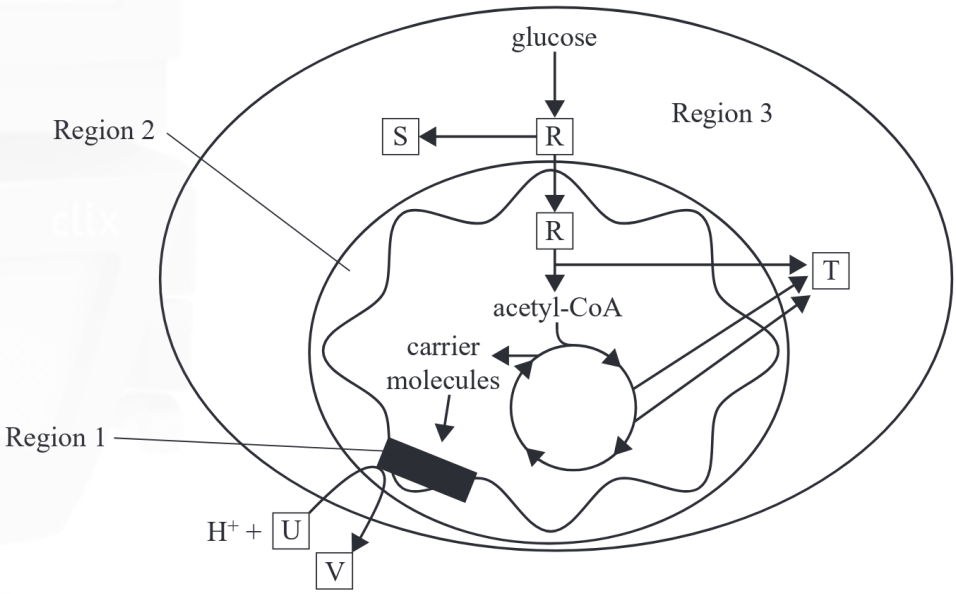
*Use the following information to answer Questions 13–16.*

There are a number of ways in which an animal cell is able to use compounds such as glucose to produce the energy that it needs to be able to function. The diagram below outlines the general metabolic pathways for cellular respiration in an animal cell.




Which metabolic pathway is found in Region 3 of the cell?

**A.** electron transport chain
**B.** Calvin cycle
**C.** Krebs cycle
**D.** glycolysis

Which of the following gives the names of compounds R, T and V, shown in the diagram above?

| | R | T | V |
|---|---|---|---|
| **A.** | lactic acid | carbon dioxide | oxygen |
| **B.** | lactic acid | carbon dioxide | $NAD^+$ |
| **C.** | pyruvate | carbon dioxide | water |
| **D.** | pyruvate | NADH | oxygen |

The carrier molecules represented in the diagram on page 10 are

**A.** $NAD^+$ and water.
**B.** $FAD^+$ and oxygen.
**C.** NADH and $FADH_2$.
**D.** $NAD^+$, carbon dioxide and $FADH_2$.

The last electron acceptor in cellular respiration is

**A.** water.
**B.** oxygen.
**C.** NADH.
**D.** carbon dioxide.

*Marking Scheme*

| Question | Correct answer | % A | % B | % C | % D | Comments |
|---|---|---|---|---|---|---|
| **13** | D | 10 | 4 | 8 | **79** | |
| **14** | C | 6 | 7 | **72** | 15 | |
| **15** | C | 14 | 9 | **70** | 7 | |
| **16** | B | 18 | **46** | 27 | 9 | The three regions labelled in the diagram, along with the input of glucose, meant the process in question was aerobic cellular respiration. The other input to this process not shown is oxygen and in region 1 this is the final electron acceptor. |

## 2022

DO NOT WRI

A student investigated the effect of temperature and oxygen on the production of lactic acid by cultured human skin cells. At the start of this experiment, each test tube contained the same number of skin cells and the same concentration of glucose. The temperature of each test tube and the amount of oxygen supplied to each test tube are given in the table below. After 24 hours, the student measured the amount of lactic acid in the test tubes.

**Temperature and oxygen content of each test tube in the experiment**

| Test tube | Temperature (°C) | Oxygen content (%) |
|---|---|---|
| 1 | 20 | 20 |
| 2 | 37 | 20 |
| 3 | 37 | 5 |
| 4 | 75 | 5 |

Which test tube would be expected to contain the highest concentration of lactic acid?

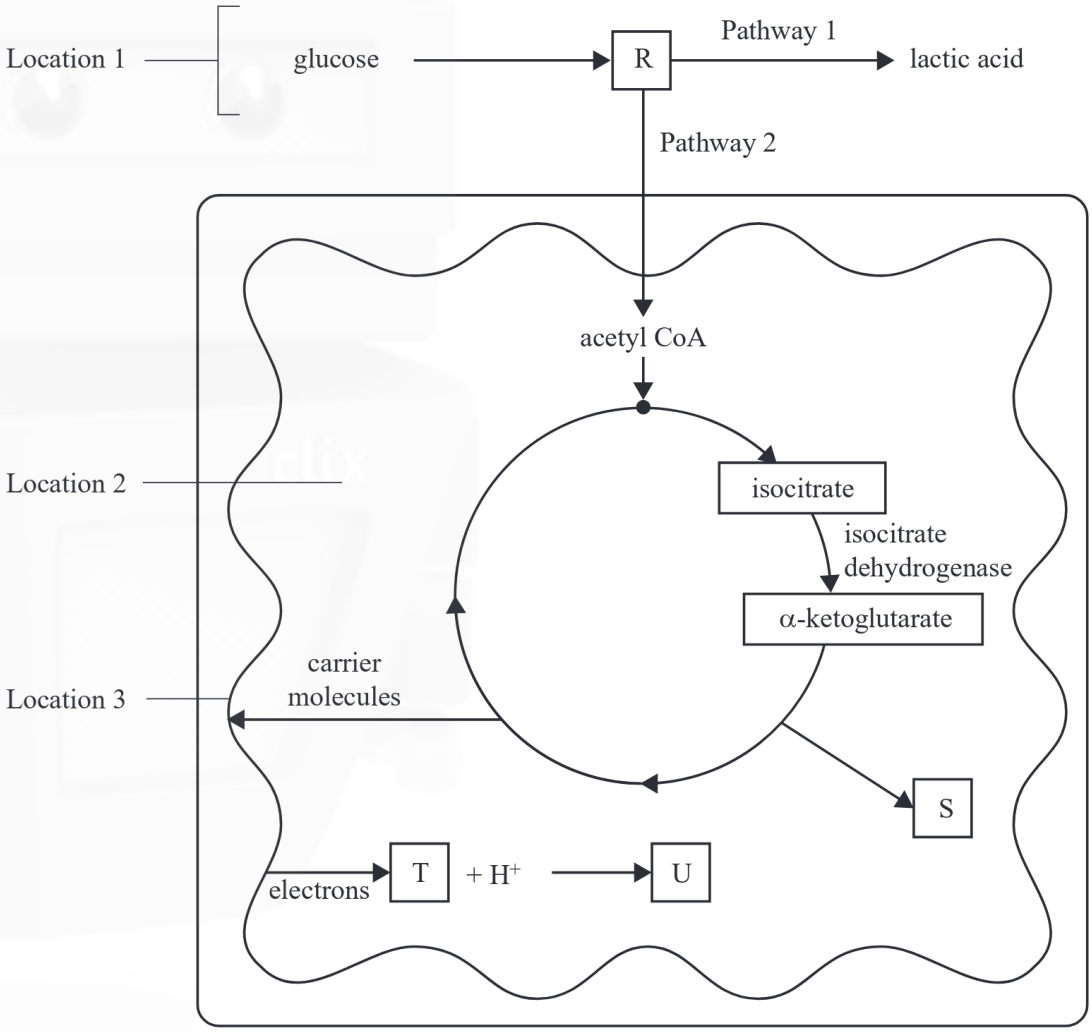
**A.** Test tube 1
**B.** Test tube 2
**C.** Test tube 3
**D.** Test tube 4

*Marking Scheme*

| Question | Correct answer | % A | % B | % C | % D | Comments |
|---|---|---|---|---|---|---|
| **18** | C | 4 | 20 | **57** | 18 | |

*Use the following information to answer Questions 11–15.*

The diagram below outlines the general biochemical pathways in cellular respiration in an animal cell.




Biochemical pathways 1 and 2 are similar in animal cells because they

**A.** create a high yield of ATP.
**B.** cycle the coenzyme $NAD^+$.
**C.** occur in the mitochondrion.
**D.** produce carbon dioxide gas.

Assume that oxygen levels are maintained.

If glucose supply to this animal cell were to

**A.** decrease, then the movement of molecule R into Location 2 would increase.
**B.** increase, then the production of molecule S would decrease.
**C.** increase, then the production of lactic acid would increase.
**D.** decrease, then ATP yield would decrease.

Consider the conversion of isocitrate into α-ketoglutarate. When ATP is produced in excess amounts for the needs of this cell, some ATP attaches to isocitrate dehydrogenase.

The role of the ATP that attaches to isocitrate dehydrogenase is to act as a

**A.** catalyst.
**B.** coenzyme.
**C.** source of hydrogen ions.
**D.** non-competitive inhibitor.

DO NOT WRITE IN T

Which of the following correctly states an input, an output and the ATP yield for Location 3?

| | Input 'T' | Output 'U' | ATP yield |
|---|---|---|---|
| **A.** | oxygen | water | 26–28 |
| **B.** | $NAD^+$ | oxygen | 26–28 |
| **C.** | carbon dioxide | water | 26–28 |
| **D.** | $NAD^+$ | carbon dioxide | 30–32 |

As the concentration of glucose increased within this animal cell, the concentration of an unknown molecule (not shown on the diagram on page 8) measured at Location 1 was decreasing.

The unknown molecule is likely to be

**A.** ADP.
**B.** NADH.
**C.** ethanol.
**D.** pyruvate.

*Marking Scheme*

| | |
|---|---|
| Question 11 | Answer = B |
| Question 12 | Answer = D |
| Question 13 | Answer = D |
| Question 14 | Answer = A |
| Question 15 | Answer = A |

A field study of a rock pool was conducted by a Biology student to explore factors that could affect marine animals. Data was collected from two locations (Location A and Location B) 50 km apart over the same seven-week period, as outlined in the tables below. It was predicted that there would be less species diversity in the rock pools in the urban coastal area (Location A) compared to the rural coastal area (Location B).

**Table 1. Location A – An urban coastal area**

| Variable | Week 1 | Week 2 | Week 3 | Week 4 | Week 5 | Week 6 | Week 7 | Average |
|---|---|---|---|---|---|---|---|---|
| air temperature (°C) | 28.6 | 22.8 | 26.4 | 25.1 | 29.1 | 25.8 | 26.5 | 26.3 |
| atmospheric carbon dioxide (ppm) | 414 | 415 | 414 | 413 | 414 | 414 | 415 | 414 |
| dissolved oxygen (mg/L) | 7.1 | 6.9 | 7.0 | 7.2 | 7.1 | 7.0 | 7.2 | 7.1 |
| average number of rock pool animal species per square metre | 12 | 17 | 22 | 13 | 19 | 7 | 14 | 15 |

**Table 2. Location B – A rural coastal area**

| Variable | Week 1 | Week 2 | Week 3 | Week 4 | Week 5 | Week 6 | Week 7 | Average |
|---|---|---|---|---|---|---|---|---|
| air temperature (°C) | 22.8 | 15.2 | 19.5 | 18.9 | 23.1 | 19.9 | 20.0 | 19.9 |
| atmospheric carbon dioxide (ppm) | 410 | 410 | 411 | 409 | 410 | 409 | 409 | 410 |
| dissolved oxygen (mg/L) | 7.2 | 6.9 | 7.2 | 7.3 | 7.4 | 7.3 | 7.1 | 7.2 |
| average number of rock pool animal species per square metre | 26 | 28 | 6 | 25 | 19 | 20 | 17 | 20 |

The data collected suggests that

**A.** there are several outliers in the measurements for dissolved oxygen.

**B.** the measurements for atmospheric carbon dioxide for both locations are imprecise.

**C.** the measurements for dissolved oxygen show a high level of repeatability for Location B only.

**D.** both air temperature and atmospheric carbon dioxide levels were higher in Location A than in Location B.

TE IN T

It could be inferred that, compared to rock pool animals from Location A, those at Location B would have a

**A.** higher rate of anaerobic respiration based on the dissolved oxygen levels.
**B.** lower rate of aerobic respiration based on the dissolved oxygen levels.
**C.** higher rate of aerobic respiration based on the carbon dioxide levels.
**D.** lower rate of aerobic respiration based on the air temperatures.

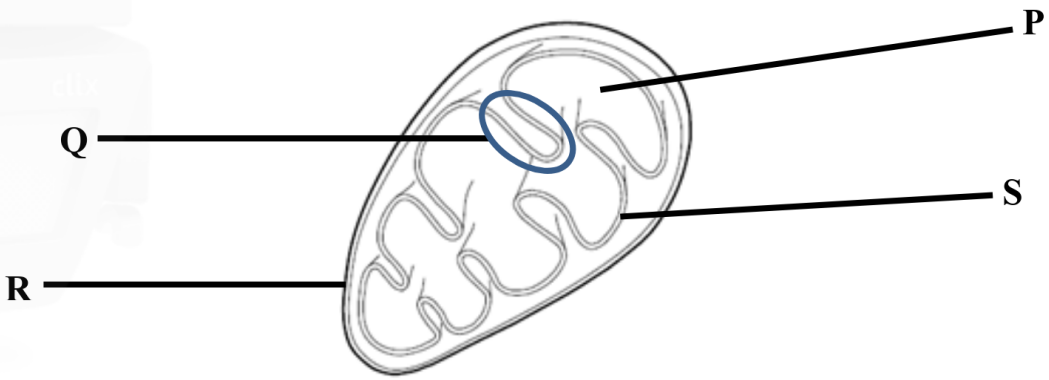
*Marking Scheme*

| | |
|---|---|
| Question 19 | Answer = D |
| Question 20 | Answer = D |

## 2022

*The next 2 questions refer to the following information.*

The following diagram is of a mitochondrion. Areas/structures **P, Q, R** and **S** are all important for the functioning of this very important organelle.




The names of areas/structures P, Q, R and S respectively are

**A.** matrix, cristae, inter-membrane space, outer membrane.
**B.** matrix, cristae, outer membrane, inter-membrane space.
**C.** cristae, inter-membrane space, outer membrane, matrix.
**D.** inter-membrane space, outer membrane, matrix, cristae.

Area P is important as it

**A.** completely converts pyruvate into carbon dioxide.
**B.** provides a concentration gradient for hydrogen ion movement.
**C.** is the site of the electron transport chain.
**D.** is where pyruvate is formed.

**Question 19**

**Solution: B**

Mitochondrial structure and how it relates to function is an important visual aid to a deeper understanding of the respiration process. The organelle has 2 membranes, an outer membrane (R) and an inner membrane (S) that has inner folding's called cristae (Q) that are the site of the ETC. The matrix (P) is the site of the Krebs's cycle.

**Question 20**

**Solution: A**

Area P is the matrix and the site for Kreb's cycle. This biochemical process converts pyruvate, that is converted into acetyl CoA, into carbon dioxide, ATP and NADH.

Both mitochondria and chloroplasts can be isolated from total plant extracts by differential centrifugation. The purpose of doing this is to investigate the processes occurring within them in more detail.

**a)** State 2 differences in the structure/location/function of a mitochondria compared to a chloroplast.

_____

_____

_____(2 marks)

Once the organelles were exposed to optimal conditions, they were both exposed to a variety of chemicals. The chemicals they were both exposed to included

- oxygen and water
- oxygen and glucose
- oxygen and pyruvic acid
- carbon dioxide and water
- carbon dioxide and glucose
- carbon dioxide and pyruvic acid

**b)** In the table below, choose the combination of chemicals that would be most beneficial for the functioning of the organelle. Justify the choice in the space provided.

| Organelle | Chemical exposure combination | Justification |
|---|---|---|
| **Mitochondria** | | |
| **Chloroplast** | | |

(4 marks)

**c)** State three of the optimal conditions that each organelle would need to be exposed to

_____

_____

_____(2 marks)

**a)** there are various differences including (students need 2 of)

- Mitochondria have cristae whereas chloroplasts have grana
- Mitochondria found in all eukaryotic cells whereas chloroplasts are located only in eukaryotic autotrophic cells
- Mitochondria undergo cellular respiration whereas chloroplasts undertake photosynthesis
- Mitochondria rod shaped whereas chloroplast are disc shaped

**(2 marks)**

**b)**

| Organelle | Chemical exposure combination | Justification |
|---|---|---|
| Mitochondria | Oxygen and pyruvic acid | Pyruvic acid an input into Krebs cycle<br>Oxygen an electron acceptor in the ETC |
| Chloroplast | Carbon dioxide and water | Carbon dioxide as an input for carbon fixation<br>Water as a substrate to be split in the LDR |

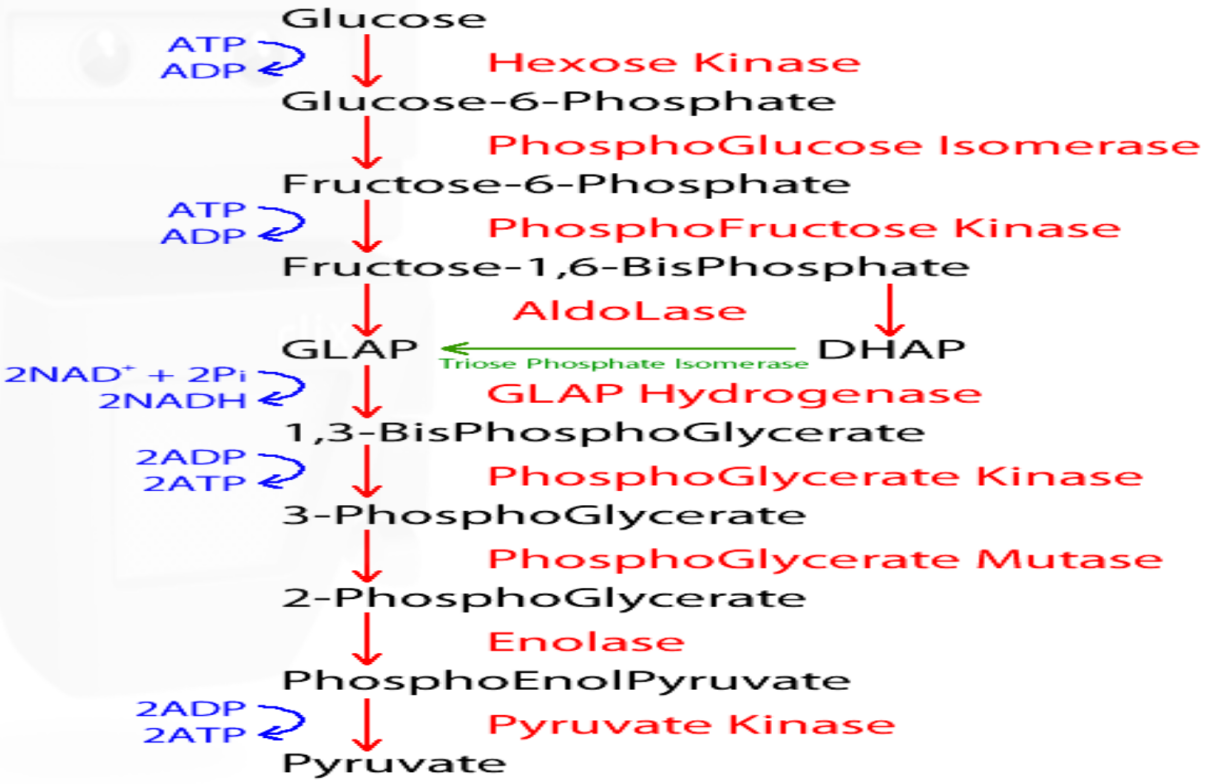
*NOTE: 1 mark for each correct cell* **(4 marks)**

**c)** 2 of

- Temperature
- pH
- Availability of inputs (no need to state them)
- Availability of enzymes

**(2 marks)**

*The next 3 question refer to the following biochemical pathway that is a simplified version of glycolysis*




The number of enzymes involved in this reaction is

**A.** 2
**B.** 9
**C.** 10
**D.** 12

Based on this representation, the outputs of Glycolysis are

**A.** Pyruvate, NADH and ATP
**B.** Glucose, NAD and ADP
**C.** 2Pyruvate, 2NADH and 4ATP
**D.** Glucose and pyruvate

The cellular location for this reaction is

**A.** Stroma
**B.** Grana
**C.** Matrix
**D.** Cytosol

**Question 21**

**Solution: C**

Most enzymes end in the suffix ‘ase’ but they are also indicated between the substrates and products of a chemical reaction. There are 10 enzymes involved in the biochemical pathway illustrated.

**Question 22**

**Solution: A**

The outputs of this reaction can be worked out by initially looking at the final product (pyruvate). Then in the intermediate steps looking at the products at the end of each arrow head (ATP and NADH). The reason ATP is a product is there are 2 ATPS in and 4 ATPs out

**Question 23**

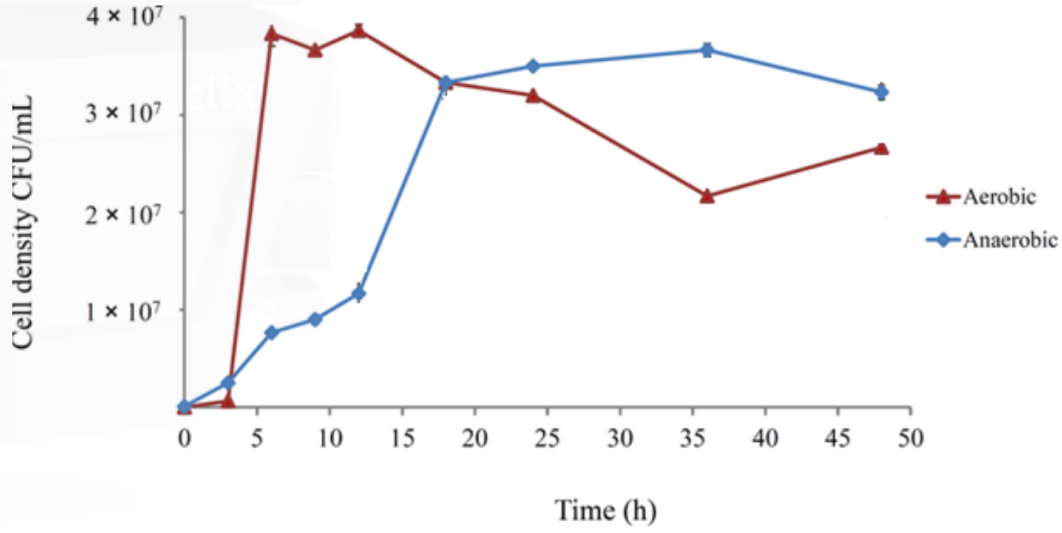
**Solution: D**

The reaction shown is glycolysis that occurs in the cytosol (cytoplasm acceptable) of most cells.

## 2022

*The next 2 questions refer to the following information*

The bacterium *Escherichia coli* is frequently forced to adapt to changing environmental conditions. One important determinant for metabolism is the availability of oxygen allowing a more efficient metabolism; however, there are no mitochondria present in *E.coli.* An experiment was conducted that investigated the effect of providing oxygen to bacteria on the cell density and the results are graphed below.




For glucose to be broken down aerobically in E. coli, which of the following chemicals would be the most important product to produce the energy yield usually expected by his form of respiration

**A.** NADPH
**B.** ATP
**C.** ADP and Pi
**D.** NADH

What is a reasonable conclusion to make based on the graph?

**A.** For the first day of the experiment anaerobic conditions led to more reproduction in the *E. coli* compared to when they were exposed to aerobic conditions
**B.** If the experiment was left for longer the reproduction rate for *E. coli* exposed to anaerobic or aerobic conditions would become equal
**C.** For the first 15 hours of the experiment, oxygen availability is advantageous to *E. coli*
**D.** After 50 hours, all the oxygen had been used by the *E. coli* bacteria exposed to aerobic conditions

*Marking Scheme*

**Question 24**

**Solution: B**

The purpose of cellular respiration is to convert the chemical potential energy within glucose to generate usable chemical energy in the form of ATP, which can be used in a variety of anabolic reactions.

**Question 25**

**Solution: C**

The graph shows that in the presence of oxygen, the bacteria is able to divide more rapidly for the first 15 hours. However; when not exposed to oxygen the bacteria take longer to increase their rate of cell division but as time progresses their efficiency at dividing surpasses the rate achieved when the bacteria are exposed to oxygen.

## 2022

Cyanide is a non-competitive inhibitor of an enzyme called cytochrome oxidase, which plays an important role as the final electron acceptor in the electron transport chain.

Apart from being a toxic and fast-acting poison, cyanide is also found in cigarette smoke, in some food and in vehicle exhaust. In manufacturing, cyanide is used to make paper, textiles, and plastics. It is present in the chemicals used to develop photographs. Cyanide salts are used in metallurgy for electroplating, metal cleaning, and removing gold from its ore. Cyanide gas is used to exterminate pests and vermin in ships and buildings

Common symptoms of cyanide exposure may include:

- Overall weakness
- Confusion
- Difficulty breathing
- Loss of consciousness
- Cardiac arrest

**b)** Explain how cyanide exposure could lead to 1 of the symptoms listed above

_____

_____

_____

_____

_____

_____(3 marks)

**c)** Compare the ATP yield of the electron transport chain compared to the other stages of respiration

_____

_____

_____

_____(2 marks)

*Marking Scheme*

b) The electron transport chain is the last step in cellular respiration in eukaryotic cells. (1 mark)

The cyanide prevents oxygen gas accepting electrons and hydrogen ions since the cytochrome oxidase is the final electron acceptor. (1 mark)

ATP cannot be generated leading to any of the symptoms mentioned (students should recognise how one of the symptoms requires energy)….for example

- Muscles require energy and may be weak due to cyanide
- Brain needs energy and may be confused due to cyanide (1 mark)

c) The theoretical ATP yield is 28 ATP molecules per glucose (could accept 26)

*NOTE: this varies from text to text but much more is produced compared to the other stages* (1 mark)

Compared to 2ATP per glucose molecule in Krebs and 2ATP per glucose in glycolysis (1 mark)

Scientists measured the metabolic activity of mammalian cells by measuring the uptake of glucose into the cells. The cells were maintained at 37 °C with a pH of 7.4 and suspended in a nutrient solution containing glucose. The uptake of glucose into the cells was recorded for the next 30 minutes.

**a.** Explain why the uptake of glucose into the cells could be used to measure the metabolic activity of the cells. 2 marks

**b.** The scientists repeated the experiment. They kept all conditions the same as for the first experiment, except that the cells were kept in low-oxygen conditions.

Would the uptake of glucose into the cells be expected to be higher, lower or the same as for the first experiment? Justify your response. 4 marks

*Marking Scheme*

## Question 3a.

| Mark | 0 | 1 | 2 | Average |
|---|---|---|---|---|
| % | 34 | 41 | 26 | 0.9 |

A suitable answer was that glucose is used in aerobic respiration and ATP is produced from glucose for metabolism.

## Question 3b.

| Mark | 0 | 1 | 2 | 3 | 4 | Average |
|---|---|---|---|---|---|---|
| % | 5 | 43 | 31 | 11 | 10 | 1.8 |

Students were required to identify what the glucose uptake would be and then to justify their answer. All uptake comparisons were justifiable, and examples of each justification are given below.

Higher uptake

- With less oxygen the cell would not respire aerobically producing less ATP for each glucose molecule.
- The cell would take up more glucose to get the same amount of energy.

OR

Lower uptake

- With less oxygen the cell would respire anaerobically and produce toxic products that could cause damage to cells.

OR

Same uptake

- Oxygen is not required for the breakdown of glucose, so glycolysis still occurs and produces less ATP and less energy for the cell.

Students were expected to correctly refer to the types or stages of cellular respiration.

# 2021

For the anaerobic production of the renewable fuel ethanol. Requirements would include

**A.** animal tissue and oxygen
**B.** animal tissue without oxygen
**C.** plant tissue without oxygen
**D.** plant tissue with oxygen

*Marking Scheme*

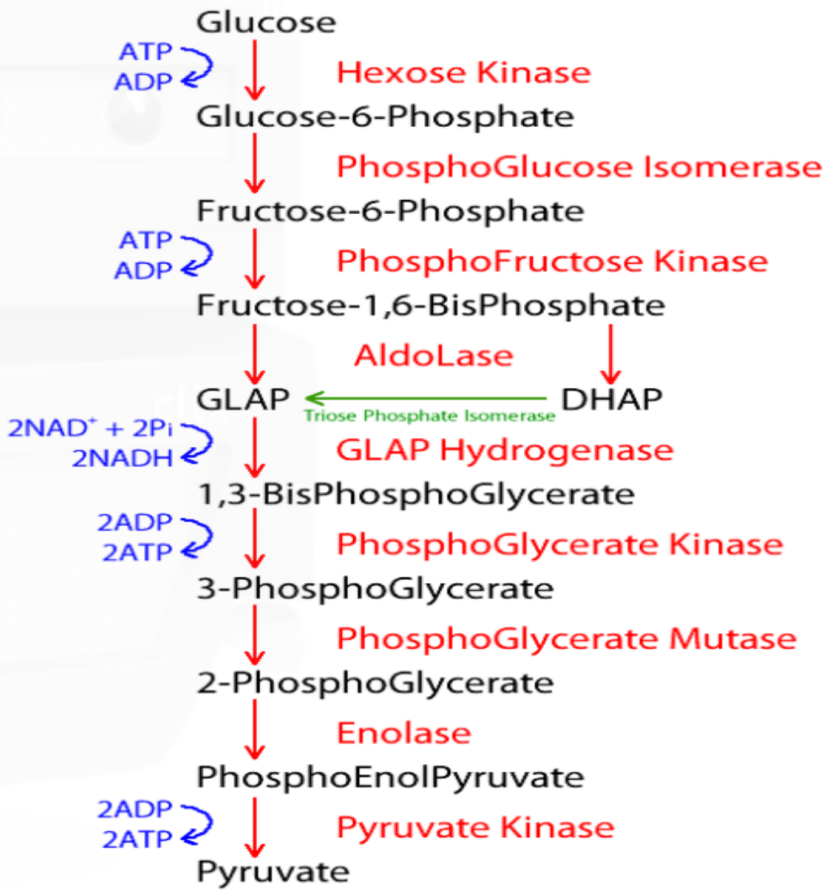
**Solution: C**
Anaerobic fermentation is the breakdown of glucose in the absence of oxygen to produce ethanol in organisms such as yeast and plants. This is being used more regularly as a renewable energy source.

**Study Design Reference**

- uses and applications of anaerobic fermentation of biomass for biofuel production.

**Web Link**
https://www.khanacademy.org/science/ap-biology/cellular-energetics/cellular-respiration-ap/a/fermentation-and-anaerobic-respiration

*The next 2 questions refer to the following biochemical pathway*




An enzyme involved in the biochemical pathway illustrated above would be

**A.** PhosphoGlycerate
**B.** NADH
**C.** Used up
**D.** Enolase

The input(s) of this chemical reaction is/are

**A.** Glucose, ATP and NADH
**B.** Glucose, 2ADP, $2NAD^+$ and 2Pi
**C.** Pyruvate, Glucose, 2ATP and 2NADH
**D.** Pyruvate, 2ADP, $2NAD^+$ and 2Pi

## *Marking Scheme*

**Question 10**
**Solution: D**
Enzymes generally end with the suffix ‘ase’ and so enolase is the only enzyme listed
**Question 11**
**Solution: B**
The inputs and outputs on the cycle are clearly listed. The only input not labelled is inorganic phosphate (Pi) but students should be aware that ATP forms from ADP and Pi.

## 2021

Outputs for the electron transport chain include

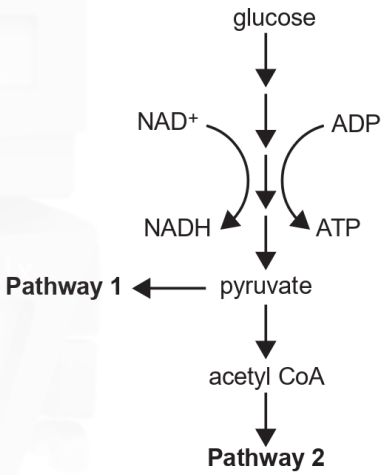
**A.** ATP and NADH
**B.** ADP, Pi and NAD
**C.** ATP, NAD and $H_2O$
**D.** ADP, Pi, NADH and $O_2$

*Marking Scheme*

**Solution: C**
This is a fact-based question that students need to consolidate. NADH provides Hydrogen for the ETC and forms NAD. ADP and Pi uses the energy provided by the movement of Hydrogen back into the matrix to make ATP. Oxygen combines with the Hydrogen in the matrix and electrons to form water.

## 2020

Shown below is a simplified diagram summarising a series of biochemical processes in a plant cell.




Source: adapted from MG Stovell et al., 'Assessing metabolism and injury in acute human traumatic brain injury with magnetic resonance spectroscopy: Current and future applications', *Frontiers in Neurology*, 12 September 2017, <https://doi.org/10.3389/fneur.2017.00426>

Which one of the following is a correct statement?

**A.** Pathway 2 releases oxygen as a by-product.
**B.** Pathway 1 requires carbon dioxide as an input.
**C.** ATP is produced in Pathway 1 and is used by the cell as an energy source.
**D.** NADH created in Pathway 2 carries electrons into the electron transport chain.

The final products of Pathway 1 are produced in the

**A.** cristae.
**B.** cytosol.
**C.** mitochondrial matrix.
**D.** chloroplast membranes.

*Marking Scheme*

| Question | % A | % B | % C | % D | Comments |
|---|---|---|---|---|---|

| | | | | | |
|---|---|---|---|---|---|
| 5 | 10 | 7 | 40 | 42 | Pathway 1 involves the breakdown of pyruvate, which does not generate ATP. ATP is generated when the glucose is broken down into pyruvate. Pathway 2 involves the Krebs cycle where NAD is loaded to form NADH and carries electrons to the electron transport chain. |
| 6 | 15 | 57 | 20 | 8 | |

## 2020

The products of glycolysis include

**A.** Carbon dioxide
**B.** Acetyl CoA
**C.** Glucose
**D.** Pyruvic acid

*Marking Scheme*

**Question 19 Solution: B**
Glucose is a substrate for cellular respiration and if oxygen is unavailable and the energy demand is high the products in plants are ethanol, carbon dioxide and ATP. This occurs quickly but cannot usually be sustained for too long. This is also known as anaerobic fermentation. Animal fermentation produces lactic acid and ATP.

## 2020

The products of glycolysis include

**A.** Carbon dioxide
**B.** Acetyl CoA
**C.** Glucose
**D.** Pyruvic acid (pyruvate)

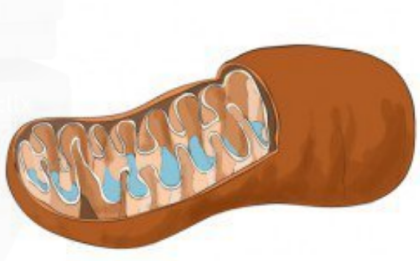
*Marking Scheme*

**Solution: D**
Glycolysis occurs in the cytosol of cells and is the conversion of glucose to pyruvate (pyruvic acid), ATP and NADH.

**Study Design Reference**
The location of, and the inputs and outputs of, glycolysis including ATP yield (details of the biochemical pathway mechanisms are not required)

## 2020

*The next 3 questions refer to the following diagrams of a mitochondrion and a chloroplast*



http://www.thecliffsidegroup.com/blog-in-focus/compare-and-contrast-chloroplasts-and-mitochondria

Both organelles contain

**A.** Ribosomes and circular DNA
**B.** NADPH and ATP
**C.** Cristae and Grana
**D.** Matrix and cytosol

Both organelles were isolated from cells and added together into a buffer solution that was isotonic to both organelles. All the chemicals and conditions required to sustain them were provided. If the light intensity was increased to a very high level

**A.** the level of carbon dioxide in the solution would remain constant.
**B.** the level of carbon dioxide and oxygen would remain constant.
**C.** the rate of respiration and the rate of photosynthesis would decrease.
**D.** the level of oxygen in the solution would increase.

Both organelles express proteins. To carry out this task, it is reasonable to assume they would both contain

**A.** DNA, tRNA and ribosomes
**B.** Membranes, DNA and mRNA
**C.** Cristae, grana and circular DNA
**D.** mRNA, tRNA but not rRNA

*Marking Scheme*

**Solution: A**
Both organelles contain ribosomes as well as circular DNA, which is in support of the endosymbiotic theory. NADPH is only involved is photosynthesis, not respiration. The crista and matrix are unique to the mitochondria and the grana is unique to the chloroplast. The cytosol is located outside both organelles.

**Solution: D**
At high light intensity the rate of photosynthesis would be higher than the rate of respiration, which would mean more carbon dioxide would be removed from the solution and oxygen would be put into the solution.

**Solution: A**
To express proteins, it would be expected that DNA would be present to provide the blueprint to make the mRNA. The mRNA would be translated into a protein at the ribosome (partly rRNA) by using tRNA to translate the message.

**Study Design Reference (for Questions 8-10)**
The purpose of cellular respiration
Mitochondria as the site of aerobic cellular respiration, an overview of their structure and evidence of their bacterial origins
The purpose of photosynthesis
Chloroplasts as the site of photosynthesis, an overview of their structure and evidence of their bacterial origins

## 2019

D

During which process would the production of lactic acid be observed?

**A.** aerobic cellular respiration
**B.** fermentation in animals
**C.** fermentation in yeasts
**D.** photosynthesis

*Marking Scheme*

| Question | % A | % B | % C | % D | Comments |
|---|---|---|---|---|---|
| **12** | 15 | 74 | 11 | 0 | |

## 2019

The rate of aerobic cellular respiration in a human cell may increase if the

**A.** temperature of the cell is lowered from 37 °C to 35 °C.
**B.** oxygen concentration available to the mitochondria increases.
**C.** carbon dioxide concentration in the cytosol of the cell increases.
**D.** rate of facilitated diffusion of glucose into the cytosol of the cell decreases.

*Marking Scheme*

| Question | % A | % B | % C | % D | Comments |
|---|---|---|---|---|---|
| **13** | 2 | 85 | 10 | 3 | |

## 2019

In glycolysis, the ATP yield per molecule of glucose is

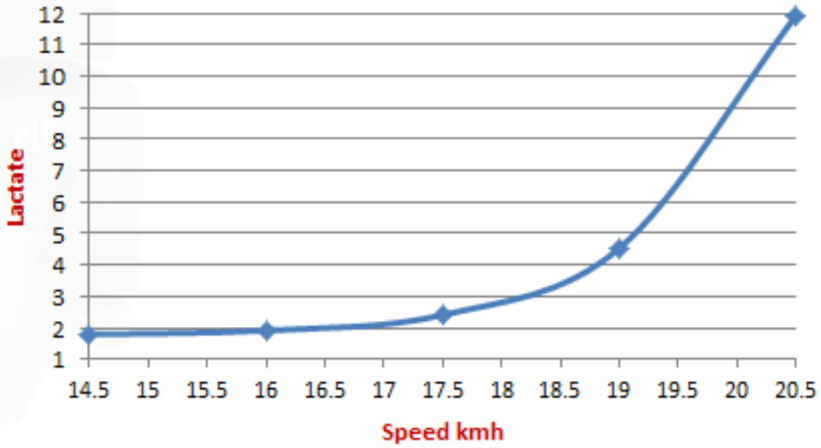
**A.** 4 ATP produced and 2 ATP used for a net gain of 2 ATP.
**B.** 2 ATP produced and 4 ATP used for a net loss of 2 ATP.
**C.** 36 to 38 ATP produced for a net gain of 2 ATP.
**D.** 36 to 38 ATP used for a net loss of 2 ATP.

*Marking Scheme*

| Question | % A | % B | % C | % D | Comments |
|---|---|---|---|---|---|
| **14** | 71 | 13 | 11 | 5 | |

*The next 2 questions refer to the following information*

The relationship between speed of running and blood lactic acid levels for an individual is illustrated in the graph below. This information can be used to develop training programs for individuals wanting to improve their fitness and stamina when running




**Link:**https://training4endurance.co.uk/physiology-of-endurance/lactate-threshold/

How fast is the individual running with a blood lactic acid level of 6.5?

**A.** 18.5 km/hr
**B.** 19 km/hr
**C.** 19.5 km/hr
**D.** 20 km/hr

When a person is running at 17 km/hr, the product(s) of cellular respiration that would be expected to find in the bloodstream would be

**A.** Carbon dioxide, water and lactic acid
**B.** Lactic acid
**C.** Ethanol, lactic acid and carbon dioxide
**D.** Ethanol and carbon dioxide

*Marking Scheme*

**Question 17**
**Solution: C**
Reading from the graph at lactic acid concentration move horizontally from that number than vertically down. It lands on about 19.5 km/hr.
**Question 18**
**Solution: A**

At a speed of 17 km/hr there would be both anaerobic respiration as well as aerobic respiration occurring. The products of these reactions would be lactic acid (anaerobic) as well as carbon dioxide and water (aerobic). Ethanol is the product od anaerobic respiration in plants and yeast.

The following diagram is a simplified version of the electron transport chain. Proteins I to V are various stages of the overall process

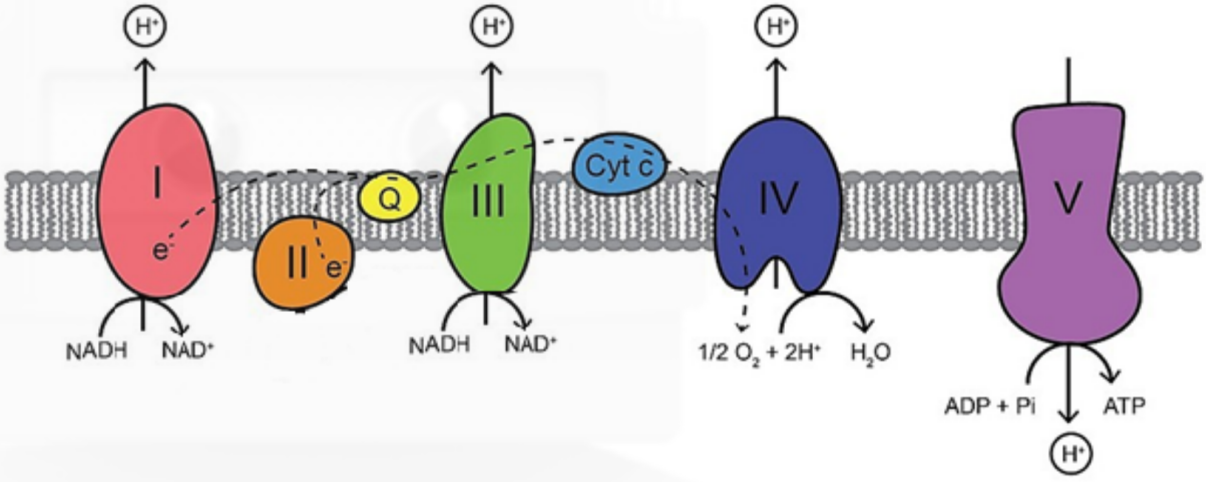



**Diagram:** https://www.redbubble.com/people/ktmthrs/works/34963852-electron-transport-chain

**a)** Describe the cellular location of the electron transport chain.

_____ **(1 mark)**

**b)** Describe the functioning of proteins I and III.

_____

_____ **(1 mark)**

**c)** Explain how efficient structure V is when 1 glucose molecule is accounted for. How can this level of efficiency be maintained over an extended period of time?

_____

_____

_____

_____ **(2 marks)**

*Marking Scheme*

a) Inner mitochondrial membrane (accept cristae) **(1 mark)**

b) I and III remove the Hydrogen from NADH and moves it into the intermembrane space of the mitochondria **(1 mark)**

c) Per glucose molecule there are approximately 34 molecules of ATP produced **(1 mark)**

To maintain this, H ions need to move through protein V. To maintain the H flow, the H in the matrix of the mitochondria combines with oxygen and electrons to produce water **(1 mark)**

*The next 2 questions refer to the following diagram*

The diagram below is of the Krebs Cycle, an important biochemical process occurring in most eukaryotic cells. C2 to C6 represent organic molecules with a differing number of carbon atoms.

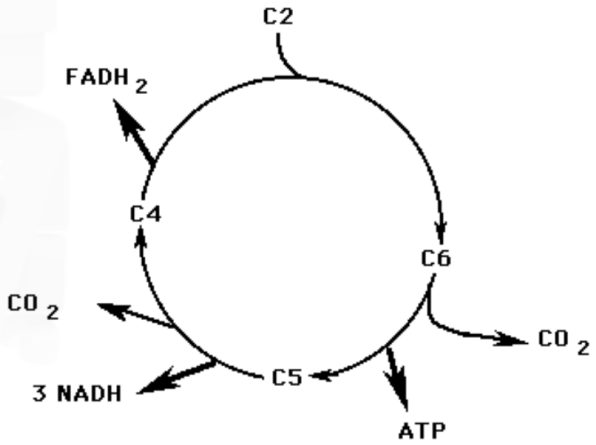



Diagram modified from: http://science.halleyhosting.com/sci/soph/energy/resp/notes/krebs.htm

The cellular location of Krebs cycle is

**A.** The lumen of the smooth endoplasmic reticulum
**B.** The grana of the chloroplast
**C.** The cytosol of an autotrophic cell
**D.** The matrix of the mitochondria

The biochemical process highlighted above undergoes 2 cycles to completely account for all the carbons from glucose. The total amount of products of this process would be

**A.** $CO_2$, ATP, NADH and $FADH_2$
**B.** $2CO_2$, ATP, 3NADH and $FADH_2$
**C.** $4CO_2$, 2ATP, 6NADH and $2FADH_2$
**D.** $6CO_2$ and 34-36ATP

*Marking Scheme*

**Solution: D**

Students should know the 3 stages of cellular respiration. Including inputs. Outputs and location. The Krebs cycle occurs in the matrix of the mitochondria. The lumen of the ER is there to transport material. The grana of the chloroplast is where the LDR occurs. The cytosol of any eukaryotic cell is the location for many chemical reactions including glycolysis.

**Solution: C**

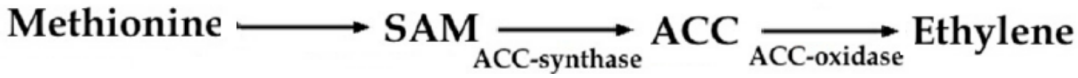
The arrows pointing outwards from the cycle indicates the products of it. If 2 cycles are completed there would be $4CO_2$, 2ATP, 6NADH and $2FADH_2$.

**Study Design Reference**

The main inputs and outputs of the Krebs (citric acid) cycle and electron transport chain including ATP yield (details of the biochemical pathway mechanisms are not required)

## 2019

Ethylene gas is naturally produced by ripening fruit to promote ripening. It is synthesised by a pathway that is simplified below and is stimulated by unripe fruit starting to develop




The diagram below illustrates the effect an increased rate of respiration has on ripening fruit

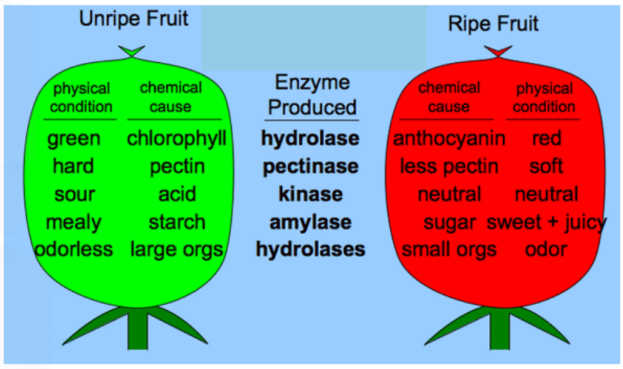



**Diagram from: http://plantphys.info/plant_physiology/ethylene.shtml**

**c)** How could an increase in respiration assist in the production of the ripening enzymes such as pectinase?

_____

_____

_____ **(1 mark)**

*Marking Scheme*

**c)** Cell respiration produces ATP that is needed at the ribosome to combine amino acids together to form proteins such as pectinase **(1 mark)**

## 2018

**Question 10**

Which pair of molecules contains the greatest amount of stored energy?

**A.** NADH and ATP

**B.** $NAD^+$ and ATP

**C.** $NAD^+$ and ADP

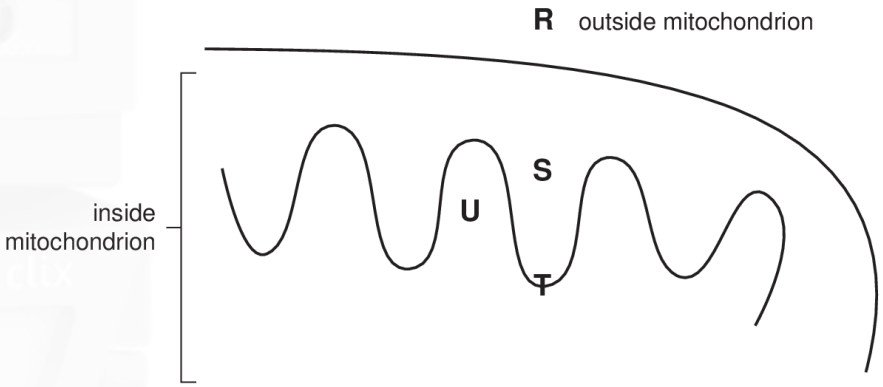
**D.** NADH and ADP

*Marking Scheme*

| Question | % A | % B | % C | % D | Comments |
|---|---|---|---|---|---|
| 10 | 74 | 18 | 4 | 4 | |

**Question 8**

The diagram below shows a section through a part of a mitochondrion.




The sites of the pathways in aerobic respiration are

**A.** R – glycolysis, S – Krebs cycle, T – electron transport chain.

**B.** U – glycolysis, T – Krebs cycle, R – electron transport chain.

**C.** R – glycolysis, U – Krebs cycle, T – electron transport chain.

**D.** T – glycolysis, R – Krebs cycle, S – electron transport chain.

*Marking Scheme*

| Question | % A | % B | % C | % D | Comments |
|---|---|---|---|---|---|
| **8** | 27 | 8 | 63 | 2 | |





**Question 9**

Which of the following gives the inputs and outputs of the electron transport chain in an animal cell?

| | Inputs | Outputs |
|---|---|---|
| **A.** | NADH, ADP, oxygen, $P_i$ | ATP, $NAD^+$, water |
| **B.** | NADH, ADP, water, $P_i$ | ATP, $NAD^+$, oxygen |
| **C.** | $NAD^+$, ADP, oxygen, $P_i$ | NADH, ATP, water |
| **D.** | NADPH, ADP, water, $P_i$ | $NADP^+$, ATP, oxygen |

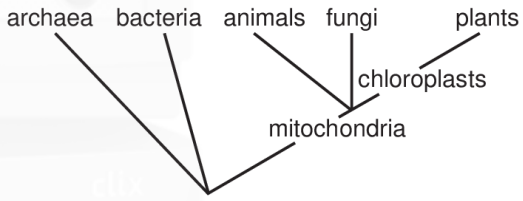
*Marking Scheme*

| Question | % A | % B | % C | % D | Comments |
|---|---|---|---|---|---|
| **9** | 60 | 11 | 20 | 9 | |

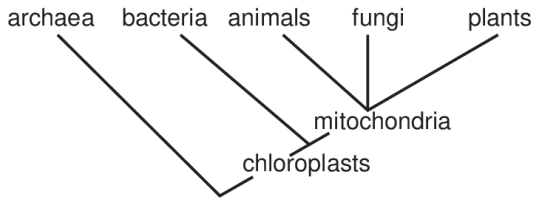
## 2018

Consider the theory of the evolution of mitochondria and chloroplasts.
Which one of the following diagrams correctly represents this theory?

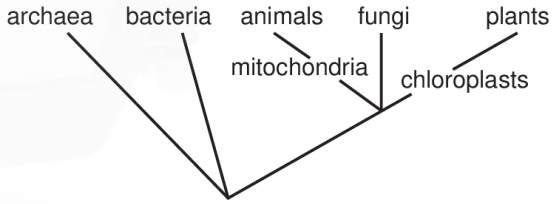
**A.**



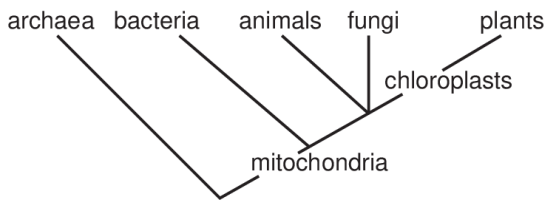

**B.**




**C.**




**D.**




*Marking Scheme*

| Question | Answer |
|---|---|
| 23 | A |

## 2018

Consider the production of ATP molecules in a eukaryotic cell.
The majority of ATP molecules are produced

**A.** during glycolysis.
**B.** in the Krebs cycle.
**C.** during anaerobic respiration.
**D.** by the electron transport chain.

*Marking Scheme*

| Question | Answer |
|---|---|
| 3 | D |

## 2018

The enzymes that are required for the Krebs cycle in cellular respiration are found

**A.** in the cytosol of the cell.
**B.** in the mitochondrial matrix.
**C.** on the plasma membrane of the cell.
**D.** on the outer membrane of the mitochondria.

*Marking Scheme*

| Question | Answer |
|---|---|
| 4 | B |

## 2018

IN THIS

NADH is a coenzyme.

Which one of the following is a correct statement about NADH?

**A.** NADH is a carrier of electrons and protons between reactions in a cell.

**B.** NADH is not produced in the glycolysis stage of aerobic respiration.

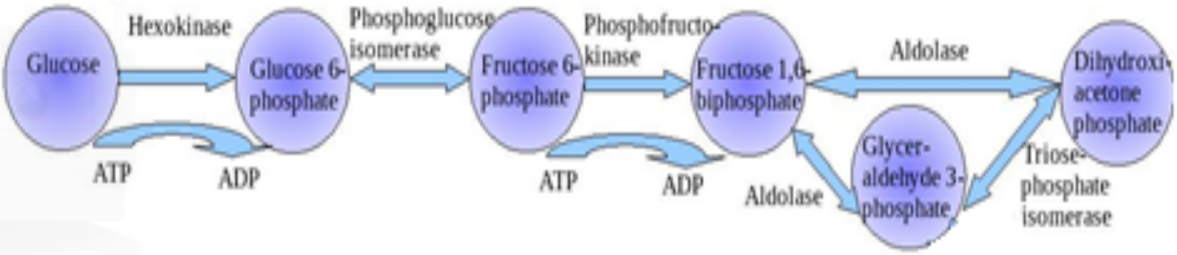
**C.** NADH is the immediate source of energy for cellular activity.

**D.** NADH is required in aerobic respiration but not in anaerobic respiration.

*Marking Scheme*

| Question | Answer |
|---|---|
| 5 | A |

## 2018




**Link:** https://socratic.org/questions/what-are-the-steps-of-glycolysis

The diagram above represents the first few steps of glycolysis. The number of different enzymes illustrated are

**A.** 6

**B.** 5

**C.** 4

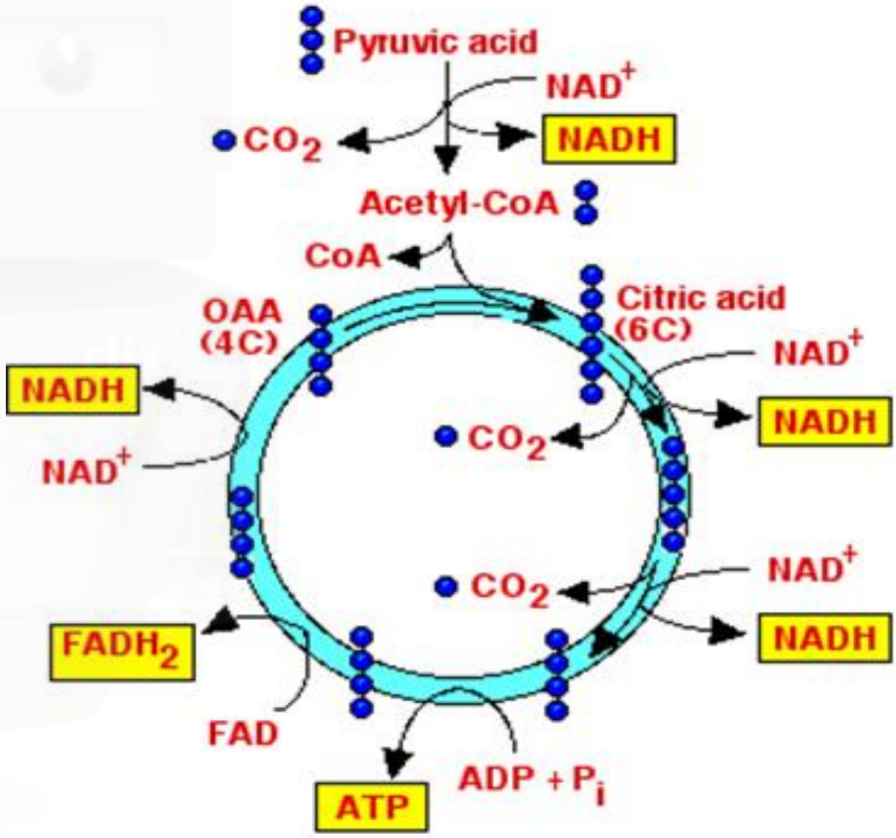
**D.** 3

*Marking Scheme*

**Solution: B**

The enzymes in a biochemical pathway usually are named along the arrows from a substrate to a product. They also usually end with the suffix ‘ase’. In this case there are 6 enzymes listed in the diagram but one of them is involved in 2 reactions, making 5 different enzymes involved overall/

The diagram illustrates one rotation of the Kreb's cycle



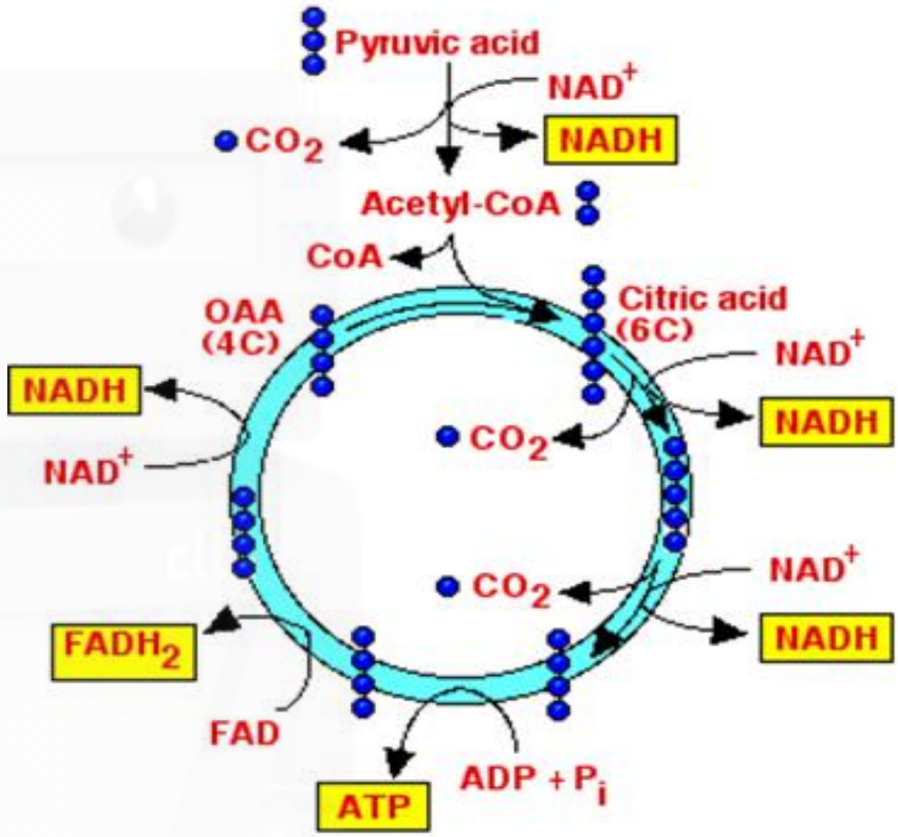

The products of this reaction are

**A.** 4NADH, FADH2, ATP and 3CO2
**B.** Pyruvate, NAD, FAD, ADP and Pi
**C.** Acetyl CoA and pyruvic acid
**D.** 4NADH, FADH2, 2ATP and 2CO2

*Marking Scheme*

**Solution: A**

Based on the information provided, the yellow boxes are the products of several 'coupled' reactions. This includes NADH (4 of them), FADH2 (1 of them) and ATP (1 of them). There is also C02 as a direct product of the breakdown of the pyruvate and there are 3 of them.




https://bit.ly/2vwnAuR

The chemical reaction illustrated in the diagram above

**A.** Occurs in the stroma of the mitochondria
**B.** Occurs in the matrix of the mitochondria
**C.** Is an endergonic reaction
**D.** Is an important step in the synthesis of carbohydrates

*Marking Scheme*

**Solution: B**

The input of pyruvic acid into a cycle which liberates ATP and carbon dioxide is suggestive of the Krebs cycle. This is the part of aerobic respiration that occurs in the matrix of the mitochondria. It is an exergonic reaction that is part of the breakdown of carbohydrates to liberate energy (ATP).

**Study Design Reference:**

The main inputs and outputs of the Krebs (citric acid) cycle and electron transport chain including ATP yield (details of the biochemical pathway mechanisms are not required)

## 2018

When comparing anaerobic with aerobic cellular respiration it is reasonable to state that

A. Aerobic respiration occurs only in the cytosol and anaerobic respiration occurs in the cytoplasm
B. Aerobic respiration has many more metabolic steps than anaerobic respiration
C. Aerobic respiration uses the substrate oxygen but anaerobic respiration uses the substrate carbon dioxide
D. Aerobic respiration uses NADH as a hydrogen carrier but anaerobic respiration uses NADPH as a hydrogen carrier

*Marking Scheme*

**Solution: B**

Aerobic respiration occurs both in the mitochondria whereas anaerobic respiration occurs in the cytosol. Aerobic respiration requires oxygen as a reactant but anaerobic respiration is the combustion of glucose in the absence of oxygen. Both aerobic and anaerobic respiration use NADH as a hydrogen carrier. There are many more steps in aerobic respiration.

**Study Design Reference:**

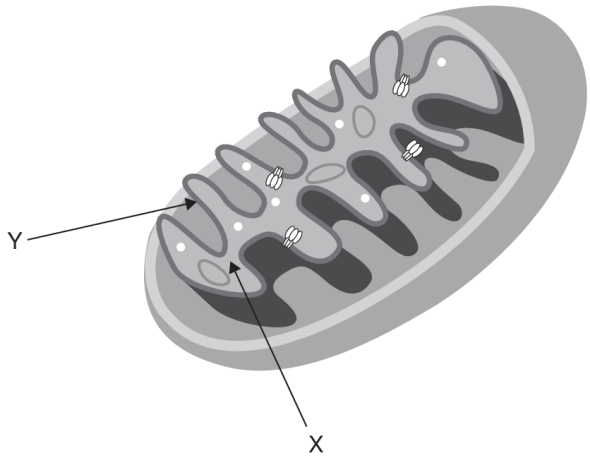
Mitochondria as the site of aerobic cellular respiration

The location of anaerobic cellular respiration, its inputs and the difference in outputs between animals and yeasts including ATP yield

## 2017

ITE IN THIS AREA

The following is a three-dimensional diagram of an organelle found in eukaryotic cells.




**Question 10**

The structure labelled Y is where

**A.** glucose enters glycolysis.
**B.** $NAD^+$ is converted into NADH.
**C.** the majority of ATP is produced in the cell.
**D.** pyruvate is broken down, releasing carbon dioxide.

*Marking Scheme*

| Question | % A | % B | % C | % D | % No answer | Comments |
|---|---|---|---|---|---|---|
| **10** | 10 | 14 | 59 | 17 | 0 | |

## 2017

**Question 11**

An animal cell culture was exposed to radioactively labelled oxygen. The cells were then monitored for three minutes. After this time, the radioactively labelled oxygen atoms would be present in which cellular chemical?

**A.** adenosine triphosphate
**B.** carbon dioxide
**C.** glucose
**D.** water

*Marking Scheme*

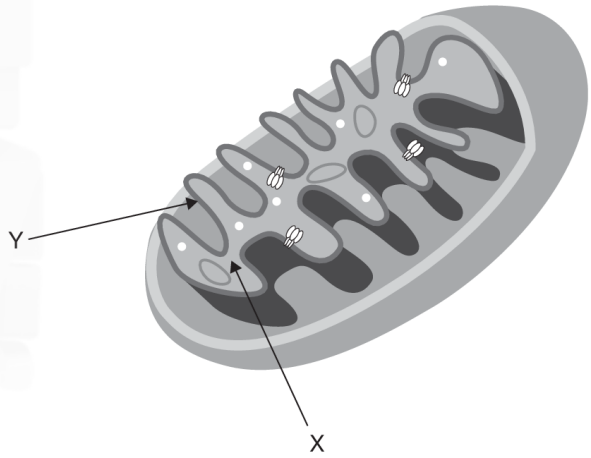
| Question | % A | % B | % C | % D | % No answer | Comments |
|---|---|---|---|---|---|---|
| **11** | 8 | 42 | 11 | 38 | 0 | Oxygen is used in the electron transport chain and combines with the hydrogen to form water. |
| **11** | 8 | 42 | 11 | 38 | 0 | Oxygen is used in the electron transport chain and combines with the hydrogen to form water. |

## 2017

DO NOT WRITE IN THIS AREA

*Use the following information to answer Questions 9 and 10.*

The following is a three-dimensional diagram of an organelle found in eukaryotic cells.




Source: Alila Medical Media/Shutterstock.com

**Question 9**

The region labelled X is called the

**A.** matrix.
**B.** crista.
**C.** inner membrane.
**D.** intermembrane space.

*Marking Scheme*

| Question | % A | % B | % C | % D | % No answer | Comments |
|---|---|---|---|---|---|---|
| 9 | 71 | 16 | 7 | 6 | 0 | |

## 2017

The cellular location of the Electron Transport Chain is

**A.** Matrix
**B.** Cristae
**C.** Grana
**D.** Stroma

*Marking Scheme*

**Solution: B**

The locations of the steps in photosynthesis as well as respiration should be known. The location of the electron transport chain is along the cristae of the mitochondria.

An experiment was set up testing the effect of different substrates on the rate of respiration in yeast cells. Yeast was suspended in a solution of water and different types of substrate were added to each of 4 thermos flasks A to D. A diagram of the apparatus is shown below and the results gained are illustrated on the data table beneath.

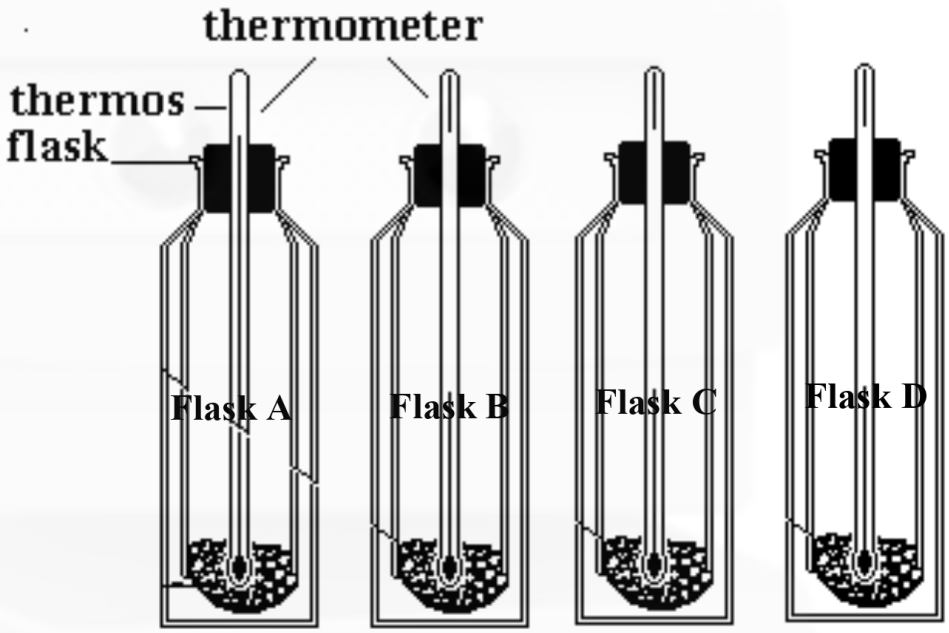



Diagram modified from: http://www.uq.edu.au/_School_Science_Lessons/UNBiology7.html

| Flask contents | Initial Temperature (°C) | Maximum Temperature reached (°C) |
|---|---|---|
| No substrate | 25 | 28 |
| Glucose | 25 | 38 |
| Equal (a glucose substitute) | 25 | 31 |
| Splenda (a glucose substitute) | 25 | 34 |

a) (i) What was the independent variable in the experiment?

_____(1 mark)

(ii) Why did the 'no substrate' results show an increase in temperature?

_____

_____(1 mark)

(iii) State 2 controlled conditions that would need to be met so the results obtained could be compared to each other

_____(1 mark)

Cell respiration rates can be measured in a range of ways apart from temperature changes

b) Describe another way of measuring respiration rate. In you answer describe a method that could be used to quantify the measurement.

_____

_____

_____

_____(2 marks)

A criticism of the initial method was that it could not clearly be determined if the yeast was undergoing aerobic or anaerobic respiration.

c) (i) Complete the table below showing the differences between anaerobic and aerobic respiration in eukaryotic cells

| | Aerobic respiration | Anaerobic respiration |
|---|---|---|
| Cellular location | | |
| ATP production | | |
| Speed of process | | |

(3 marks)

(ii) How could the initial experiment be altered to ensure the respiration was primarily anaerobic?

_____

_____

_____(2 marks)

(a) (i) The IV is the factor being tested so it is different from set up to set up. In this case it is the type of substrate available.

(1 mark)

(ii) The yeast cells have some glucose within the cells initially. They respire and generate some heat as a product, explaining the 3 degree increase.

(1 mark)

(iii) Based on the information provided controlled conditions could/should include:

- Same initial temperature (25°C)
- Same amount of yeast
- Same type of thermos used

*Note: 2 controlled conditions required*

(1 mark)

(b) There are a variety of methods that could be used. The method below is probably the most obvious.

Volume of carbon dioxide produced.

(1 mark)

Use an inverted measuring cylinder filled with water and connect this to yeast mixture. The gas produced will displace the water enabling the rate of gas production to be quantified.

(1 mark)

*NOTE: Other methods could be used*

- *Pressure changes*
- *Oxygen concentration*

*Factor and method are both required*

(c) (i)

| | Aerobic respiration | Anaerobic respiration |
|---|---|---|
| Cellular location | **Mitochondria** | **Cytosol** |
| ATP production | **36/38 ATP** | **2 ATP** |
| Speed of process | **Slow** | **Fast** |

*NOTE: 1 or 2 errors 2 marks, 3 or 4 errors 1 mark*

(3 marks)

(ii) To ensure the conditions were anaerobic the water the yeast was mixed in could be boiled first and allowed to cool.

(1 mark)

This removes the oxygen from the water and when the yeast is placed in it they will respire anaerobically.

(1 mark)

**Study Design Reference**

The location of, and the inputs and outputs of, glycolysis including ATP yield (details of the biochemical pathway mechanisms are not required).

Mitochondria as the site of aerobic cellular respiration, an overview of their structure and evidence of their bacterial origins.

The location of anaerobic cellular respiration, its inputs and the difference in outputs between animals and yeasts including ATP yield.

**Question 2** (8 marks)

Plant materials containing cellulose and other polysaccharides are reacted with acids to break them down to produce glucose. This glucose is then used by yeast cells for fermentation.

**a.** Why is fermentation important for yeast cells? 1 mark

**b.** What are the products of fermentation in yeast cells? 1 mark

*Marking Scheme*

**Question 2a.**

| Marks | 0 | 1 | Average |
|---|---|---|---|
| % | 52 | 48 | 0.5 |

To provide energy or ATP

**Question 2b.**

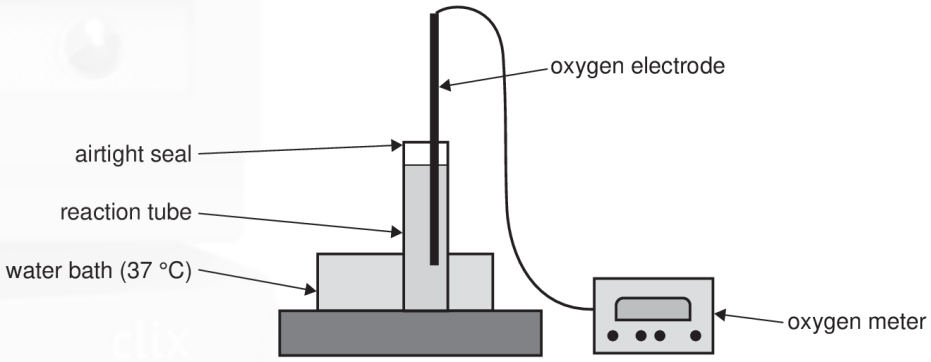
| Marks | 0 | 1 | Average |
|---|---|---|---|
| % | 50 | 50 | 0.5 |

- ethanol/alcohol
- carbon dioxide
- ATP

Energy was not an acceptable answer.

**Question 4** (6 marks)

The apparatus shown below was used in a series of experiments to study aerobic respiration.




In three different experiments, the reaction tube initially contained the following:

1. suspension of mitochondria
2. cytosol of cells from which the mitochondria had been removed
3. suspension of mitochondria and cytosol of cells

The temperatures and pH of the mixtures within the reaction tubes were carefully controlled so as not to damage the mitochondrial structure or any of the enzymes.

In each experiment, a solution containing glucose was first added to the mixture in the reaction tube and the oxygen concentration was measured for three minutes. Then, a pyruvate solution was added and the oxygen concentration was measured again for three minutes.

DO NOT WRITE IN THIS AREA

Using your knowledge and understanding of aerobic respiration and mitochondria, complete the tables below with your prediction of the change in oxygen concentration of the mixture in the reaction tube after the addition of each substance and give a reason for your prediction.

**Experiment 1 – Suspension of mitochondria**

| Substance added | Change in oxygen concentration (increase/decrease/no change) | Reason |
|---|---|---|
| glucose | | |
| pyruvate | | |

**Experiment 2 – Cytosol of cells from which the mitochondria had been removed**

| Substance added | Change in oxygen concentration (increase/decrease/no change) | Reason |
|---|---|---|
| glucose | | |
| pyruvate | | |

**Experiment 3 – Suspension of mitochondria and cytosol of cells**

| Substance added | Change in oxygen concentration (increase/decrease/no change) | Reason |
|---|---|---|
| glucose | | |
| pyruvate | | |

*Marking Scheme*

**Question 4**

**Experiment 1 – Suspension of mitochondria**

| Substance added | Change in oxygen concentration (increase/decrease/no change) | Reason |
|---|---|---|
| *glucose* | no change | Glucose is not metabolised (broken down) by the mitochondria. |
| *pyruvate* | decrease | Pyruvate is a substrate of the Krebs |

**Experiment 2 – Cytosol of cells from which the mitochondria had been removed**

| Substance added | Change in oxygen concentration Increase/decrease/no change | Reason |
|---|---|---|
| *glucose* | no change | Glycolysis is anaerobic (or glucose converted to pyruvate but no mitochondria so oxygen is not used). |
| *pyruvate* | no change | No aerobic breakdown of pyruvate. |

**Experiment 3 – Suspension of mitochondria and cytosol of cells**

| Substance added | Change in oxygen concentration Increase/decrease/no change | Reason |
|---|---|---|
| *glucose* | decrease | Glucose is converted into pyruvate, which is metabolised by the mitochondria using oxygen. |
| *pyruvate* | decrease | Pyruvate is metabolised by the mitochondria in a process that uses oxygen. |

## 2016

**Question 9**

ATP is important in living cells as it

**A.** is required for osmosis.

**B.** provides a supply of usable energy for the cell.

**C.** provides one of the building blocks for lipid synthesis.

**D.** is an important structural component of the plasma membrane.

*Marking Scheme*

**The table below indicates the percentage of students who chose each alternative. The correct answer is indicated by shading.**

| Question | % A | % B | % C | % D | Comments |
|---|---|---|---|---|---|
| 9 | 1 | 98 | 1 | 0 | |

## 2015

Rotenone is a chemical compound that is used as an insecticide and a piscicide (a substance that kills fish). The rotenone molecule disrupts the electron transport chain in animal cells by interfering with one of the essential reactions within the electron transport chain.

In the past, people sometimes put extracts containing rotenone into a river to poison the fish, allowing the fish to be more easily caught. When rotenone-poisoned fish are eaten by people, no poisonous effect is observed.

Which one of the following statements best explains this observation?

**A.** Rotenone is not absorbed through the cell membranes of people who have eaten poisoned fish.

**B.** Rotenone is not absorbed by fish tissue and remains dissolved in water.

**C.** Human cell metabolism does not involve the electron transport chain.

**D.** Rotenone only affects organisms that respire anaerobically.

*Marking Scheme*

**The table below indicates the percentage of students who chose each alternative. The correct answer is indicated by shading.**

| Question | % A | % B | % C | % D | Comments |
|---|---|---|---|---|---|
| 10 | 67 | 17 | 4 | 11 | |

## 2015

A student was investigating four cell types from different organisms. She recorded the results of her microscopic examination of the cells in the table below.

| | Cell W | Cell X | Cell Y | Cell Z |
|---|---|---|---|---|
| **Mitochondria** | few | many | absent | few |
| **Chloroplasts** | present | absent | absent | present |
| **Nucleus** | present | present | absent | present |

Which one of the following is the correct conclusion that can be drawn from this data?

**A.** Cell W could be a muscle cell from an insect.

**B.** Cell Y could be a living leaf cell from a corn plant.

**C.** Cell X could be a heart-muscle cell from a mammal.

**D.** Cell Z could be an underground root cell from a pea plant.

*Marking Scheme*

**The table below indicates the percentage of students who chose each alternative. The correct answer is indicated by shading.**

| Question | % A | % B | % C | % D | Comments |
|---|---|---|---|---|---|
| 12 | 2 | 2 | 88 | 8 | |

## 2015

The production of adenosine triphosphate (ATP) is represented by the following equation.

$$ADP + Pi \rightarrow ATP$$

The production of ATP

**A.** is a catabolic reaction.

**B.** requires an overall input of energy.

**C.** only occurs in the absence of oxygen.

**D.** occurs only in the mitochondria of a cell.

*Marking Scheme*

**The table below indicates the percentage of students who chose each alternative. The correct answer is indicated by shading.**

| Question | % A | % B | % C | % D | Comments |
|---|---|---|---|---|---|
| **7** | 22 | 56 | 3 | 19 | |

## 2015

Rotenone is a chemical compound that is used as an insecticide and a piscicide (a substance that kills fish). The rotenone molecule disrupts the electron transport chain in animal cells by interfering with one of the essential reactions within the electron transport chain.

Which one of the following statements best explains the effect of rotenone in causing death in insects and fish?

**A.** The rate of glycolysis would increase.

**B.** ATP would accumulate in the mitochondria.

**C.** Aerobic respiration in the mitochondria would be disrupted.

**D.** The cell membrane would no longer be permeable to oxygen.

*Marking Scheme*

**The table below indicates the percentage of students who chose each alternative. The correct answer is indicated by shading.**

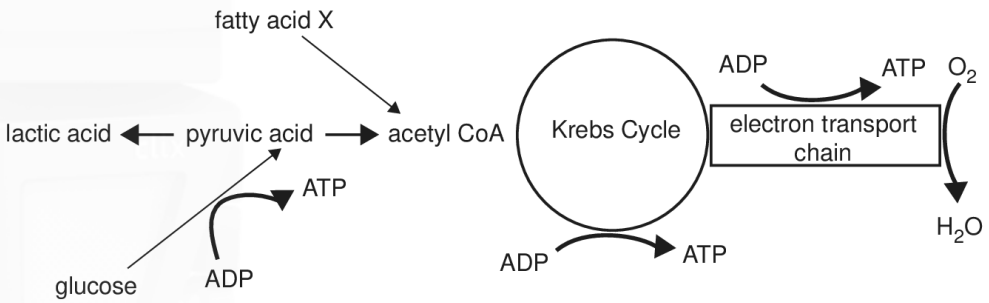
| Question | % A | % B | % C | % D | Comments |
|---|---|---|---|---|---|
| **9** | 3 | 9 | 71 | 17 | |

## 2014

If there is insufficient glucose for cellular respiration, fatty acids can be changed to acetyl CoA. Each fatty acid X molecule produces eight molecules of acetyl CoA.

The diagram below summarises the pathways for the breakdown of fatty acid X and glucose.

The number of molecules produced in each step is **not** shown.




Referring to the information above and your knowledge of cellular respiration, which one of the following conclusions can be made?

**A.** Most of the ATP is made in the Krebs Cycle.

**B.** Pyruvic acid is converted to acetyl CoA under anaerobic conditions.

**C.** No ATP can be formed from the breakdown of glucose under anaerobic conditions.

**D.** One fatty acid X molecule produces more ATP in aerobic conditions than one glucose molecule does.

*Marking Scheme*

**The table below indicates the percentage of students who chose each alternative. The correct answer is indicated by shading.**

| Question | % A | % B | % C | % D |
|---|---|---|---|---|
| **12** | 10 | 39 | 7 | 43 |

**Question 3** (6 marks)

Muscle cells in the heart contract and relax more rapidly during exercise and require a constant supply of energy.

**c.** Which organelle would you expect to see in large numbers in heart muscle cells to supply this energy? Explain your response. 2 marks

DO NOT WRITE IN THIS

*Marking Scheme*

**Question 3c.**

| Marks | 0 | 1 | 2 | Average |
|---|---|---|---|---|
| % | 15 | 64 | 21 | **1.1** |

Heart muscle cells would have large numbers of mitochondria, in which aerobic respiration occurs, producing ATP.

**Question 1** (7 marks)

Yeast is a single-celled, microscopic fungus that uses sucrose as a food source. An experiment was carried out to investigate cellular respiration by a particular species of yeast.

Yeast cells were placed in a container and a sucrose solution was added. An airtight lid was placed on the container. The percentages of oxygen and ethanol in the container were recorded over a one-hour period. The experiment was carried out at room temperature. The results are shown in the following table.

| | **Percentage of oxygen** | **Percentage of ethanol** |
|---|---|---|
| at the start of the experiment | 21 | 0 |
| at the end of the experiment | 18 | 4 |

**a.** Explain any changes that have been observed in oxygen and ethanol levels within the airtight container. 2 marks

Levels of carbon dioxide were also monitored during the experiment.

**b.** Predict whether the carbon dioxide concentration inside the airtight container would increase, stay the same or decrease within the time the experiment was carried out. Explain the reasoning behind your prediction. 2 marks

prediction _____

explanation _____

## Marking Scheme

**Question 1a.**

| Marks | 0 | 1 | 2 | Average |
|---|---|---|---|---|
| % | 55 | 26 | 19 | **0.7** |

Ethanol levels rose as ethanol is a product of anaerobic respiration. Oxygen levels decreased as oxygen is required for aerobic respiration.

Cellular respiration was not a suitable term to use in the answer.

**Question 1b.**

| Marks | 0 | 1 | 2 | Average |
|---|---|---|---|---|
| % | 21 | 24 | 56 | **1.4** |

Prediction: Increase

Explanation: $CO_2$ is a product of (one of)

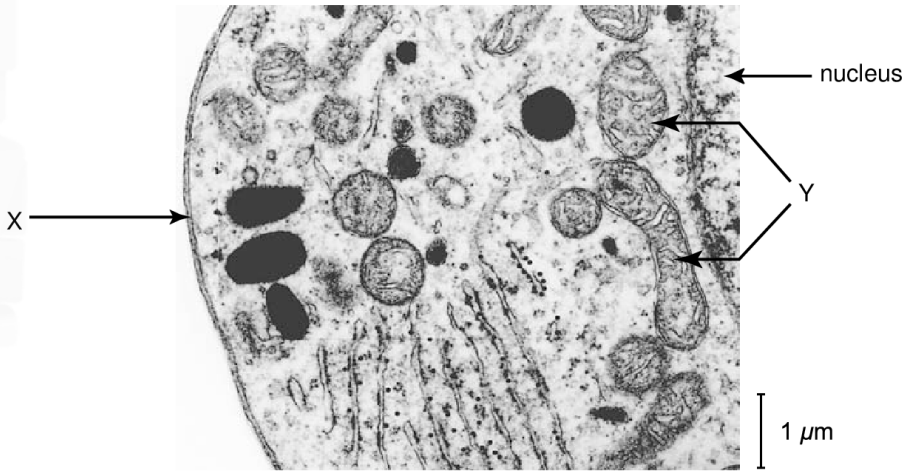
- cellular respiration
- aerobic respiration
- anaerobic respiration.

Respiration alone was not awarded any marks.

# 2012

**Question 1**

The electromicrograph below shows a portion of a cell.




It has been suggested that as humans age the structures labelled Y become less efficient.

**c.** Explain the consequence of this for an elderly person.

2 marks

## Marking Scheme

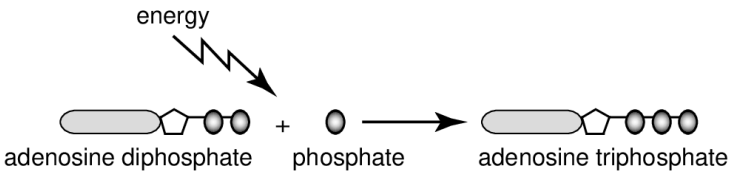
**Question 1c.**

| Marks | 0 | 1 | 2 | Average |
|---|---|---|---|---|
| % | 18 | 30 | 52 | **1.4** |

A lack of mitochondria would mean a lower rate of cellular respiration and the person would tire more readily.

## 2012

Adenosine diphosphate (ADP) is an organic molecule found in large quantities in most cells. ADP is converted to adenosine triphosphate (ATP) by phosphorylation, as shown in the diagram below.




The process that produces the largest number of ATP molecules is

**A.** synthesis of polypeptide molecules.

**B.** breakdown of glucose during glycolysis.

**C.** the light-independent reactions of photosynthesis.

**D.** the electron transport chain in cellular respiration.

### *Marking Scheme*

| Question | % A | % B | % C | % D |
|---|---|---|---|---|
| **22** | 2 | 9 | 7 | 82 |

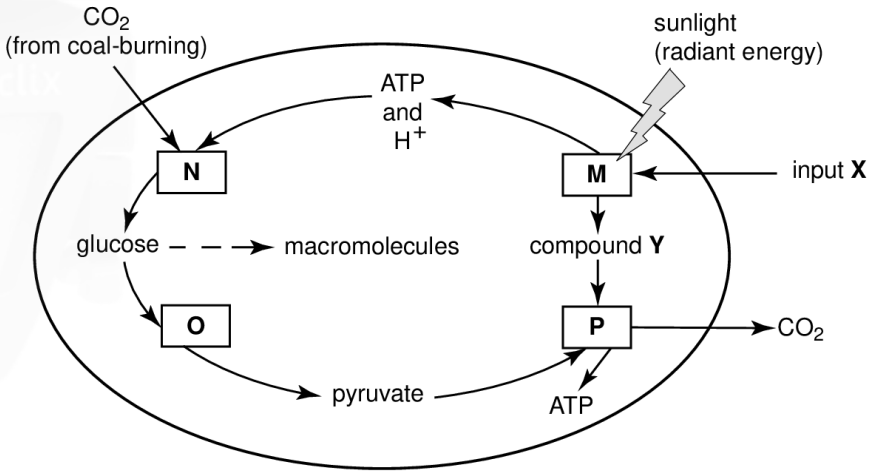
## 2012

**Question 8**

Climate change has been linked to an excess of carbon dioxide in the atmosphere. The burning of coal is a major contributor to this excess of carbon dioxide.

Microalgae such as *Chlorella* can use greater amounts of carbon dioxide than land plants and they do not require prime soil, reliable rainfall and a particular climate. *Chlorella* can be grown cheaply in existing or engineered ponds which are supplied with carbon dioxide from a coal-burning power station nearby.

The following diagram represents a summary of the processes (labelled M, N, O, P) occurring in a *Chlorella* cell.



**b.** With reference to the diagram above, complete the following table.

| Process | Name of process | Site of process |
|---|---|---|
| **M** | | grana of chloroplast |
| **O** | glycolysis | |
| **P** | stages of cellular respiration | |

3 marks

*Marking Scheme*

**Question 8b.**

| Marks | 0 | 1 | 2 | 3 | Average |
|---|---|---|---|---|---|
| % | 17 | 15 | 23 | 45 | 2 |

| Process | Name of process | Site of process |
|---|---|---|
| **M** | light-dependent reaction | grana of chloroplast |
| **O** | glycolysis | cytoplasm/cytosol |
| **P** | stages of cellular respiration | mitochondria |

## 2011

The reaction ADP + Pi ⟶ ATP

**A.** is irreversible.

**B.** occurs without the presence of enzymes.

**C.** occurs in yeast cells during fermentation.

**D.** only occurs in cells containing mitochondria.

*Marking Scheme*

**The table below indicates the percentage of students who chose each alternative. The correct answer is indicated by shading.**

| Question | % A | % B | % C | % D | Comments |
|---|---|---|---|---|---|
| **20** | 6 | 20 | 33 | 41 | ATP is produced in aerobic and anaerobic respiration, such as fermentation in yeast cells. The reaction is reversible and is catalysed by enzymes. |

## 2011

**a.** Write the word or chemical equation for aerobic cellular respiration.

1 mark

*Marking Scheme*

Either of:

- glucose + oxygen→carbon dioxide + water
- $C_6H_{12}O_6 + 6O_2 \rightarrow 6H_2O + 6CO_2$

## 2011

**b.** Cyanide inactivates metabolic reactions at the cristae of mitochondria. Cyanide poisoning often results in death. Explain why.

2 marks

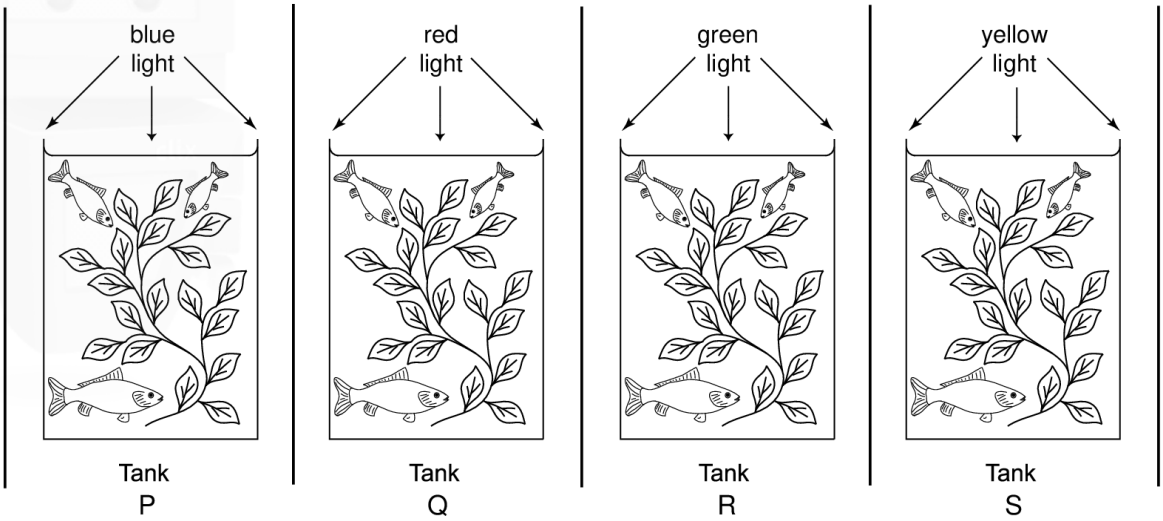
### *Marking Scheme*

Both of:

- the electron transport chain would be unable to provide larger amounts of ATP
- there would be insufficient energy available to maintain life.

## 2010

Samples of a particular water plant and fish were placed in four identical glass tanks. The fish were provided with food pellets. The tanks were isolated from each other, and each was illuminated by a different coloured light source.




During cellular respiration, the fish in the tanks use oxygen

**A.** in the glycolysis stage.

**B.** to break down ATP molecules to ADP molecules.

**C.** to combine with carbon dioxide to produce glucose.

**D.** as the final acceptor of electrons and hydrogen ions.

### *Marking Scheme*

| | | | | | | |
|---|---|---|---|---|---|---|
| **18** | 18 | 15 | 11 | 56 | 0 | |

**Question 3**

*Elysia chlorotica* is a bright green sea slug, with a soft leaf-shaped body. It has a life span of 9 to 10 months. This sea slug is unique among sea slugs as it is able to survive on solar power.

*E. chlorotica* acquires chloroplasts from the algae it eats, and stores them in the cells that line its digestive tract.

Young *E. chlorotica* fed with algae for two weeks can survive for the rest of their lives without eating.

The product of photosynthesis must undergo a three-stage process for the slug to access the energy in the product.

**b.** Name and give a brief description of each of these stages.

3 marks

## *Marking Scheme*

**Question 3b.**

| Marks | 0 | 1 | 2 | 3 | Average |
|---|---|---|---|---|---|
| % | 53 | 9 | 14 | 25 | **1.1** |

Suitable answers included:

- glycolysis: glucose is converted to pyruvate, 2 ATP produced
- Krebs (cycle): pyruvate is converted to carbon dioxide, 2 ATP produced
- electron transport chain: hydrogen combines with oxygen to produce water, 32–34 ATP produced.

The question required a brief description of three stages of cellular respiration. Answers could also include the inputs or outputs of each stage, where each stage occurred or the amount of ATP produced.

Many students, however, described different stages of photosynthesis and did not gain any marks. Some students wrote large amounts of information for each part; this was unnecessary and wasted valuable examination time. Some students gave contradictory information.

Errors included:

- $O_2$ being a part of glycolysis
- NADPH rather than NADH in the Krebs cycle
- $CO_2$ being an output of the electron transport chain and 36–38 ATP being produced.