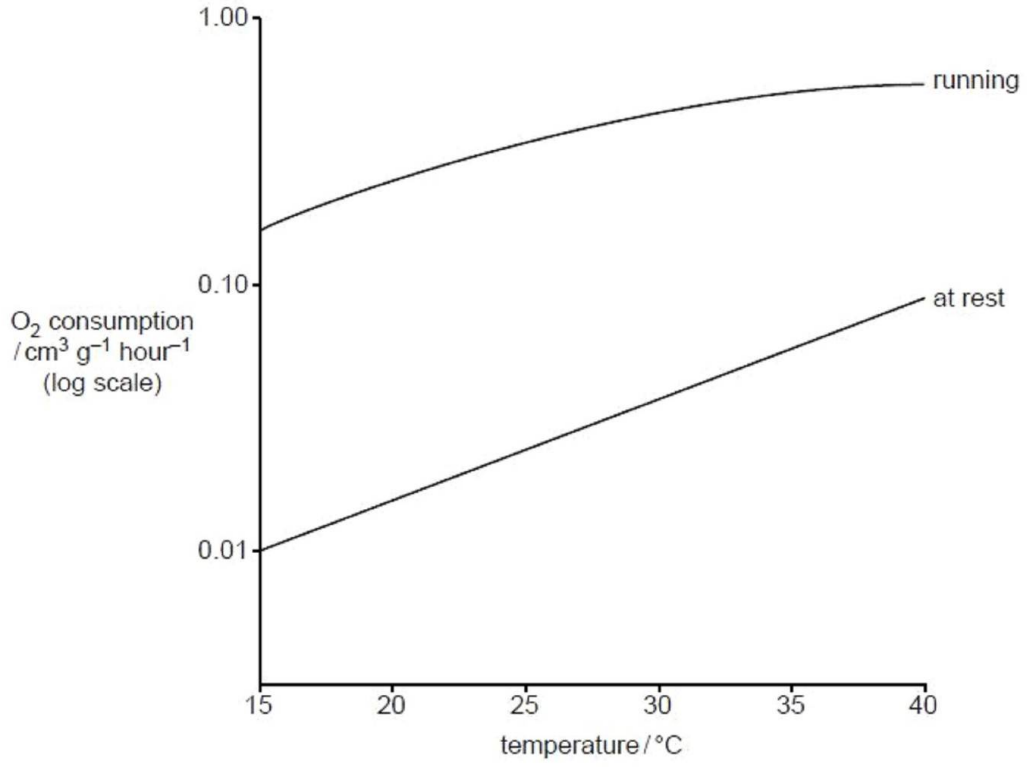


Fig. 4.1

STEMUP.CO.UK

(i) Running requires rapid use of ATP by muscle cells in the legs and heart of a lizard.

With reference to the events occurring inside a mitochondrion, explain why a faster use of ATP requires a greater rate of oxygen consumption.

.....

.....

.....

.....

.....

.....

.....

.....

.....

..... [4]

(ii) Explain the effect of temperature on the rate of oxygen consumption in *Sauromalus* when at rest.

.....

.....

.....

.....

.....

.....

.....

..... [3]

STEMUP.CO.UK

(b) The researchers also measured the oxygen debt that was built up when a lizard was running.

They measured this for two species of lizard, *Sauromalus hispidus* and *Varanus gouldi*, at six different temperatures.

The results are shown in Table 4.1.

Table 4.1

temperature / °C	15	20	25	30	35	40
Sauromalus **oxygen debt / $cm^3 O_2 kg^{-1}$**	70.3	81.3	93.0	102.0	118.0	154.0
Varanus **oxygen debt / $cm^3 O_2 kg^{-1}$**	62.0	72.2	78.5	87.9	96.7	102.0

(i) The oxygen debts were found by using the masks described in **(a)**.

Suggest what measurements were taken, and how these measurements were used to calculate the oxygen debt.

.....

.....

.....

..... [2]

(ii) Compare the oxygen debt built up by a running *Varanus* with that of a running *Sauromalus*.

.....

.....

.....

.....

.....

..... [3]

STEMUP.CO.UK

(iii) *Varanus* is a fast-moving carnivore. *Sauromalus* is a slow-moving herbivore.

Explain how the results in Table 4.1 indicate that *Varanus* is well-adapted for its mode of life.

.....

.....

.....

.....

.....

..... [3]

(iv) Most lizards, including *Sauromalus*, have very simple lungs with no alveoli. *Varanus*, however, has lungs that are more like those of mammals, containing large numbers of air sacs similar to the alveoli of human lungs.

Suggest how this difference could account for the differences in the oxygen debts of *Sauromalus* and *Varanus* shown in Table 4.1.

.....

.....

.....

..... [2]

[Total: 17]

Q12.

STEMUP.CO.UK

4 **(a)** The production of ATP by oxidative phosphorylation takes place in the electron transport chain in a mitochondrion.

(i) State the part of the mitochondrion in which the electron transport chain is found.

..... [1]

(ii) Describe briefly where the electrons that are passed along the electron transport chain come from.

.....

.....

.....

.....

.....

..... [3]

(iii) Describe the role of oxygen in the process of oxidative phosphorylation.

.....

.....

.....

.....

.....

..... [2]

(b) The brain depends on a constant supply of oxygen for aerobic respiration. Anaerobic respiration is not sufficient to keep neurones in the brain alive. This is because neurones require especially large amounts of ATP. Up to 80% of the ATP is used to provide energy for the Na^+/K^+ pump.

When a person suffers a stroke, blood flow to part of the brain is stopped, so some neurones receive no oxygen. ATP production by oxidative phosphorylation stops. Fig. 4.1 shows some of the ways in which the lack of ATP affects a neurone in the brain.

STEMUP.CO.UK

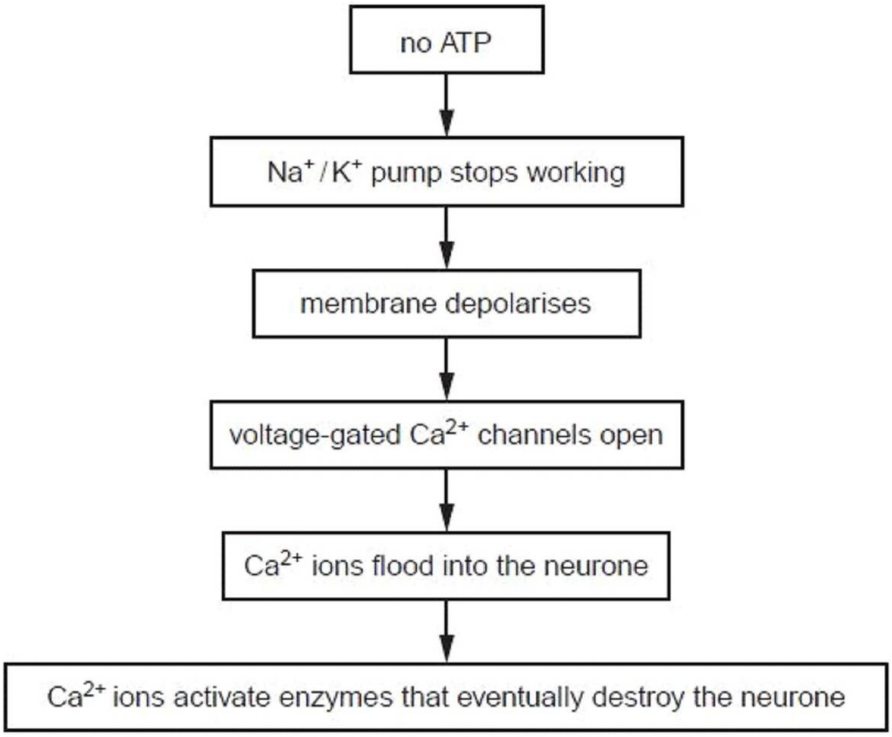


Fig. 4.1

STEMUP.CO.UK

(i) Explain why the membrane of the neurone depolarises when the Na^+/K^+ pump stops working.

.....

.....

.....

.....

.....

.....

.....

.....

..... [4]

(ii) Suggest why calcium ions flood into the neurone when the Na^+/K^+ pump stops working.

.....

.....

.....

..... [2]

STEMUP.CO.UK

(c) The freshwater turtle, *Trachemys scripta*, is able to survive for long periods in conditions of very low oxygen concentration. As in humans, the rate of activity of the Na^+/K^+ pump in the neurones in its brain falls sharply. However, in turtles this does not result in damage to these cells.

A better understanding of how the neurones in the turtle's brain survive in these conditions could lead to new treatments for people who have suffered a stroke.

Experiments show that, in turtle brain neurones, in conditions of low oxygen availability:

- most ion channels in the cell surface membranes immediately close
- after about four hours, the quantity of mRNA involved in the synthesis of proteins used to build ion channels, falls to less than one fifth of normal concentrations.

(i) Suggest how the closure of ion channels in the neurones of the turtle in very low oxygen concentrations could allow the cells to survive.

.....

.....

.....

..... [2]

(ii) Suggest what causes the quantity of mRNA for protein channels to fall.

.....

.....

.....

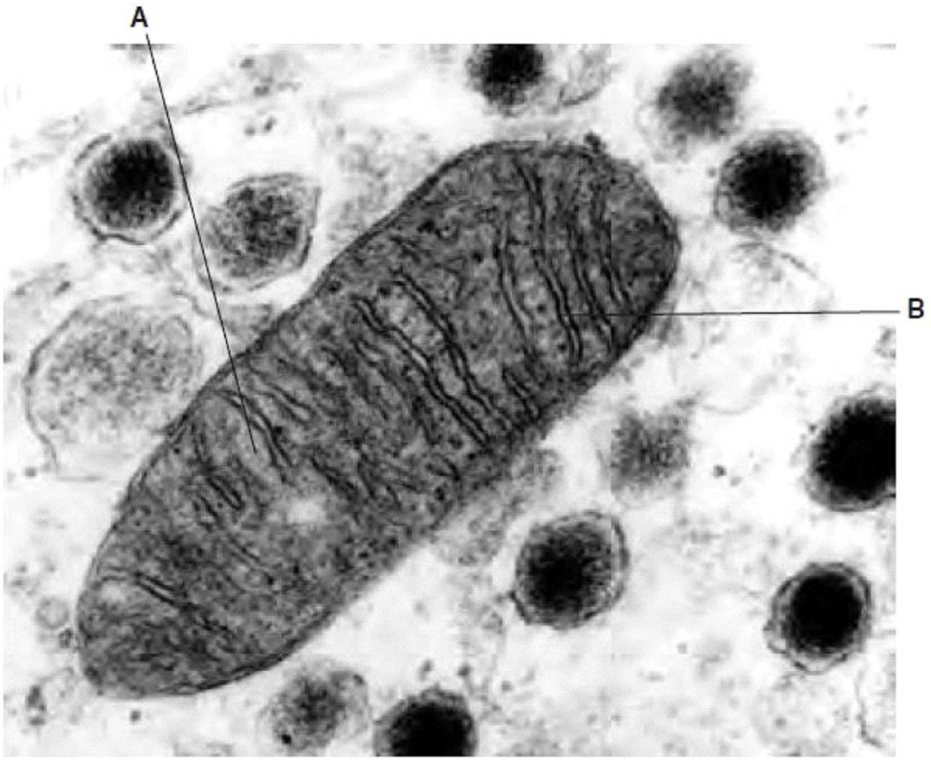
..... [2]

[Total: 16]

Q13.

STEMUP.CO.UK

2 Fig. 2.1 is an electron micrograph of a mitochondrion.



Two stages of respiration occur in mitochondria. These are the Krebs cycle and oxidative phosphorylation.

(a) Complete the table below by naming the structures labelled **A** and **B** and stating which of the stages of respiration occur in each.

	name of structure	stage of respiration
A	.....	.....
	.....	.....
B	.....	.....
	.....	.....

[2]

STEMUP.CO.UK

(b) Describe how the structure of a mitochondrion is adapted to carry out these two processes.

.....

.....

.....

.....[3]

(c) Describe briefly the role of NAD in respiration.

.....

.....

.....

.....[3]

(d) Describe how *photophosphorylation* differs from *oxidative phosphorylation*.

.....

.....

.....

.....[3]

[Total : 11]

Q14.

STEMUP.CO.UK

2 Fig. 2.1 shows the reduction of NAD that occurs during respiration.

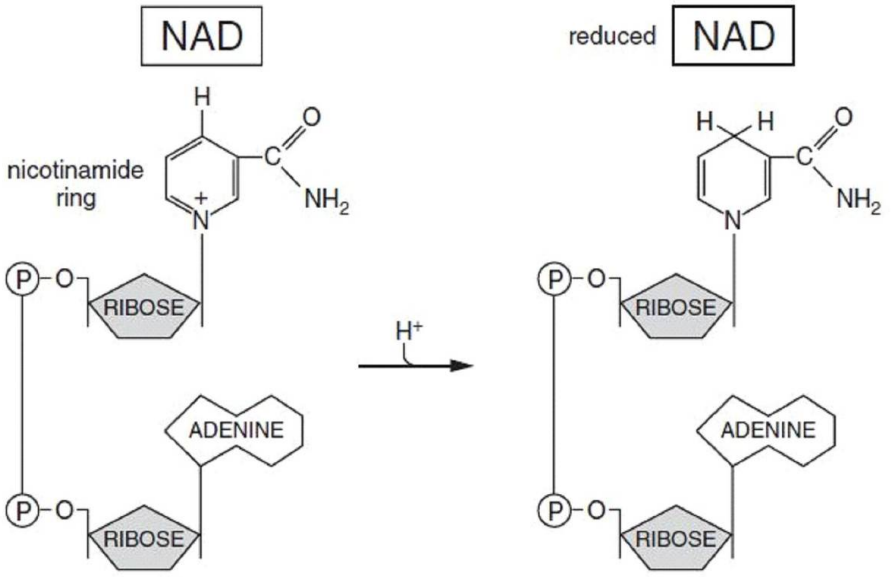


Fig. 2.1

(a) State two specific places in the eukaryotic cell where NAD is reduced.

.....

.....

.....[2]

(b) Describe the role of NAD in cellular respiration.

.....

.....

.....

.....[3]

(c) Explain why NAD cannot be regenerated from reduced NAD in mitochondria in the absence of oxygen.

.....

.....

.....

.....

.....[3]

STEMUP.CO.UK

(d) Yeast can respire aerobically and anaerobically. When there is insufficient oxygen, yeast cells switch from aerobic to anaerobic respiration. This results in a significant increase in the rate of glucose uptake and glycolysis in the yeast cells.

Suggest why the rate of glycolysis increases significantly when yeasts cells switch from aerobic to anaerobic respiration.

.....

.....

.....[2]

[Total : 10]

Q15.

3 Fig. 3.1 shows the changes in blood lactate concentration with increasing workload in a distance runner and untrained person.

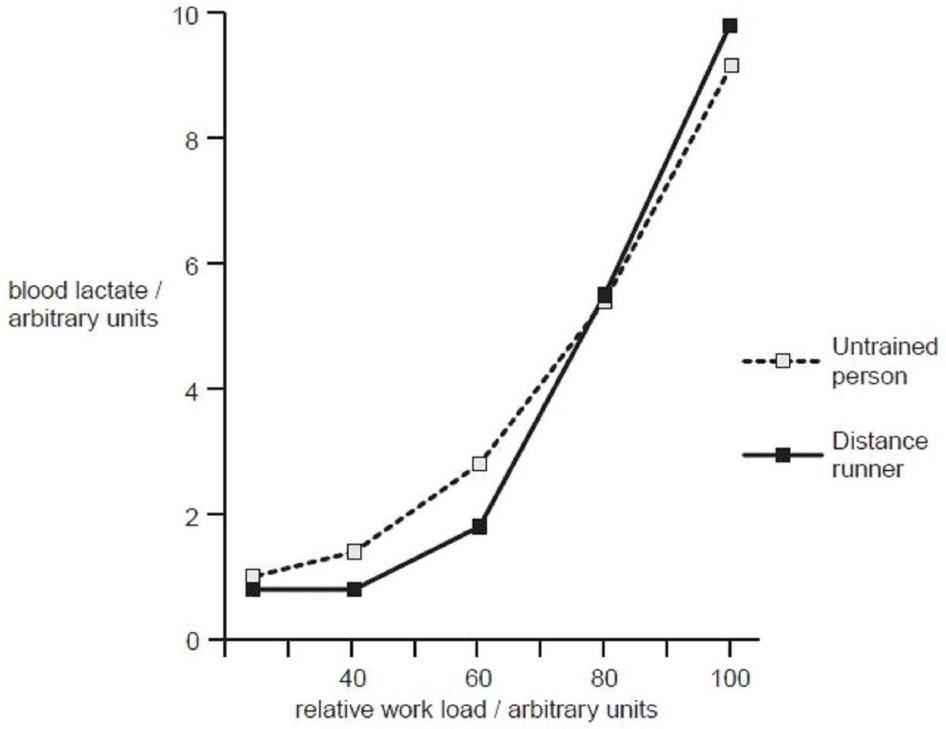


Fig. 3.1

STEMUP.CO.UK

(a) Describe the relationship between blood lactate concentration and relative workload for the distance runner.

.....

.....

.....

.....[2]

(b) Describe how the lactate that appears in the blood is formed.

.....

.....

.....

.....

.....[3]

(c) Outline how blood lactate is linked to oxygen debt.

.....

.....

.....

.....[3]

(d) Suggest why the build up of lactate occurs at a higher workload in the distance runner.

.....

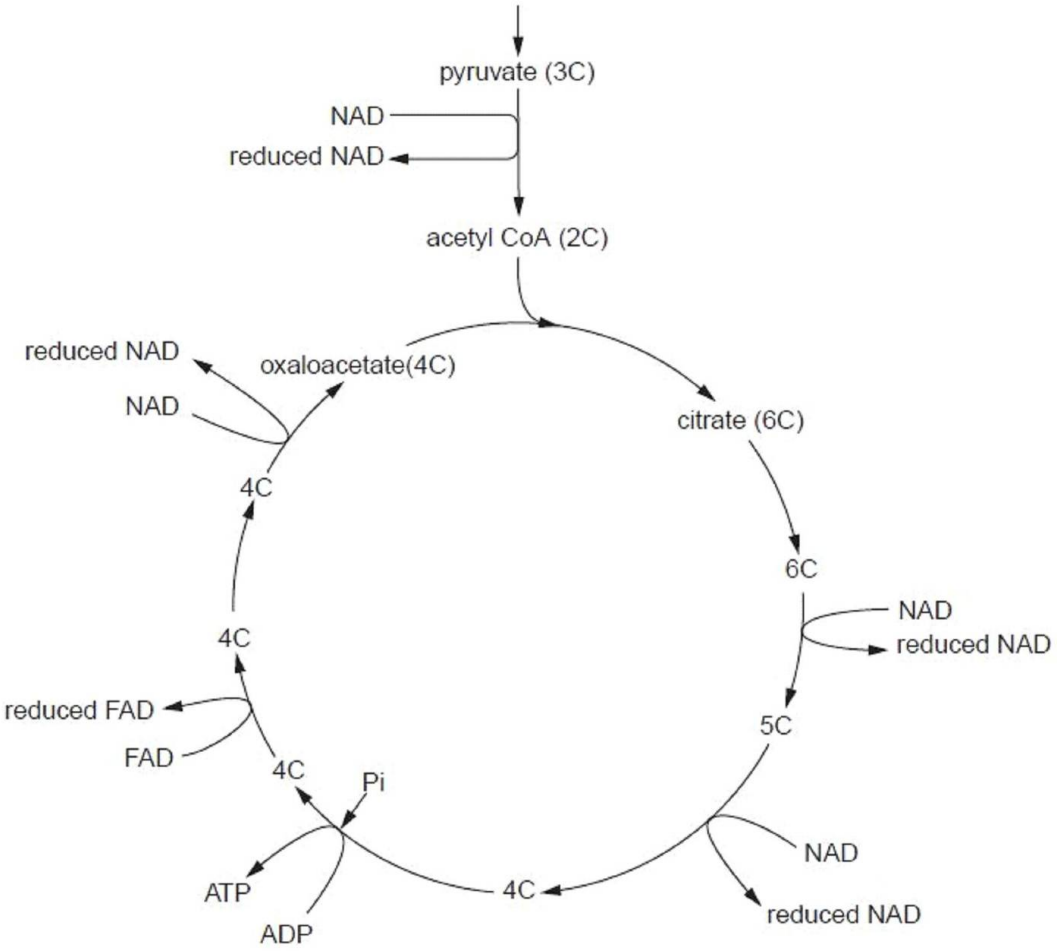
.....[1]

[Total: 9]

Q16.

1 Fig. 1.1 shows the Krebs cycle and the reactions preceding it.

STEMUP.CO.UK



(a) State precisely where the Krebs cycle occurs in cells.

.....[1]

(b) **Label on Fig. 1.1 all** the stages where

(i) decarboxylation reactions occur with a letter **X**. [2]

(ii) dehydrogenation reactions occur with a letter **H**. [2]

STEMUP.CO.UK

(c) Explain how NAD is regenerated.

.....

.....

.....

.....[3]

(d) State how the formation of ATP in the Krebs cycle differs from the formation of ATP in oxidative phosphorylation.

.....

.....[1]

[Total : 9]

Q17.

3 **(a)** State what is meant by the term *respiratory quotient* (RQ).

.....

.....[1]

(b) **(i)** Complete the following equation for the aerobic respiration of the respiratory substrate A.

$C_{18}H_{36}O_2 + 26O_2$ ..... + ... [2]

(ii) Calculate the respiratory quotient (RQ) of this respiratory substrate.

[2]

(iii) Identify respiratory substrate A from the respiratory quotient value calculated.

.....[1]

STEMUP.CO.UK

(c) Explain why carbohydrates release half as much energy per unit mass as fats and oils.

.....

.....

.....[2]

[Total : 8]

Q18.

1 Carbohydrates and lipids are important fuels in generating ATP in animal cells.

(a) Explain the relative energy values of carbohydrate and lipid as respiratory substrates.

.....

.....

.....

.....

.....

..... [3]

Aerobic respiration uses oxygen and produces carbon dioxide as a waste substance. Animal cell metabolism can be analysed using the respiratory quotient, RQ. The RQ is the volume of the carbon dioxide produced divided by the volume of the oxygen consumed.

(b) State typical RQ values for carbohydrates and lipids.

carbohydrate .....

lipid ..... [2]

The Siberian hamster, a small rodent like a mouse, had its RQ measured at different air temperatures. Fig. 1.1 shows the results of this experiment.

STEMUP.CO.UK

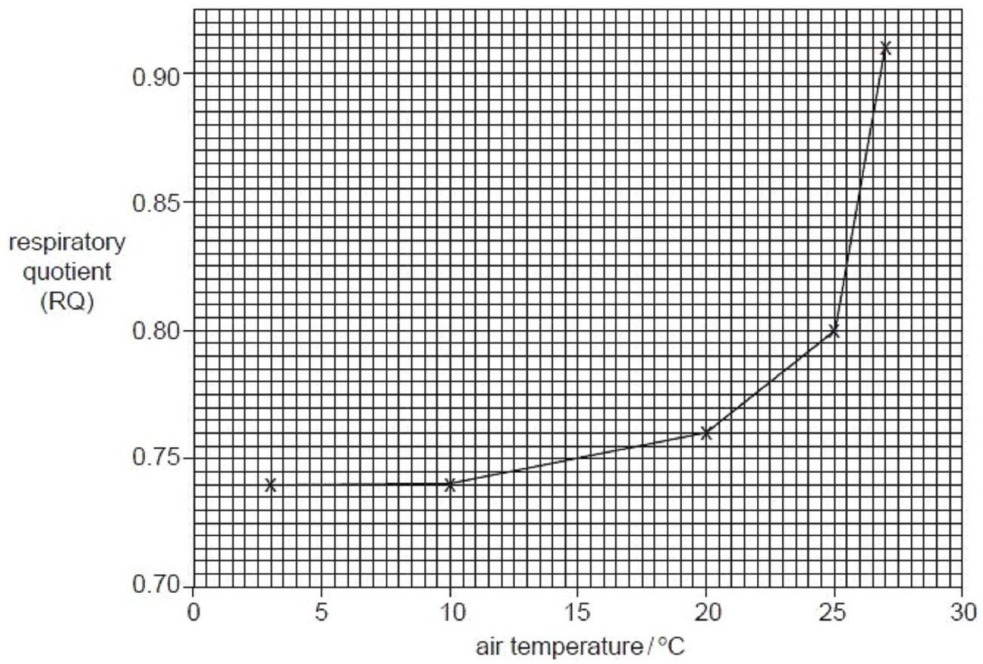


Fig. 1.1

(c) Using the information in Fig. 1.1, describe and explain the relationship between RQ and air temperature.

.....

.....

.....

.....

.....

.....

.....

..... [4]

(d) State a circumstance under which the RQ value would rise to over 1.0.

.....

..... [1]

[Total: 10]

STEMUP.CO.UK

Q19.

Use

7 In aerobic respiration, the Krebs cycle is regarded as a series of small steps. One of these steps is the conversion of succinate to fumarate by an enzyme, succinate dehydrogenase.

(a) State the role played by dehydrogenase enzymes in the Krebs cycle **and** explain briefly the importance of this role in the production of ATP.

.....

.....

.....

.....

.....

.....

.....

..... [3]

(b) An investigation was carried out on the effect of different concentrations of aluminium ions on the activity of succinate dehydrogenase. The enzyme concentration and all other conditions were kept constant. Fig 7.1 shows the results of this investigation.

STEMUP.CO.UK

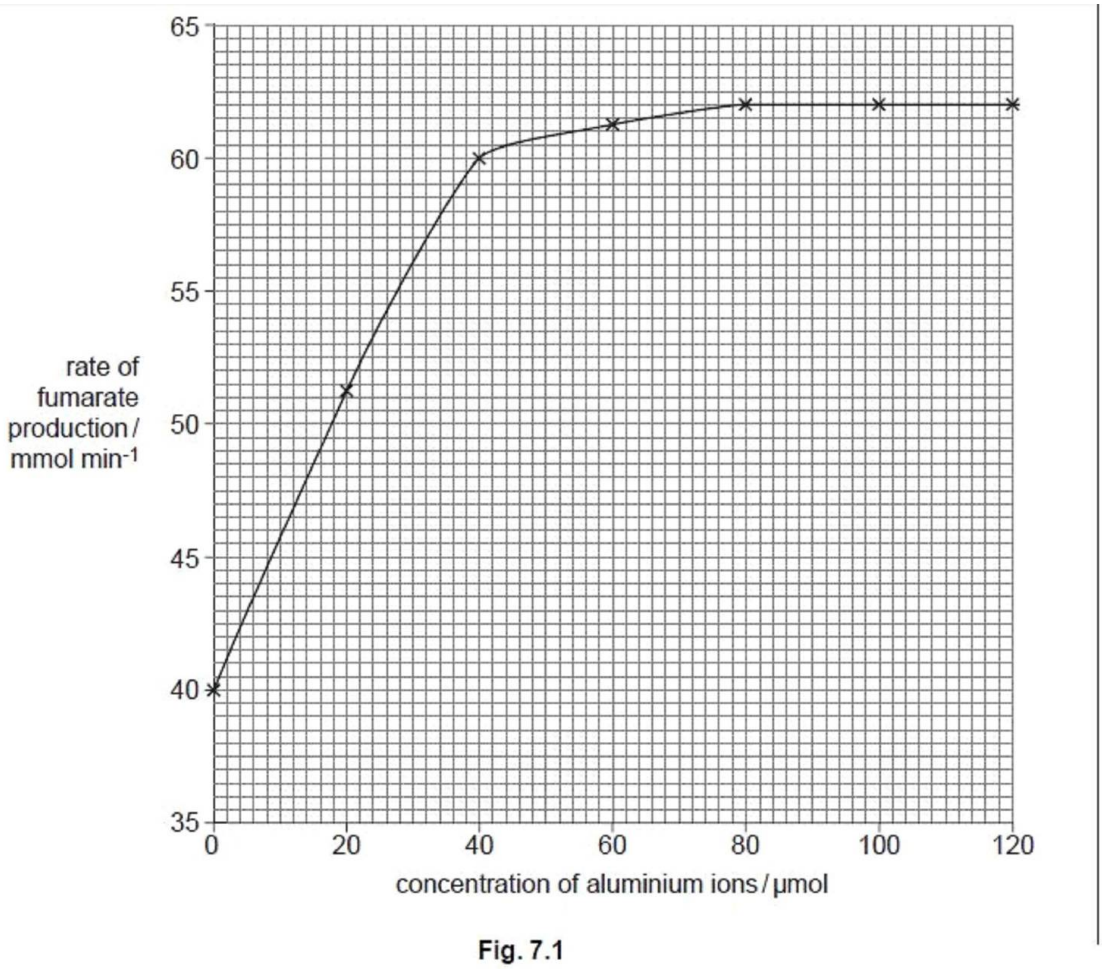


Fig. 7.1

STEMUP.CO.UK

With reference to Fig. 7.1,

(i) describe the effect of the concentration of aluminium ions on the rate of production of fumarate

.....

.....

.....

..... [2]

(ii) suggest an explanation for this effect.

.....

.....

.....

..... [2]

[Total: 7]

Q20.

STEMUP.CO.UK

6 Fig. 6.1 shows the structure of ATP.

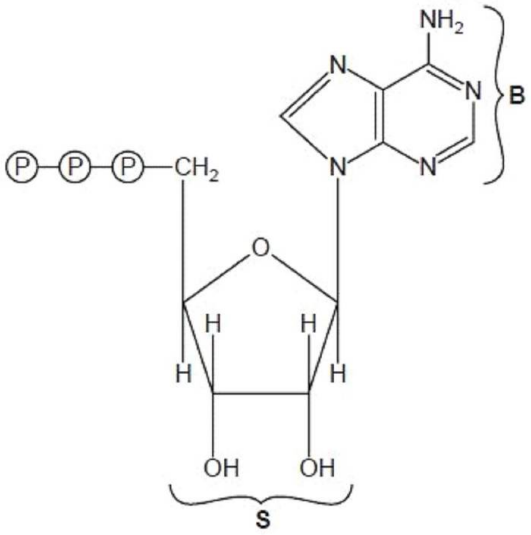


Fig. 6.1

(a) (i) Name the nitrogenous base labelled **B**.

.....[1]

(ii) Name the sugar labelled **S**.

.....[1]

(b) ATP is described as having a universal role as the energy currency in all living organisms. Explain why it is described in this way.

.....

.....

.....

.....

.....

.....

.....

.....[4]

STEMUP.CO.UK

(c) State **precisely** two places where ATP is synthesised in cells.

1 .....

.....

2 .....

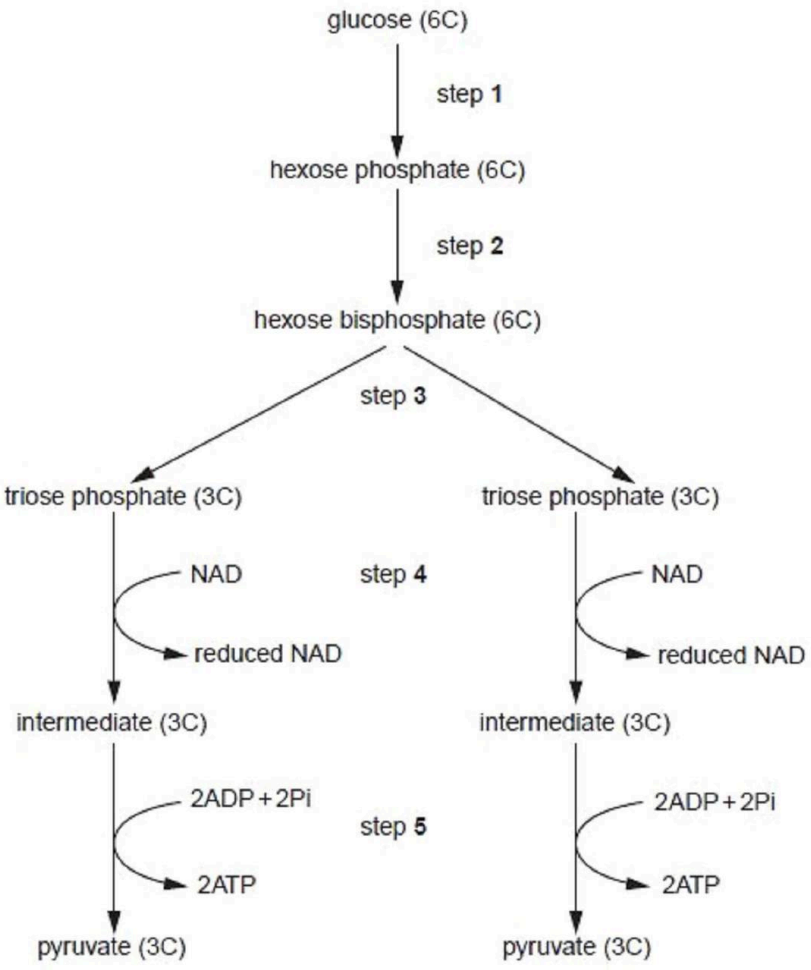
.....[2]

[Total: 8]

Q21.

6 During the process of glycolysis, glucose is converted by a series of steps into two molecules of pyruvate.

Fig. 6.1 outlines glycolysis.



STEMUP.CO.UK

(a) With reference to Fig. 6.1, state the process occurring at:

(i) steps **1** and **2** .....[1]

(ii) step **3** .....[1]

(iii) step **4**. .....[1]

(b) Explain why glucose needs to be converted to hexose bisphosphate.

.....

.....

.....

.....[2]

(c) Pyruvate can enter a mitochondrion when oxygen is present.

Describe what happens to pyruvate in a yeast cell when oxygen is **not** present.

.....

.....

.....

.....

.....

.....

.....

.....[4]

[Total: 9]

Q22.

STEMUP.CO.UK

6 **(a)** Fig. 6.1 outlines anaerobic respiration in yeast cells.

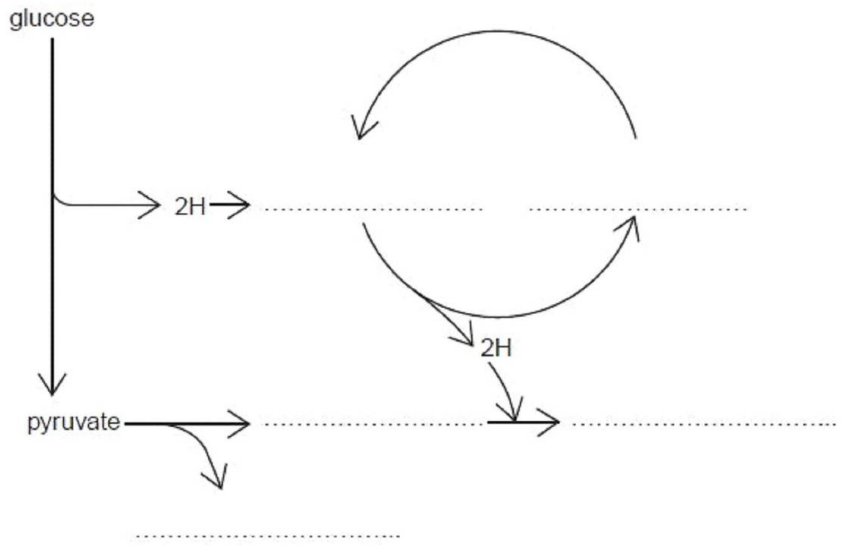


Fig. 6.1

Complete Fig. 6.1 by writing in the missing compounds. [5]

(b) Describe how anaerobic respiration in mammalian cells differs from anaerobic respiration in yeast cells.

.....

.....

.....

.....

.....

.....

.....[3]

STEMUP.CO.UK

(c) Explain why anaerobic respiration results in a small yield of ATP compared with aerobic respiration.

.....

.....

.....

.....

.....

.....

.....[3]

[Total: 11]

Q23.

8 **(a)** Fig. 8.1 is an electronmicrograph of a section through a mitochondrion.

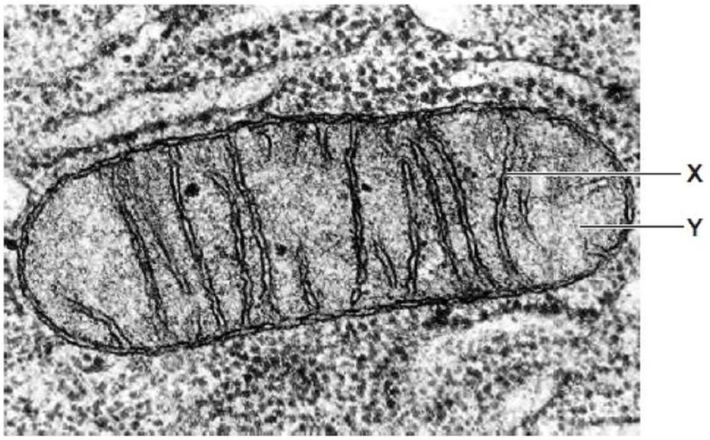


Fig. 8.1

Name **X** and **Y**.

X .....

Y ..... [2]

STEMUP.CO.UK

(b) Fig. 8.2 outlines the early stages of respiration.

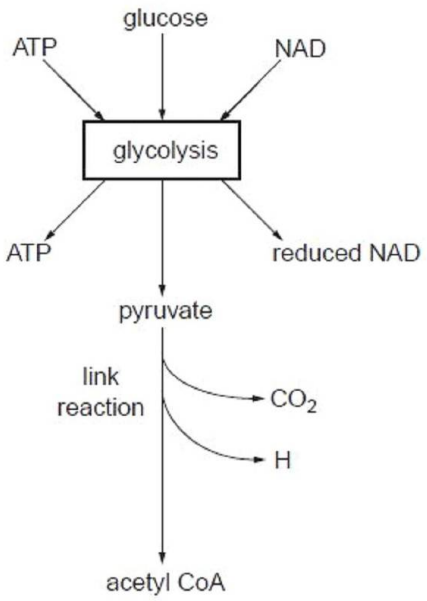


Fig. 8.2

With reference to Fig. 8.2:

(i) explain why ATP is needed at the start of glycolysis

.....

.....

.....

.....[1]

(ii) state the role of NAD in glycolysis

.....

.....

.....[1]

(iii) state how many molecules of ATP are produced from one molecule of glucose during glycolysis

.....[1]

STEMUP.CO.UK

(iv) name the two types of reaction that occur during the conversion of pyruvate to acetyl CoA in the link reaction

1. .....

2. .....[2]

(v) name the location, in the mitochondrion, of the link reaction

.....[1]

(vi) describe what happens to the hydrogen released during the link reaction.

.....

.....

.....

.....

.....

.....[2]

STEMUP.CO.UK

(c) Explain why ATP is regarded as the universal energy currency in organisms.

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....[5]

[Total: 15]

Q24.

STEMUP.CO.UK

8 **(a)** Fig. 8.1 outlines some steps in glucose metabolism in mammalian cells.

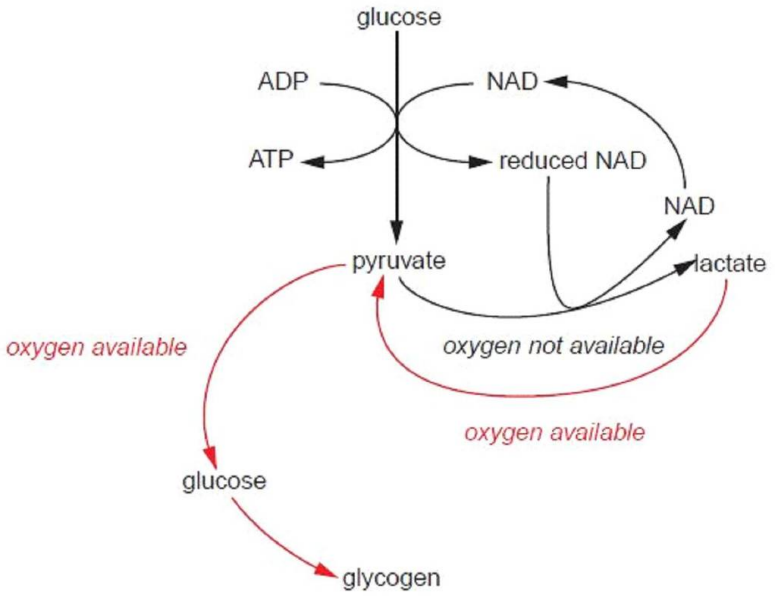


Fig. 8.1

With reference to Fig. 8.1:

(i) name the part of the cell where glucose is converted to pyruvate

.....[1]

(ii) explain why, in the absence of oxygen, pyruvate needs to be converted to lactate

.....

.....

.....

.....

.....[2]

(iii) name the enzyme responsible for the conversion of pyruvate to lactate

.....[1]

(iv) name the type of reaction **and** the type of bonds formed when glucose molecules are used to make glycogen.

reaction .....

bonds .....[2]

STEMUP.CO.UK

(b) Describe how anaerobic respiration in yeast cells differs from anaerobic respiration in mammalian cells.

E

.....

.....

.....

.....

.....

.....

.....

.....

.....[4]

(c) The respiratory quotient (RQ) is used to determine the type of respiratory substrate, such as carbohydrate or lipid, which an organism uses at any one time.

(i) State how the RQ is calculated.

.....

.....

.....

.....[2]

(ii) State the typical RQ values obtained from the respiration of carbohydrates and lipids.

carbohydrate .....

lipid ..... [2]

(iii) Suggest what would happen to the RQ value when respiration becomes anaerobic.

.....[1]

[Total: 15]

Q25.

STEMUP.CO.UK

3 **(a)** The components of a molecule of ATP (adenosine triphosphate) are shown in Fig. 3.1.

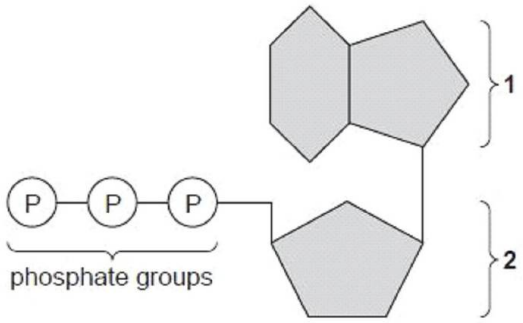


Fig. 3.1

With reference to Fig. 3.1, name components **1** and **2**.

1 .....

2 .....[2]

(b) Describe the consequences for the cell of the following statements.

- Each cell has only a very small quantity of ATP in it at any one time.
- The molecules, ATP, ADP (adenosine diphosphate) or AMP (adenosine monophosphate) **rarely** pass through the cell surface membrane.

.....

.....

.....

.....

.....

.....

.....[2]

STEMUP.CO.UK

(c) Glucose is a respiratory substrate. Table 3.1 shows the yield of ATP from some other substrates.

Table 3.1

respiratory substrate	number of ATP molecules produced per mole of substrate
alanine (an amino acid)	15
glycogen	39
lactate	18
palmitic acid (a fatty acid)	129

(i) Explain the different yields of ATP from glycogen and palmitic acid.

.....

.....

.....

.....[2]

(ii) Describe the circumstances in which alanine and lactate are used as respiratory substrates.

alanine .....

.....

lactate .....

.....[2]

[Total: 8]

Q26.

STEMUP.CO.UK

3 **(a)** Outline the role of oxygen in aerobic respiration.

.....

.....

.....

.....

.....

.....[3]

(b) Table 3.1 shows the results of some measurements of the energy released by different respiratory substrates and the water produced in the process.

Table 3.1

respiratory substrate	energy released / kJ		mass of water produced / g
	per g of substrate	per dm^3 of oxygen consumed	per g of substrate
carbohydrate	17.4	20.9	0.56
lipid	39.3	19.6	1.07
protein	17.8	18.6	0.45

STEMUP.CO.UK

(i) Describe **and** explain the differences in energy released by the three respiratory substrates.

.....

.....

.....

.....

.....

.....

.....

.....[3]

(ii) Suggest why more water is produced from the metabolism of lipid than from the other two substrates.

.....

.....[1]

[Total: 7]

Q27.

STEMUP.CO.UK

2 ATP is the universal energy currency which provides the immediate source of energy for cellular processes.

(a) Fig. 2.1 shows some ways in which ATP may be synthesised and used in cells.

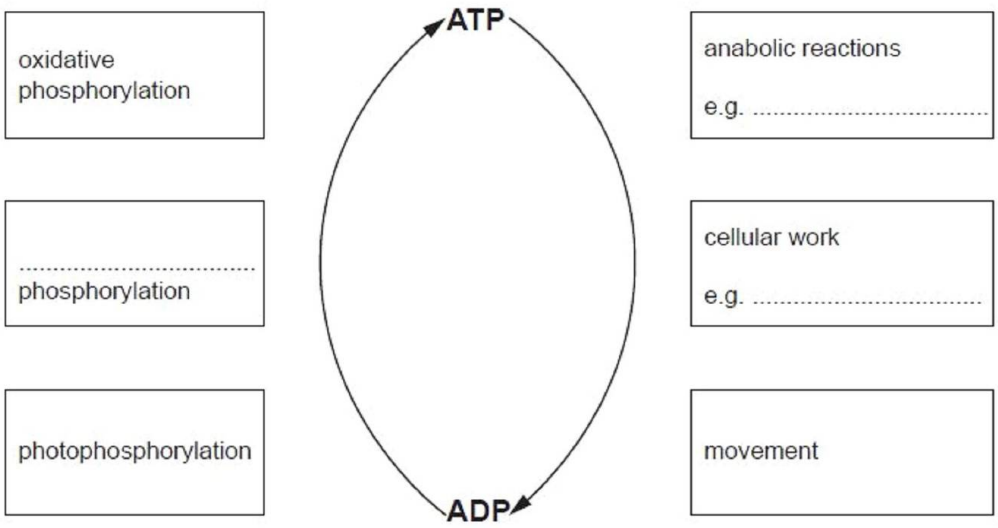


Fig. 2.1

(i) Complete Fig. 2.1 by writing correct terms or examples on the three dotted lines provided. [3]

(ii) Name the molecule that is required to react with ATP in order to convert ATP into ADP and an inorganic phosphate.

..... [1]

(iii) Name the membrane-bound enzyme responsible for phosphorylating ADP to make ATP.

..... [1]

Q28.

STEMUP.CO.UK

8 (a) A mitochondrion contains DNA and ribosomes and is the organelle in which aerobic respiration takes place.

Suggest the functions of the DNA and ribosomes **in a mitochondrion**.

.....

.....

.....

.....

.....

.....

.....

.....[3]

(b) Oxidative phosphorylation takes place in the mitochondrion.

Different stages of oxidative phosphorylation are listed below.

They are **not** listed in the correct order.

stage	description of stage
Q	protons diffuse through the channel protein into the matrix
R	a proton gradient is set up across the crista
S	hydrogen atoms split into protons and electrons
T	protons combine with electrons and oxygen atoms to form water
U	electrons are passed from carrier to carrier
V	reduced NAD releases hydrogen atoms to cytochrome carriers
W	energy from electron transfer is used to pump protons into the intermembrane space
X	ATP synthase produces ATP

Complete Table 8.1 to show the correct order of the stages.

Two of the stages have been done for you.

STEMUP.CO.UK

Table 8.1

correct order	letter of stage
1	V
2	.....
3	.....
4	.....
5	R
6	.....
7	.....
8	.....

[4]

(c) ATP can be converted to ADP and inorganic phosphate by the enzyme ATPase.

State the **type** of reaction taking place.

..... [1]

(d) Some parasitic worms, such as tapeworms, live in a mammalian gut where there is no oxygen.

Suggest how a tapeworm produces ATP in this environment.

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....[5]

[Total: 13]

Q29.

STEMUP.CO.UK

8 Adipose tissue is specialised connective tissue that functions as the major storage site for fat in the form of triglycerides.
The human body contains two types of adipose tissue:
white adipose tissue (WAT) and brown adipose tissue (BAT).

- WAT is more common and is found under the skin and around some internal organs.
- BAT is found in infants around the back and shoulders.
- BAT is also found in adults but in relatively smaller quantities.
- BAT cells contains more mitochondria than WAT cells.
- BAT is involved in the maintenance of a constant blood temperature when the external environment is cold.

(a) (i) Blood temperature in humans is maintained by a process called homeostasis.

With reference to blood temperature, outline the main principles of homeostasis.

.....

.....

.....

.....

.....

.....

.....

.....

.....[4]

(ii) Suggest why infants have relatively more BAT than adults.

.....

.....

.....

.....

.....[2]

STEMUP.CO.UK

(b) Mitochondria in BAT cells function differently from those in other cells during periods of cold environmental conditions.

Fig. 8.1 shows part of a mitochondrion in a BAT cell.

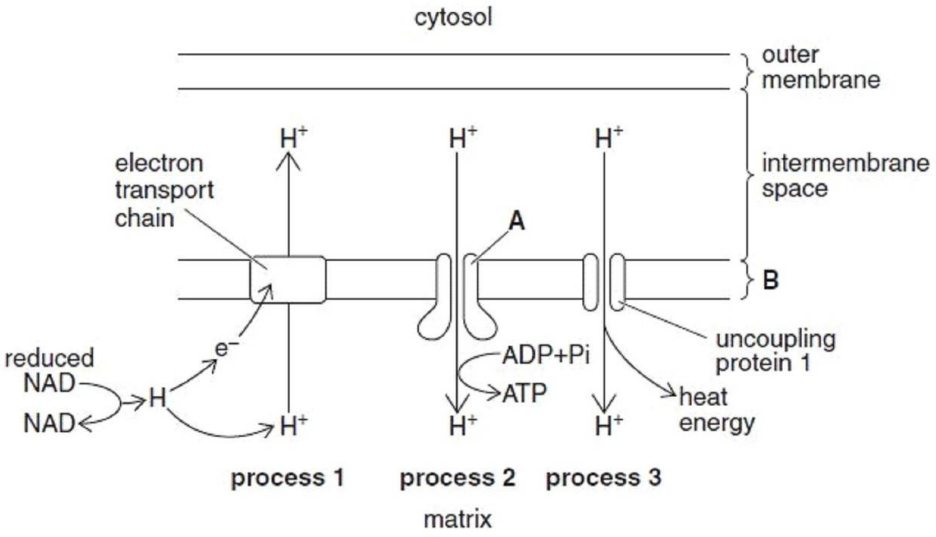


Fig. 8.1

(i) Name structures **A** and **B**.

A .....

B ..... [2]

(ii) Draw an arrow on Fig. 8.1 to indicate the direction of the proton gradient that exists between the matrix and the intermembrane space. [1]

(iii) State the **two** processes, shown in Fig. 8.1, that will be more active during periods of cold external environmental conditions.

.....[1]

(iv) State the by-product that is obtained as a result of processes **1** and **2**.

.....[1]

(v) Suggest the main respiratory substrate for BAT cells.

.....[1]

[Total: 12]

Q30.

STEMUP.CO.UK

5 (a) Fig. 5.1 shows the structure of an ATP molecule.

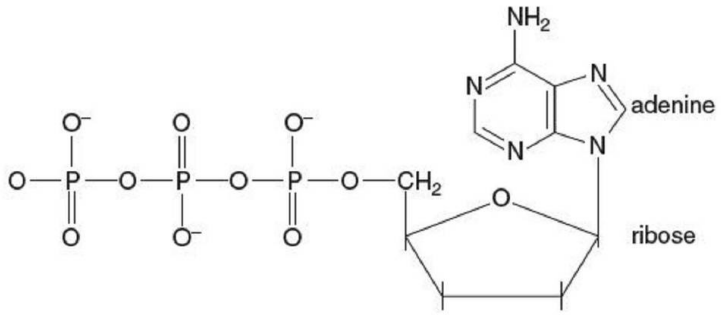


Fig. 5.1

State two ways in which the structure of ATP differs from the structure of an adenine nucleotide in a DNA molecule.

1. .....

.....

2. .....

.....[2]

(b) In respiration, energy from various substrates is used to synthesise ATP.

(i) Explain why less ATP can be synthesised from the same mass of glucose in anaerobic respiration than in aerobic respiration.

.....

.....

.....

.....

.....

.....

.....

.....[3]

STEMUP.CO.UK

(ii) Explain why more ATP can be synthesised in aerobic respiration from one gram of lipid than from one gram of glucose.

.....

.....

.....

.....

.....

.....

.....[3]

[Total: 8]

Q31.

4 (a) All living organisms require a continuous supply of energy.

Outline the need for energy in living organisms.

.....

.....

.....

.....

.....

.....[2]

(b) Fig. 4.1 is a diagram of ATP.

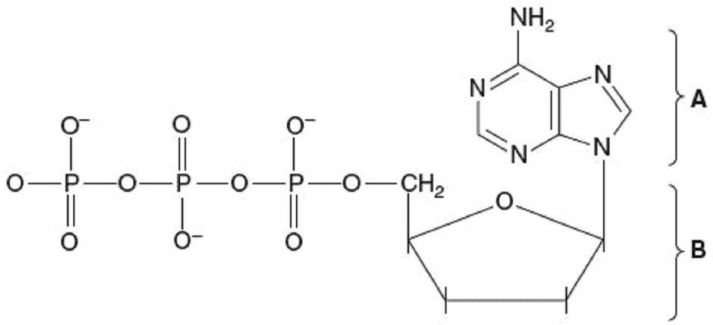


Fig. 4.1

STEMUP.CO.UK

(i) Name **A** and **B**.

A .....

B ..... [1]

(ii) Describe how the structure of ATP is related to its role as energy currency.

.....

.....

.....

.....

.....

.....

.....[3]

(c) *Thermus thermophilus* is a bacterium found in geothermal environments, such as hot springs. The bacterium respires **aerobically**, even though at high temperatures the solubility of oxygen in water is low.

(i) Explain how **aerobic** respiration may be affected by a decrease in oxygen availability.

.....

.....

.....

.....

.....

.....[2]

(ii) One strain of *T. thermophilus*, HB8, has an enzyme, nitrate reductase, which allows nitrate to be used as the final electron acceptor in the electron transport chain (ETC).

Suggest an advantage to the bacterium of this adaptation.

.....

.....[1]

STEMUP.CO.UK

(d) A mutant strain of HB8 (HB8 mutant) was made by adding an insertion mutation to the gene that codes for the enzyme nitrate reductase.

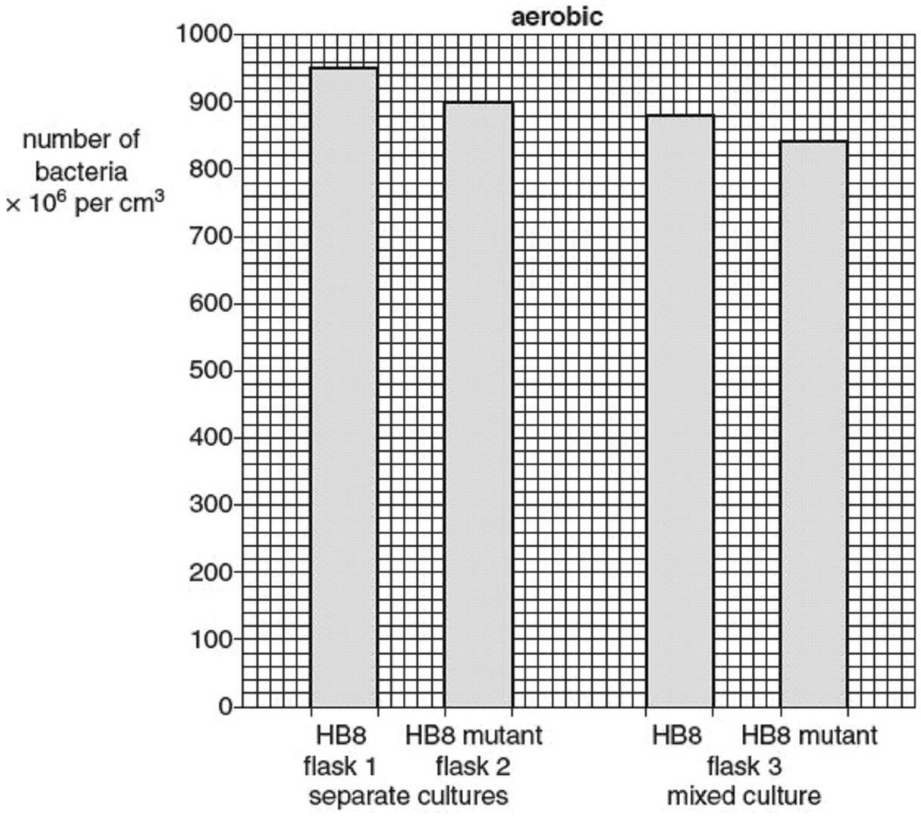
An investigation was carried out into population growth of HB8 and of HB8 mutant in aerobic and in anaerobic conditions. In each experiment, a flask containing bacterial culture medium was incubated. Table 4.1 shows how the flasks were set up.

The number of bacteria of each strain per cm^3 was calculated after 20 hours.

Table 4.1

flask	bacteria	conditions
1	HB8	aerobic
2	HB8 mutant	aerobic
3	HB8 and HB8 mutant	aerobic
4	HB8	anaerobic
5	HB8 mutant	anaerobic
6	HB8 and HB8 mutant	anaerobic

The results are shown in Fig. 4.2.



STEMUP.CO.UK

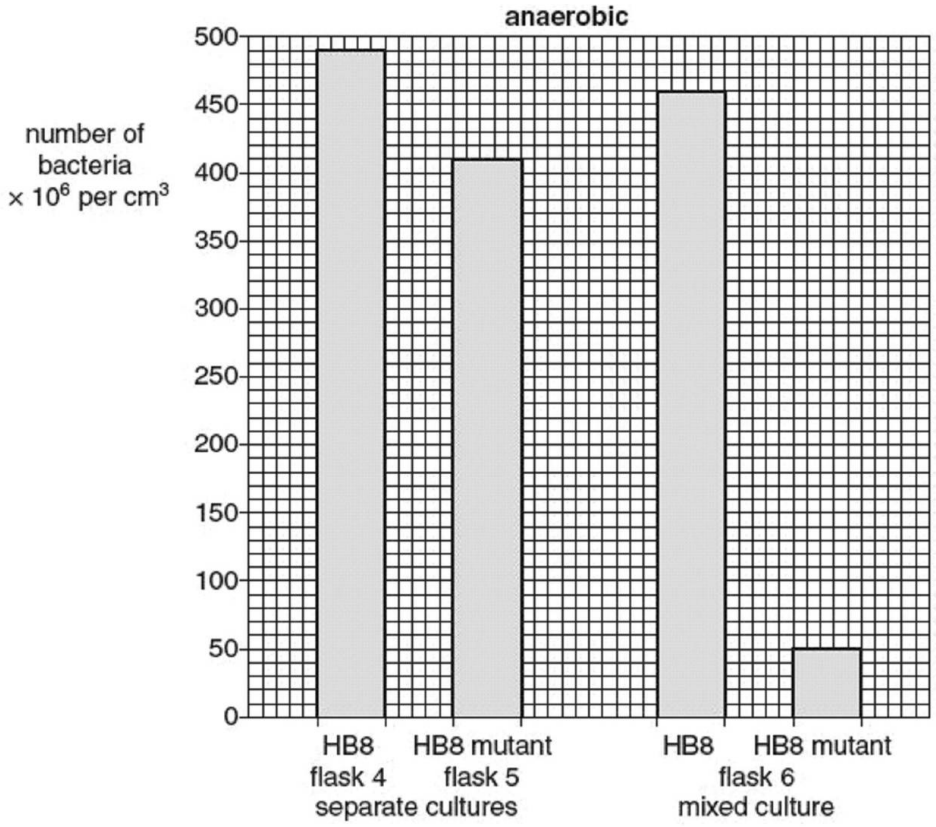


Fig. 4.2

(i) Compare the growth of the two strains of bacteria in aerobic and anaerobic conditions in **separate** cultures.

.....

.....

.....

.....

.....[2]

(ii) Compare the growth of the two strains of bacteria in aerobic and anaerobic conditions in **mixed** cultures.

.....

.....

.....

.....

.....[2]

STEMUP.CO.UK

(iii) Suggest an explanation for the results shown in flask 6.

.....

.....

.....[1]

[Total: 14]

Section B

1.

9 **(a)** Describe the process of oxidative phosphorylation in the mitochondrion. [9]

(b) Explain the roles of NAD in anaerobic respiration in **both** plants and animals. [6]

[Total: 15]

2.

9 **(a)** Describe how ATP is synthesised by oxidative phosphorylation. [8]

(b) Using examples, outline the need for energy in living organisms. [7]

[Total: 15]

3.

9 **(a)** Explain the role of ATP in active transport of ions **and** in named anabolic reactions. [7]

(b) Outline the process of anaerobic respiration in both mammal and yeast cells. [8]

[Total: 15]

4.

6 **(a)** Describe the main features of the Krebs Cycle. [9]

(b) Explain the role of NAD in aerobic respiration. [6]

5.

STEMUP.CO.UK

7 **(a)** Describe the transfer of light energy to chemical energy in ATP during photosynthesis. [6]

(b) Describe the process of oxidative phosphorylation. [9]

[Total: 15]

6.

9 **(a)** Describe the process of glycolysis. [7]

(b) Describe the structure and synthesis of ATP **and** its universal role as the energy currency in all living organisms. [8]

[Total: 15]

7.

9 **(a)** Outline the main features of the Krebs cycle. [9]

(b) Explain the role of NAD in aerobic respiration. [6]

[Total: 15]

8.

10 **(a)** Outline the need for energy in living organisms using named examples. [9]

(b) Explain the different energy values of carbohydrate, lipid and protein as respiratory substrates. [6]

[Total: 15]

9.

10 **(a)** Describe the structure of ATP and the role of ATP as the energy currency in all living organisms. [8]

(b) Outline anaerobic respiration in mammalian cells and describe how it differs from anaerobic respiration in yeast cells. [7]

[Total: 15]

10.

STEMUP.CO.UK

11 **(a)** Describe the main features of an organism belonging to the plant kingdom. [7]

(b) Describe the structure of a mitochondrion and outline its function in a plant cell. [8]

[Total: 15]

STEMUP.CO.UK

1. Nov/2018/Paper_41/No.6

(a) Fig. 6.1 outlines some of the steps of glycolysis.

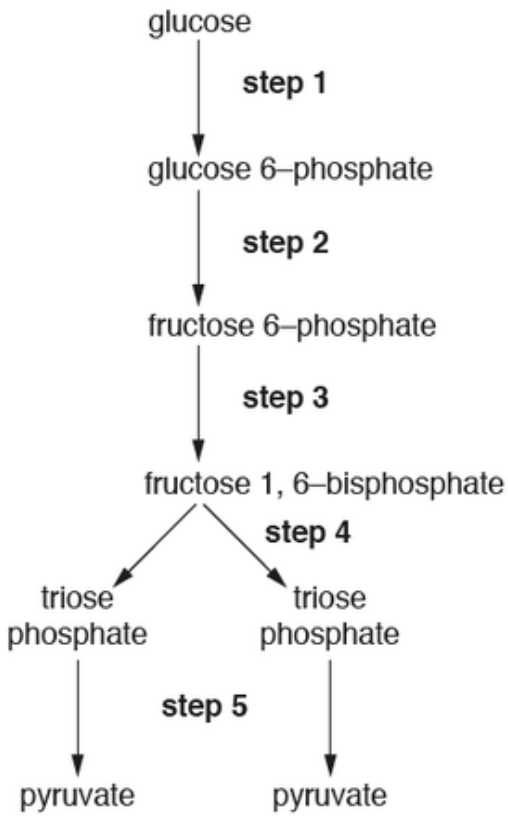


Fig. 6.1

(i) State the precise location of glycolysis in the cell.

..... [1]

(ii) With reference to Fig. 6.1:

state the steps where phosphorylation occurs

.....

state the step where oxidation occurs

.....

name the type of reaction by which ATP is made during **step 5**.

.....

[3]

STEMUP.CO.UK

(b) Some cancer cells have different metabolic requirements from normal cells. These cancer cells obtain most of their ATP from glycolysis, even if oxygen is available.

State how the glucose and oxygen requirements of these cancer cells differ from normal cells.

.....

.....

.....

.....

.....

..... [2]

[Total: 6]

STEMUP.CO.UK

1. Nov/2019/Paper_41/No.10

(a) Describe the features of ATP that make it suitable for its role as the universal energy currency of cells. [6]

(b) Describe how you would carry out an investigation on the effect of temperature on the rate of respiration of yeast in anaerobic conditions using a redox indicator, such as methylene blue. [9]

[Total: 15]

2. Nov/2019/Paper_42/No.8

The passage below outlines the process of oxidative phosphorylation in mitochondria.

Complete the passage by using the most appropriate scientific terms.

Reduced ..... releases hydrogen atoms to cytochrome carriers.

Hydrogen atoms split into protons and electrons and the electrons are passed from carrier to carrier. Energy from electron transfer is used to pump protons into the

..... , so that a proton gradient is set up across the

..... .

Protons ..... through the channel protein known as

..... , into the matrix, producing ATP. The protons combine with electrons and ..... atoms to form water.

[Total: 6]

STEMUP.CO.UK

3. Nov/2019/Paper_42/No.10

(a) Describe the features of ATP that make it suitable for its role as the universal energy currency of cells. [6]

(b) Describe how you would carry out an investigation on the effect of temperature on the rate of respiration of yeast in anaerobic conditions using a redox indicator, such as methylene blue. [9]

[Total: 15]

STEMUP.CO.UK

4. Nov/2019/Paper_43/No.8

The passage below outlines the structure of the mitochondrion.

Complete the passage by using the most appropriate scientific term(s).

The mitochondrion is found in eukaryotic cells. It is bound by a double membrane.

The outer membrane is permeable to pyruvate, which is the main product of

..... .

The inner membrane is folded to form ..... ,

which increase the surface area of the membrane. Embedded in the inner membrane are the carrier proteins of the electron transport chain and the protein complex responsible for ATP production, known as ..... .

Electron flow leads to the build-up of a large concentration of ..... in the intermembrane space due to the activity of the electron transport chain. The ..... of the mitochondrion, which contains enzymes, is the site of the link reaction and the ..... .

[6]

STEMUP.CO.UK

5. Nov/2019/Paper_43/No.7(a, b)

(a) Gibberellin is involved in the germination of barley seeds.

In an investigation, aleurone layers from barley seeds were extracted. One sample was treated with gibberellin and the other sample was given no gibberellin treatment. The rate of production of amylase enzyme by the aleurone layers was measured over 15 hours.

The results are shown in Fig. 7.1.

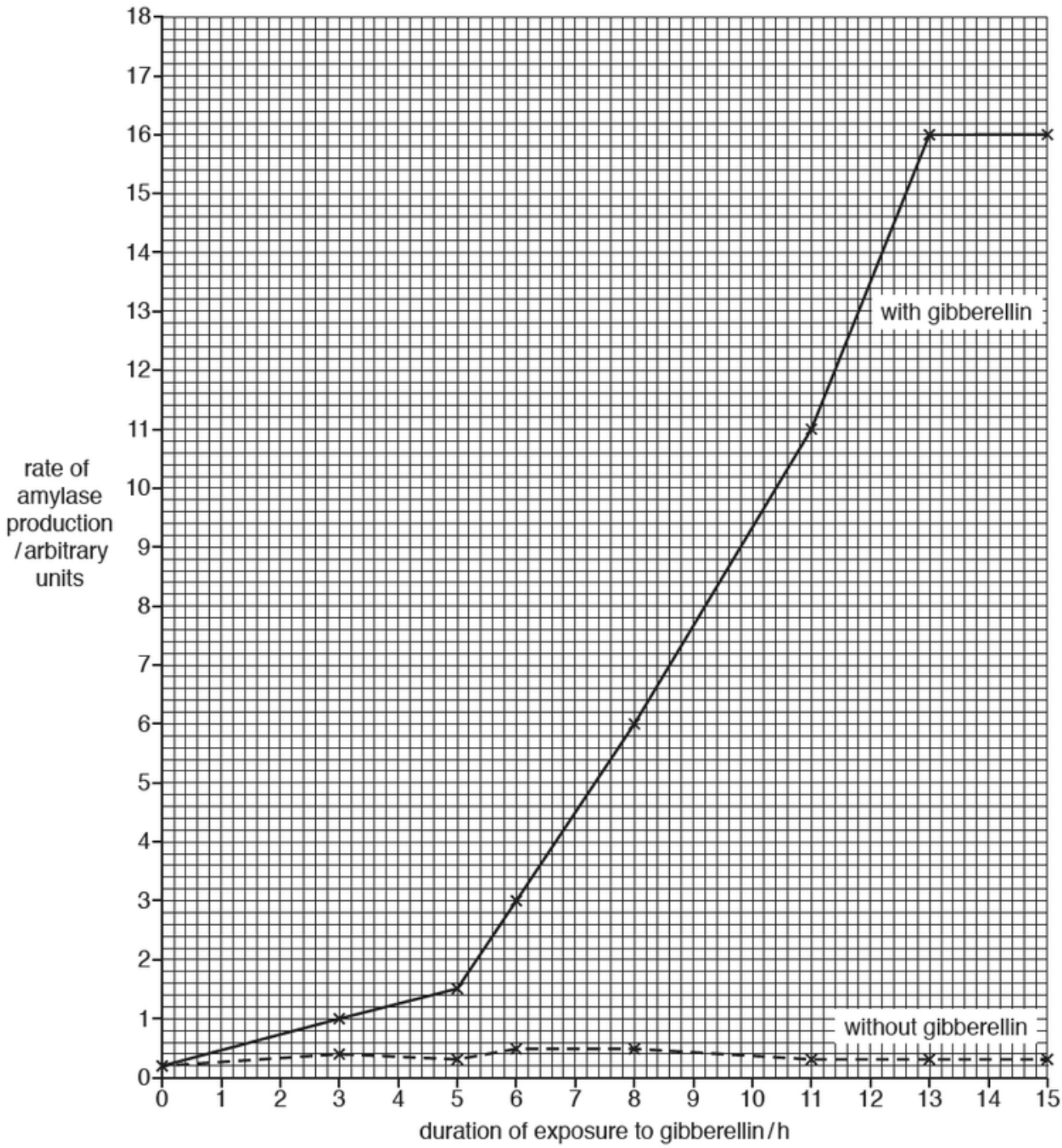


Fig. 7.1

STEMUP.CO.UK

Describe the results shown in Fig. 7.1.

.....

.....

.....

.....

.....

.....

..... [3]

(b) Explain why the aleurone layers of barley seeds need to produce amylase during germination.

.....

.....

.....

.....

.....

..... [3]

STEMUP.CO.UK

6. June/2019/Paper_41/No.4

(a) The link reaction and Krebs cycle take place in the mitochondrion.

The main stages of the link reaction and Krebs cycle are listed in Table 4.1.

They are **not** listed in the correct order.

Table 4.1

stage	description of stage
A	acetyl group combines with coenzyme A to form acetyl CoA
B	citrate is formed
C	hydrogen atoms are accepted by NAD and FAD
D	oxaloacetate is regenerated
E	pyruvate enters the mitochondrial matrix
F	acetyl group is formed
G	acetyl CoA enters Krebs cycle
H	ATP is made by substrate-linked phosphorylation
I	pyruvate is decarboxylated and dehydrogenated
J	acetyl CoA combines with oxaloacetate
K	citrate is decarboxylated and dehydrogenated

STEMUP.CO.UK

Complete Table 4.2 to show the correct order of the stages.

Three of the stages have been done for you.

Table 4.2

correct order	letter of stage
1	**E**
2	.....
3	.....
4	.....
5	.....
6	**J**
7	.....
8	.....
9	.....
10	.....
11	**D**

[4]

(b) Outline the role of NAD in respiration in aerobic conditions.

.....

.....

.....

.....

.....

.....

.....

.....

..... [4]

STEMUP.CO.UK

(c) Carbon dioxide is removed from compounds in the link reaction and Krebs cycle by decarboxylation.

(i) State the total number of molecules of carbon dioxide removed in the link reaction and Krebs cycle for each molecule of glucose respired.

..... [1]

(ii) In a mammal, carbon dioxide diffuses from cells into the blood to be transported to the lungs.

Suggest why carbon dioxide is transported in the blood mainly as hydrogen carbonate ions and not as carbonic acid.

..... [1]

[Total: 10]

STEMUP.CO.UK

7. June/2019/Paper_42/No.8

(a) Oxidative phosphorylation takes place in the mitochondrion.

Table 8.1 shows the different stages of oxidative phosphorylation.

The stages are **not** listed in the correct order.

Table 8.1

stage	description of stage
Q	protons diffuse through the membrane proteins into the matrix
R	a proton gradient is set up across the crista membrane
S	hydrogen atoms split into protons and electrons
T	protons combine with electrons and oxygen atoms to form water
U	electrons are passed from carrier to carrier
V	reduced NAD releases hydrogen atoms to cytochrome carriers
W	energy from electron transfer is used to pump protons into the intermembrane space
X	ATP synthase produces ATP

Complete Table 8.2 to show the correct order of the stages.

Two of the stages have been completed for you.

Table 8.2

correct order	letter of stage
1	**V**
2	.....
3	.....
4	.....
5	**R**
6	.....
7	.....
8	.....

[4]

STEMUP.CO.UK

(b) State the precise location in a mitochondrion of each of the following.

ATP synthase .....

Krebs cycle .....

electron transport chain .....

coenzyme A .....

pyruvate .....

[5]

[Total: 9]

STEMUP.CO.UK

8. June/2019/Paper_42/No.9(a)

(a) Describe how you would carry out an investigation into the effect of temperature on the rate of photosynthesis of an aquatic plant. [8]

STEMUP.CO.UK

9. June/2019/Paper_43/No.8

(a) Table 8.1 shows some of the stages of glycolysis and respiration in anaerobic conditions in yeast.

The stages are **not** listed in the correct order.

Table 8.1

stage	description of stage
A	triose phosphate is dehydrogenated by NAD
B	pyruvate is decarboxylated
C	ethanal is formed
D	ethanol is formed
E	glucose is phosphorylated by ATP
F	pyruvate is formed
G	ethanal is reduced by alcohol dehydrogenase
H	fructose bisphosphate is formed
I	ATP is made by substrate-linked phosphorylation

Complete Table 8.2 to show the correct order of the stages.

One stage has been completed for you.

Table 8.2

correct order	letter of stage
1	.....
2	.....
3	.....
4	.....
5	**F**
6	.....
7	.....
8	.....
9	.....

[4]

(b) Yeast respires glucose in aerobic and anaerobic conditions.

Explain why less ATP is produced when yeast respires in anaerobic conditions compared to when yeast respires in aerobic conditions.

.....

.....

.....

.....

.....

.....

.....

.....

.....

..... [5]

[Total: 9]

STEMUP.CO.UK

10. June/2019/Paper_43/No.10

(a) Describe how ATP is synthesised by oxidative phosphorylation. [8]

(b) Describe how you would carry out an investigation, using a simple respirometer, to measure the effect of temperature on the respiration rate of insect larvae. [7]

[Total: 15]

STEMUP.CO.UK

11. Feb/2019/Paper_42/No.7

(a) Isolated mitochondria were used to investigate respiration.

- Mitochondria were extracted from respiring mammalian cells and incubated in a buffer solution.
- Pyruvate and inorganic phosphate (Pi) were added at time zero.
- ADP was added one minute later.
- The oxygen concentration of the buffer solution containing mitochondria was monitored throughout the investigation.

The results of the investigation are shown in Fig. 7.1.

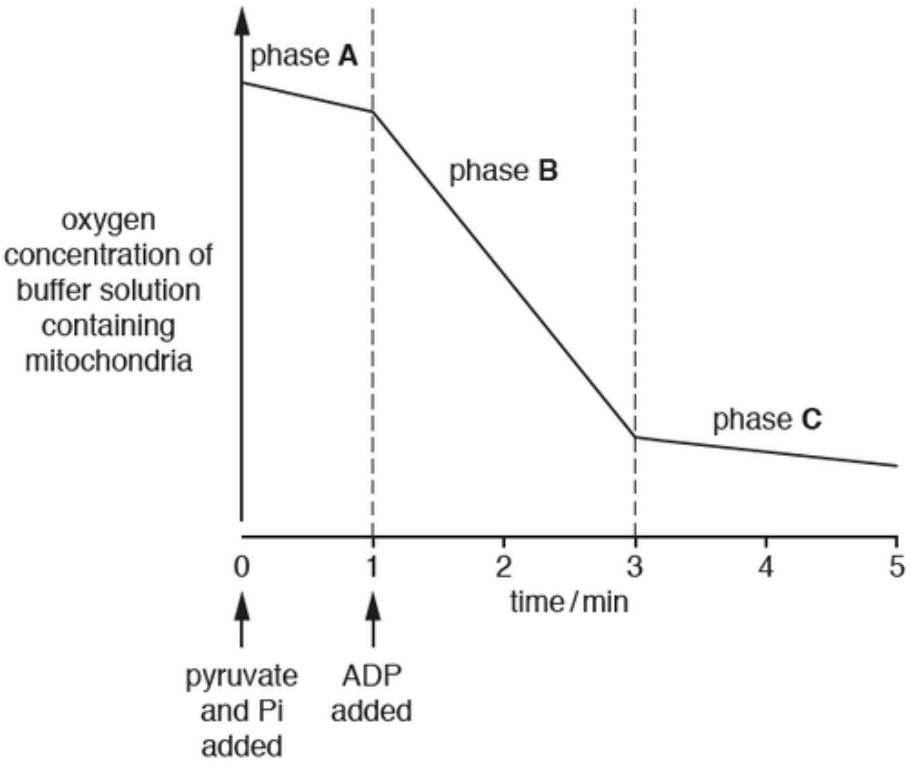


Fig. 7.1

(i) Suggest why the line of the graph in Fig. 7.1 is steeper during phase **B** than during phase **A**.

.....

.....

.....

.....

.....

..... [3]

STEMUP.CO.UK

(ii) Suggest why the line of the graph starts to level out in phase **C**.

.....

..... [1]

STEMUP.CO.UK

(b) Some plants, such as rice, grow with their roots submerged in water.

Fig. 7.2 shows a group of rice plants.



Fig. 7.2

Explain how rice is adapted to grow with its roots submerged in water.

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

..... [5]

STEMUP.CO.UK

1. Nov/2021/Paper_41/No.6

(a) Cotton, *Gossypium hirsutum*, and false flax, *Camelina sativa*, are crop plants that are grown in different parts of the world.

Rubisco activase is an enzyme in the stroma of chloroplasts that is needed to maintain the activity of a second enzyme, rubisco.

Scientists measured the activity of rubisco activase in cotton and in false flax at a range of temperatures.

Fig. 2.1 shows the results.

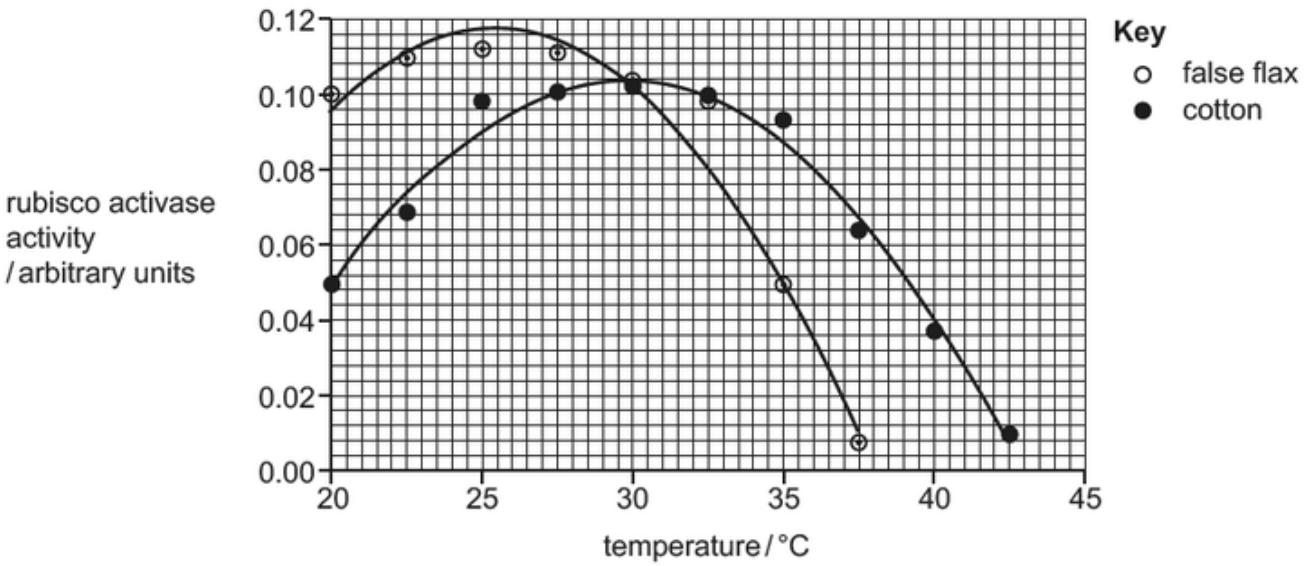


Fig. 2.1

(i) With reference to Fig. 2.1, compare the results obtained for cotton and false flax.

.....

.....

.....

.....

.....

.....

.....

.....

.....

..... [4]

STEMUP.CO.UK

(ii) Suggest reasons for the differences shown in Fig. 2.1.

.....

.....

.....

.....

.....

.....

..... [3]

(b) Rubisco enzymes from cotton and false flax are active at temperatures up to 45 °C and will denature at 45 °C.

Explain how the Calvin cycle is affected when rubisco denatures.

.....

.....

.....

.....

.....

.....

..... [3]

(c) One goal of genetic engineering is to make crops that are heat tolerant. This means that crops can grow and produce a good yield at high environmental temperatures.

Use the information given in Question 2 to suggest **and** explain a way to improve the tolerance of a crop to high temperatures.

.....

.....

.....

.....

.....

.....

..... [2]

[Total: 12]

STEMUP.CO.UK

2. Nov/2021/Paper_42/No.2

Scientists are researching new ways to reduce the global atmospheric carbon dioxide (CO_2) concentration. There are concerns that an increasing atmospheric CO_2 concentration may lead to effects that decrease biodiversity.

(a) Give **one** example of a human activity, other than deforestation, that contributes greatly to the increase in global atmospheric CO_2 concentration.

..... [1]

Algae are aquatic photosynthetic protoctists. Some researchers genetically modified the unicellular alga, *Chlorella vulgaris*, to try to increase the rate of the light independent stage of photosynthesis.

C. vulgaris was modified to increase the expression of the gene coding for aldolase. Aldolase is an enzyme that causes an increase in the concentration of rubisco.

Two cultures of *C. vulgaris*, one that was not genetically modified (unmodified) and one genetically modified, were grown under controlled conditions for 14 days. Samples were taken from the cultures at regular intervals during the 14 days to obtain measurements of dry mass.

The results are shown in Fig. 2.1.

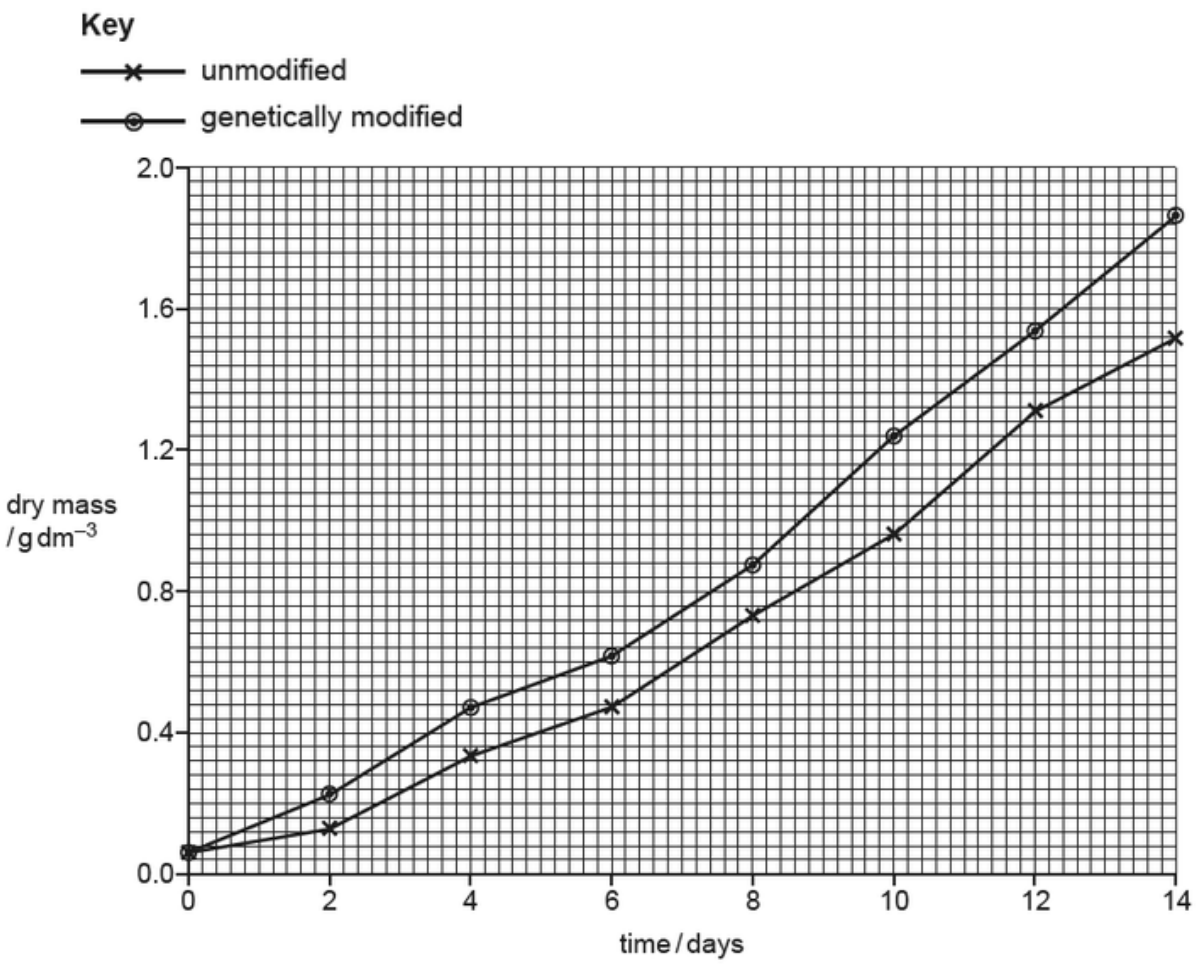


Fig. 2.1

STEMUP.CO.UK

(b) With reference to Fig. 2.1, describe the differences between the results for the two cultures.

.....

.....

.....

.....

.....

..... [3]

(c) Explain how the Calvin cycle was affected by the genetic modification of *C. vulgaris*.

.....

.....

.....

.....

.....

..... [3]

(d) Intermediate products of the Calvin cycle are needed to produce organic molecules for use by the cell.

Describe how these organic molecules are used by cells.

.....

.....

.....

.....

.....

..... [3]

(e) Planting large numbers of trees is one way to reduce global atmospheric CO_2 concentration. Large scale culture of genetically modified *C. vulgaris* could also reduce global atmospheric CO_2 concentration.

Suggest **one** advantage of using genetically modified *C. vulgaris* instead of trees to reduce global atmospheric CO_2 concentration.

.....

..... [1]

[Total: 11]

STEMUP.CO.UK

3. Nov/2021/Paper_42/No.6

(a) ATP is needed for many metabolic processes in living organisms.

(i) Describe the properties of ATP that make it suitable for its role as the universal energy currency.

.....

.....

.....

.....

.....

.....

.....

..... [4]

(ii) Suggest why ATP is needed for protein synthesis.

.....

.....

.....

.....

..... [2]

(b) Fig. 6.1 is a diagram of mitochondrion.

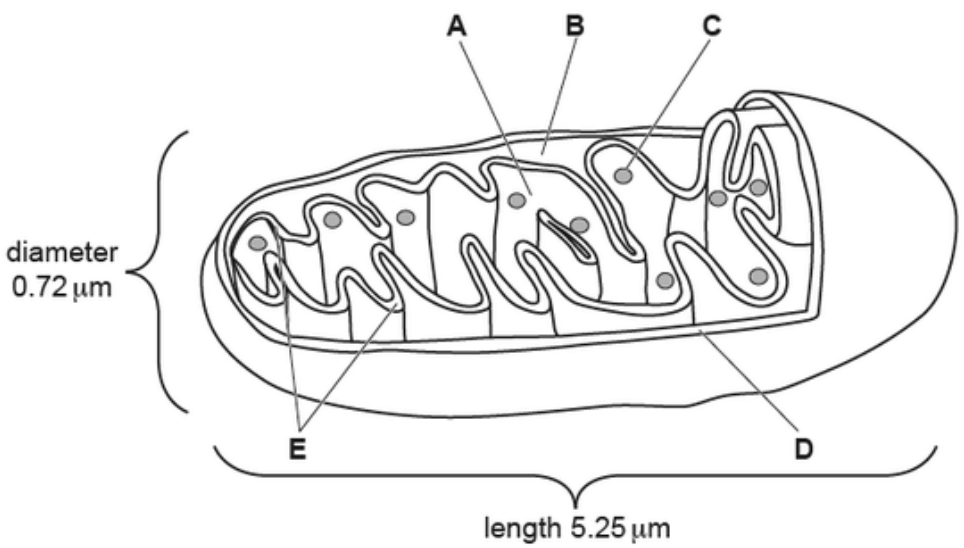


Fig. 6.1

STEMUP.CO.UK

(i) Complete Table 6.1 using the letters **A** to **E** from Fig. 6.1.

Each letter may be used once, more than once, or not at all.

Table 6.1

statement	letter
the site of the Krebs Cycle	.....
a phospholipid bilayer impermeable to H^+ ions	.....
the site of translation	.....

[2]

(ii) Assume that the mitochondrion in Fig. 6.1 is a cylinder.

Calculate the surface area of this mitochondrion.

Use the formula: Surface area of cylinder = $2\pi r^2 + 2\pi rh$

Show your working.

surface area = ... μm^2 [2]

(iii) The inner membrane of the mitochondrion has a much larger surface area than the outer membrane because of the presence of cristae.

Different cell types vary in the number of cristae present per mitochondrion. Cardiac muscle cells have mitochondria with a very large number of cristae.

Suggest **and** explain why cardiac muscle cells have mitochondria with very large numbers of cristae.

.....

.....

.....

.....

..... [2]

[Total: 12]

STEMUP.CO.UK

1. June/2022/Paper_41/No.3

Respiration is a process that results in the synthesis of ATP. The ATP can be used within the cell for energy-requiring reactions and processes.

There are four stages in aerobic respiration: glycolysis, the link reaction, the Krebs cycle and oxidative phosphorylation.

(a) The ATP synthesised in respiration can be used to make larger and more complex biological molecules from smaller molecules.

Name the type of reaction that occurs when larger more complex biological molecules are made from smaller molecules.

..... [1]

(b) The first part of glycolysis uses ATP.

Explain why ATP is needed in the first part of glycolysis.

.....

.....

.....

.....

..... [2]

(c) State the precise locations of substrate-linked phosphorylation reactions in aerobic respiration.

.....

..... [1]

(d) Explain what happens to pyruvate in the link reaction in aerobic respiration.

.....

.....

.....

.....

..... [2]

(e) Chemiosmosis is a process that occurs in mitochondria during aerobic respiration and in chloroplasts during photosynthesis.

Describe the differences between the process of chemiosmosis in mitochondria and the process of chemiosmosis in chloroplasts.

.....

.....

.....

.....

.....

.....

.....

..... [3]

[Total: 9]

STEMUP.CO.UK

2. June/2022/Paper_42/No.3

Aerobic respiration occurs when oxygen is available. A much greater energy yield is obtained from aerobic respiration than from respiration in anaerobic conditions.

(a) Explain why the link reaction only occurs when oxygen is available.

.....

.....

.....

.....

.....

.....

.....

.....

..... [4]

(b) Outline the stage of aerobic respiration that occurs in the cytoplasm of eukaryotic cells.

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

..... [5]

[Total: 9]

STEMUP.CO.UK

3. June/2022/Paper_43/No.3

(a) ATP is synthesised from ADP and P_i in a phosphorylation reaction.

State the **two** different ways in which this phosphorylation reaction occurs in aerobic respiration.

.....

..... [2]

(b) Coenzymes are important in all four stages of aerobic respiration.

Describe **and** explain the role of the coenzymes NAD and FAD in aerobic respiration.

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

..... [6]

STEMUP.CO.UK

(c) The enzyme pyruvate dehydrogenase catalyses the link reaction. Pyruvate dehydrogenase is inhibited when the ratio of acetyl coenzyme A to coenzyme A increases.

Suggest the importance of this inhibition to the functioning of the cell.

.....

.....

.....

.....

..... [2]

[Total: 10]

STEMUP.CO.UK

1. Nov/2022/Paper_41/No.3

(a) The results of investigations carried out on mitochondria show how the structure of a mitochondrion is related to its role in aerobic respiration.

- Intact mitochondria (not damaged) were removed from cells.
- A technique was used to remove the outer mitochondrial membrane, leaving the inner membrane intact.
- The inner mitochondrial membrane was separated from the contents of the matrix so that both could be analysed.

(i) The removal of the outer membranes of mitochondria involves placing the organelles in pure water. This results in the rupture (bursting) of the outer membrane. The inner mitochondrial membrane does not rupture and remains intact.

Suggest **and** explain why the inner membrane of a mitochondrion remains intact when the organelle is placed in pure water.

.....

.....

.....

.....

..... [2]

(ii) Name **three** molecules, other than coenzymes, that are found in the mitochondrial matrix **and** explain their role in aerobic respiration.

.....

.....

.....

.....

.....

.....

..... [3]

(iii) The inner membrane contains a very high proportion of the molecule cardiolipin. Cardiolipin makes the membrane impermeable to some ions.

Suggest why the inner membrane contains a very high proportion of cardiolipin.

.....

.....

..... [1]

STEMUP.CO.UK

(b) In further experiments it was found that, in an intact mitochondrion:

- there is a membrane potential across the inner mitochondrial membrane, with the matrix having a negative charge
- the transport of ATP, ADP and inorganic phosphate (P_i) is driven by the membrane potential across the inner membrane.

Fig. 3.1 shows the location of some inner membrane carrier proteins.

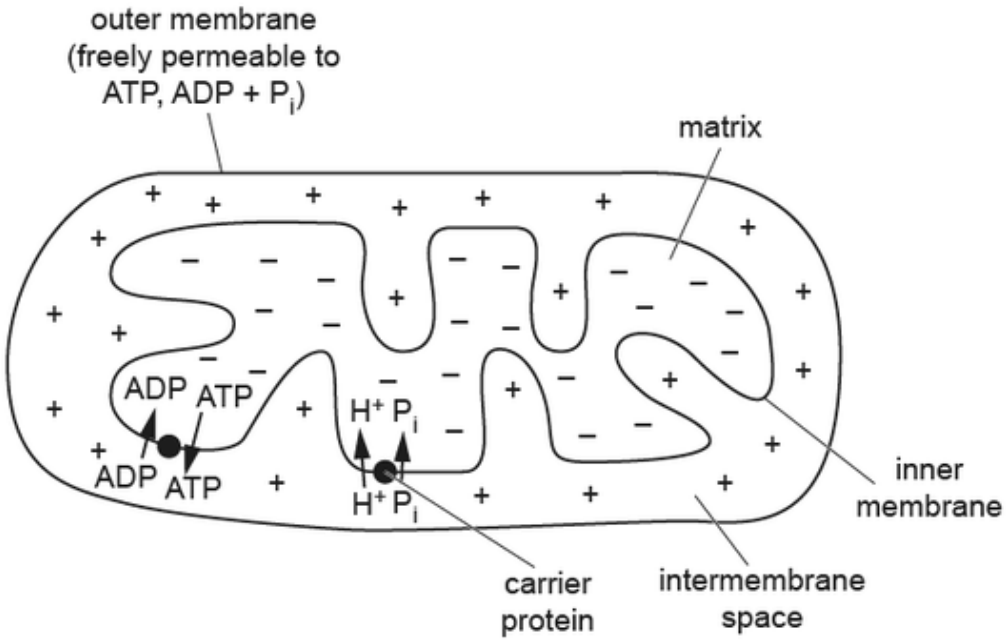


Fig. 3.1

(i) Reduced NAD and reduced FAD transfer hydrogen atoms to carriers located in the inner mitochondrial membrane.

Explain how hydrogen atoms from reduced NAD and reduced FAD lead to a membrane potential forming across the inner mitochondrial membrane during oxidative phosphorylation.

.....

.....

.....

.....

.....

.....

.....

..... [4]

STEMUP.CO.UK

(ii) Suggest **and** explain how P_i is transported across the inner membrane of the mitochondrion into the matrix.

.....

.....

.....

.....

..... [2]

(iii) Suggest the advantages of linking ATP transport to ADP transport across the inner membrane of the mitochondrion.

.....

.....

.....

.....

..... [2]

[Total: 14]

STEMUP.CO.UK

2. Nov/2022/Paper_42/No.2

Yeast cells can respire in anaerobic conditions.

(a) (i) Outline how yeast carries out respiration in anaerobic conditions.

.....

.....

.....

.....

.....

.....

.....

.....

..... [4]

(ii) Explain why respiration in anaerobic conditions is an advantage to yeast.

.....

.....

.....

.....

..... [2]

Bioethanol is a type of biofuel produced from maize starch on an industrial scale. In the high temperature method, heating to 120 °C is used to break apart starch molecules. The enzymes α-amylase and glucoamylase are added to the resulting starch suspension once it has cooled down. These enzymes hydrolyse the starch to glucose. Yeast cells are then added and maintained in anaerobic conditions to produce ethanol.

The high temperature method is expensive to carry out, so a new method has been developed which heats starch to a lower temperature of 80 °C.

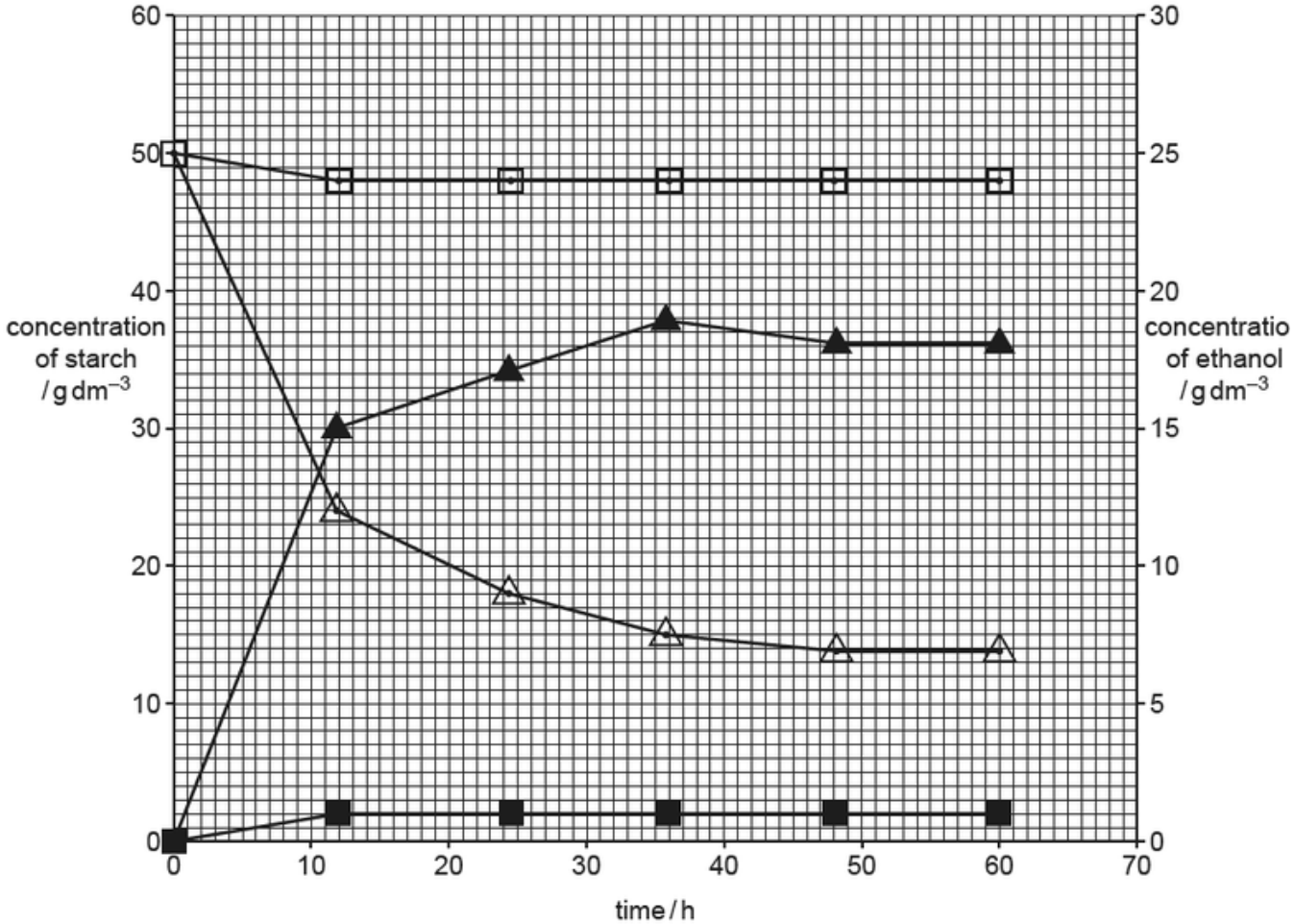
STEMUP.CO.UK

In the lower temperature method, enzymes catalysing the hydrolysis of starch do **not** need to be added to the starch suspension. A genetically modified (GM) strain of the same yeast species is used. The GM strain of yeast has genes that allow the cell to produce α-amylase and glucoamylase and to attach these enzymes to the external surface of the cell surface membrane. The GM yeast cells are added to the starch that was heated to 80 °C and are maintained in anaerobic conditions to produce ethanol.

(b) An investigation was carried out to compare the GM strain of yeast with the yeast that had **not** been genetically modified (non-GM strain).
In this investigation, the starch suspension produced after heating to 80 °C was allowed to cool to 30 °C before adding yeast cells.

The results are shown in Fig. 2.1.

STEMUP.CO.UK



Key

■ ethanol concentration using non-GM strain

□ starch concentration using non-GM strain

▲ ethanol concentration using GM strain

△ starch concentration using GM strain

Fig. 2.1

With reference to Fig. 2.1, describe the trends in the data for **ethanol** production by the GM strain compared to the non-GM strain.

.....

.....

.....

.....

.....

..... [2]

STEMUP.CO.UK

(c) The rate of ethanol production is similar for the lower temperature method and the higher temperature method.

Suggest why using the lower temperature method has a similar rate of production of ethanol to the higher temperature method.

.....

.....

.....

.....

..... [2]

(d) Suggest **one** reason why the high temperature method is expensive to carry out.

.....

..... [1]

[Total: 11]

STEMUP.CO.UK

3. Nov/2022/Paper_42/No.8

(a) Selective reabsorption takes place in the proximal convoluted tubule of a kidney nephron.

Fig. 8.1 is a diagram of two cells of the proximal convoluted tubule and part of the adjacent blood capillary.

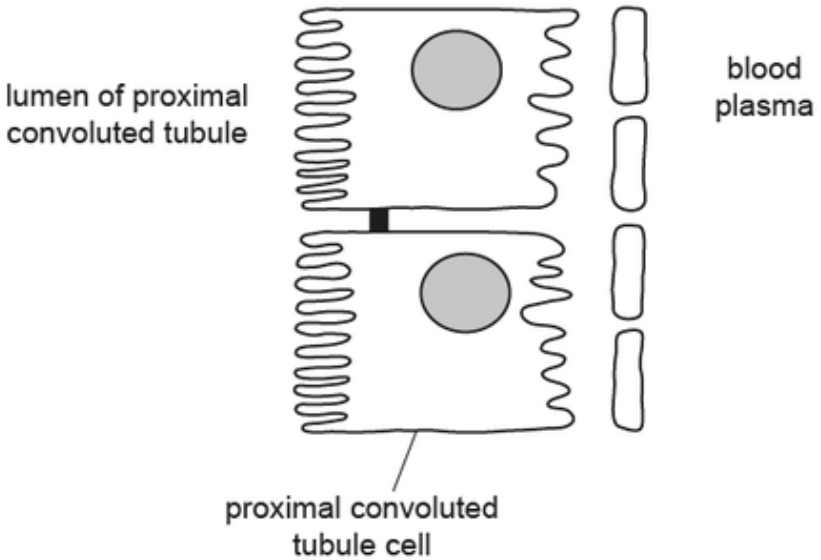


Fig. 8.1

The cells of the proximal convoluted tubule are adapted to carry out selective reabsorption.

On Fig. 8.1, use label lines and letters to indicate:

- **C**, where cotransporter proteins are located
- **P**, where sodium-potassium pumps are located. [2]

STEMUP.CO.UK

(b) Explain how the cells of the proximal convoluted tubule are adapted to carry out selective reabsorption.

.....

.....

.....

.....

.....

.....

.....

.....

.....

..... [5]

STEMUP.CO.UK

(c) The plasma, the glomerular filtrate and urine are composed of various substances.

Table 8.1 shows the percentage composition of plasma, the glomerular filtrate and urine.

Table 8.1

substance	percentage composition		
	plasma	glomerular filtrate	urine
water	90.00	90.00	94.00
glucose	0.10	0.10	0.00
amino acids	0.05	0.05	0.00
plasma proteins	8.00	0.00	0.00
urea	0.03	0.03	2.00
other substances	1.82	9.82	4.00

As a result of the action of the cells of the proximal convoluted tubule, glucose and amino acids have been reabsorbed by the blood, whereas only some of the urea has been reabsorbed.

Calculate how many times the percentage composition of urea has increased in the urine compared with the glomerular filtrate.

Show your working and give your answer to the nearest whole number.

answer ..... [2]

[Total: 9]

STEMUP.CO.UK

1. March/2023/Paper_ 9700/42/No.6

(a) Fig. 6.1 is a diagram of a section through a mitochondrion.

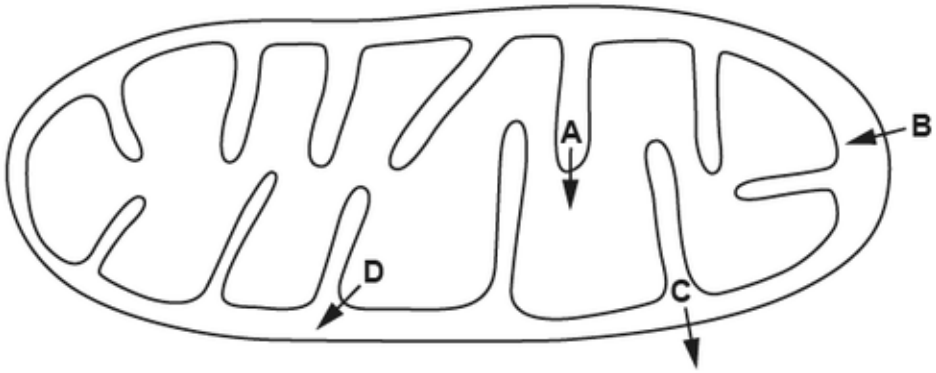


Fig. 6.1

The four arrows, **A**, **B**, **C** and **D**, show the movement of molecules and ions.

Use the letters to identify **all** the arrows (one or more) that show:

(i) active transport of protons

..... [1]

(ii) diffusion of carbon dioxide.

..... [1]

(b) Outline the role of the mitochondrial matrix in respiration.

.....

.....

.....

.....

.....

.....

..... [3]

STEMUP.CO.UK

(c) Explain how a lack of oxygen affects oxidative phosphorylation.

.....

.....

.....

.....

.....

.....

.....

.....

..... [4]

[Total: 9]

STEMUP.CO.UK

2. June/2023/Paper_ 9700/41/No.7

Amino acids are the monomers that are used to produce proteins in organisms. Amino acids also have other, non-protein, roles in the body.

(a) Fig. 7.1 shows the structures of five amino acids with varying numbers and arrangements of carbon atoms.

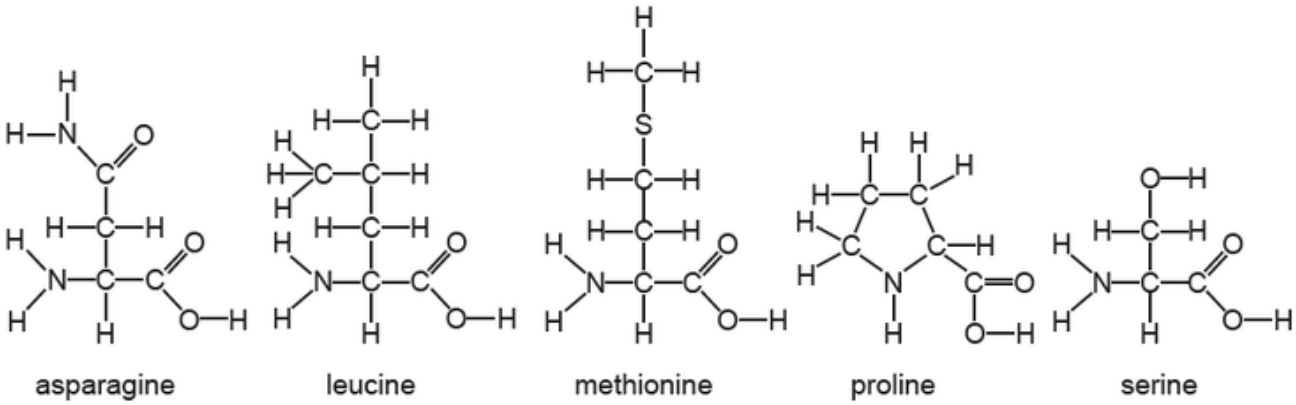


Fig. 7.1

In the liver, one of these amino acids can be converted to pyruvate and one of these amino acids can be converted to oxaloacetate.

Suggest which of the amino acids shown in Fig. 7.1 would be most directly converted to:

- pyruvate
- oxaloacetate.

amino acid converted to pyruvate .....

amino acid converted to oxaloacetate .....

[2]

STEMUP.CO.UK

(b) The amino acid glycine can act as a neurotransmitter.

A glycinergic synapse is shown in Fig. 7.2.

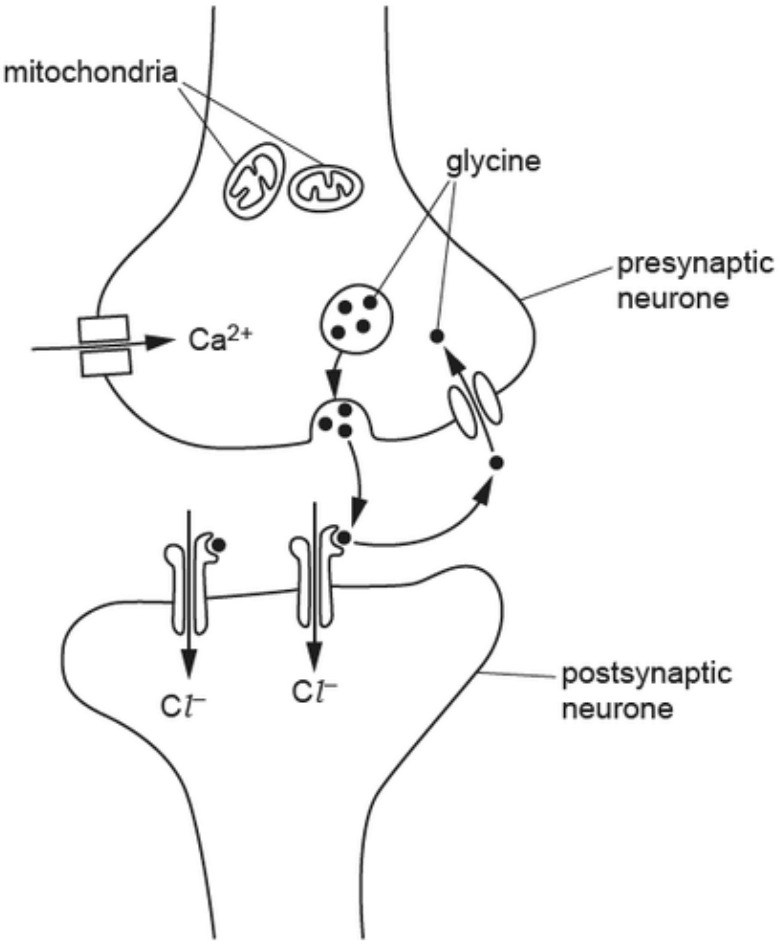


Fig. 7.2

(i) The glycinergic synapse and a cholinergic synapse use different neurotransmitters and different postsynaptic receptors.

Describe differences between the glycinergic synapse shown in Fig. 7.2 and a cholinergic synapse.

.....

.....

.....

.....

.....

..... [2]

STEMUP.CO.UK

(ii) The binding of glycine to receptors, as shown in Fig. 7.2, makes an action potential less likely to occur in the postsynaptic neurone.

Suggest why an action potential is less likely to occur after the binding of glycine to receptors.

.....

.....

.....

.....

..... [2]

(iii) Neurones need to maintain a resting potential before an action potential can occur.

Describe how a neurone maintains a resting potential.

.....

.....

.....

.....

.....

.....

.....

.....

..... [4]

[Total: 10]

STEMUP.CO.UK

3. June/2023/Paper_ 9700/41/No.9

Many factors affect the rate of cellular respiration.

(a) Pyruvate carboxylase (PC) deficiency is a rare disease. The rate of respiration in the cells of a person with PC deficiency is much lower than normal.

The passage describes the occurrence of PC deficiency in human populations.

Complete the passage by using the most appropriate scientific terms.

PC deficiency affects one in 250 000 people. A person either has the disease or does not, so there are no intermediate forms of the disease. PC deficiency is caused by a genetic mutation in one gene. Whether a person develops the disease is not influenced by ..... factors. The distribution of PC deficiency in human populations shows ..... variation. [2]

(b) Coenzymes are important in aerobic respiration.

Outline the roles of named coenzymes in aerobic respiration.

.....

.....

.....

.....

.....

.....

.....

.....

.....

..... [5]

[Total: 7]

STEMUP.CO.UK

4. June/2023/Paper_ 9700/42/No.1

(a) Glycolysis is a biochemical pathway that occurs in the cytoplasm of cells.

In glycolysis, a molecule of glucose is metabolised to two molecules of pyruvate. The process is outlined in Fig. 1.1.

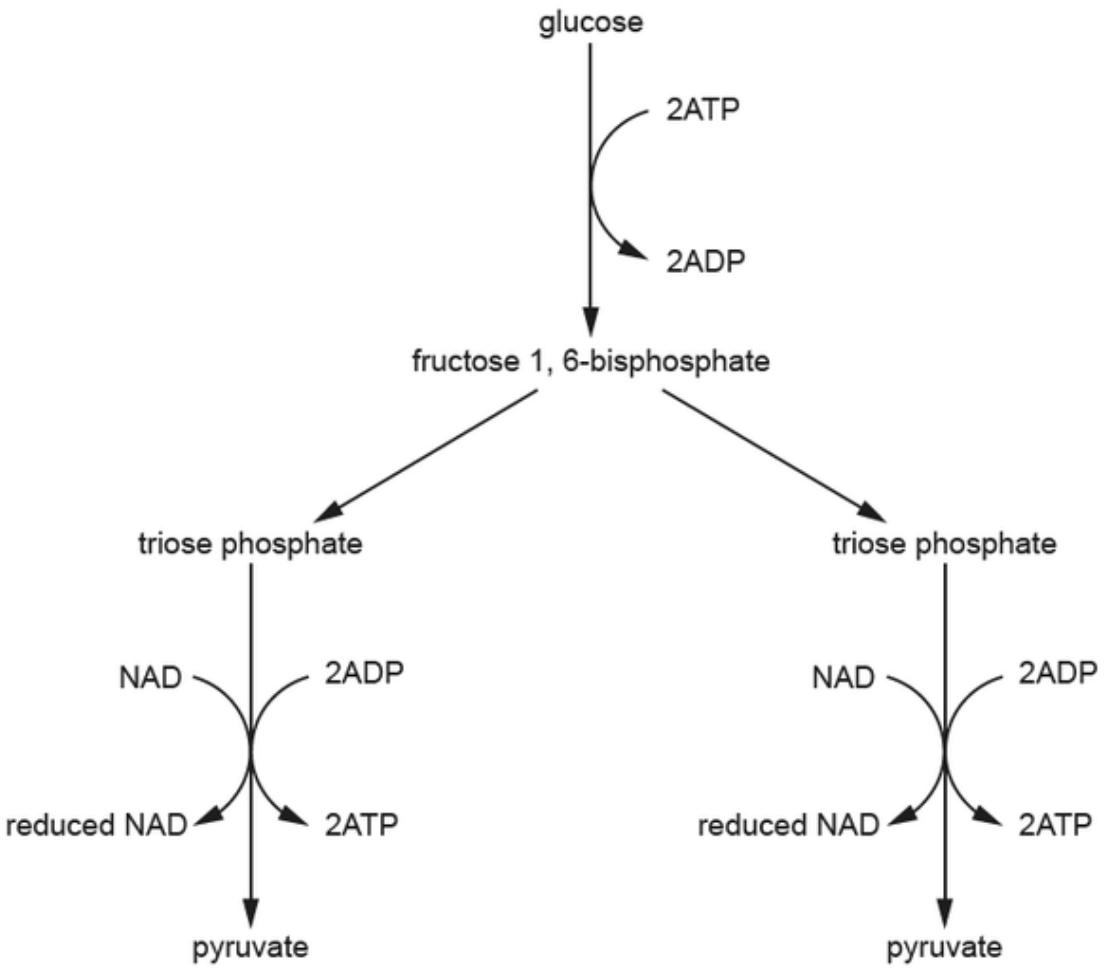


Fig. 1.1

(i) Explain why glucose is phosphorylated at the beginning of glycolysis.

.....

..... [1]

STEMUP.CO.UK

(ii) Suggest **one** use of the reduced NAD that is produced in glycolysis.

.....

..... [1]

(iii) Name the type of phosphorylation reaction by which ATP is made during glycolysis.

.....

..... [1]

(b) Pyruvate can enter the mitochondrion by active transport.

Describe the main conditions that are required for pyruvate to enter the mitochondrion by active transport.

.....

.....

.....

.....

.....

.....

..... [3]

(c) Pyruvate is involved in the link reaction in the matrix of the mitochondrion.

Describe the link reaction.

.....

.....

.....

.....

.....

.....

..... [3]

[Total: 9]

STEMUP.CO.UK

5. June/2023/Paper_ 9700/43/No.1

(a) The Krebs cycle was named after the biochemist Sir Hans Krebs, who worked out the sequence in 1937.

Fig. 1.1 is an outline of the Krebs cycle.

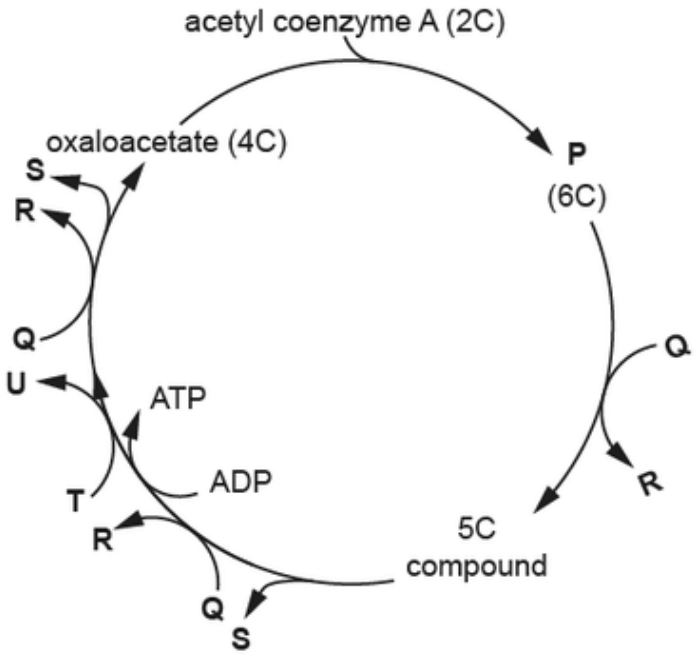


Fig. 1.1

Identify substances **P**–**U**.

P .....

Q .....

R .....

S .....

T .....

U .....

[3]

STEMUP.CO.UK

(b) Describe how ATP is produced from ADP in the Krebs cycle.

.....

.....

.....

.....

..... [2]

(c) Describe **and** explain the features of ATP that make it suitable as the universal energy currency.

.....

.....

.....

.....

.....

.....

.....

.....

..... [4]

[Total: 9]

STEMUP.CO.UK

1. Nov/2023/Paper_9700/41/No.5

(a) The respiratory quotient (RQ) values for different respiratory substrates can be calculated.

Table 5.1 shows:

- the formulae of four respiratory substrates
- the number of oxygen molecules (O_2) needed to completely respire each substrate to carbon dioxide and water.

Table 5.1

respiratory substrate	formula	number of oxygen molecules needed for respiration
beta-hydroxybutyric acid	$C_4H_8O_3$	4.5
glucose	$C_6H_{12}O_6$	6.0
malic acid	$C_4H_6O_5$	3.0
oleic acid	$C_{18}H_{34}O_2$	25.5

Using Table 5.1, name the respiratory substrate with the highest RQ and the respiratory substrate with the lowest RQ.

respiratory substrate with the **highest** RQ .....

respiratory substrate with the **lowest** RQ .....

[2]

STEMUP.CO.UK

(b) In anaerobic conditions, the production of ATP in mammals and yeast involves glycolysis and fermentation.

Describe the similarities **and** differences between fermentation in mammals and in yeast.

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

..... [5]

[Total: 7]

STEMUP.CO.UK

(a) Some organisms carry out respiration in anaerobic conditions when oxygen is not available or when there is a low concentration of oxygen. In yeast and some plants, this is called ethanol fermentation. In mammals, it is called lactate fermentation.

Fig. 1.1 outlines ethanol fermentation and lactate fermentation.

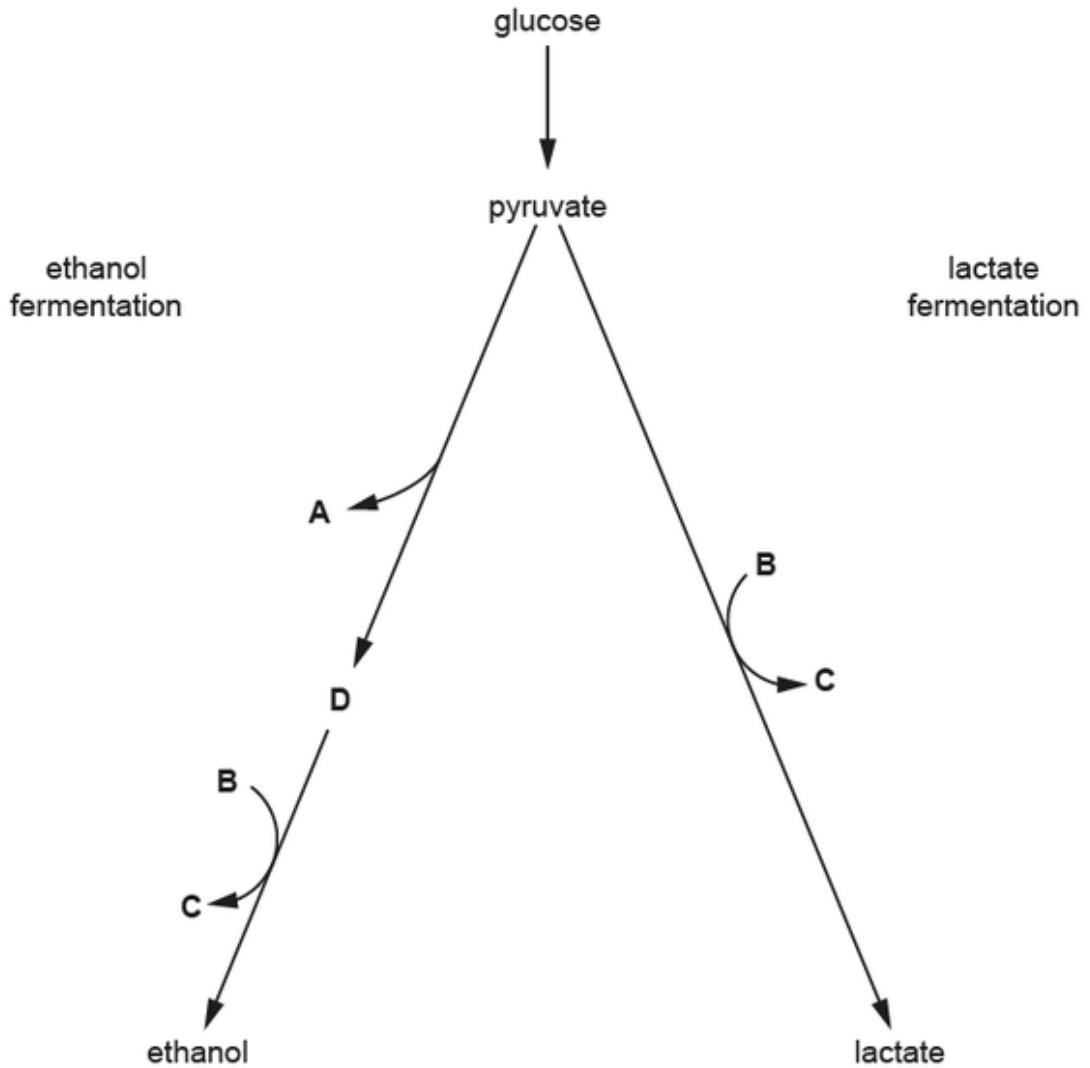


Fig. 1.1

Identify substances **A**–**D**.

A .....

B .....

C .....

D .....

[3]

STEMUP.CO.UK

(b) Explain how processes such as ethanol fermentation and lactate fermentation allow cells to continue to function in the absence of oxygen.

.....

.....

.....

.....

.....

.....

..... [3]

(c) The cereal crop rice, *Oryza sativa*, grows in fields that are flooded with water. The roots of the rice plants are submerged in water that contains very little oxygen.

Describe **and** explain how rice plants are adapted to grow in flooded fields.

.....

.....

.....

.....

.....

.....

.....

.....

..... [3]

[Total: 9]

STEMUP.CO.UK

3. Nov/2023/Paper_9700/42/No.7

(a) There are many mitochondria located in the presynaptic knobs of neuromuscular junctions and in the sarcomeres of muscle fibres of striated muscle.

Explain the need for many mitochondria in the presynaptic knobs and in the sarcomeres.

.....

.....

.....

.....

.....

.....

.....

.....

.....

..... [4]

STEMUP.CO.UK

(b) Fig. 7.1 is a diagram of synapses between a postsynaptic neurone and two presynaptic neurones, **X** and **Y**.

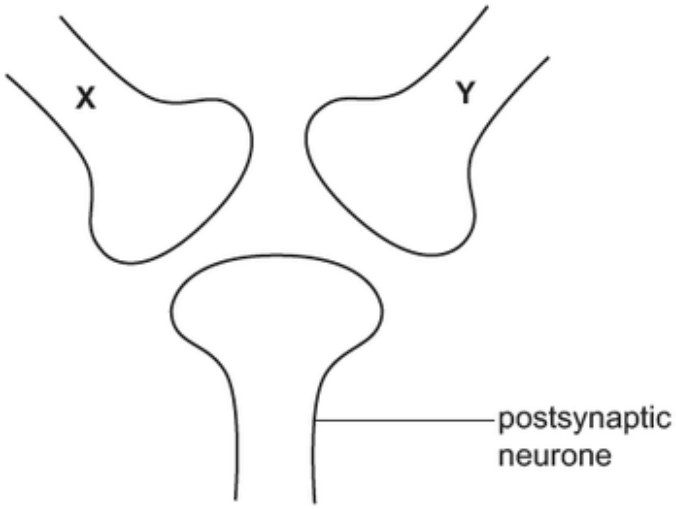


Fig. 7.1

- Neurone **X** releases the neurotransmitter acetylcholine.
- Neurone **Y** releases the neurotransmitter glutamate.
- Both neurotransmitters bind to channel proteins in the membrane of the postsynaptic neurone.
- Acetylcholine binding results in an influx (entry) of sodium ions.
- Glutamate binding results in an influx of chloride ions.

A student made three statements:

1. When only neurone **X** is stimulated, an action potential **will** occur in the postsynaptic neurone.
2. When only neurone **Y** is stimulated, an action potential **will** occur in the postsynaptic neurone.
3. When neurone **X** and neurone **Y** are stimulated at the same time, an action potential **will not** occur in the postsynaptic neurone.

Explain whether or not you agree with these statements.

.....

.....

.....

.....

.....

.....

.....

..... [3]

STEMUP.CO.UK

(c) Multiple sclerosis is a condition in which the myelin sheath breaks down in some neurones.

Suggest the effect of multiple sclerosis on the transmission of action potentials in the affected neurones.

.....

.....

.....

.....

..... [2]

[Total: 9]

STEMUP.CO.UK

4. Nov/2023/Paper_9700/42/No.8

(a) Non-cyclic photophosphorylation occurs in the light-dependent stage of photosynthesis.

Outline the main features of non-cyclic photophosphorylation.

.....

.....

.....

.....

.....

.....

.....

.....

.....

..... [4]

(b) Some Calvin cycle intermediates are used to produce other molecules that are **not** part of the Calvin cycle.

Name **two** of these intermediates.

For each intermediate, state **one** example of the type of molecule that is produced.

intermediate .....

molecule produced .....

intermediate .....

molecule produced .....

[2]

STEMUP.CO.UK

(c) Fig. 8.1 shows how the rate of uptake of carbon dioxide by a plant varies with temperature, at an optimum intensity of light on a clear day.

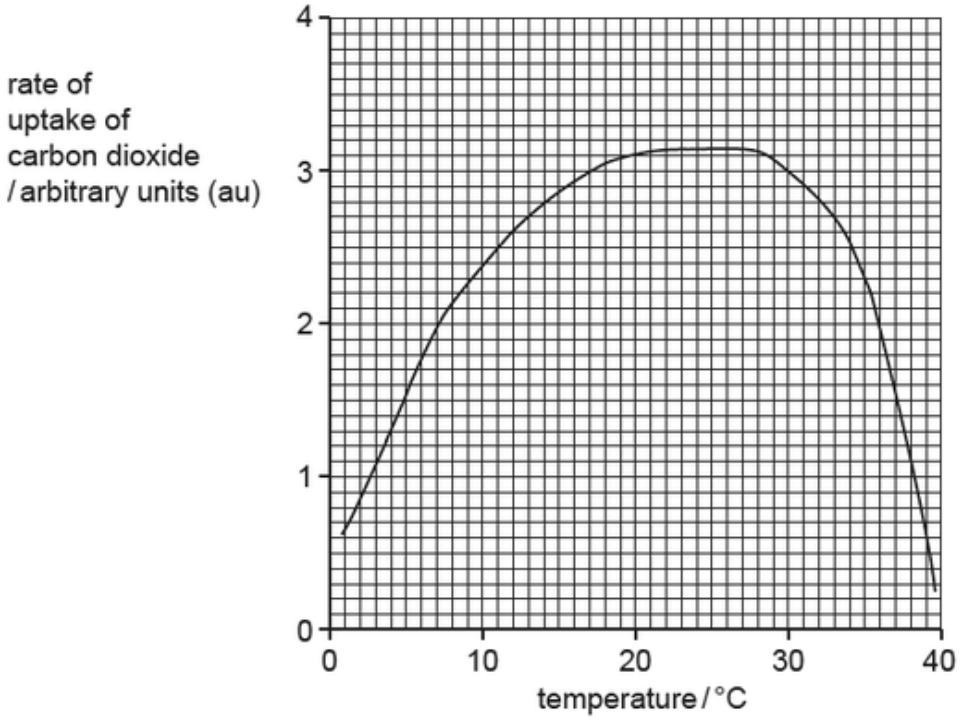


Fig. 8.1

(i) Calculate the mean increase in rate of uptake of carbon dioxide as the temperature increases from 5 °C to 20 °C.

Show your working.

Give your answer to **two** decimal places.

..... au °C^{-1} [2]

(ii) Suggest why the rate of carbon dioxide uptake levels off and then decreases after 20 °C.

.....

.....

.....

.....

.....

..... [3]

(iii) On Fig. 8.1, draw a curve to show the uptake of carbon dioxide on a cloudy day. [1]

[Total: 12]

STEMUP.CO.UK