Name:_____ Period:_____

Cellular Respiration Problem Set

This problem set is worth 40 points and is due the day of your cumulative test on cellular respiration.
Best of luck.

1.
Fig. 6.1 shows the structure of ATP.

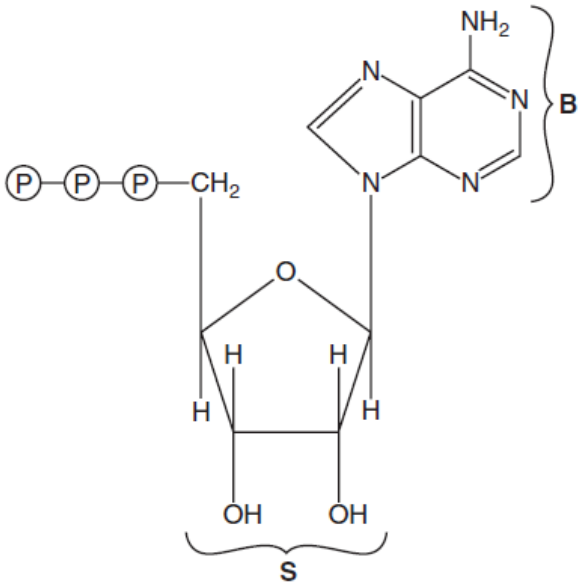

Fig. 6.1

(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.

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.....[4]

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

1 .....

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2 .....

.....[2]

[Total: 8]

2.

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

Fig. 6.1 outlines glycolysis.

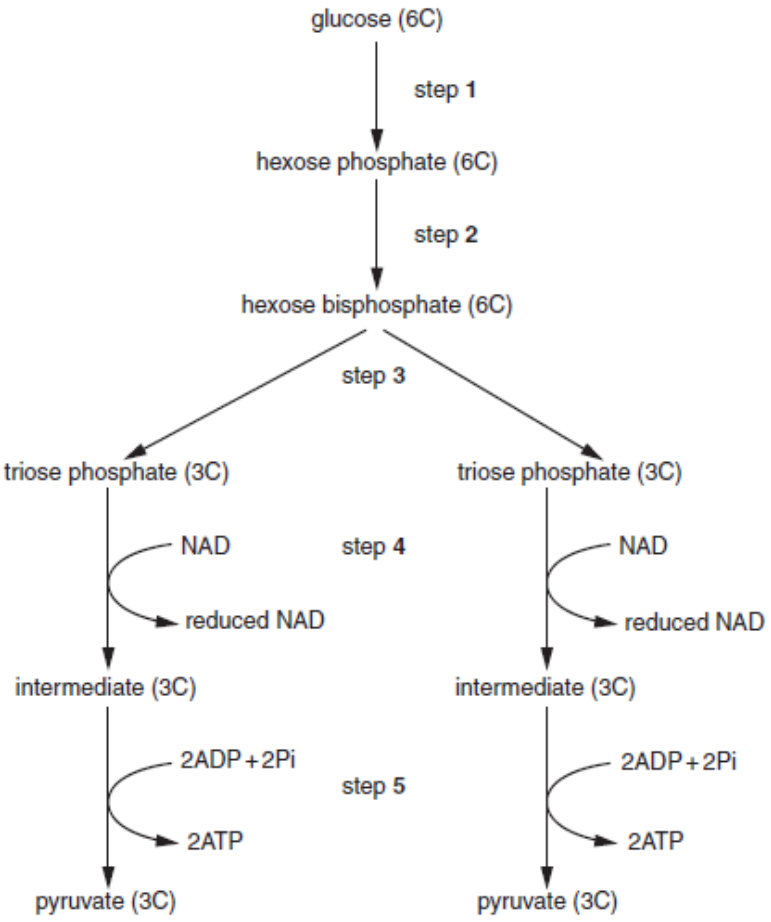

Fig. 6.1

(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.

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

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

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[Total: 9]

3.

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

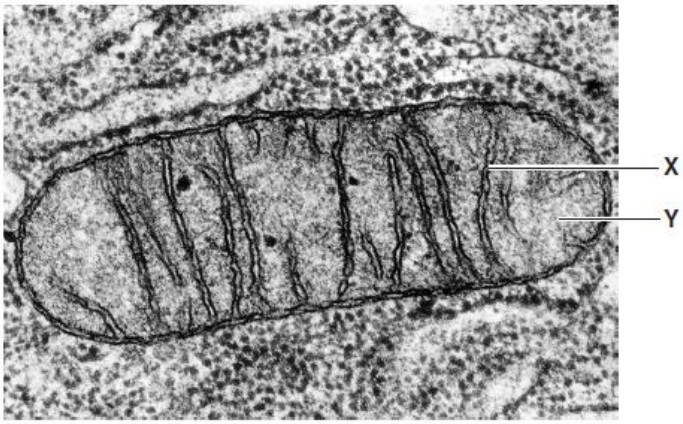

Fig. 8.1

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

X .....

Y ..... [2]

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

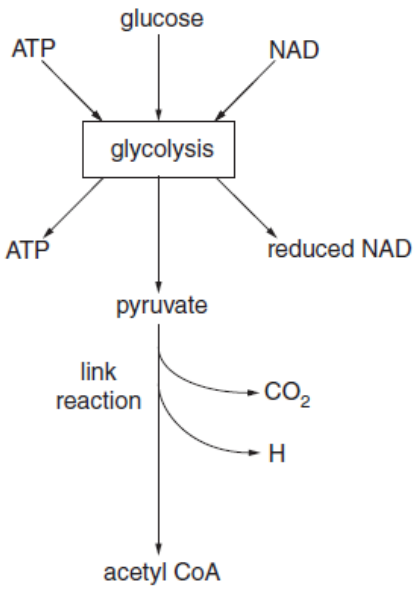

Fig. 8.2

With reference to Fig. 8.2:

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

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.....[1]

(ii) state the role of NAD in glycolysis

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.....[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.

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

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[Total: 15]

4.

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

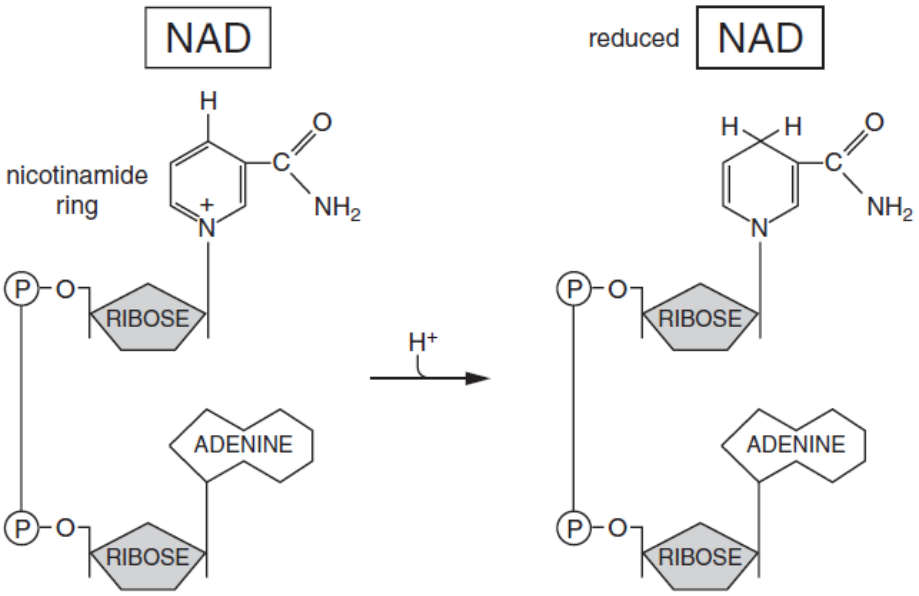

Fig. 2.1

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

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.....[2]

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

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.....[3]

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

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.....[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.

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.....[2]

[Total : 10]

5.

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

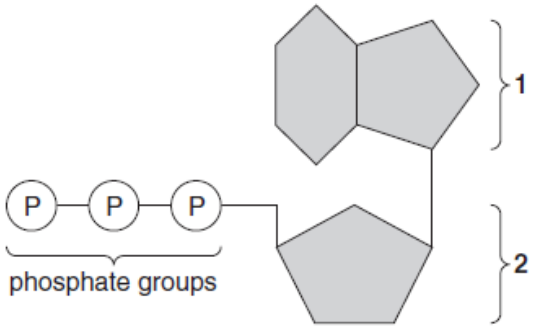

Fig. 3.1

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.

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.....[2]

(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.

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.....[2]

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

alanine .....

.....

lactate .....

.....[2]

[Total: 8]

6.

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

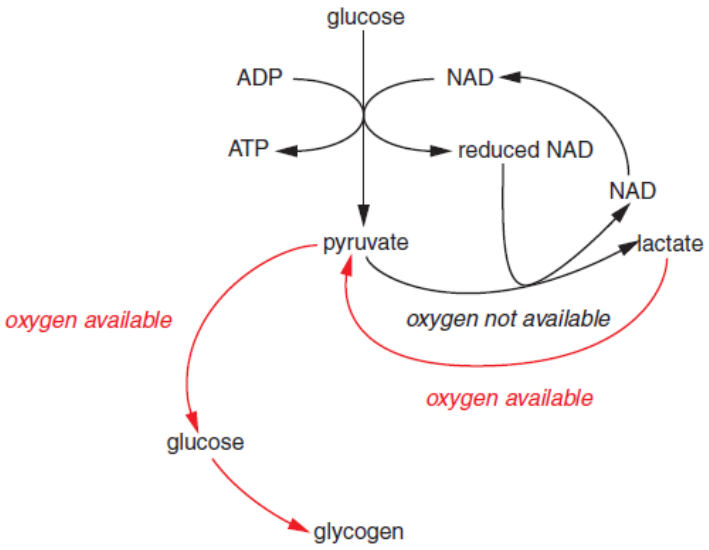

Fig. 8.1

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

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.....[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.

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.....[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.

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.....[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]

7.

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

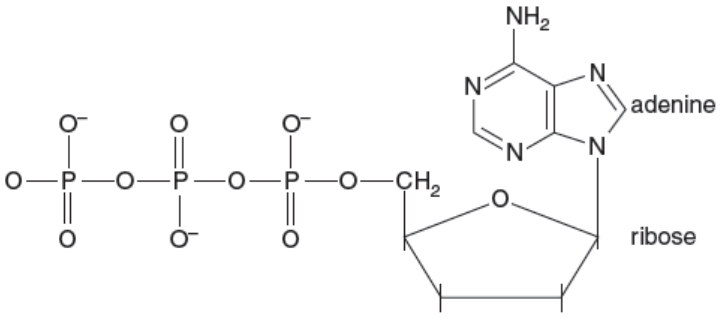

Fig. 5.1

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

1. .....

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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.

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.....[3]

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

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.....[3]

[Total: 8]

8.

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

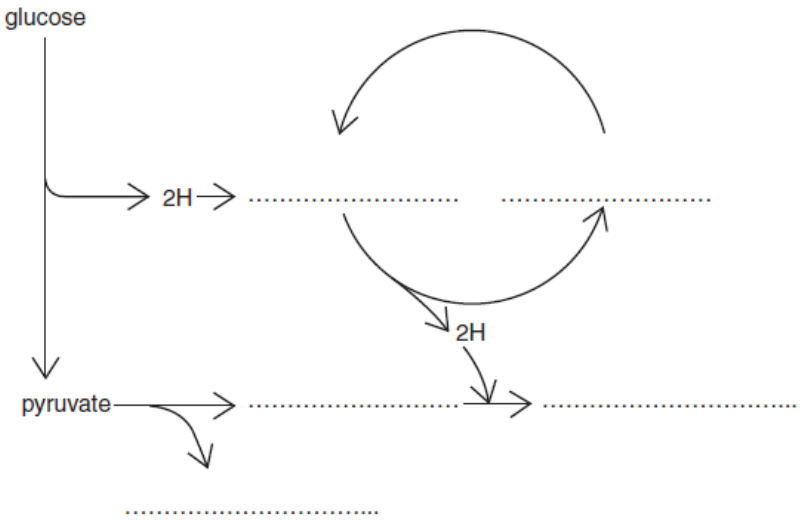

Fig. 6.1

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

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.....[3]

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

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[Total: 11]

9.

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

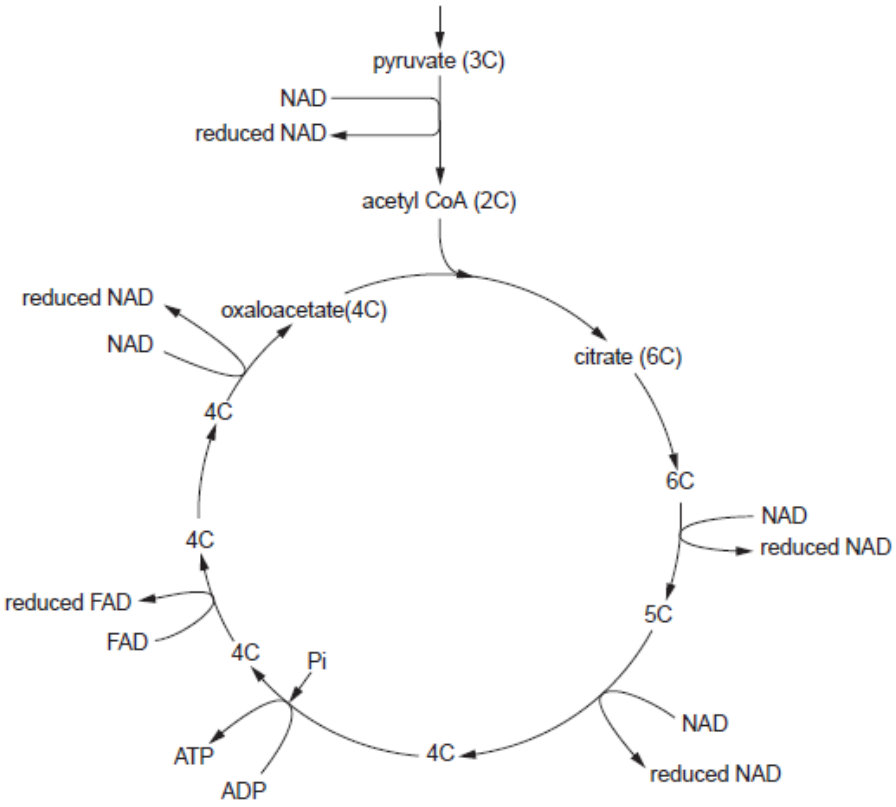

Fig. 1.1

(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.

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.....[3]

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

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.....[1]

[Total : 9]

10.

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

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.....[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.

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.....[3]

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

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.....[1]

[Total: 7]

11.

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

Outline the need for energy in living organisms.

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.....[2]

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

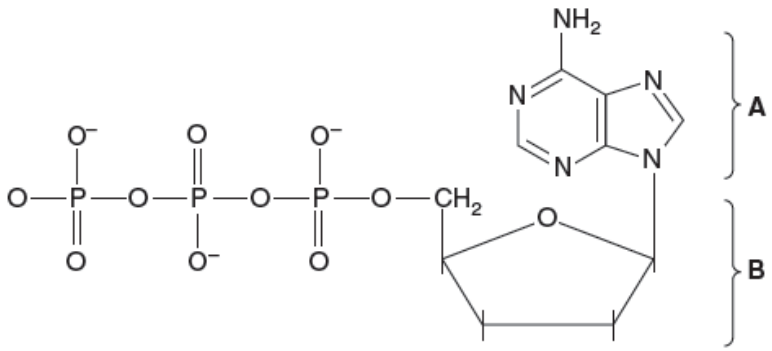

Fig. 4.1

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

A .....

B ..... [1]

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

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.....[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.

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.....[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.

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.....[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.

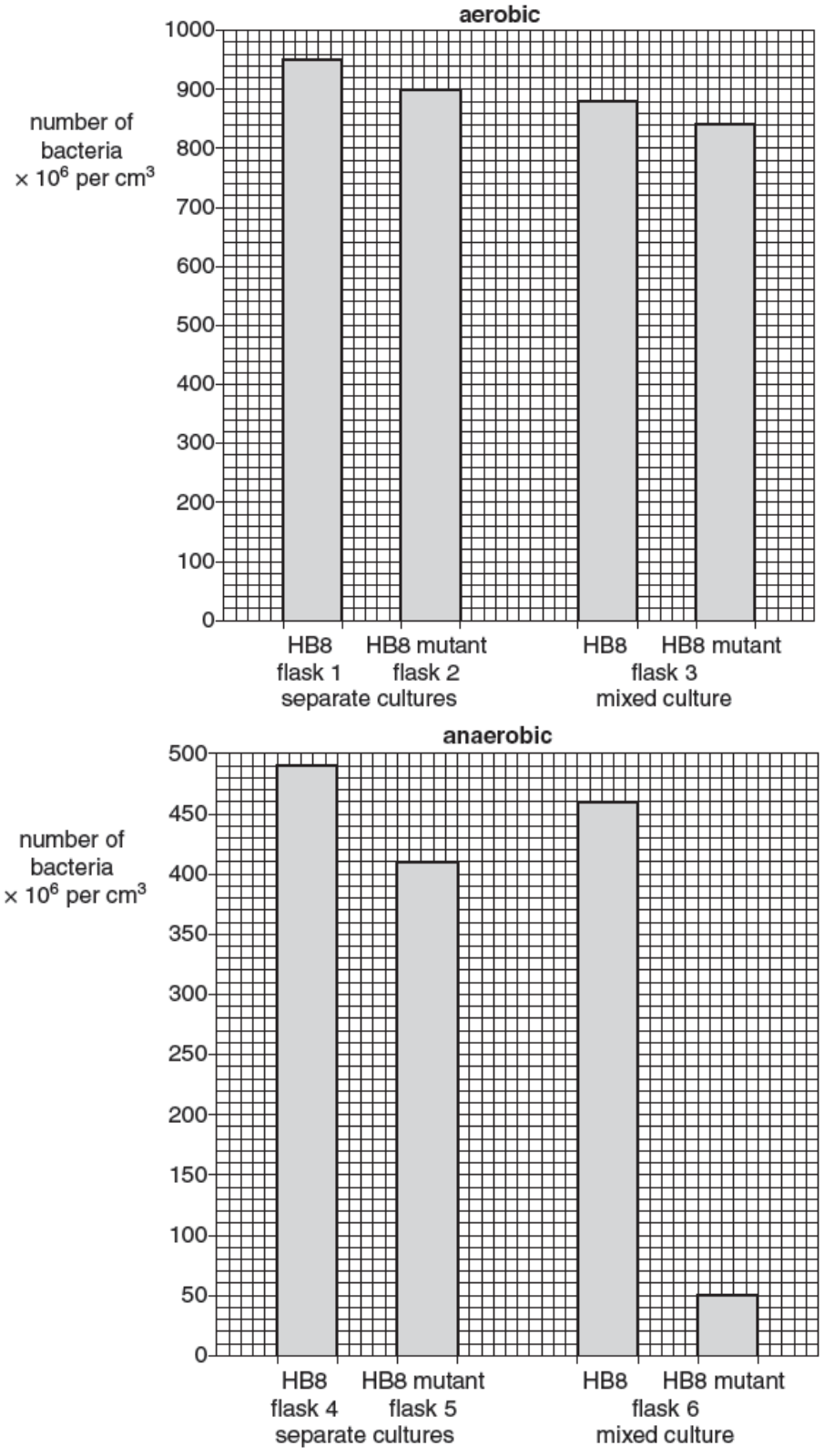

Fig. 4.2

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

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.....[2]

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

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.....[2]

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

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.....[1]

[Total: 14]

12.

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.

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..... [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.

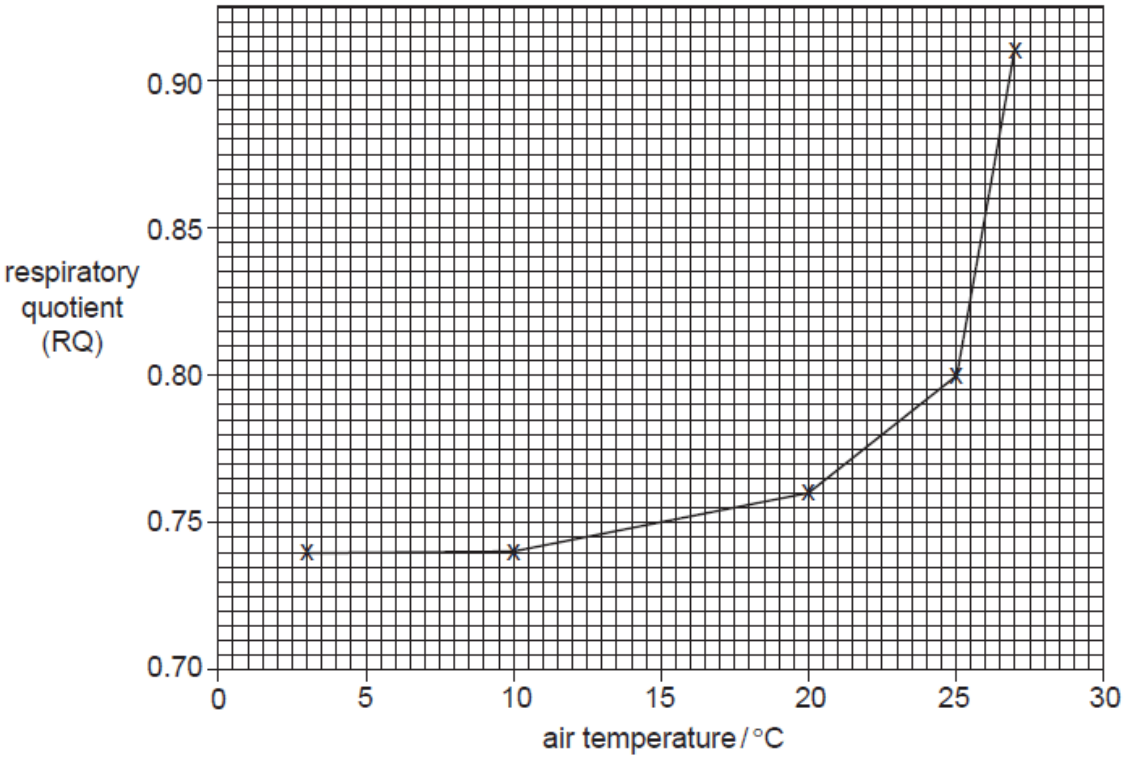

Fig. 1.1

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

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..... [4]

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

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..... [1]

[Total: 10]

Extended Essays: Answer the following essays on separate sheets of paper and attach.

13.

(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]

14.

(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]

15.

(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]