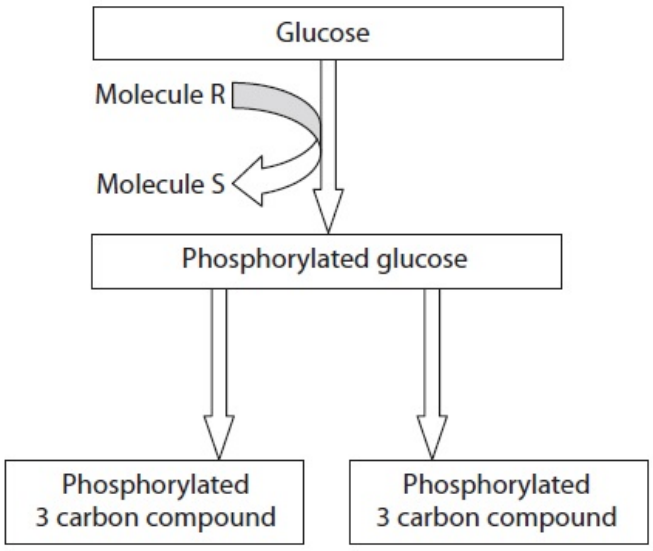
Q1.

Respiration is a vital process in living organisms. All organisms carry out glycolysis. The Krebs cycle also occurs in some organisms.

(a) The diagram below shows some of the stages in glycolysis, using the hexose sugar glucose.



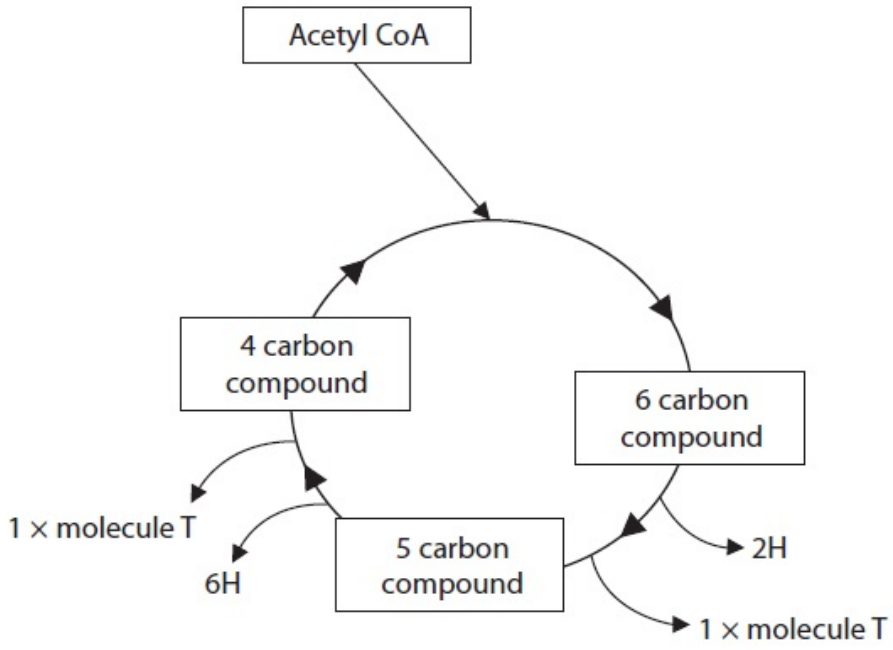
Name the molecules R and S shown in the diagram.

(2)

Molecule R .....

Molecule S .....

(b) The diagram below shows some of the stages in the Krebs cycle.



(i) Name molecule T and use the information in the Krebs cycle diagram to give a reason for your answer.

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(ii) Using information in the diagram, suggest what would happen in the Krebs cycle if acetyl CoA became unavailable.

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(b) The hydrogen (H) from the Krebs cycle enters the electron transport chain and oxidative phosphorylation occurs.

Explain what is meant by the term **oxidative phosphorylation**.

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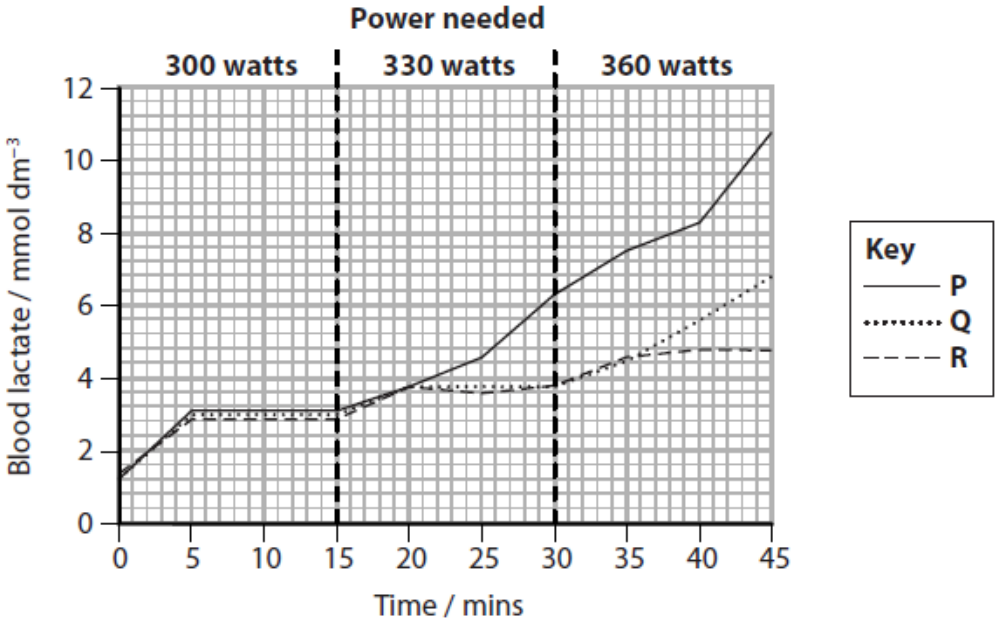
(Total for question = 10 marks)

Q2.

Athletes monitor the effect of different levels of exercise on their blood lactate concentration. This helps them to train effectively.

In a study, three athletes, **P**, **Q** and **R**, used an exercise bicycle for 45 minutes.
The power needed to maintain a constant speed was increased every 15 minutes.
Their blood lactate concentration was measured at 5-minute intervals.

The results are shown in the graph.



Explain the increase in blood lactate concentration observed between 0 and 5 minutes.

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(Total for question = 2 marks)

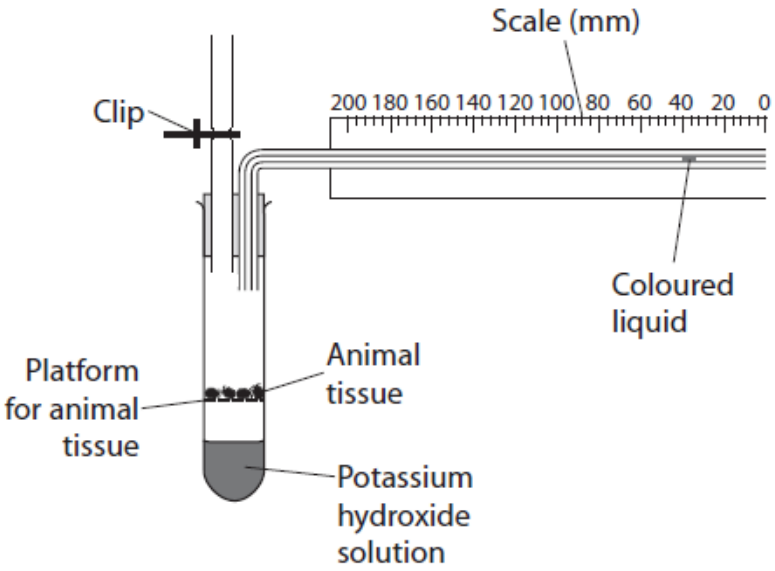
Q3.

The tissues of some animals can carry out anaerobic and aerobic respiration.

Three investigations were carried out to study respiration in an animal tissue, using the apparatus shown below.

The tissue used glucose as the respiratory substrate.

All other variables were kept constant.



The table below shows the three investigations that were carried out and the result for investigation 1.

Investigation	Type of respiration	Potassium hydroxide solution absent or present	Coloured liquid moved to the left	Coloured liquid moved to the right	Coloured liquid did not move
1	Anaerobic	Absent	☐	☐	☒
2	Aerobic	Absent	☐	☐	☐
3	Aerobic	Present	☐	☐	☐

(i) Complete the table by placing a cross in one box ☒ for each of investigations 2 and 3 to show the response of the coloured liquid.

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(ii) Explain why the coloured liquid did not move in investigation 1.

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(iii) Reduced NAD ($NADH + H^+$) would be formed in investigations 2 and 3.

Describe the fate of reduced NAD in aerobic respiration.

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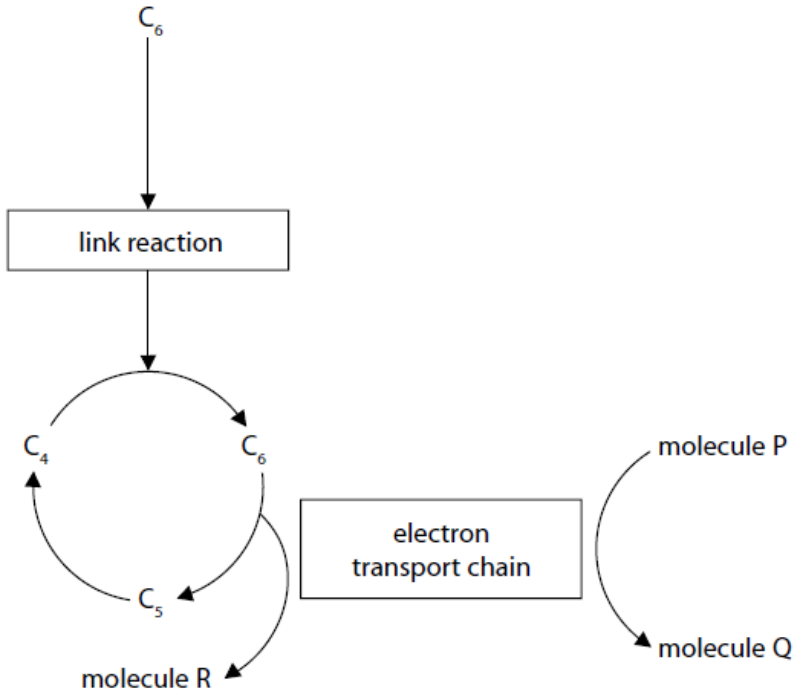
Q4.

The diagram shows some of the stages of aerobic respiration.



(i) Which row of the table correctly describes molecule R and molecule Q?

	Molecule R	Molecule Q
☒ A	ATP	oxygen
☒ B	carbon dioxide	water
☒ C	reduced NAD	carbon dioxide
☒ D	ATP	reduced NAD

(1)

*(ii) The last carrier in the electron transport chain is the enzyme cytochrome oxidase. Cyanide attaches permanently to the active site of this enzyme.

Explain why cyanide is a lethal metabolic poison.

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(Total for question = 7 marks)

Q5.

Nandrolone is an anabolic steroid, it is a molecule with a similar shape to testosterone. Nandrolone has been used as a performance-enhancing substance by athletes in the past.

A number of investigations with mice have been carried out to study the effect of nandrolone on the structure and function of the aorta.

In these investigations, all the mice were of one type and were all supplied with the same amount of food and water. These mice were placed into four groups.

Each group was treated differently for eight weeks. The treatments are shown in the table.

Group	Treatment	
	Allowed to exercise	Given nandrolone
P	No	No
Q	No	Yes
R	Yes	No
S	Yes	Yes

After eight weeks, the aorta of each mouse was studied.

(i) In investigation 1, samples of aorta were put under tension to test elastic recoil.

The tension was removed and the mean maximum percentage recoil for each group was found.

The results are shown in the table.

Group	Mean maximum percentage recoil (%)
P	57
Q	38
R	80
S	53

The use of nandrolone has been linked to a variety of cardiovascular conditions.

Explain how the use of nandrolone could lead to atherosclerosis.

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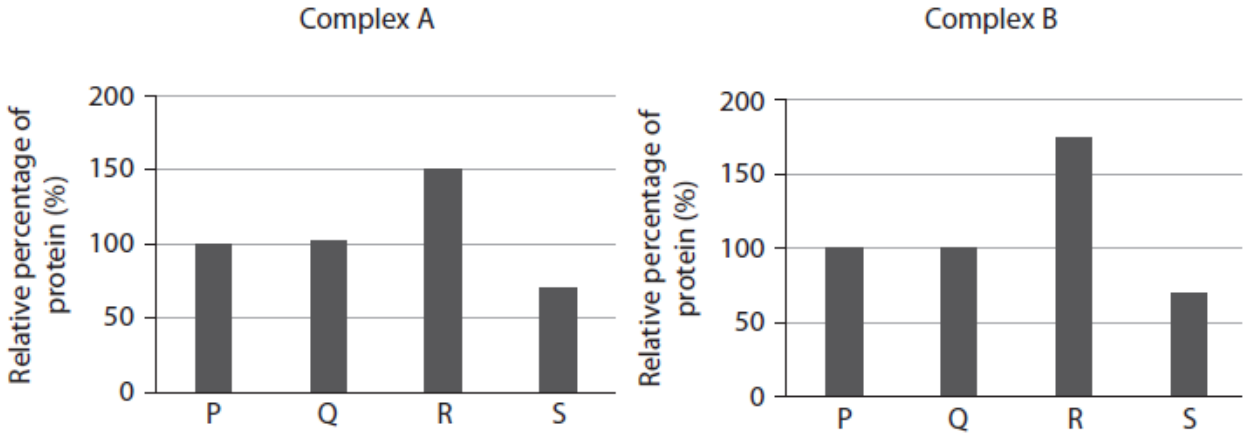
(ii) In investigation 2, some of the cells from the middle layer of the aortas of the

mice were removed.

Two protein complexes, A and B, are found in the cells of the middle layer.
These protein complexes are involved in the electron transport chain.

The graphs show the relative percentage of these two protein complexes in each group of mice.



Comment on the effects of nandrolone on the production of ATP.

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(iii) The transcription factor Tfam is involved in the production of mitochondria.

In investigation 3, some of the cells from the middle layer of the aortas of the mice were removed. The quantity of mRNA per cell coding for Tfam was measured.

The results are shown in the table.

Group	Quantity of mRNA per cell coding for Tfam / a.u.
P	100 ± 20
Q	75 ± 10
R	170 ± 25
S	85 ± 15

A student concluded that nandrolone affects the quantity of mRNA per cell coding for Tfam.

Explain why this conclusion is not valid for all the mice.

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(2)

(Total for question = 8 marks)

Q6.

Dark chocolate contains a chemical called epicatechin.

An investigation was carried out to study the effect of epicatechin on mice.

Two groups of one-year-old male mice, group A and group B, were used in this investigation.

The mice in group A were given water containing epicatechin at a concentration of 1 mg per kg of their body mass, twice a day for 15 days. The mice in group B were given water without epicatechin added.

All other variables were kept constant.

(a) Suggest why the mice in group A were given water containing epicatechin at a concentrat of 1 mg per kg of their body mass rather than at a concentration of 1 mg per mouse.

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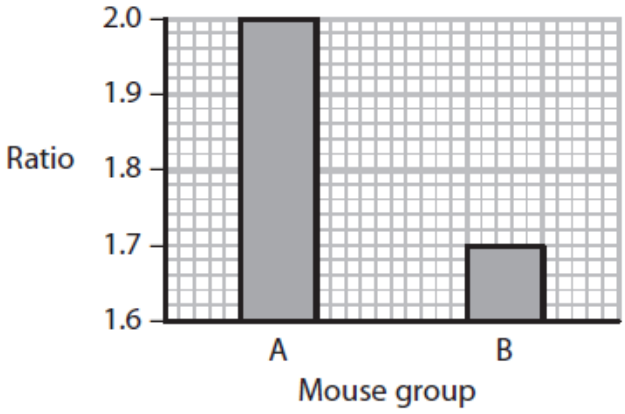
(b) After 15 days, skeletal muscle from the mice in the groups was compared.

(i) Skeletal muscle cells contain mitochondria. The surface areas of the inner and outer membranes of the mitochondria were compared.

The surface area of the inner membrane was divided by the surface area of the outer membrane to obtain a ratio.

The bar chart below shows the ratios for the two groups of mice.



Use the information in the bar chart to describe the effect of epicatechin on the mitochondria.

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(ii) The ability of the skeletal muscle to contract was compared. The time taken for the muscle to start to fatigue (fail to contract) was recorded.

The results are shown in the table below.

Group	Mean time taken for skeletal muscle to start to fatigue / seconds
A	164
B	130

Using information from the bar chart and your knowledge of respiration, suggest an explanation for the results shown in the table.

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(Total for question = 10 marks)