AQA A-LEVEL · 7402

BIOLOGY



EXAM QUESTION PACK

3.1.6 ATP

SCORE	PERCENTAGE
/104	%

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Q1.

(a) State **and** explain the property of water that can help to buffer changes in temperature.

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_____

(2)

(b) Water is used to hydrolyse ATP.

Name the **two** products of ATP hydrolysis.

1. _____

2. _____

(1)

Hydrolysis of ATP is catalysed by the enzyme ATP hydrolase.

A student investigated the effect of ATP concentration on the activity of ATP hydrolase. She used shortening of strips of muscle tissue caused by contraction as evidence that ATP was being hydrolysed.

- She took four slides **A**, **B**, **C** and **D**, and added strips of muscle tissue of the same length to each slide.
- She then added the same volume of ATP solutions of different concentrations to the four slides and left each slide for five minutes.
- She then recorded the final length of each strip of muscle tissue.

Her results can be seen in the table.

Slide	Concentration of ATP solution added to slide / $\times 10^{-6}$ mol dm^{-3}	Final length of muscle tissue after 5 minutes / mm
A	2	36

B	4	31
C	6	29
D	8	26

(c) Other than those given, name two variables the student should have controlled.

1. _____

_____

2. _____

_____

(2)

(d) Describe and explain the pattern shown by the data in the table.

Description

_____

_____

_____

_____

_____

Explanation _____

_____

_____

_____

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(2)

(e) The hydrolysis of 1 dm^3 of a 1 mol dm^{-3} solution of ATP releases 30 500 J of energy.

60% of the energy released during the hydrolysis of 1 mol dm^{-3} of ATP is released as heat; the rest is used for muscle contraction.

The student added 0.05 cm^3 of ATP solution to slide **D**.

Calculate the energy available from ATP for contraction of the muscle on this slide.

Answer = _____ J

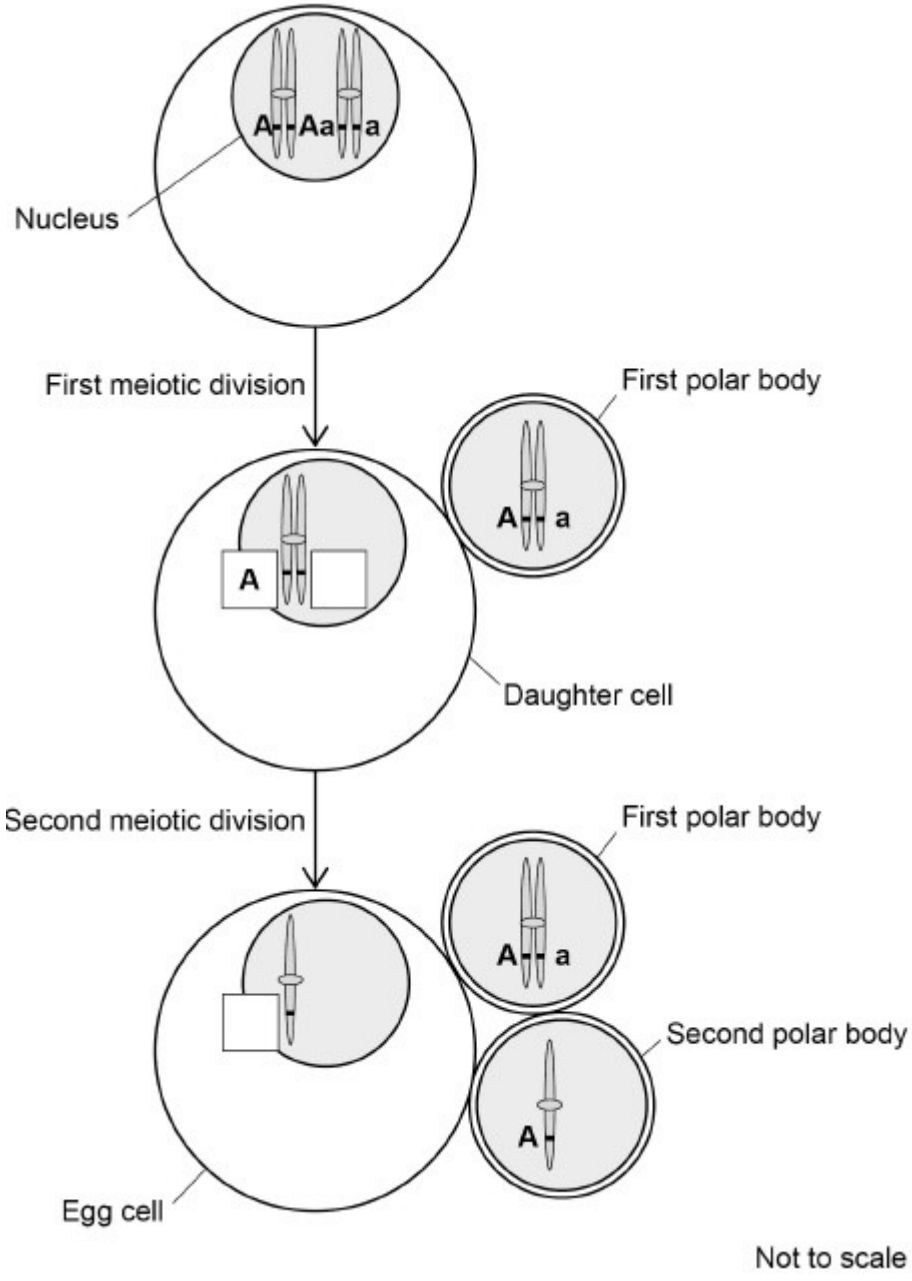
(3)

(Total 10 marks)

Q2.

In women, the first division of meiosis produces one daughter cell that has almost all of the cytoplasm. The other daughter cell consists of a nucleus surrounded by a very small amount of cytoplasm and a cell-surface membrane. This very small daughter cell is called a polar body. Polar bodies do not usually divide. The same process occurs in the second division of meiosis, resulting in one egg cell and two polar bodies.

The diagram shows the formation of an egg cell and two polar bodies during meiosis. It also shows what happens to one pair of homologous chromosomes. This pair carries two alleles of gene A.



(a) Complete the diagram by putting **A** or **a** in the boxes. One box has been completed

for you with **A**.

(1)

(b) Put a tick (✓) in the box next to the name of the process that produced the combination of alleles on the chromosome in the first polar body in the diagram.

Anaphase ☐

Crossing over ☐

Independent assortment ☐

Semi-conservative replication ☐

(1)

(c) A scientist measured the diameter of a polar body and the diameter of the nucleus inside it. The diameter of the polar body was 10.4 μm and the diameter of the nucleus was 7.0 μm. The density of mitochondria in the cytoplasm of the polar body (outside of the nucleus) was 0.08 mitochondria per μm^3.

Calculate the number of mitochondria in the polar body. You should assume polar bodies and nuclei are spherical.

The formula for the volume of a sphere is $\frac{4}{3}\pi r^3$ where $\pi = 3.14$

Show your working.

Number of mitochondria =_____

(2)

(d) Mitochondrial diseases are caused by faulty mitochondria. All of a person's mitochondria are inherited from their mother via the egg cell. An egg cell contains approximately 3×10^5 mitochondria.

One proposed treatment to prevent passing on faulty mitochondria involves

- removing the nucleus from an egg cell donated by a woman with healthy mitochondria
- replacing this nucleus with the contents of the polar body from a woman whose egg cells are affected by mitochondrial disease.

Suggest how this treatment prevents inheritance of mitochondrial diseases.

_____

_____

_____

_____

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_____

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_____

_____

_____

(2)

(e) If most of the mitochondria in a cell are faulty, this prevents many important enzyme-catalysed reactions taking place or slows them down.

Suggest and explain **one** reason why.

_____

_____

_____

_____

_____

_____

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(2)

(Total 8 marks)

Q3.

Scientists investigated treatment of a human bladder infection caused by a species of bacterium. This species of bacterium is often resistant to the antibiotics currently used for treatment.

They investigated the use of a new antibiotic to treat the bladder infection. The new antibiotic inhibits the bacterial ATP synthase enzyme.

(a) Place a tick (✔) in the appropriate box next to the equation which represents the

reaction catalysed by ATP synthase.

$ATP \longrightarrow ADP + P_i + H_2O$ ☐

$ATP + H_2O \longrightarrow ADP + P_i$ ☐

$ADP + P_i \longrightarrow ATP + H_2O$ ☐

$ADP + P_i + H_2O \longrightarrow ATP$ ☐

(1)

(b) The new antibiotic is safe to use in humans because it does **not** inhibit the ATP synthase found in human cells.

Suggest why human ATP synthase is not inhibited and bacterial synthase is inhibited.

_____

_____

_____

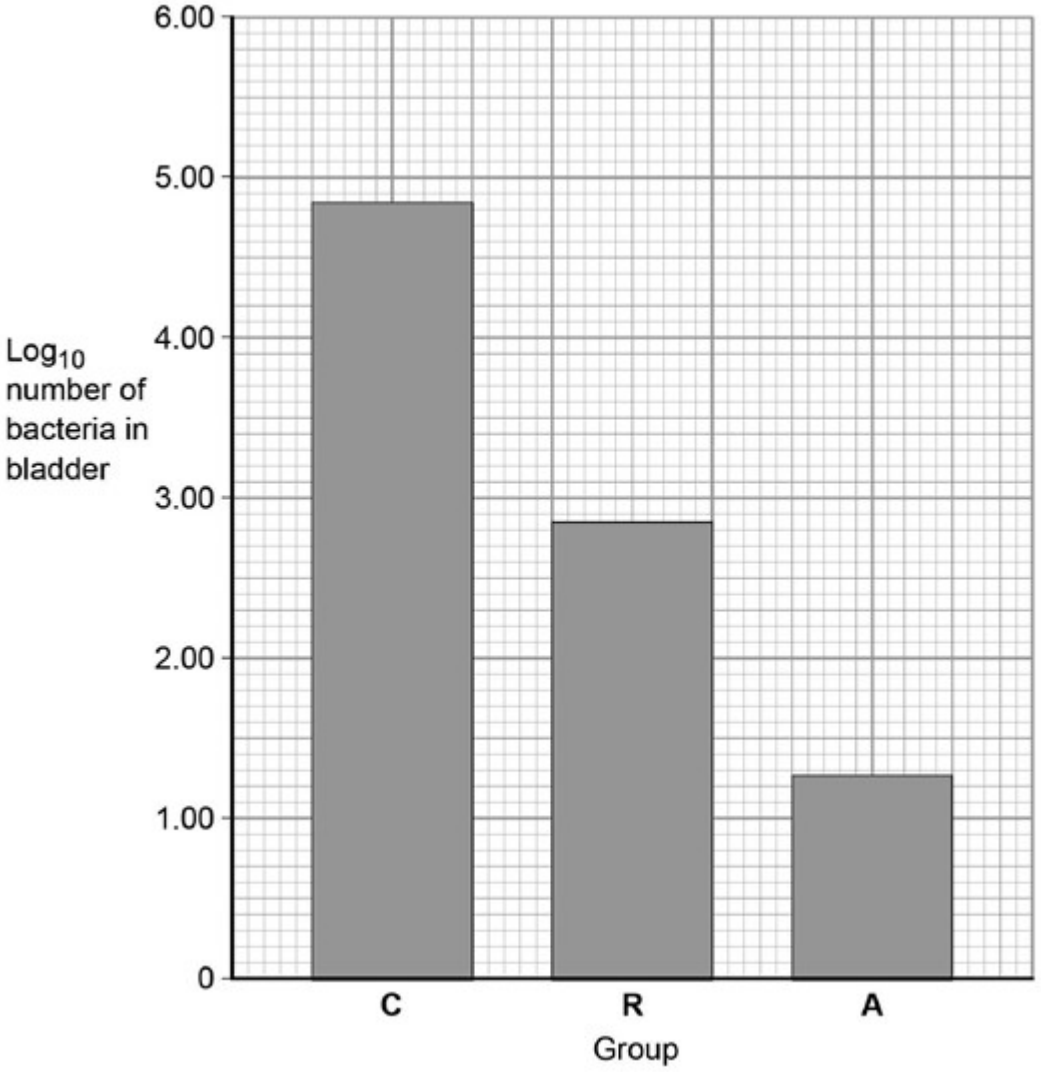
(1)

(c) The scientists tested the new antibiotic on mice with the same bladder infection. They divided these mice into three groups, **C**, **R** and **A**.

- Group **C** was the control (untreated).
- Group **R** was treated with an antibiotic currently used against this bladder infection.
- Group **A** was treated with the new antibiotic.

They removed samples from the bladder of these mice after treatment and estimated the total number of bacteria in the bladder.

Their results are shown in the graph.



The antibiotics were given to the mice at a dose of 25 mg kg^{-1} per day.

Calculate how much antibiotic would be given to a 30 g mouse each day.

Show your working.

Answer = _____ mg

(2)

(d) Calculate the percentage difference in actual numbers of bacteria in group **A** compared with group **R**. The actual number of bacteria can be calculated from the $\log_{10}$ value by using the 10^x function on a calculator.

Show your working.

Answer = _____ %

(2)

(e) The scientists suggested that people newly diagnosed with this bladder infection should be treated with both the current antibiotic and the new antibiotic.

Explain why the scientists made this suggestion.

Use information from the graph in part (c) and your knowledge of evolution of antibiotic resistance in bacteria in your answer.

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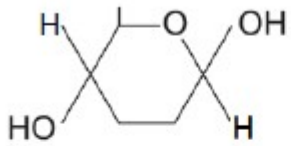
(3)

(Total 9 marks)

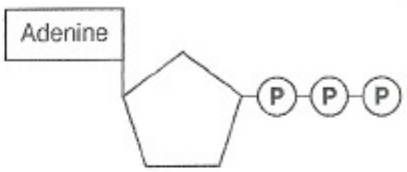
Q4.

The diagram shows four biological molecules.

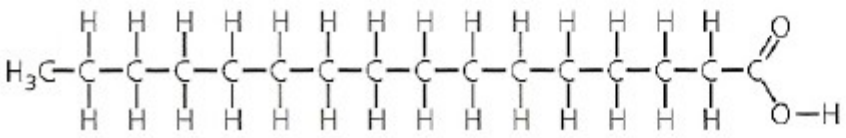
Molecule **A**



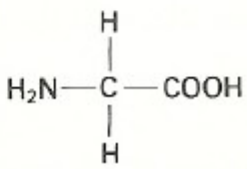
Molecule **B**



Molecule **C**



Glycine



(a) Give the **full** name of:

Molecule **A** _____

Molecule **B** _____

(2)

(b) What type of molecule is molecule **C**?

_____

(2)

(c) Glycine, shown in the diagram, is an amino acid.

In the space below, draw a diagram to show the dipeptide produced when two molecules of glycine are joined together.

(2)

(d) Name the other molecule formed when two molecules of glycine are joined together.

_____

(1)

(Total 7 marks)

Q5.

(a) Describe the roles of calcium ions and ATP in the contraction of a myofibril.

_____

_____

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_____

(5)

(b) ATP is an energy source used in many cell processes. Give **two** ways in which ATP

is a suitable energy source for cells to use.

1. _____

_____

2. _____

_____

(2)

(Total 7 marks)

Q6.

Cells constantly hydrolyse ATP to provide energy.

(a) Describe how ATP is resynthesised in cells.

_____

_____

_____

_____

(2)

(b) Give **two** ways in which the hydrolysis of ATP is used in cells.

1. _____

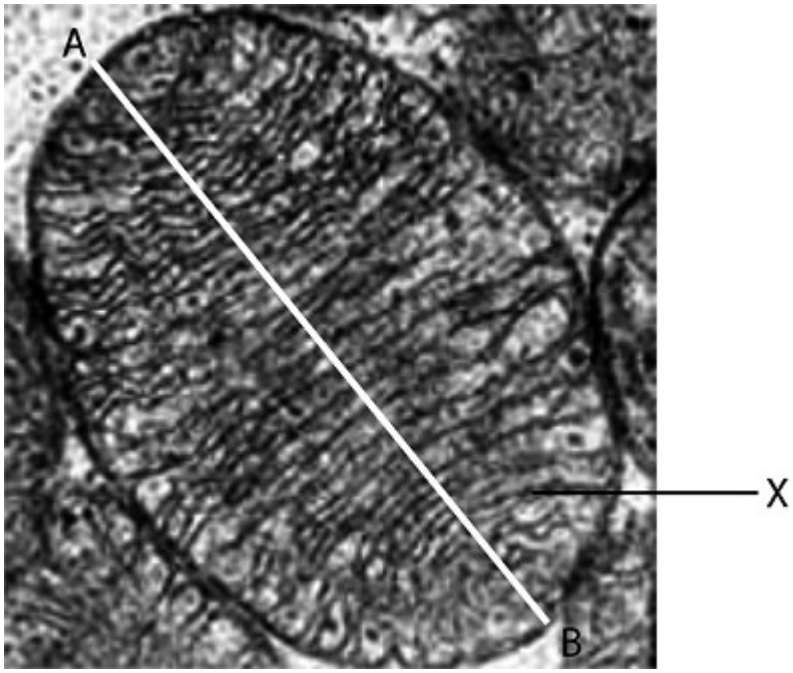
_____

2. _____

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(2)

(c) This is a photograph (micrograph) of a mitochondrion taken using a scanning electron microscope.



What is the evidence that a scanning electron microscope was used to take this photograph?

_____

_____

_____

(1)

(d) Name the part of the mitochondrion labelled **X** in the photograph.

_____

(1)

(e) The actual length of the mitochondrion between points **A** and **B** in the photograph is 4 µm.

What is the magnification of the mitochondrion in the photograph?

Show your working.

Magnification _____

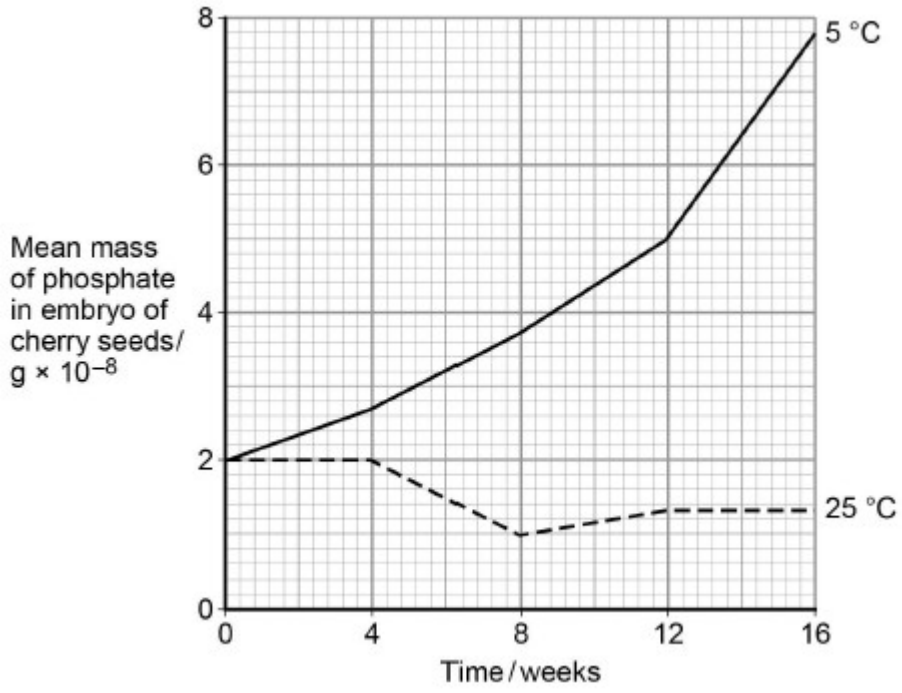
(2)

(Total 8 marks)

Q7.

The seeds of some plant species require chilling (exposure to low temperatures) before the embryos they contain grow into plants. During chilling, storage molecules in the seed that contain phosphate are broken down and phosphates are transported to the embryo. Scientists investigated the change in the mass of phosphate in the embryos of cherry seeds exposed to two different temperatures for 16 weeks.

The following graph shows their results.



(a) Phospholipids are one of the storage molecules found in cherry seeds.

Name the type of reaction used to break down phospholipids to release phosphate.

_____

(1)

(b) The scientists concluded that an increase in phosphate in the embryo was linked to growth of the embryo.

Suggest **two** reasons why an increase in phosphate can be linked to growth of the embryo.

1. _____

_____

_____

2. _____

_____

_____

(2)

(c) Calculate the ratio of the mean mass of phosphate found at 5 °C to the mean mass of phosphate found at 25 °C after 9 weeks of chilling.

Ratio = _____

(1)

(d) The chilling requirement of seeds of certain plant species is considered to be an adaptation for survival in countries with seasonal changes in environmental conditions.

Suggest how this adaptation may enable these plant species to survive and respond to seasonal changes.

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(3)

(Total 7 marks)

Q8.

(a) ATP is useful in many biological processes. Explain why.

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(4)

(b) Describe how ATP is made in mitochondria.

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(6)

(c) Plants produce ATP in their chloroplasts during photosynthesis. They also produce ATP during respiration. Explain why it is important for plants to produce ATP during respiration in addition to during photosynthesis.

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(5)

(Total 15 marks)

Q9.

(a) The table contains statements about three biological processes.

Complete the table with a tick if the statement in the first column is true, for each process.

	Photosynthesis	**Anaerobic respiration**	**Aerobic respiration**
ATP produced			
Occurs in organelles			
Electron transport chain involved			

(3)

(b) Write a simple equation to show how ATP is synthesised from ADP.

_____

(1)

(c) Give **two** ways in which the properties of ATP make it a suitable source of energy in biological processes.

1. _____

_____

2. _____

_____

(2)

(d) Humans synthesise more than their body mass of ATP each day. Explain why it is necessary for them to synthesise such a large amount of ATP.

_____

_____

_____

_____

_____

(2)

(Total 8 marks)

Q10.

(a) Describe the part played by the inner membrane of a mitochondrion in producing ATP.

_____

_____

_____

_____

_____

_____

(3)

(b) A scientist investigated ATP production in a preparation of isolated mitochondria. He suspended the mitochondria in an isotonic solution and added a suitable respiratory substrate together with ADP and phosphate. He bubbled oxygen through the preparation.

(i) Why was the solution in which the mitochondria were suspended isotonic?

_____

_____

(1)

(ii) Explain why the scientist did **not** use glucose as the respiratory substrate.

_____

_____

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_____

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(2)

(iii) Explain why the oxygen concentration would change during this investigation.

_____

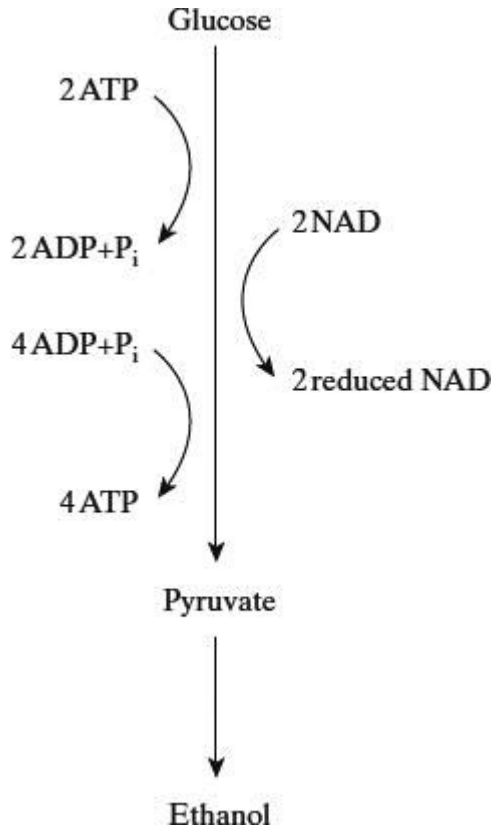
_____

(1)

(Total 7 marks)

Q11.

The diagram summarises the process of anaerobic respiration in yeast cells.



(a) (i) In anaerobic respiration, what is the net yield of ATP molecules per molecule of glucose?

_____

(1)

(ii) Give **two** advantages of ATP as an energy-storage molecule within a cell.

1. _____

_____

2. _____

_____

(2)

(b) Describe how NAD is regenerated in anaerobic respiration in yeast cells.

_____

_____

(1)

(Total 4 marks)

Q12.

(a) Mitochondria in muscle cells have more cristae than mitochondria in skin cells. Explain the advantage of mitochondria in muscle cells having more cristae.

_____

_____

_____

_____

(2)

(b) Substance **X** enters the mitochondrion from the cytoplasm. Each molecule of substance **X** has three carbon atoms.

(i) Name substance **X**.

_____

(1)

(ii) In the link reaction substance **X** is converted to a substance with molecules effectively containing only two carbon atoms. Describe what happens in this process.

_____

_____

_____

_____

(2)

(c) The Krebs cycle, which takes place in the matrix, releases hydrogen ions. These hydrogen ions provide a source of energy for the synthesis of ATP, using coenzymes and carrier proteins in the inner membrane of the mitochondrion.

Describe the roles of the coenzymes and carrier proteins in the synthesis of ATP.

_____

_____

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(3)

(Total 8 marks)

Q13.

When one mole of glucose is burned, 2800 kJ of energy are released. However, when one mole of glucose is respired aerobically, only 40% of the energy released is incorporated into ATP. Each mole of glucose respired aerobically produces 38 moles of ATP.

(a) (i) Calculate how much energy is incorporated into each mole of ATP. Show your working.

Answer _____ kJ

(2)

(ii) When glucose is respired what happens to the energy which is **not** incorporated into ATP?

_____

(1)

(b) (i) When one mole of glucose is respired anaerobically, only 2 moles of ATP are produced. Explain why less energy is released in anaerobic respiration.

_____

_____

(1)

(ii) At the end of a sprint race, a runner continues to breathe rapidly for some time. Explain the advantage of this.

_____

_____

_____

_____

(2)

(Total 6 marks)