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).

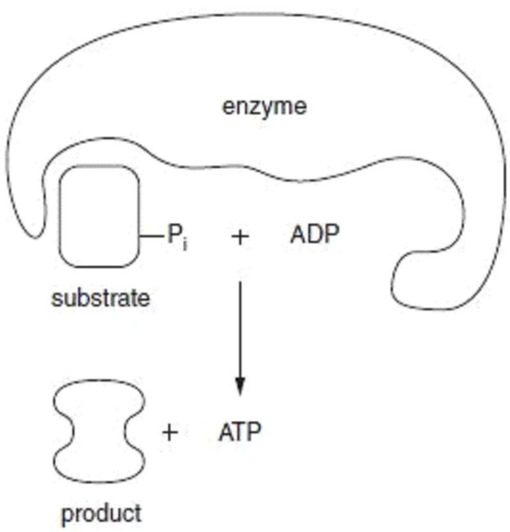


Fig. 2.1

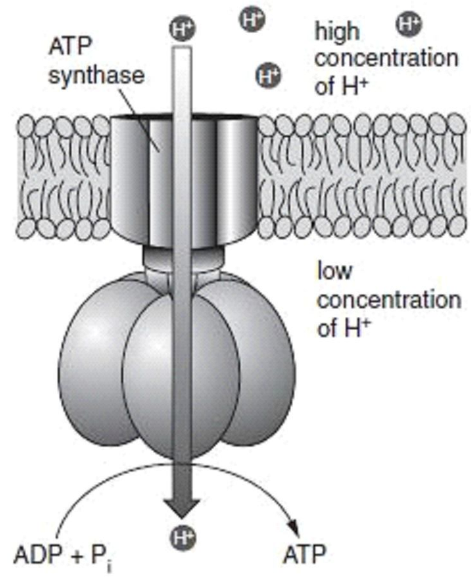


Fig. 2.2

(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.

....

....

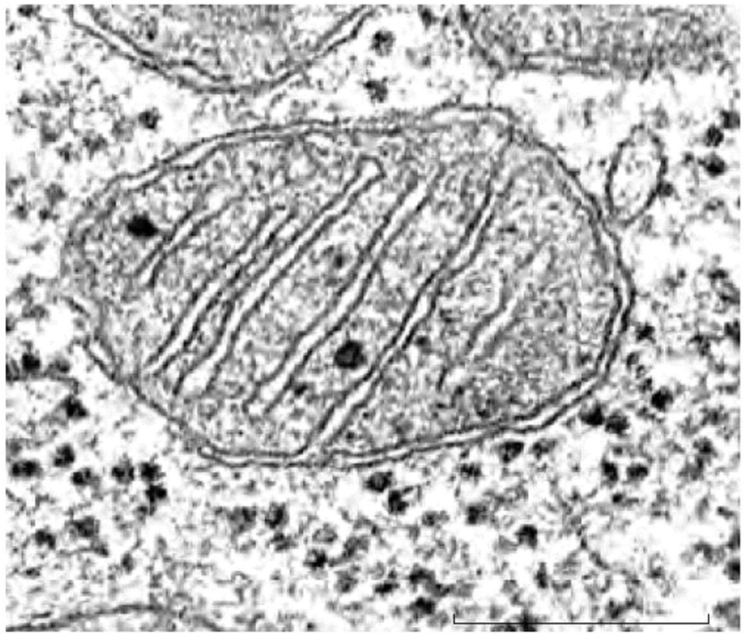
....

....[3]

[Total : 10]

Q2.

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



1 µm

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]

(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.

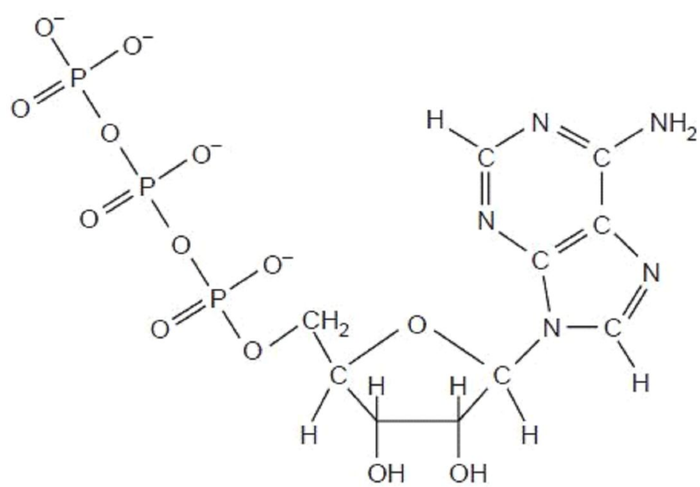


Fig. 1.1

(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.

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.

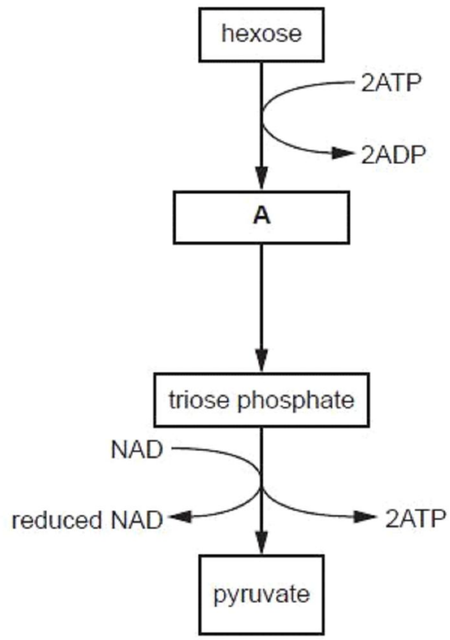


Fig. 1.1

(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]

(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]

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:

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

(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.

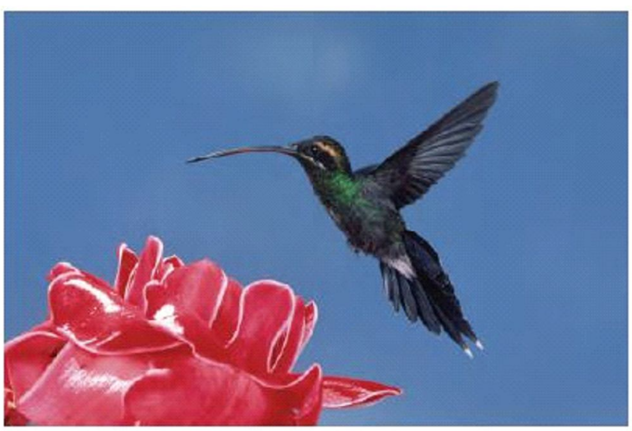


Fig. 1.1

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.

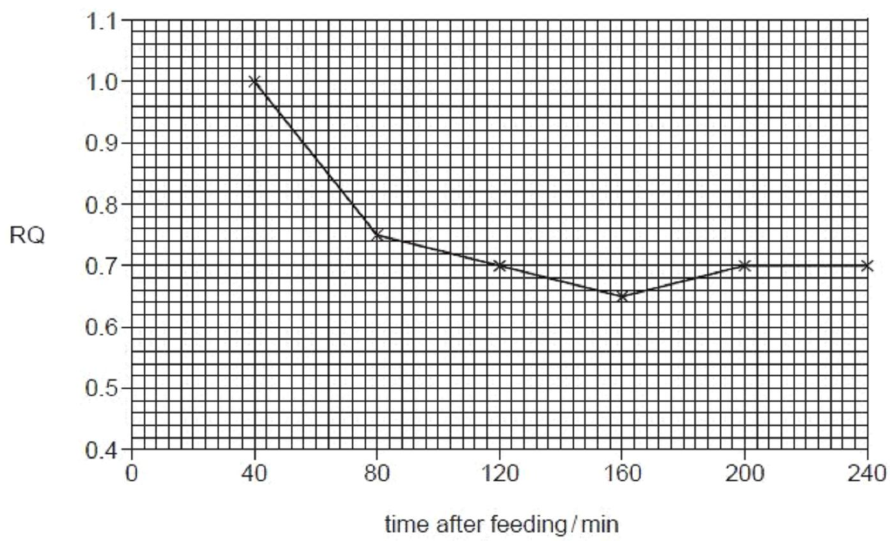


Fig. 1.2

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

....

....

....

....

....

....

.... [4]

(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]

(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.

Exa

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]

(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.

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 Examiner's Use

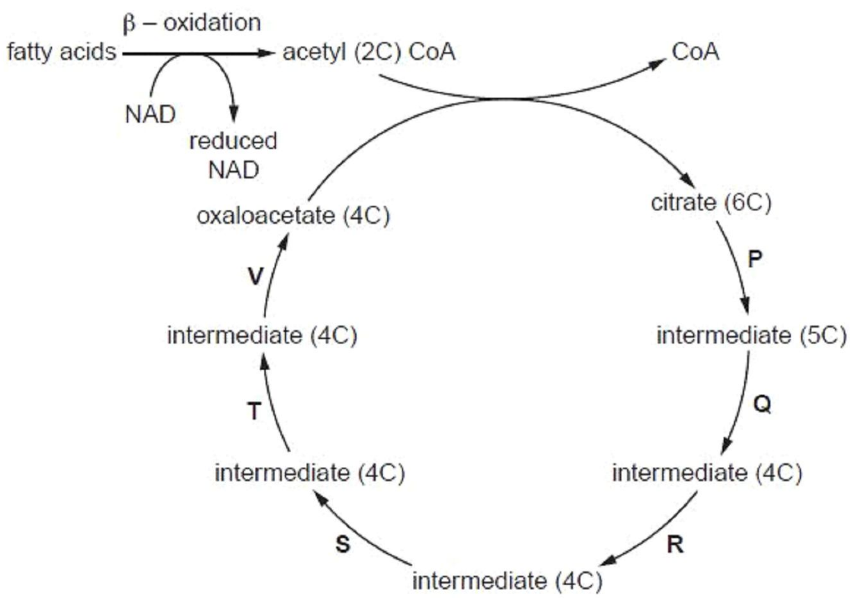


Fig. 7.1

(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]

(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]

(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.

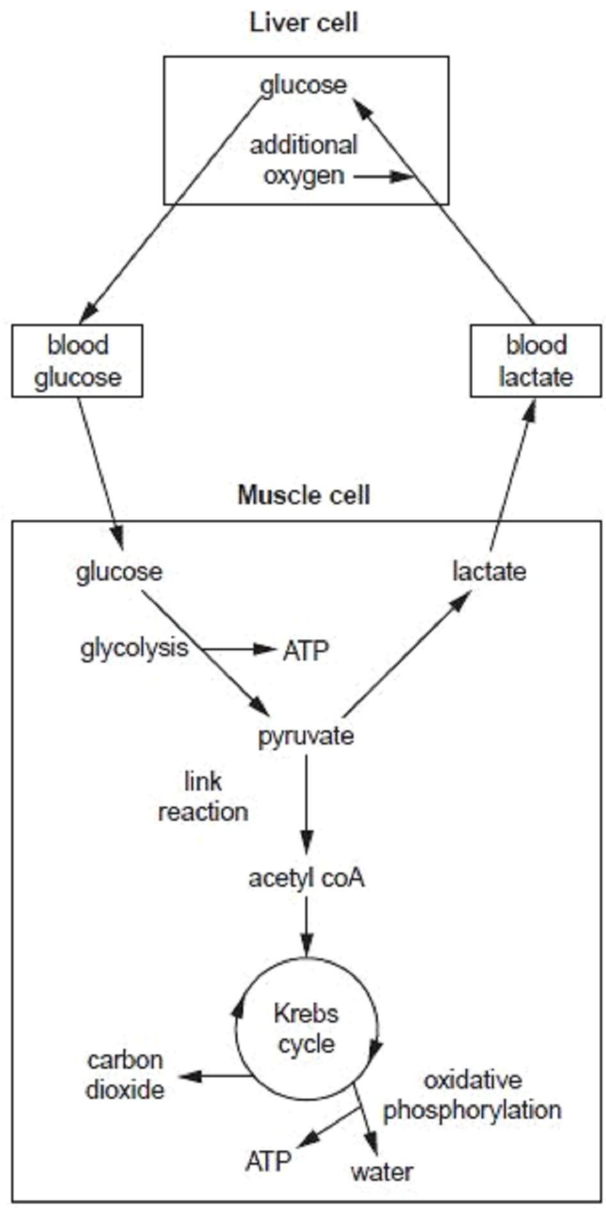
A certain proportion of this energy is lost as ....

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.


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

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

For Examiner's Use

(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]

(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.

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

Fig. 6.1 outlines the steps of the Krebs cycle.

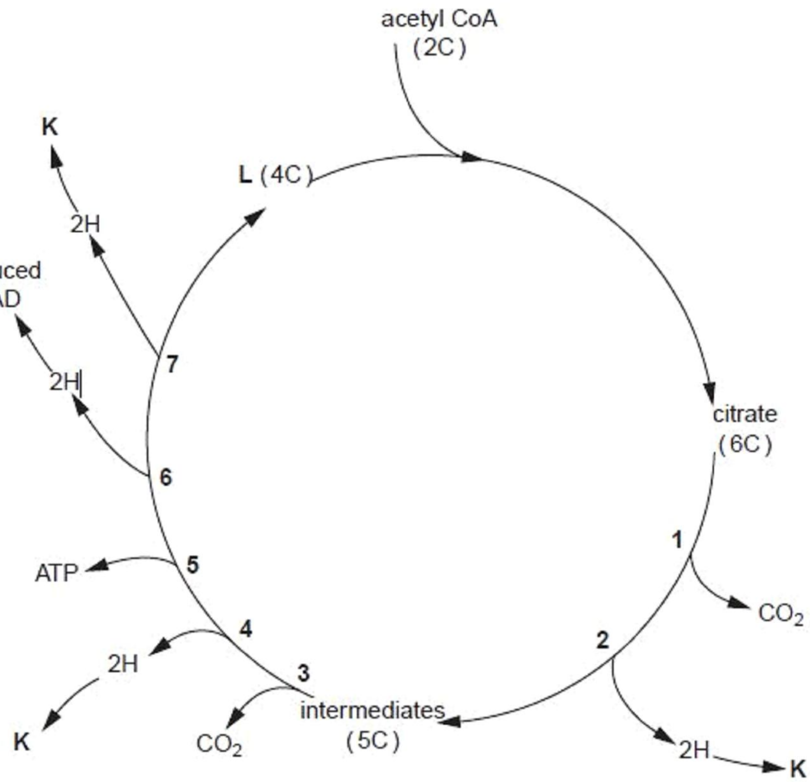


Fig. 6.1

(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]

(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.

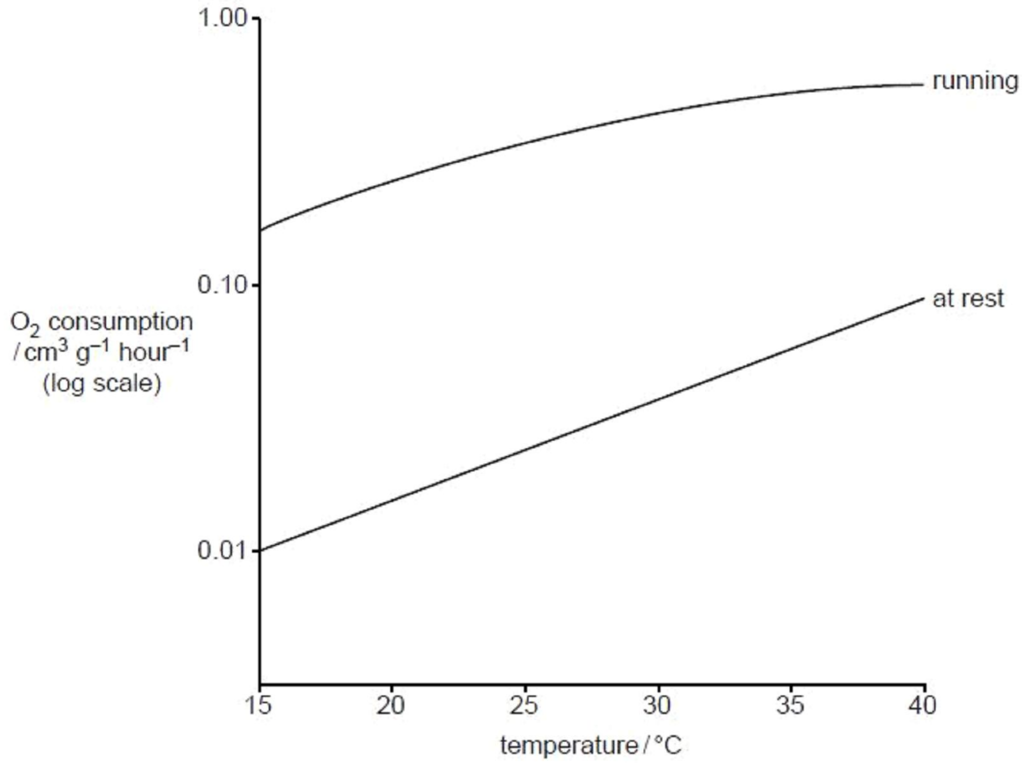

1.00
0.10
0.01
O_2 consumption / $cm^3\ g^{-1}\ hour^{-1}$ (log scale)
running
at rest
15
20
25
30
35
40
temperature / °C

Fig. 4.1

(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]

(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]

Exa

(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.

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.

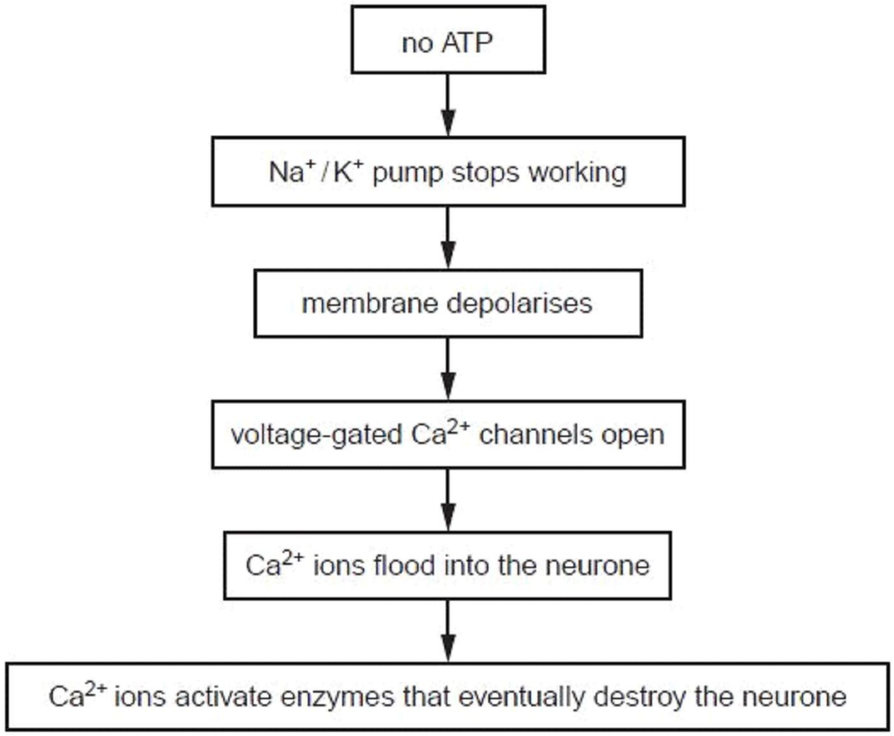

no ATP
Na+ / K+ pump stops working
membrane depolarises
voltage-gated Ca2+ channels open
Ca2+ ions flood into the neurone
Ca2+ ions activate enzymes that eventually destroy the neurone

Fig. 4.1

(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]

F
Exam
U

(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.

Exa

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.

....

....

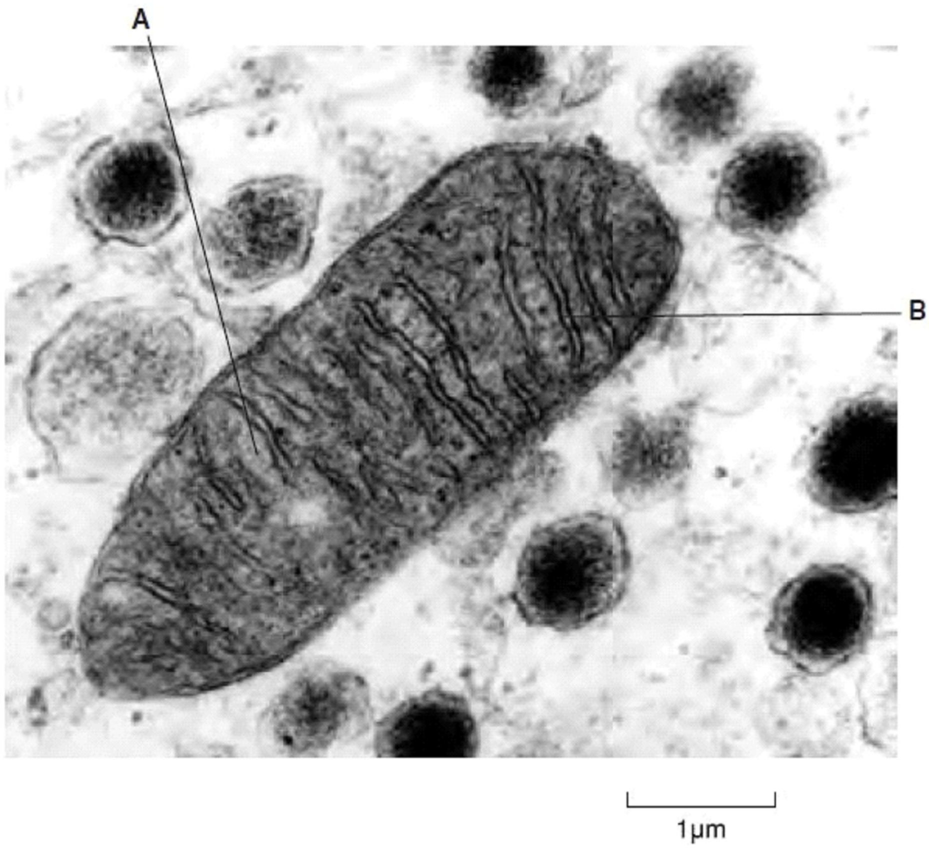
....

.... [2]

[Total: 16]

Q13.

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]

(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.

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

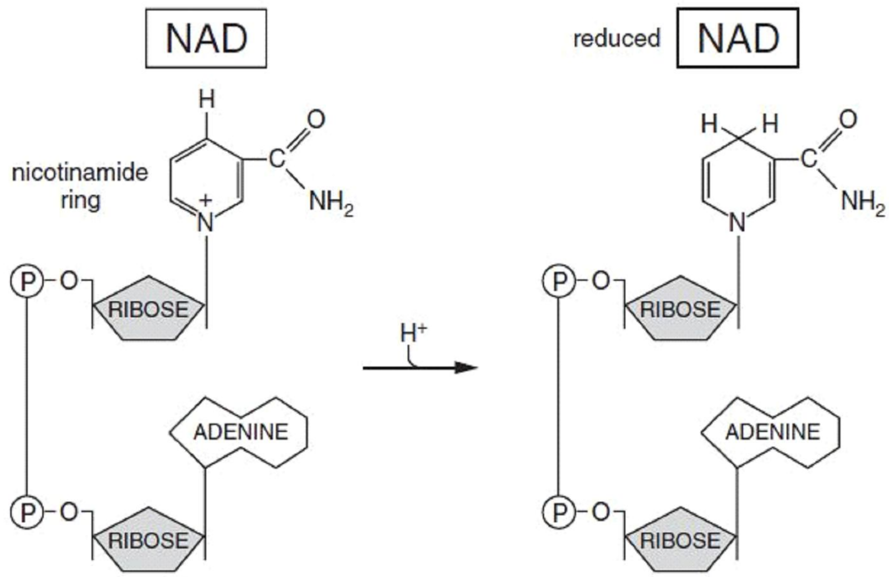


Fig. 2.1

(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]

(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.

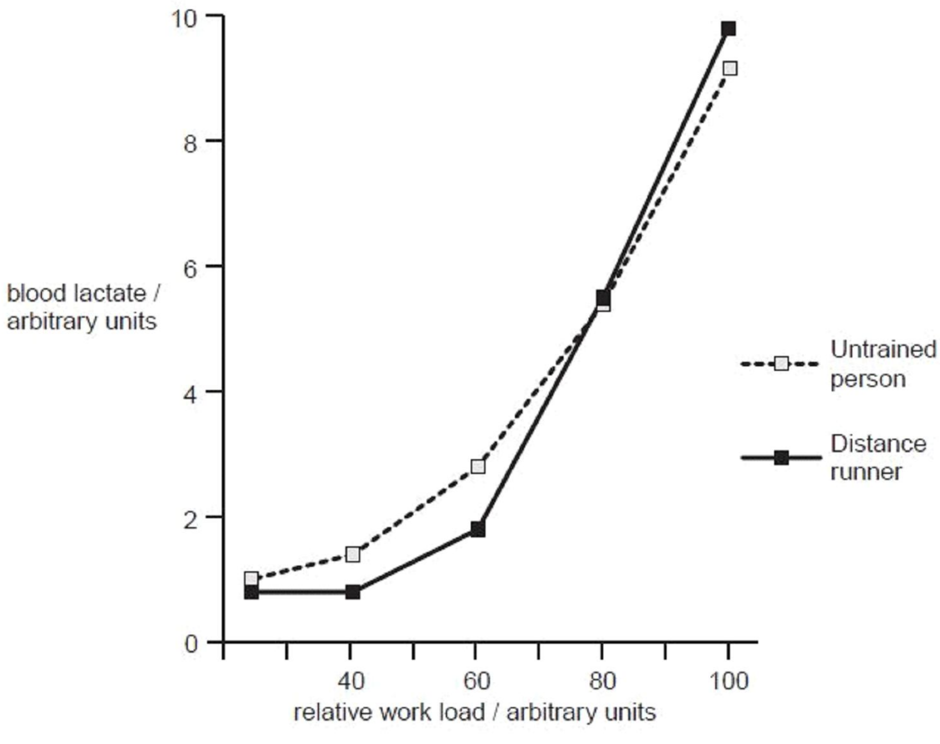


Fig. 3.1

(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.

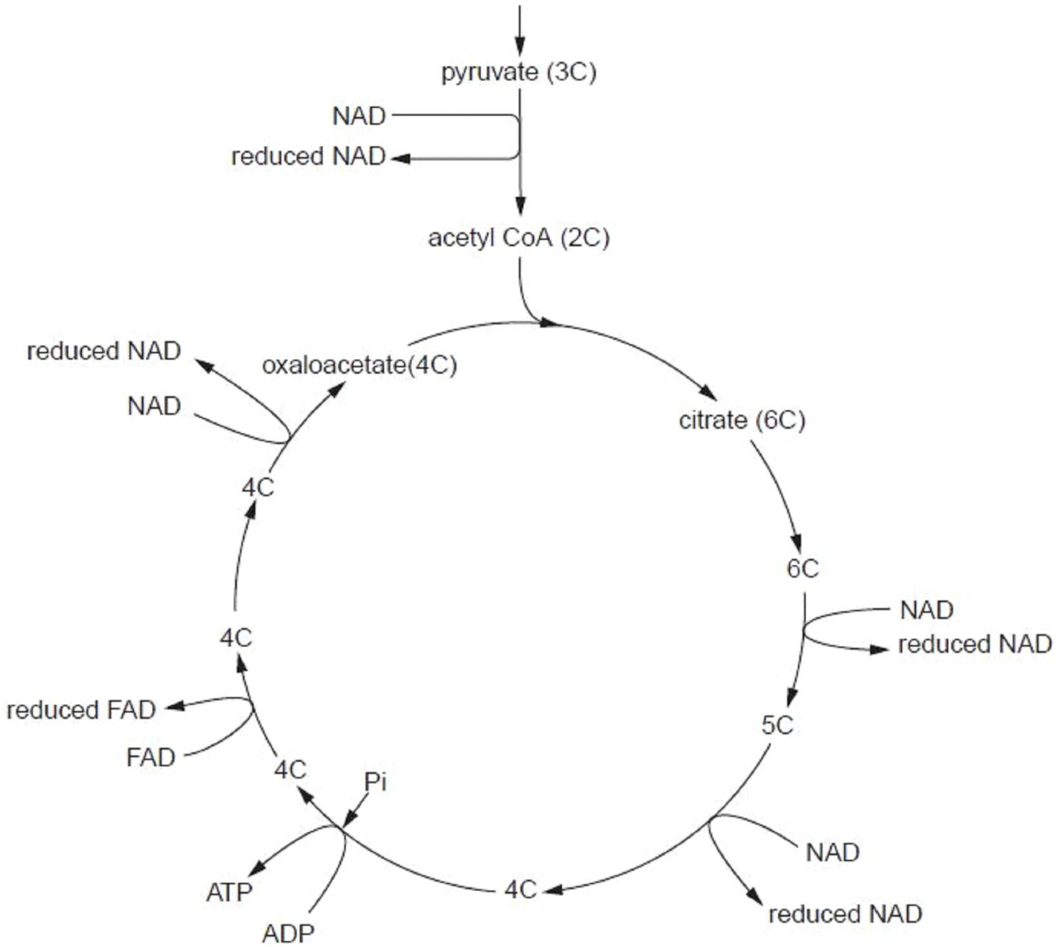
....

....[1]

[Total: 9]

Q16.

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



(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]

(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]

(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.

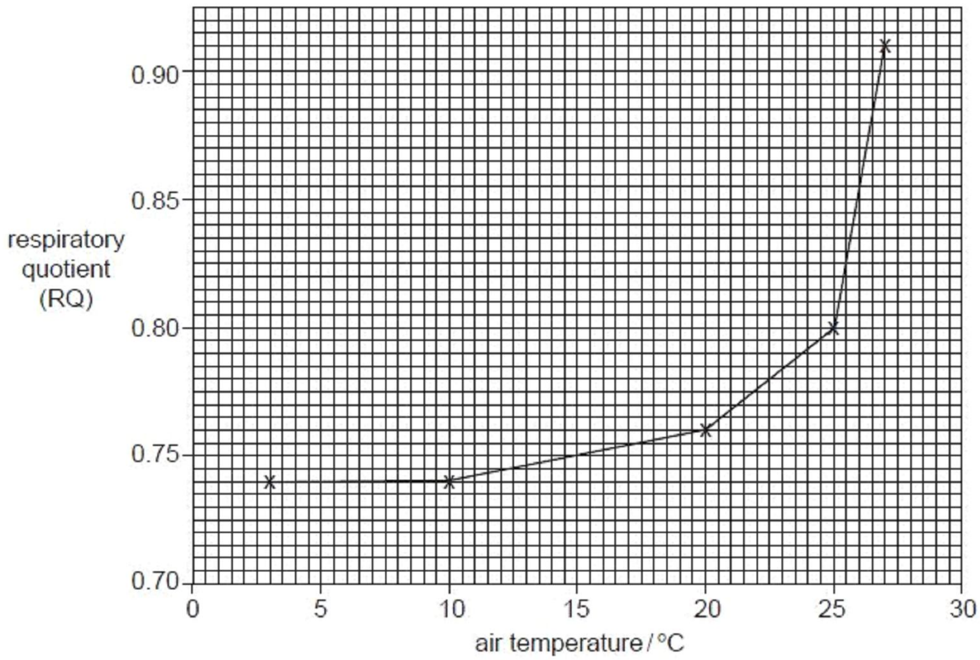


Fig. 1.1

(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]

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.

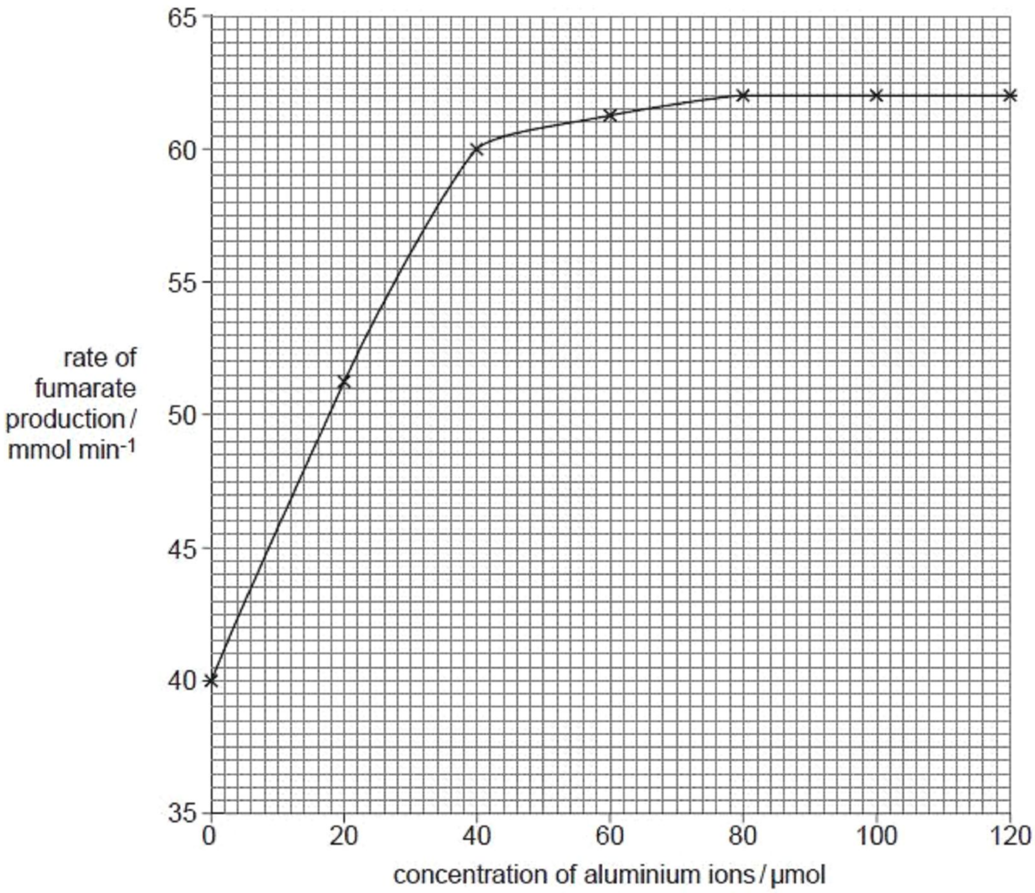

65
60
55
50
45
40
35
rate of fumarate production / mmol min-1
0
20
40
60
80
100
120
concentration of aluminium ions / µmol

Fig. 7.1

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.

6 Fig. 6.1 shows the structure of ATP.

For Examiner's Use

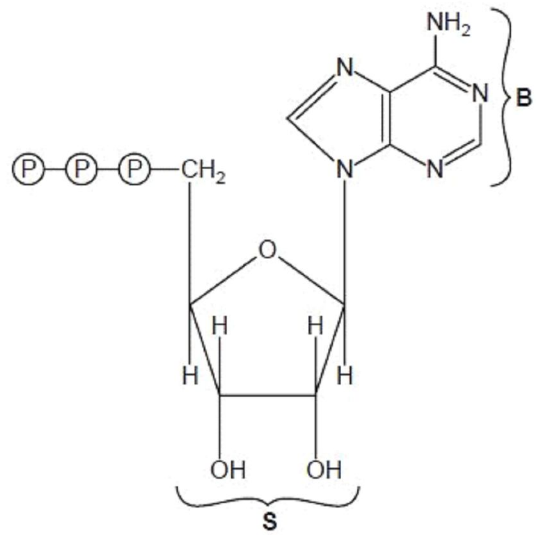


Fig. 6.1

(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]

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

1 ....

....

2 ....

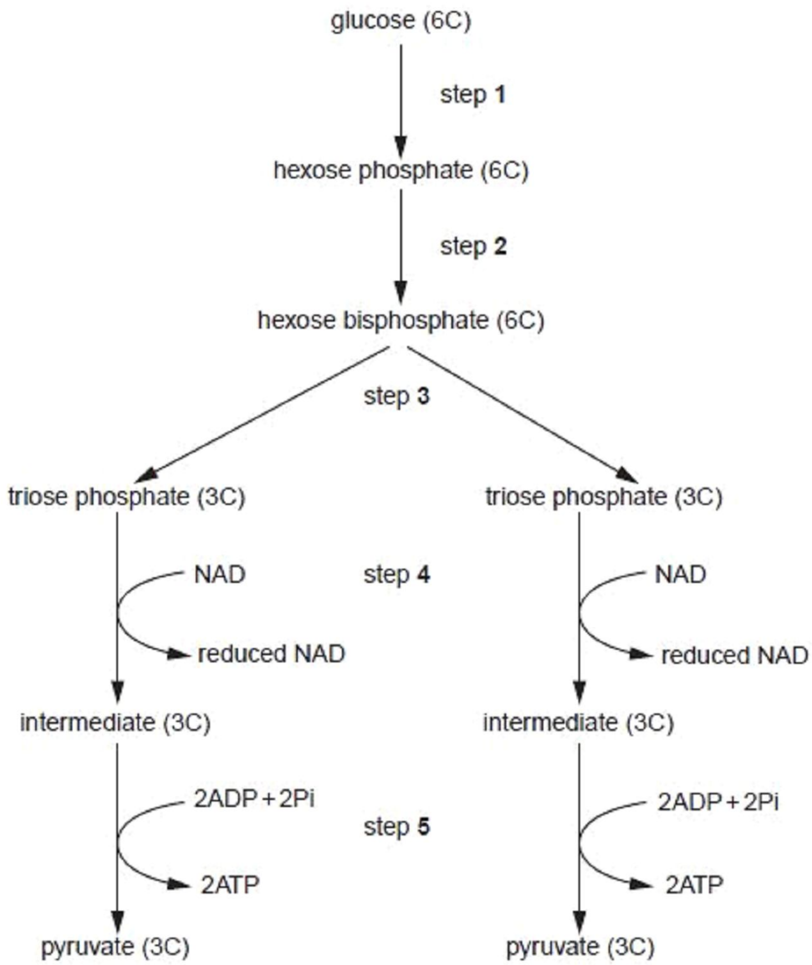
....[2]

[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.



(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.

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

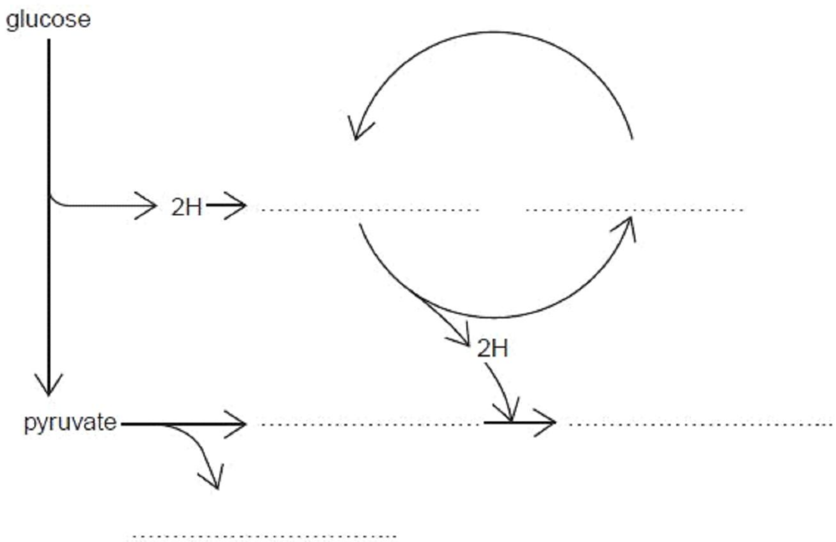


Fig. 6.1

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]

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

....

....

....

....

....

....

....[3]

[Total: 11]

For Examiner's Use

Q23.

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

For Examiner's Use

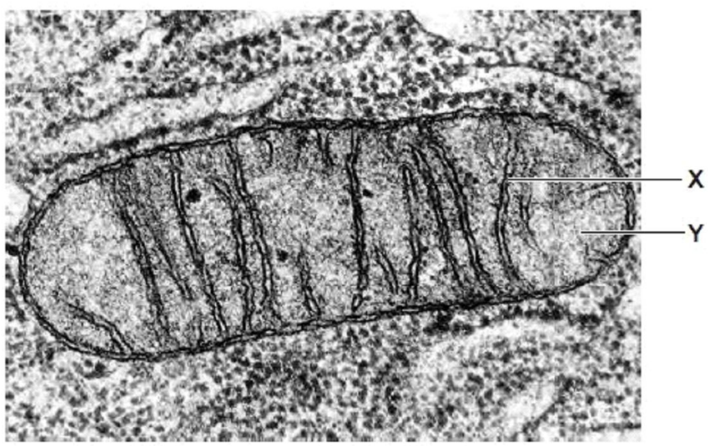


Fig. 8.1

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

X ....

Y .... [2]

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

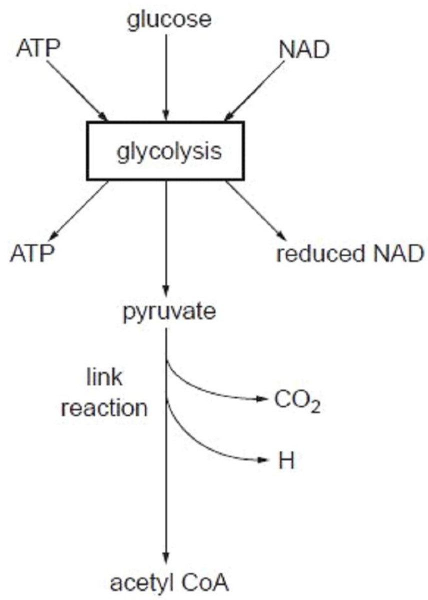


Fig. 8.2

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]

(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]

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

....[5]

[Total: 15]

Q24.

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

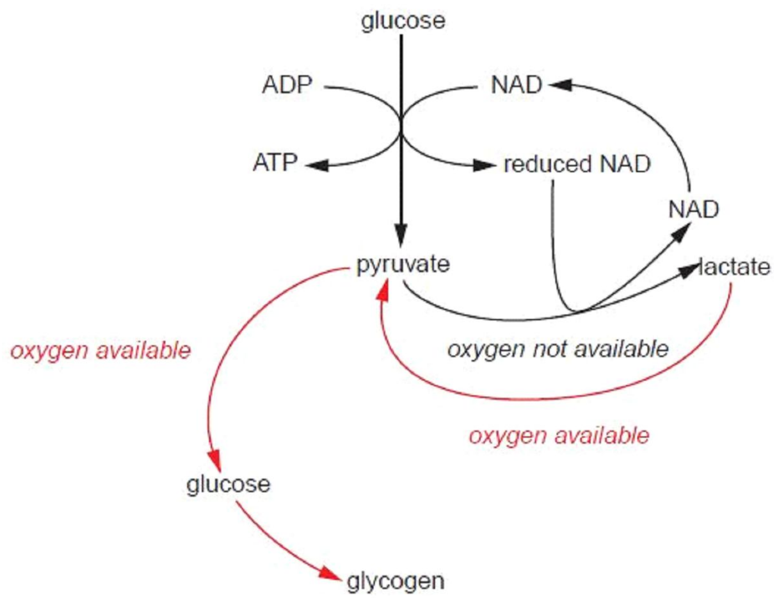


Fig. 8.1

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]

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

....

....

....

....

....

....

....

....

....[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.

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

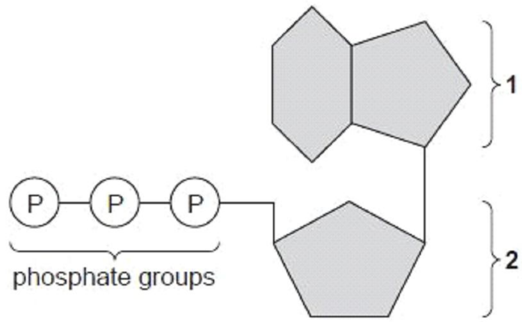


Fig. 3.1

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]

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

Ex

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.

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

(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.

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.

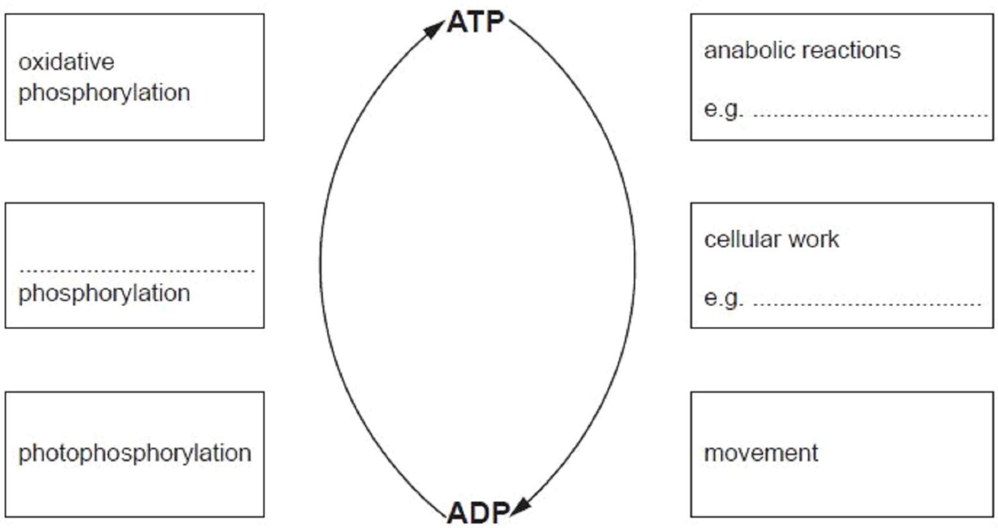


Fig. 2.1

(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.

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.

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.

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]

(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.

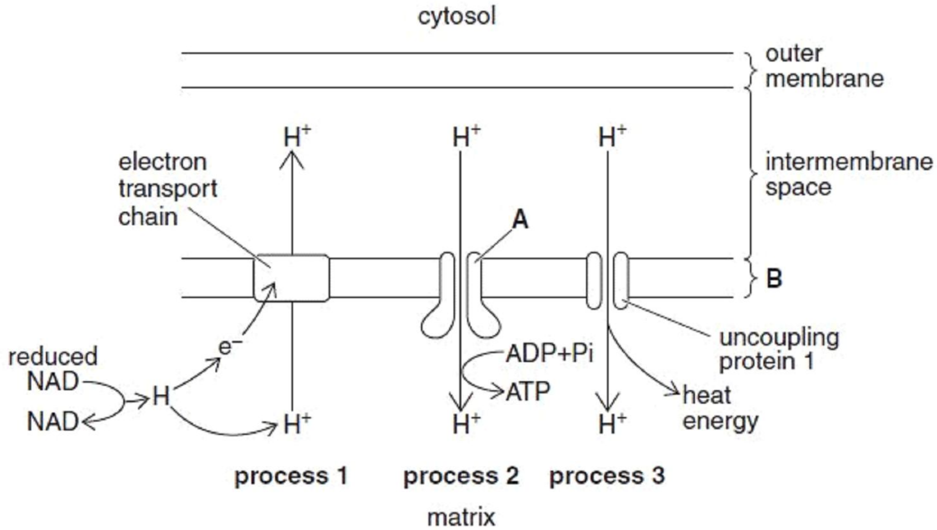


Fig. 8.1

(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.

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

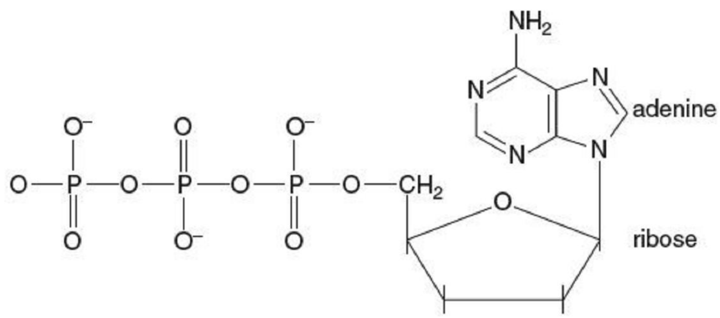


Fig. 5.1

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]

(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.

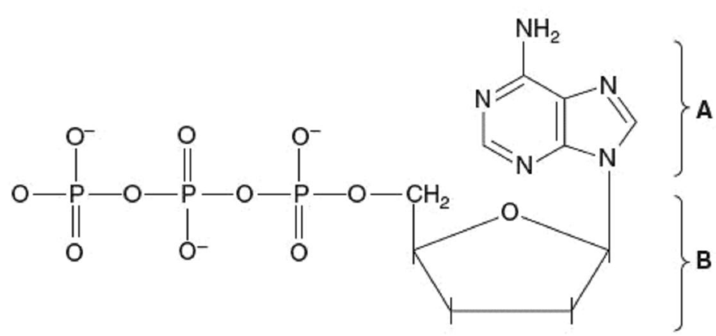


Fig. 4.1

(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]

(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.

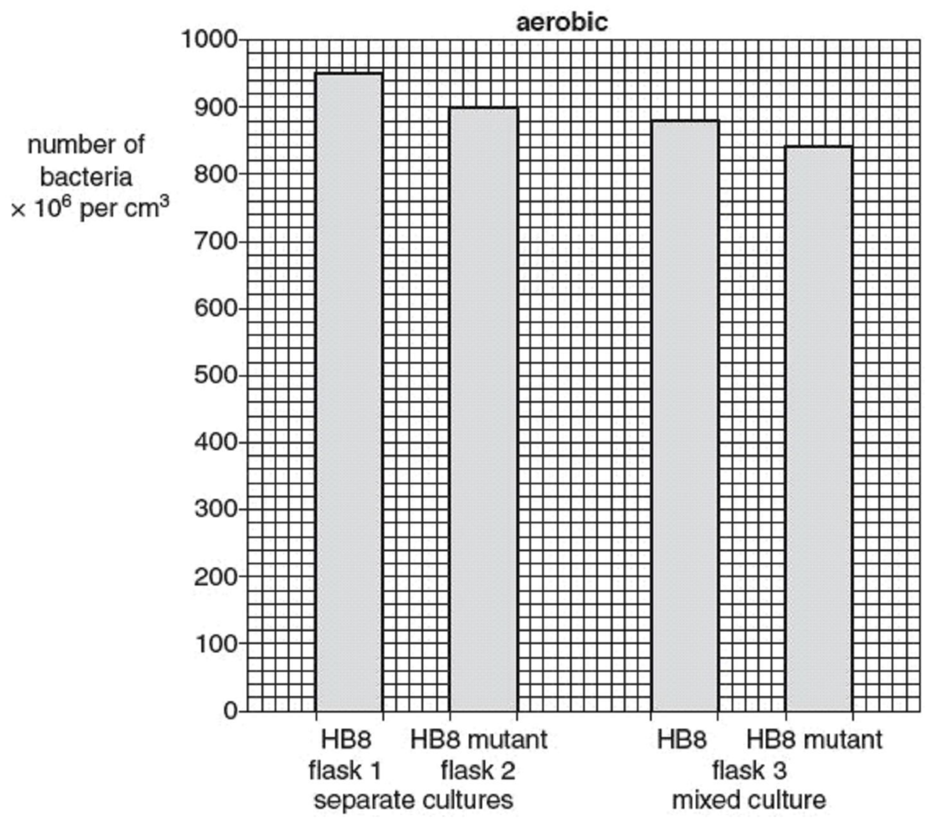
An investigation was carried out into population growth of HB8 and of HB8 mutant in aerobic and in anaerobic conditions. In each experiment, a flask containing bacterial culture medium was incubated. Table 4.1 shows how the flasks were set up.

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.



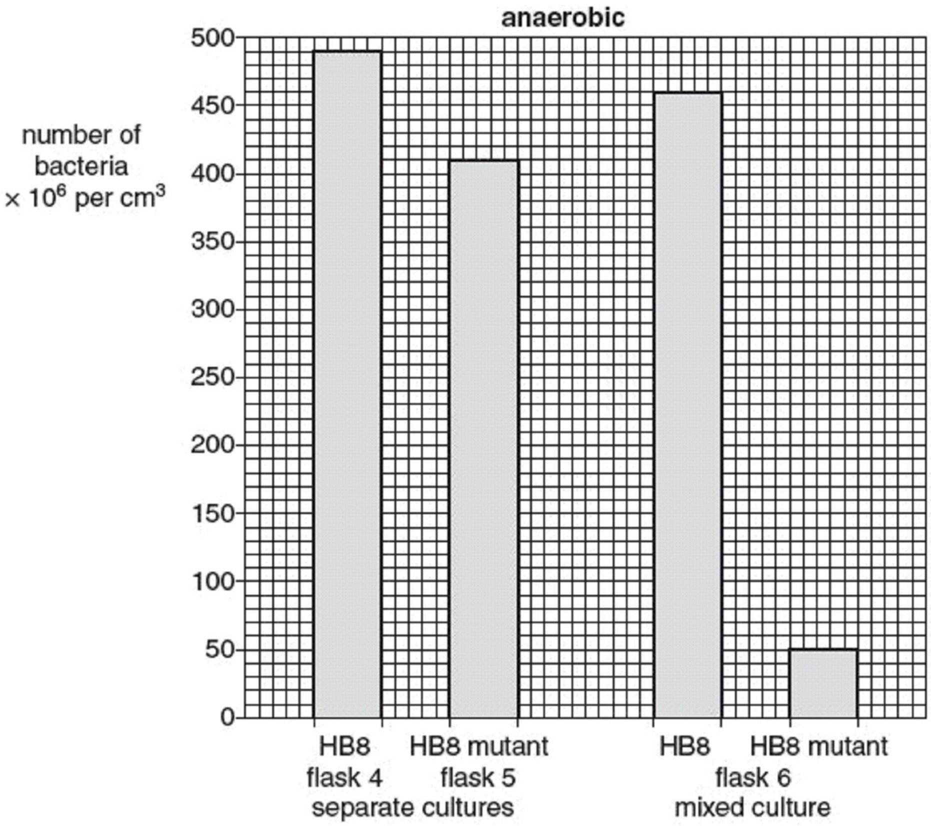


Fig. 4.2

(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]

(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.

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.

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]