PEARSON EDEXCEL A-LEVEL BIOLOGY B · 9BI0

BIOLOGY



EXAM QUESTION PACK

TOPIC 5: ENERGY FOR BIOLOGICAL PROCESSES

LINK REACTION AND KREBS CYCLE

SCORE	PERCENTAGE
/241	%

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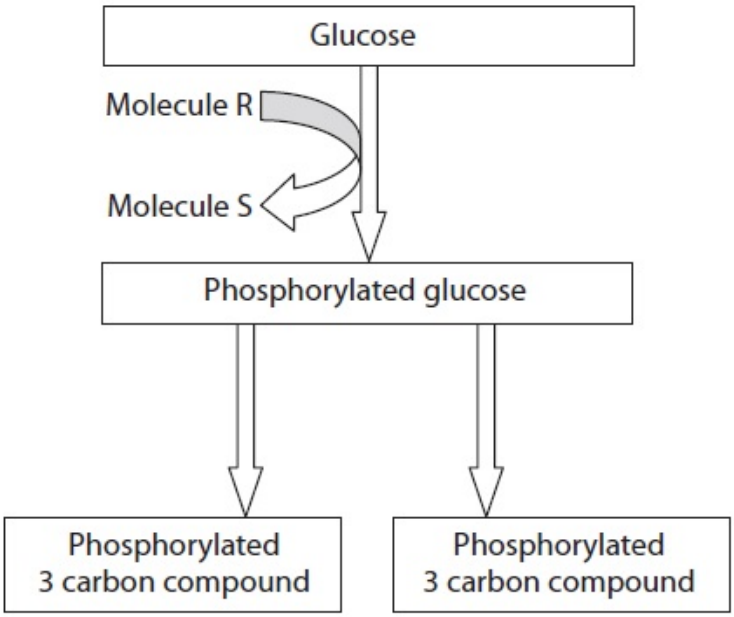
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Q1.

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.



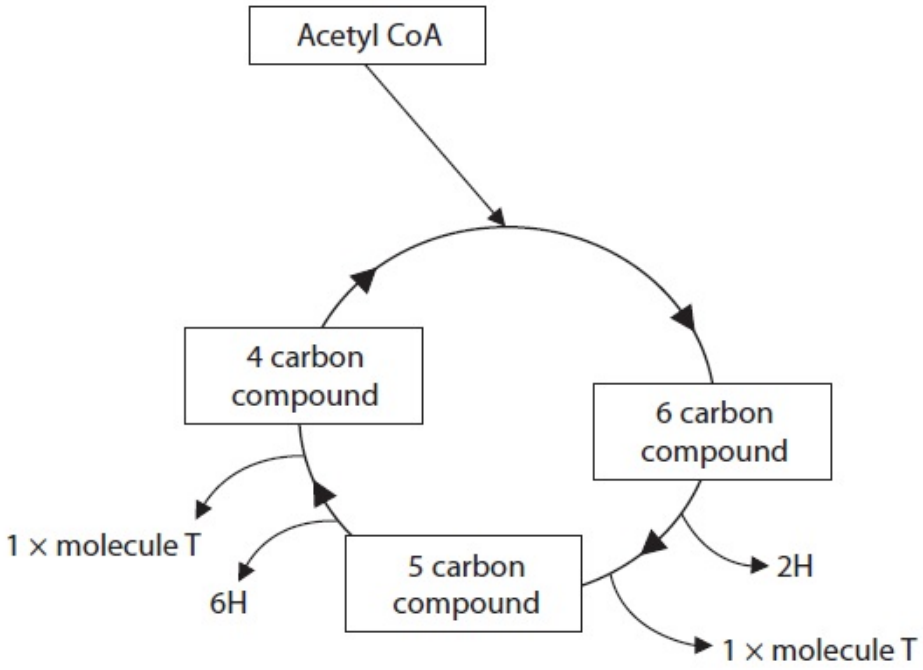
Name the molecules R and S shown in the diagram.

(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.

(2)

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

(3)

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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.

Compare and contrast the way in which ATP is synthesised in mitochondria and in chloroplasts.

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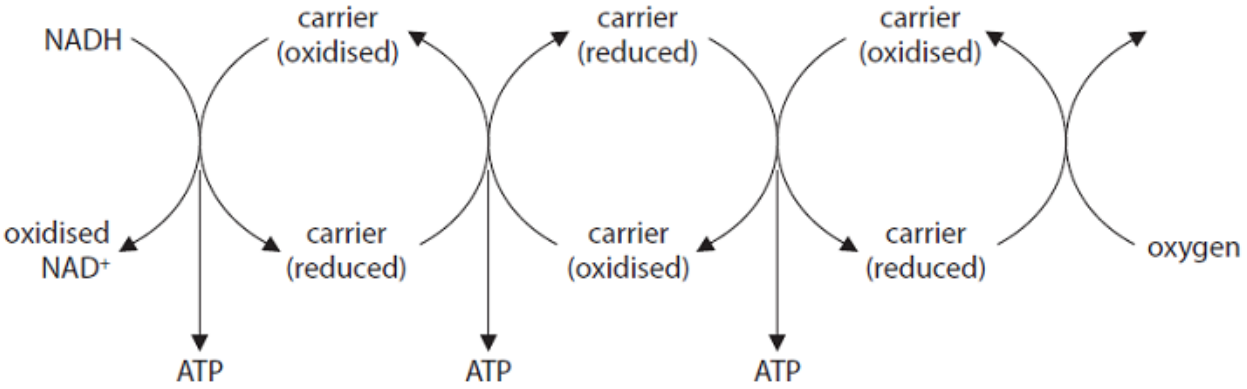
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Q3.

The electron transport chain requires oxygen and synthesises ATP.

The diagram below shows part of the electron transport chain.



Describe what happens to oxygen at the end of the electron transport chain.

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(Total for question = 2 marks)

Q4.

Hydrogen cyanide gas is a poison that can kill an animal if it is inhaled.

Cyanide is a non-competitive inhibitor of the enzyme cytochrome oxidase.

Cytochrome oxidase is the last carrier in the electron transport chain.

(i) Explain why hydrogen cyanide gas can kill an animal.

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(ii) A dose of 1.0 mg of hydrogen cyanide per kilogram of body mass is fatal.

An animal with a body mass of 10 kg inhaled air containing 0.24 mg dm^{-3} of hydrogen cyanide.

The animal breathed at a rate of 15 dm^3 of air per minute.

Calculate how many minutes it would take for this animal to obtain a fatal dose.

Give your answer to three significant figures.

(3)

Answer ..... minutes

(Total for question = 8 marks)

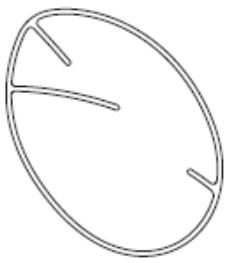
Q5.

Some antibiotics work by inhibiting the production of ribosomes in bacteria.

The structure of ribosomes in bacteria is similar to the structure of ribosomes in mitochondria.

These antibiotics can destroy cancer cells in humans.

The diagram shows the membranes of a mitochondrion from a cancer cell treated with these antibiotics.



(i) Give one difference in the membranes of this mitochondrion compared with the membranes of a mitochondrion from an untreated cancer cell.

(1)

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(ii) Some cancer cells depend on oxidative phosphorylation for ATP production.

Explain why the antibiotics that inhibit the production of ribosomes prevent oxidative phosphorylation when used to treat cancer cells.

(2)

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(iii) Some scientists suggested that inhibiting both glycolysis and mitochondrial respiration may be an effective way of treating cancer cells.

Explain why this suggestion may be an effective way of treating cancer cells.

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(Total for question = 5 marks)

Q6.

The table shows the protein : lipid ratio of the inner and outer membrane of a mitochondrion.

Membrane of mitochondrion	Protein : lipid ratio
inner	3:2
outer	1:1

Explain the difference in the protein : lipid ratio of the inner and outer membrane of a mitochondrion.

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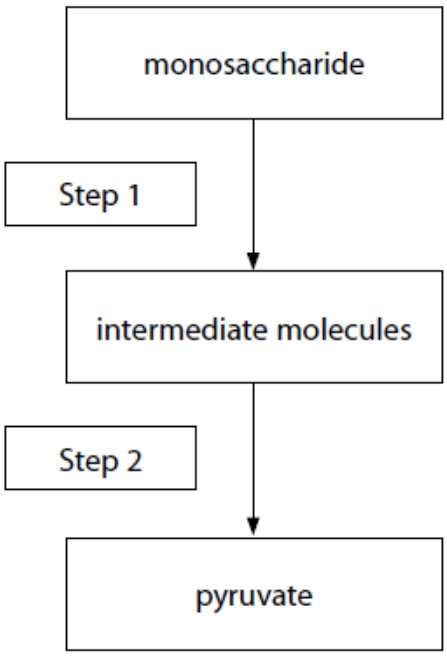
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(Total for question = 6 marks)

Q7.

The diagram below shows a stage of the process of respiration in the cytoplasm of muscle cells.



(a) What is the name of this stage?

(1)

- ☒ **A** Calvin cycle
- ☒ **B** glycogenolysis
- ☒ **C** glycolysis
- ☒ **D** Krebs cycle

(b) Which other products are formed during this stage?

(1)

- ☒ **A** ADP and carbon dioxide
- ☒ **B** ADP and oxidised coenzyme
- ☒ **C** ATP and carbon dioxide
- ☒ **D** ATP and reduced coenzyme

(c) What occurs in the first reaction of step 1?

(1)

- ☒ **A** condensation
- ☒ **B** hydrolysis
- ☒ **C** phosphorylation
- ☒ **D** photophosphorylation

(d) Describe what happens to the pyruvate when the muscle is supplied with oxygen.

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(Total for question = 7 marks)

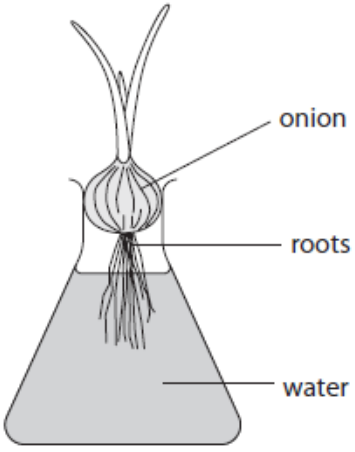
Q8.

A student read that some plants do not grow well in waterlogged soil.

The student formed the following hypothesis:

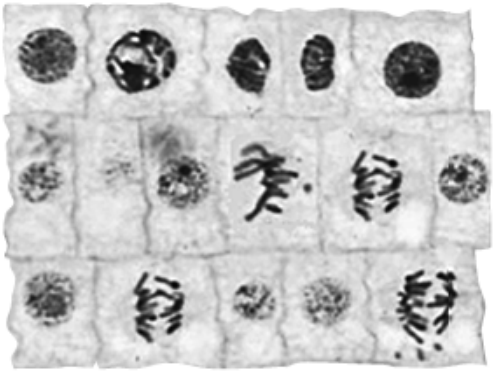
Adding water.

To test this hypothesis, the student grew onion roots in the apparatus shown.



The tips of the onion roots were removed and observed for stages of mitosis.

The photomicrograph shows a preparation from one onion root tip.



Waterlogged soil lacks oxygen.

Explain why a lack of oxygen in waterlogged soil could reduce the growth of a plant.

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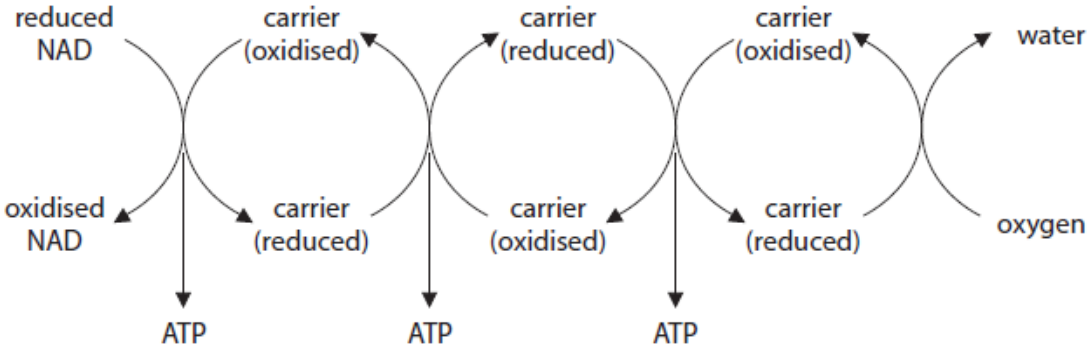
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(Total for question = 4 marks)

Q9.

The electron transport chain generates ATP.

The diagram shows the electron transport chain.



State the location of the electron transport chain in a mitochondrion.

(1)

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(Total for question = 1 mark)

Q10.

Mitochondrial disorders may be caused by mutations in the genes coding for mitochondrial components. Some of these genes are found in mitochondrial DNA (mtDNA) and some are found in nuclear DNA.

Leigh syndrome is an example of a mitochondrial disorder. In this syndrome, a number of different proteins involved in respiration are affected.

These mutations may be inherited or may occur when DNA replicates.

Some people with Leigh syndrome have a mutation in the MT-ATP6 gene.
This gene codes for ATP synthase.

This is a point mutation at nucleotide 8993 that changes thymine to guanine.

(i) What type of mutation is this?

(1)

☒ **A** insertion

☒ **B** monosomy

☒ **C** substitution

☒ **D** translocation

(ii) Explain how this mutation could affect oxidative phosphorylation.

(3)

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(Total for question = 4 marks)

Q11. The scientific article you have studied is adapted from several sources.

Use the information from the article and your own knowledge to answer the following questions.

(a) The sweet potato eaten by naked mole rats (paragraph 3) is very rich in starch. Starch can be a combination of amylose and amylopectin.

Give **two** structural differences between amylose and amylopectin.

(2)

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(b) Explain why a colony of naked mole rats is considered 'a eusocial society' (paragraph 4).

(2)

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(c) Naked mole rats show evidence of poikilothermy (paragraph 5).

(i) Explain what is meant by the term **poikilothermic**.

(1)

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(ii) Suggest how each of the following 'contribute to poikilothermic responses to changing temperature of this mammal'.

(2)

'Lack of an insulating layer'

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'A marked reduction in sweat glands'

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(d) Suggest a mechanism that could have been used to genetically modify cells from mice with cancer-causing genes (paragraph 13).

(2)

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*(e) Whilst naked mole rats are 'impervious to chemical pain' they do feel 'acute pain such as cuts and burns' (paragraph 31).

Touching something hot, which could lead to a burn, can cause nerve impulses to travel along myelinated sensory neurones very rapidly.

Explain how myelination increases the speed of transmission of nerve impulses in a sensory neurone.

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(f) Explain how a heart attack can temporarily reduce the oxygen concentration in brain tissue (paragraph 36).

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(g) Using the information in paragraph 48, name **one** hormone **and** state its function.

(1)

Hormone:

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Function:

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(h) Suggest how a change in the mid region of the sperm may make it non-motile (paragraph 48).

(2)

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(i) Disperser naked mole rats 'are laden with fat' (paragraph 50).

Suggest why it may be advantageous for disperser naked mole rats to have high levels of fat.

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(j) Explain the statement that 'a preference by reproductively active females for unfamiliar males is interpreted as inbreeding avoidance' (paragraph 52).

(2)

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(k) 'The naked mole rat hasn't yet had its genome sequenced' (paragraph 53).

Explain what is meant by the term **genome sequenced**.

(1)

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(l) 'With so much to offer science, it is no surprise that naked mole rats are becoming more common in labs' (paragraph 53).

Using information from the article, describe **two** adaptations of naked mole rats. For each adaptation, explain why it could be of interest in a medical research laboratory.

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(Total for Question = 30 marks)

Q12.

A student investigated the rate of uptake of nitrate ions (NO_3^-) into plant cells.

Discs of carrot were cut and half of them were immersed in a solution containing 10 µmol dm^{-3} nitrate ions. The other half were placed in the same nitrate ion solution to which 2,4-dinitrophenol (DNP) was added.

DNP inhibits the process of oxidative phosphorylation.

The nitrate ion concentration of the discs was determined every five minutes.

The student failed to pre-treat the carrot discs before placing them in the solution.

(a) Explain how the carrot discs should be pre-treated.

(3)

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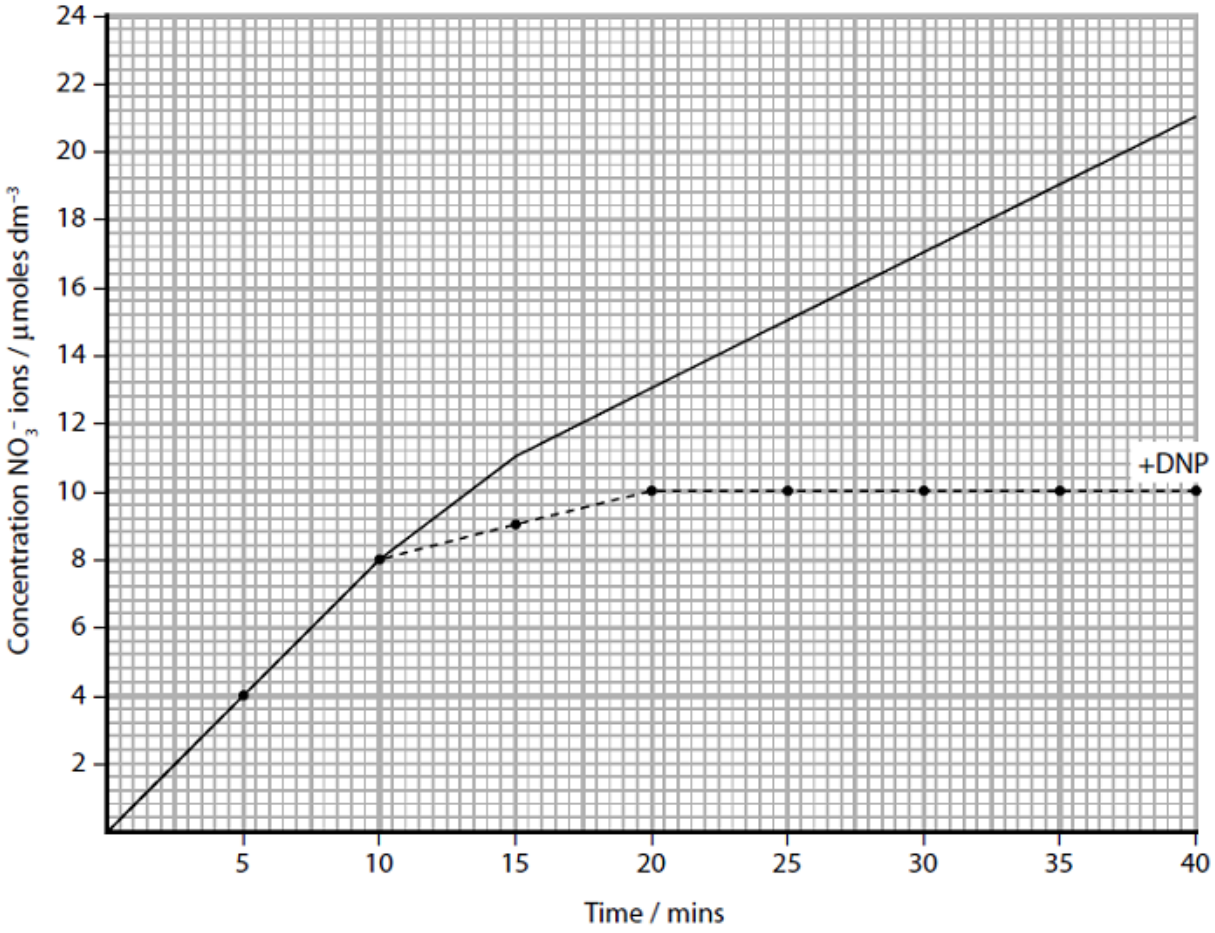
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The graph below shows the results of this investigation after the carrot discs were pre-treated.



(b) Calculate the mean rate of nitrate ion uptake of the carrot discs placed in the nitrate ion solution without DNP between 5 and 10 minutes.

(3)

Answer .....

(c) Analyse the data to explain the effect of DNP on the nitrate ion uptake of the carrot tissue between 0 to 10 minutes and 20 to 30 minutes.

(3)

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(d) DNP acts by rapidly transferring protons (H^+ ions) across biological membranes.

Explain how this action will bring about the effect of DNP on oxidative phosphorylation.

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(Total for question = 12 marks)

Q13.

The electron carriers in chloroplasts are inhibited by detergent.

Detergents dissolve lipids.

Explain how detergents inhibit the functioning of electron carriers in chloroplasts.

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Q14.

The photograph below shows a desert mammal.



(Source: http://www.ardea.com)

Some desert mammals do not drink water. They obtain water from the food they eat and from respiration.

(a) Explain how water is formed in respiration.

(2)

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(b) The table below shows the percentage of plant roots and insects in the diet of two different species of desert mammal.

Food	Percentage of food in diet (%)	
	M. hurrianae	*T. indica*
Plant roots	40	20
Insects	10	25

(i) The desert mammals eat 8 g of food in one day. Calculate how many more grams of insects are eaten by *T. indica* than by *M. hurrianae*.

(2)

Answer ..... g

(ii) Which species has kidneys that will produce the most concentrated urine?
Justify your answer.

(2)

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(c) Which row of the table below shows the correct changes to the concentration of sodium ions as fluid moves along the descending and ascending loop of Henle?

(1)

	Concentration of sodium ions (Na^+) in descending loop of Henle	Concentration of sodium ions (Na^+) in ascending loop of Henle
☒ **A**	increases	increases
☒ **B**	increases	decreases
☒ **C**	decreases	increases
☒ **D**	decreases	decreases

(d) The concentration of urine is controlled by osmoreceptors and the secretion of ADH.

Which row of the table below shows the location of the osmoreceptors and the correct level of ADH secretion in a desert mammal that produces concentrated urine?

(1)

	Location of osmoreceptors	Level of ADH
☒ **A**	carotid body	high
☒ **B**	carotid body	low
☒ **C**	hypothalamus	high
☒ **D**	hypothalamus	low

(e) Explain how the nephrons of desert mammals enable them to survive in a dry environment.

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(Total for question = 12 marks)

Q15.

Mitochondrial disorders may be caused by mutations in the genes coding for mitochondrial components. Some of these genes are found in mitochondrial DNA (mtDNA) and some are found in nuclear DNA.

Leigh syndrome is an example of a mitochondrial disorder. In this syndrome, a number of different proteins involved in respiration are affected.

These mutations may be inherited or may occur when DNA replicates.

Some people with Leigh syndrome have mutations that affect proteins involved in the electron transport chain.

Explain why these mutations lead to a build-up of lactate.

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(Total for question = 3 marks)

Q16.

Lipids and carbohydrates are used as respiratory substrates.

The respiration of lipids generates more ATP than the respiration of carbohydrates.

The electron transport chain uses hydrogen ions to generate ATP.

Explain why the respiration of lipids generates more ATP than the respiration of carbohydrates.

(2)

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(Total for question = 2 marks)

Q17.

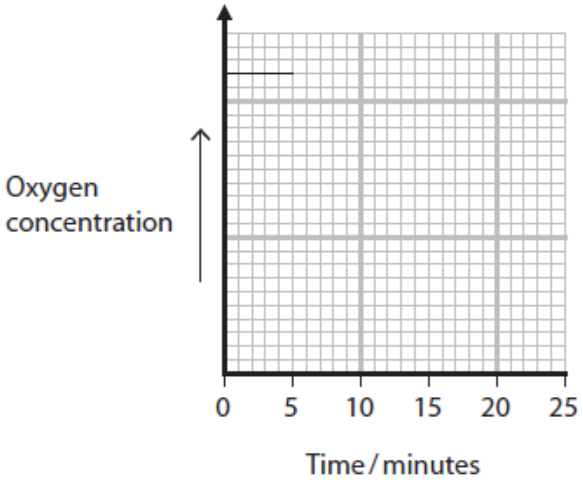
The effect of cyanide on oxygen uptake by mitochondria was investigated using the following method:

- suspend mitochondria in a flask containing a buffer solution
- measure the concentration of oxygen in the flask for the first five minutes
- then add a respiratory substrate and ADP to the flask
- measure the concentration of oxygen in the flask for the next 10 minutes
- then add cyanide solution to the flask
- measure the concentration of oxygen in the flask for the next 10 minutes.

The graph shows the results for the first five minutes.

Complete the graph to show the results for the next 20 minutes.

(2)

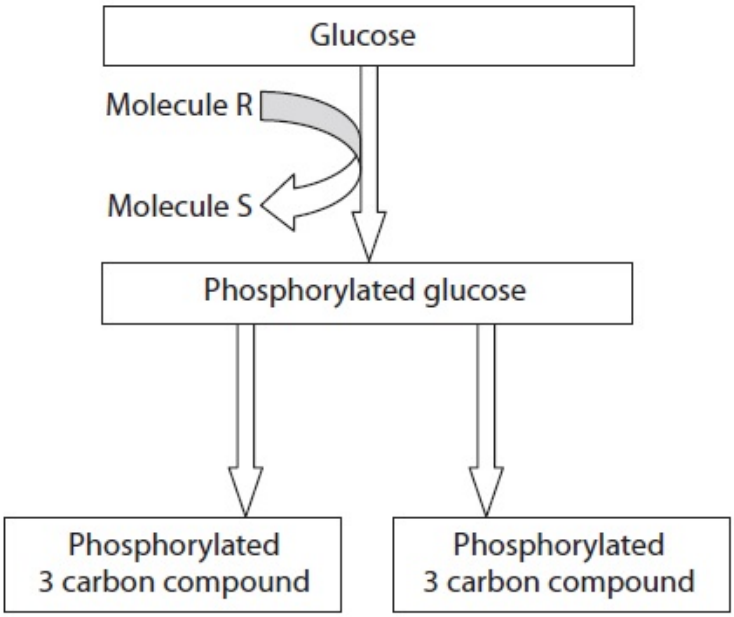


(Total for question = 2 marks)

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.



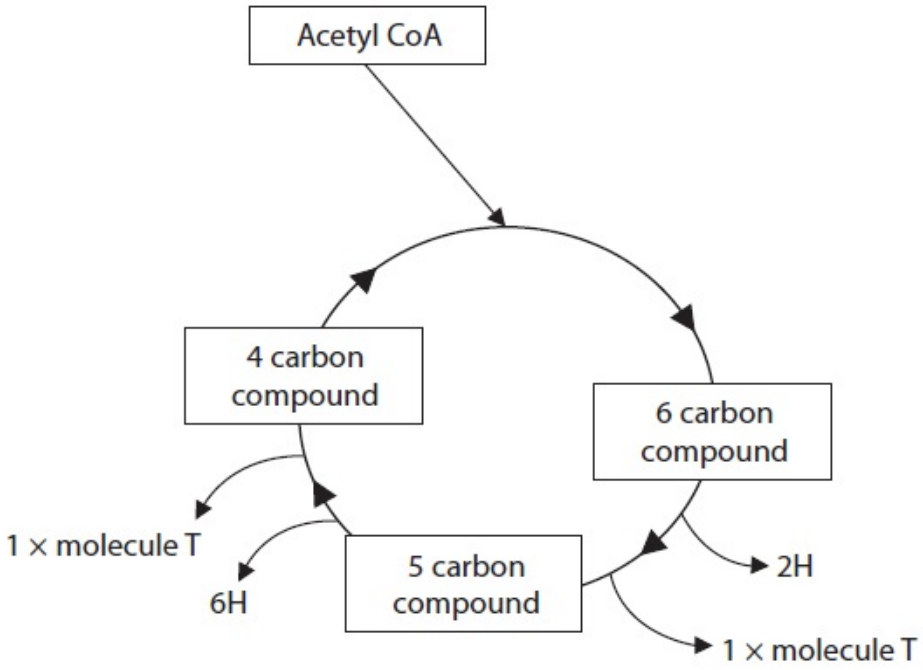
Name the molecules R and S shown in the diagram.

(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.

(2)

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

(3)

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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**.

(3)

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(Total for question = 10 marks)

Q2.

The scientific article you have studied is adapted from articles in New Scientist.

Use the information from the article and your own knowledge to answer the following questions.

(a) Suggest why 'incredibly efficient cellular mechanisms' can increase the chance of obesity (paragraphs 4 and 5).

(2)

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(b) A larger VO_2max means more oxygen can enter a mitochondrion and therefore more energy can be released from fuel (paragraph 8).

Name **two** substances, other than oxygen, that need to enter the mitochondrion to enable energy to be released from fuel.

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(c) Describe the structure of glycogen (paragraph 11).

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(d) Using the information in paragraphs 12 to 14, explain how lowered testosterone levels may help a cyclist to race harder on successive days.

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(e) Explain why Coyle suggests that greater muscle efficiency may be linked to an increase in the percentage of **slow twitch** muscle fibres (paragraph 20).

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*(f) Suggest how 'the development of a leak in a specific class of calcium channel in muscle cells' can lead to muscle fatigue (paragraph 23).

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(g) The ACE gene codes for the synthesis of angiotensin converting enzyme (ACE) (paragraph 25).

Complete the table by naming two nucleic acids involved in each of the processes described.

(2)

Process	Two nucleic acids involved in the process
Transcription of the ACE gene	1 ..... 2 .....
Synthesis of ACE at a ribosome	1 ..... 2 .....

(h) A variant of the APOE gene could put individuals at increased risk in contact sports. DNA profiling is a technique that can be used in genetic screening.

Suggest how DNA profiling could be carried out to identify this variant of the APOE gene (paragraph 27).

(4)

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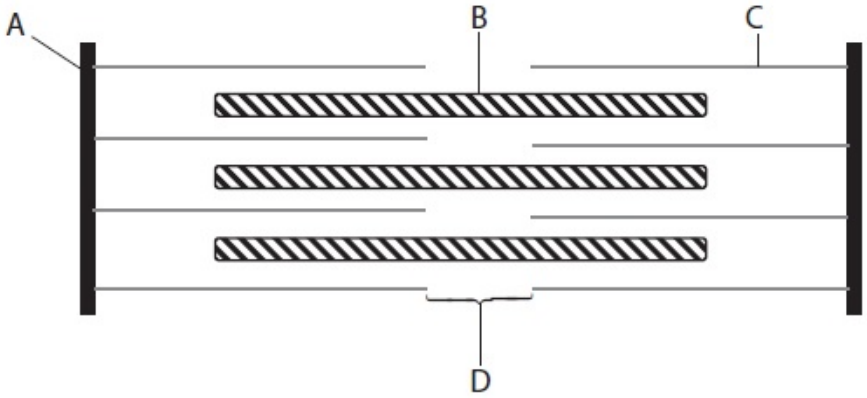
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(i) The titin gene produces a protein that attaches to myosin in a sarcomere (paragraph 30).



Place a cross (☒) in the box that identifies myosin shown in the diagram.

(1)

☒ **A**

☒ **B**

☒ **C**

☒ **D**

(j) The colder the water Japanese Ama divers swim in, the higher their resting metabolic rate (paragraph 50).

Suggest and explain why this might be an advantage to these divers.

(3)

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(k) Pugh noticed the effects of climate change (paragraph 53).

Name **two** greenhouse gases that contribute to climate change. Give **one** source of each of these gases.

(2)

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(l) Using the information in paragraph 55, calculate the percentage increase in Pugh's core body temperature due to his "anticipatory thermogenesis".

Show your working.

(2)

Answer = ... %

(Total for question = 30 marks)

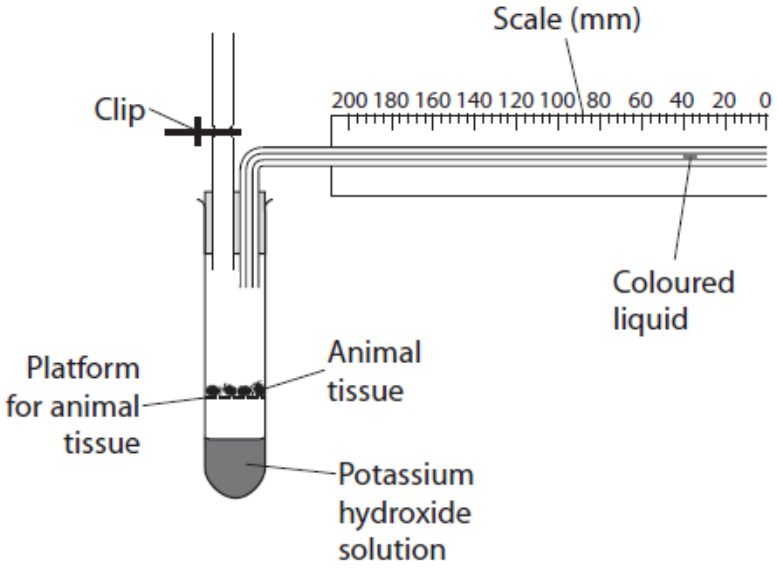
Q3.

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.

(2)

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

(3)

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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 table shows the protein : lipid ratio of the inner and outer membrane of a mitochondrion.

Membrane of mitochondrion	Protein : lipid ratio
inner	3:2
outer	1:1

Explain the difference in the protein : lipid ratio of the inner and outer membrane of a mitochondrion.

(6)

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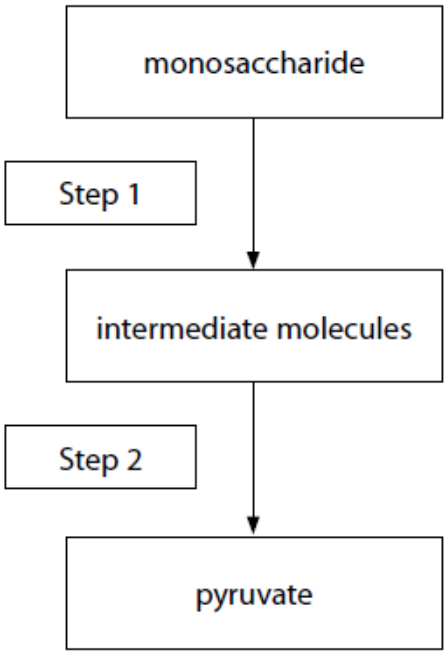
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(Total for question = 6 marks)

Q5.

The diagram below shows a stage of the process of respiration in the cytoplasm of muscle cells.



(a) What is the name of this stage?

(1)

☒ **A** Calvin cycle

☒ **B** glycogenolysis

☒ **C** glycolysis

☒ **D** Krebs cycle

(b) Which other products are formed during this stage?

(1)

☒ **A** ADP and carbon dioxide

☒ **B** ADP and oxidised coenzyme

☒ **C** ATP and carbon dioxide

☒ **D** ATP and reduced coenzyme

(c) What occurs in the first reaction of step 1?

(1)

☒ **A** condensation

☒ **B** hydrolysis

☒ **C** phosphorylation

☒ **D** photophosphorylation

(d) Describe what happens to the pyruvate when the muscle is supplied with oxygen.

(4)

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(Total for question = 7 marks)

Q6.

(i) Which of the following stages of aerobic respiration produces four molecules of carbon dioxide for each glucose molecule?

(1)

☒ **A** glycolysis

☒ **B** Krebs cycle

☒ **C** link reaction

☒ **D** oxidative phosphorylation

(ii) Which of the following is the approximate percentage of total ATP produced, directly from the Krebs cycle?

(1)

☒ **A** 0%

☒ **B** 5%

☒ **C** 63%

☒ **D** 100%

(iii) Describe how glucose is converted to pyruvate in glycolysis.

(3)

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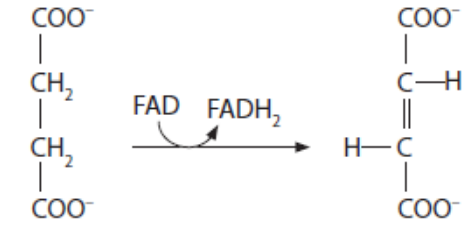
Q7.

Mitochondria can be extracted from liver cells.

In order to monitor the purification of a sample of mitochondria,
a protein concentration : enzyme activity ratio can be determined.

The enzyme used to monitor the purification of mitochondria is succinate dehydrogenase.

This enzyme is involved in the Krebs cycle and converts succinate into fumarate in this reaction.



Succinate Fumarate

(i) When succinate is converted into fumarate, succinate is

(1)

☒ **A** hydrolysed

☒ **B** oxidised

☒ **C** phosphorylated

☒ **D** reduced

(ii) Explain the role of the Krebs cycle.

(4)

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(Total for question = 5 marks)

Q8. The scientific article you have studied is adapted from several sources.

Use the information from the article and your own knowledge to answer the following questions.

(a) The sweet potato eaten by naked mole rats (paragraph 3) is very rich in starch. Starch can be a combination of amylose and amylopectin.

Give **two** structural differences between amylose and amylopectin.

(2)

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(b) Explain why a colony of naked mole rats is considered 'a eusocial society' (paragraph 4).

(2)

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(c) Naked mole rats show evidence of poikilothermy (paragraph 5).

(i) Explain what is meant by the term **poikilothermic**.

(1)

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(ii) Suggest how each of the following 'contribute to poikilothermic responses to changing temperature of this mammal'.

(2)

'Lack of an insulating layer'

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'A marked reduction in sweat glands'

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(d) Suggest a mechanism that could have been used to genetically modify cells from mice with cancer-causing genes (paragraph 13).

(2)

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*(e) Whilst naked mole rats are 'impervious to chemical pain' they do feel 'acute pain such as cuts and burns' (paragraph 31).

Touching something hot, which could lead to a burn, can cause nerve impulses to travel along myelinated sensory neurones very rapidly.

Explain how myelination increases the speed of transmission of nerve impulses in a sensory neurone.

(5)

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(f) Explain how a heart attack can temporarily reduce the oxygen concentration in brain tissue (paragraph 36).

(3)

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(g) Using the information in paragraph 48, name **one** hormone **and** state its function.

(1)

Hormone:

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Function:

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(h) Suggest how a change in the mid region of the sperm may make it non-motile (paragraph 48).

(2)

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(i) Disperser naked mole rats 'are laden with fat' (paragraph 50).

Suggest why it may be advantageous for disperser naked mole rats to have high levels of fat.

(3)

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(j) Explain the statement that 'a preference by reproductively active females for unfamiliar males is interpreted as inbreeding avoidance' (paragraph 52).

(2)

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(k) 'The naked mole rat hasn't yet had its genome sequenced' (paragraph 53).

Explain what is meant by the term **genome sequenced**.

(1)

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(l) 'With so much to offer science, it is no surprise that naked mole rats are becoming more common in labs' (paragraph 53).

Using information from the article, describe **two** adaptations of naked mole rats. For each adaptation, explain why it could be of interest in a medical research laboratory.

(4)

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(Total for Question = 30 marks)

Q9.

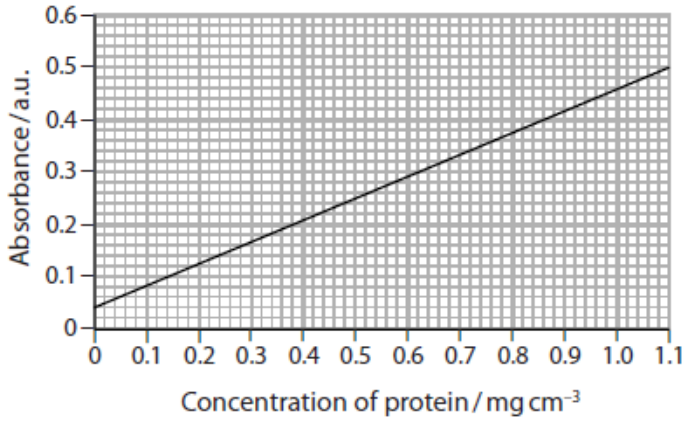
Mitochondria can be extracted from liver cells.

In order to monitor the purification of a sample of mitochondria,
a protein concentration : enzyme activity ratio can be determined.

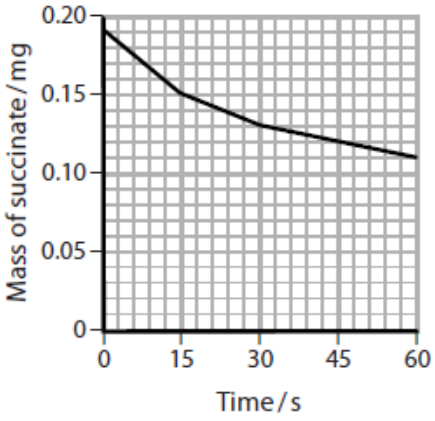
Protein concentrations can be determined by using a calibration curve, shown in graph 1.

The initial rate of activity of succinate dehydrogenase, from a sample of mitochondria, can be determined using graph 2.

Graph 1



Graph 2



(i) This sample of mitochondria had an absorbance of 0.28 when the protein concentration was

measured.

Determine the protein concentration of this sample of mitochondria.

(1)

Answer .....

(ii) Determine the initial rate of enzyme activity to obtain the protein : enzyme activity ratio for this sample of mitochondria.

(2)

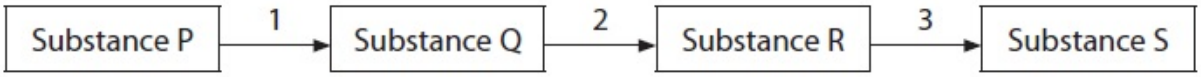
Ratio .....

(Total for question = 3 marks)

Q10. Respiration is a metabolic process which consists of many steps.

(a) The diagram below shows a metabolic process consisting of three steps.

Each letter represents a different substance and each number a different enzyme.



Describe and explain the functions of enzymes in this metabolic process.

(4)

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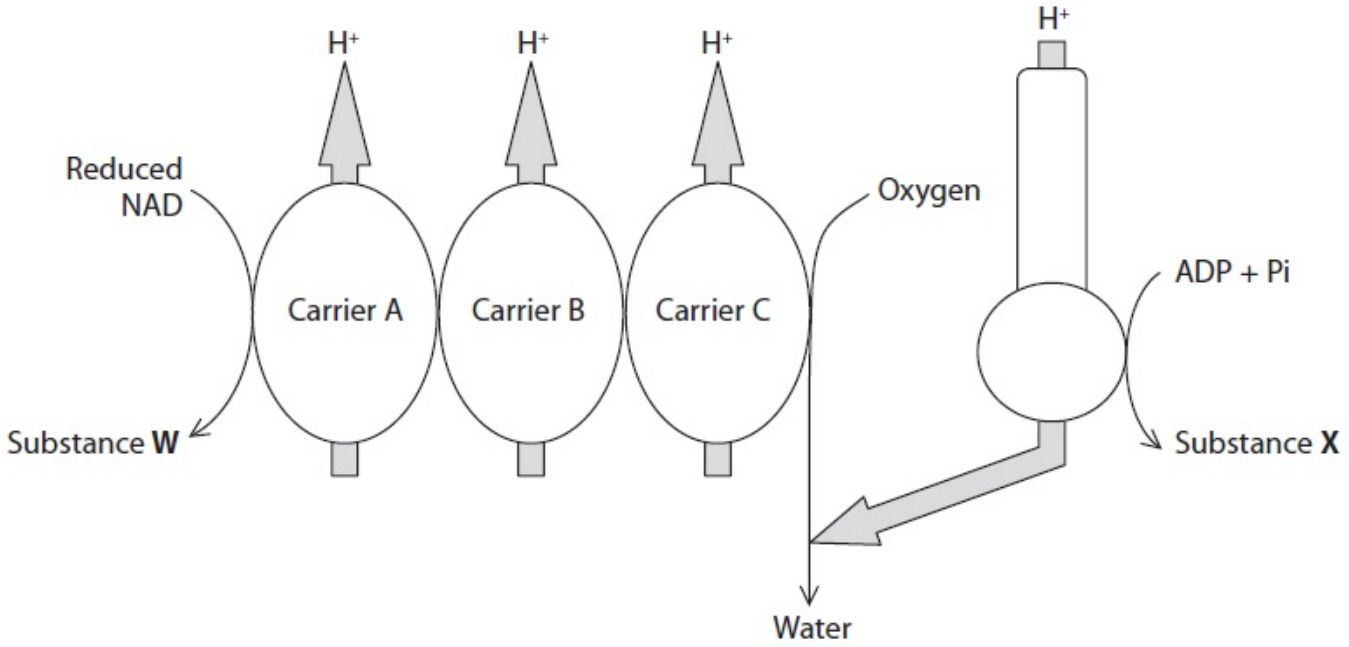
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(b) The diagram below shows the electron transport chain, which is part of aerobic respiration.



(i) Using the information in the diagram, name substance **W** and explain how it is formed.

(3)

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(ii) Name substance **X**.
Explain the link between the formation of substance **X** and the H^+ shown on the diagram.

(3)

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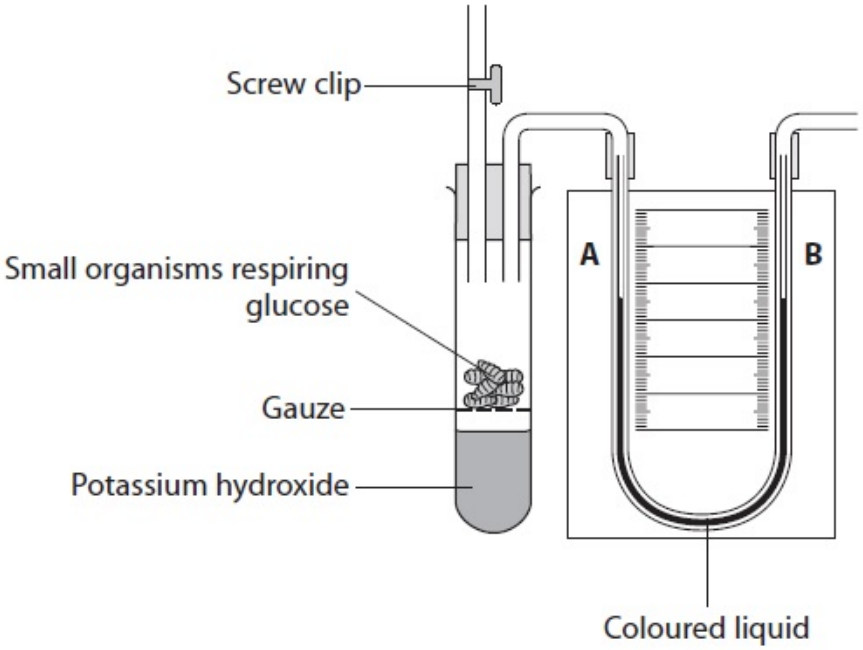
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(c) The diagram below shows a respirometer used to measure the rate of aerobic respiration in small organisms.



Potassium hydroxide absorbs carbon dioxide.
The table below describes three different situations.
Place a cross in the box ☒ that correctly shows the movement of the coloured liquid in the U-shaped tube for each situation.

(3)

Situation	Movement of coloured liquid		
	towards A	towards B	does not move
Screw clip is open	☒	☒	☒
Screw clip is closed	☒	☒	☒
Potassium hydroxide is replaced with water and screw clip is closed	☒	☒	☒

(Total for Question = 13 marks)

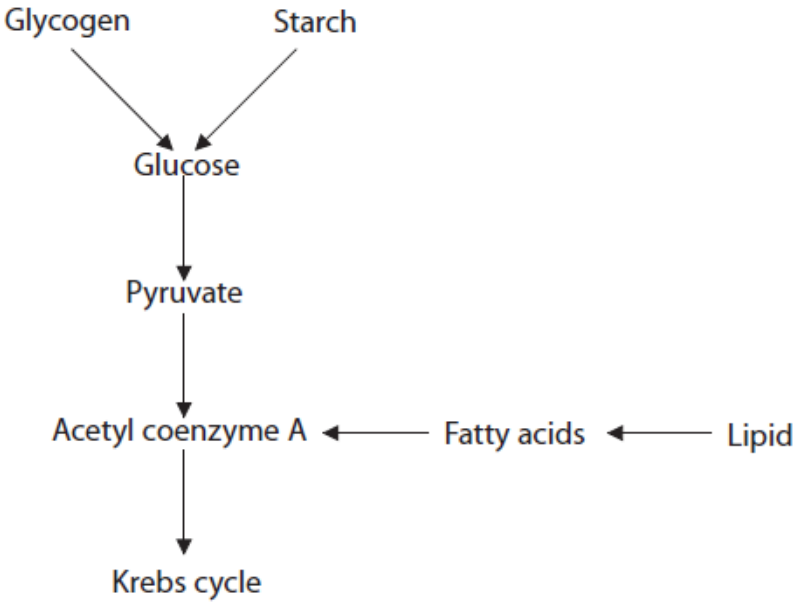
Q11.

Answer the question with a cross in the box you think is correct ☒. If you change your mind about an answer, put a line through the box ☒ and then mark your new answer with a cross ☒.

Lipids and carbohydrates are used as respiratory substrates.

The respiration of lipids generates more ATP than the respiration of carbohydrates.

The diagram shows some steps in the respiration of carbohydrates and lipids.



(i) Where in a cell does the conversion of pyruvate to acetyl coenzyme A take place?

(1)

☒ **A** cytoplasm

☒ **B** matrix

☒ **C** stroma

☒ **D** tonoplast

(ii) Explain why lipids can be respired only in aerobic conditions.

(3)

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(Total for question = 4 marks)

Q12.

Lipids and carbohydrates are used as respiratory substrates.

The respiration of lipids generates more ATP than the respiration of carbohydrates.

The respiratory quotient (RQ) can indicate which substrate is being used in respiration.

The formula used to calculate RQ is

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

(i) State why the RQ for carbohydrate is 1.0.

(1)

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(ii) The table shows the formula for calculating the volume of oxygen used and the volume of carbon dioxide produced in the respiration of lipids.

The number of carbon atoms in the lipid is represented by n.

Volume of oxygen used / a.u.	Volume of carbon dioxide produced / a.u.
4.5n + 3.75	3n + 6

Calculate the RQ for a lipid containing 21 carbon atoms.

(2)

Answer .....

(Total for question = 3 marks)