Website: contoureducation.com.au | **Phone:** 1800 888 300
Email: hello@contoureducation.com.au

VCE Biology ¾

Cellular Respiration and Anaerobic Fermentation [2.2]

Homework Solutions

Homework Outline:

Homework Questions	Pg 02 – Pg 21

Section A: Homework Questions (42 Marks)

Sub-Section [2.2.1]: Recall the Inputs, Outputs & Locations of All Stages of Aerobic Cellular Respiration

Question 1

Definitions:

a. Glycolysis

The first stage of cellular respiration that occurs in the cytoplasm, breaking down one molecule of glucose (a 6-carbon sugar) into two molecules of pyruvate (each containing 3 carbons).

b. Link Reaction

Converts pyruvate into acetyl-CoA in the mitochondrial matrix, releasing CO_2 and generating NADH.

c. Krebs Cycle (Citric Acid Cycle)

A series of reactions in the mitochondrial matrix that oxidises acetyl-CoA, producing ATP, NADH, $FADH_2$, and CO_2.

d. Electron Transport Chain (ETC)

A series of protein complexes in the cristae of the mitochondria where NADH and $FADH_2$ donate electrons, driving ATP production via oxidative phosphorylation.

Space for Personal Notes

Question 2 (1 mark)

Which of the following correctly describes the role of oxygen in aerobic respiration?

A. It is a substrate in glycolysis.

B. It acts as the final electron acceptor in the Electron Transport Chain.

C. It is converted into CO_2 in the Krebs cycle.

D. It generates NADH in the link reaction.

Question 3 (1 mark)

In the Electron Transport Chain, what drives the production of ATP by ATP synthase?

A. The breakdown of glucose.

B. The flow of electrons through protein complexes.

C. The movement of protons down their concentration gradient.

D. The release of CO_2 from the Krebs cycle.

Question 4 (1 mark)

Which of the following best describes the role of the link reaction in cellular respiration?

A. It produces ATP by oxidising acetyl-CoA.

B. It transfers electrons to the ETC.

C. It connects glycolysis to the Krebs cycle by producing acetyl-CoA and NADH.

D. It regenerates NAD^+ for glycolysis in the absence of oxygen.

Space for Personal Notes

Question 5 (1 mark)

Which stage of aerobic respiration produces the most NADH?

A. Glycolysis

B. Link Reaction

C. Krebs Cycle

D. Electron Transport Chain

Question 6

Stage	Inputs	Outputs	Location
Glycolysis	Glucose, $2ADP + Pi$, $2NAD^+$	2 Pyruvate, 2NADH, 2ATP	Cytosol
Link Reaction	2 Pyruvate, $2NAD^+$	2 Acetyl-CoA, $2\ CO_2$, 2NADH	Mitochondrial Matrix
Krebs Cycle	2 Acetyl-CoA, $2ADP + Pi$, NAD^+, FAD	$4CO_2$, 2ATP, 4NADH, $FADH_2$	Mitochondrial Matrix
Electron Transport Chain	$\frac{26}{28}$ ADP + Pi, NADH, $FADH_2$, O_2	$\frac{26}{28}$ ATP, NAD^+, FAD, H_2O	Cristae of Mitochondrial

Space for Personal Notes

Sub-Section [2.2.2]: Recall the Inputs, Outputs & Locations of All Stages of Anaerobic Cellular Respiration, Including Lactic Acid & Alcoholic Fermentation

Question 7

Definitions:

a. Lactic Acid Fermentation

Occurs in animals when oxygen is absent; pyruvate is reduced to lactic acid, regenerating NAD^+ to sustain glycolysis.

b. Alcoholic Fermentation

Occurs in yeast, converting pyruvate into ethanol and CO_2, also regenerating NAD^+ for glycolysis.

c. Anaerobic Respiration Location

Cytoplasm for both fermentation types.

Question 8 (1 mark)

Why does glycolysis occur in both aerobic and anaerobic conditions?

A. It requires oxygen as an input.

B. It occurs in the mitochondria, independent of oxygen.

C. It is the only stage of respiration that does not require oxygen.

D. It produces water as a byproduct.

Question 9 (1 mark)

In yeast fermentation, why is CO_2 released?

A. It is a waste product of glycolysis.

B. It results from the breakdown of ethanol.

C. It is produced when pyruvate is decarboxylated.

D. It forms when NADH is oxidised.

Question 10 (1 mark)

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

Space for Personal Notes

Question 11

Stage	Inputs	Outputs	Location
Glycolysis	Glucose, 2ADP + Pi, $2NAD^+$	2 Pyruvate, 2NADH, 2ATP	cytoplasm
Lactic Acid Fermentation	2 Pyruvate, 2NADH	2 Lactic Acid, $2NAD^+$	cytoplasm

Stage	Inputs	Outputs	Location
Glycolysis	Glucose, 2ADP + Pi, $2NAD^+$	2 Pyruvate, 2NADH, 2ATP	cytoplasm
Alcoholic Fermentation	2 Pyruvate, 2NADH	2 Ethanol + $2CO_2$, $2NAD^+$	cytoplasm

Space for Personal Notes

Sub-Section [2.2.3]: Describe the Significance of the Mitochondria as the Necessary Location for Aerobic Respiration

Question 12

Definitions:

a. Cristae

Folded inner membranes of mitochondria where the ETC occurs, maximising ATP production through a large surface area.

b. Matrix

Inner compartment of mitochondria where the Link Reaction and Krebs cycle take place.

c. Endosymbiotic Theory

Explains mitochondria's origin as once-independent prokaryotes, evidenced by their double membrane and DNA.

Question 13 (1 mark)

What feature of the mitochondria is directly related to its efficiency in ATP production?

A. Its ability to synthesise glucose.

B. Its highly folded cristae that increase surface area.

C. Its single membrane that enhances permeability.

D. Its location in the cytoplasm.

Space for Personal Notes

Question 14 (1 mark)

Which statement best explains why the Krebs cycle occurs in the mitochondrial matrix?

A. The matrix is where glucose is stored.

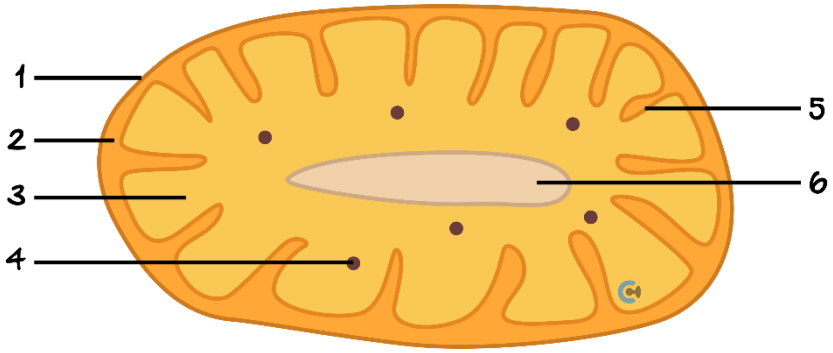
B. The enzymes needed for the Krebs cycle are located there.

C. The matrix contains the DNA required for the Krebs cycle.

D. The matrix traps CO_2 released during the cycle.

The following information applies to the two questions that follow.

The diagram below shows a mitochondrion with labels 1-6 representing locations or structures within the organelle.



Question 15 (1 mark)

Which one of the following processes occurs at structure 5?

A. Glycolysis

B. Krebs Cycle

C. Electron Transport Chain

D. ATP Phosphorylation

Question 16 (1 mark)

The purpose of location 2 is to:

A. Remove hydrogen from NADH.

B. Provide a difference in hydrogen concentration compared to location 3.

C. Store enzymes produced by structure 4.

D. Separate structure 1 from structure 6.

Space for Personal Notes

Sub-Section [2.2.4]: Identify & Describe Factors - Such As Temperature, Glucose Availability, & Oxygen Concentration - On the Rate of Cellular Respiration

Question 17

Definitions:

a. Temperature

Enzymes operate at an optimal temperature; extreme heat denatures enzymes, and low temperatures slow reaction rates.

b. Glucose Availability

Determines the substrate supply for glycolysis; excess glucose does not increase the rate beyond enzyme saturation.

c. Oxygen Concentration

Essential for the ETC; low oxygen halts aerobic respiration, leading to reliance on anaerobic pathways.

d. pH

Enzymes in glycolysis and the Krebs cycle function optimally within a specific pH range, usually near neutral. Extreme pH levels can denature enzymes, reducing their efficiency.

Space for Personal Notes

Question 18 (1 mark)

ATP synthase is a key enzyme in the electron transport chain. A molecule bound to ATP synthase, altering the shape of the active site so that the substrate could no longer bind is an example of:

A. Competitive Inhibition

B. Non-competitive Inhibition

C. Saturation

D. Limiting Factor

As the inhibitor has bound to a site other than the active site (allosteric), the inhibition is non-competitive as the substrate and inhibitor are not competing for the same region of the enzyme.

Question 19 (1 mark)

An experiment was conducted to determine the effect of heat on aerobic cellular respiration. Five sets of mitochondria suspended in the cytosol were exposed to temperatures of 0℃, 20℃, 40℃, 60℃and 80℃. All other variables remained the same.

One way that the rate of aerobic respiration could be measured is to:

A. Measure the decrease in carbon dioxide.

B. Measure the decrease in oxygen.

C. Measure the decrease in water level.

D. Measure the increase in glucose concentration.

As oxygen is an input for aerobic respiration, and carbon dioxide is an output, when aerobic respiration is occurring oxygen levels will decrease and carbon dioxide levels will increase. B is the best answer since CO_2 levels will still change during anaerobic respiration

Question 20 (1 mark)

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

A. Temperature of the cell is lowered from 37℃ to 35℃.

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.

Space for Personal Notes

Question 21 (1 mark)

At high glucose concentrations, why does ATP production plateau?

A. Enzymes involved in glycolysis and the Krebs cycle are saturated.

B. Excess glucose is converted into lactic acid.

C. Oxygen is no longer needed to sustain respiration.

D. Mitochondria lack the capacity to oxidise pyruvate.

Question 22 (2 marks)

If oxygen is not present in sufficient amounts, cells undergo anaerobic respiration. A student investigated the rate of carbon dioxide production by yeast undergoing fermentation at different temperatures and obtained the following results.

Temperature (°C)	**Mean Rate of CO_2 Production (cm^3/min)**
0	0.002
10	0.062
20	0.120
30	0.235
40	0.237
50	0.202

Explain the results observed.

As the temperature increases to 30-40°C the rate of respiration increases because the substrates move with more energy giving a higher chance of collisions with the energy needed for reaction (1).
As the temperature increases above the optimum temperature (30-40°C) the enzymes involved denature and the rate of respiration decreases (1).

Sub-Section [2.2.5]: Identify & Explain the Role of Enzymes & Coenzymes in Cellular Respiration, Including Both Aerobic & Anaerobic

Question 23

Definitions:

a. Enzymes

Biological catalysts that speed up reactions, e.g., ATP synthase in the ETC produces ATP.

b. Co-enzymes

NAD^+ and FAD transport electrons and protons to the ETC; their reduced forms (NADH, $FADH_2$) are critical for ATP production.

Question 24 (1 mark)

The loaded co-enzymes in cellular respiration include:

A. NADPH, ATP and $FADH_2$

B. NADH, ATP + Pi and H_2O

C. NADH, ATP and $FADH_2$

D. NADPH, ATP and Pi

NADPH is a co-enzyme in photosynthesis. ADP + Pi is the unloaded form of ATP.

Space for Personal Notes

Question 25 (1 mark)

Which one of the following statements about enzyme structure and function during cellular respiration is correct?

A. Any of the substrates would have a complementary shape to all enzymes involved in the process.

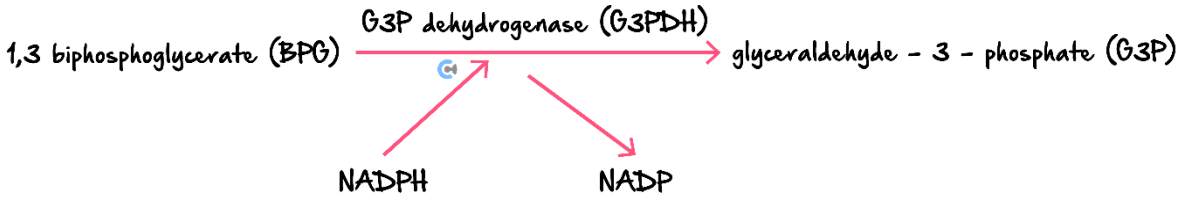
B. Once a reaction is complete, the enzyme needs to be replaced to maintain a constant concentration of the enzyme.

C. A greater number of collisions between an enzyme and a substrate will occur as the temperature increases indefinitely.

D. Each enzyme could function at a tertiary or quaternary level of arrangement.

Question 26 (1 mark)

The biochemical reaction shown below occurs within the cytosol of an autotrophic cell.



Which row of the table correctly identifies each part of the reaction?

	Substrate	Product	Catalyst	Co-enzyme
A.	BPG	G3P	G3PDH	NADPH
B.	NADPH	G3P	NADP	G3PDH
C.	G3P	G3PDH	NADPH	BPG
D.	BPG	NADP	G3PDH	G3P

Space for Personal Notes

Question 27 (5 marks)

In most mammalian cells the ATP produced from the complete breakdown of glucose occurs by a series of chemical reactions. Coenzymes also play an important role in glucose metabolism.

a. Describe the roles of coenzymes in the formation of ATP. (3 marks)

Coenzymes are organic molecules which bind to the active site of enzymes, involved in the formation of ATP via aerobic + anaerobic pathways - improving efficiency of catalysis of reactions involved in ATP production. such as NAD+ and FAD
Further, they can act as electron + proton carriers, received from the breakdown of glucose, to be involved in ATP production at the ETC

When glucose enters a cell, it is converted into glucose 6-phosphate by hexokinase. Glucose 6-phosphate is a key metabolic substrate because it lies at the intersection of several major metabolic pathways. It can enter glycolysis via phosphoglucose isomerase to provide cellular energy. Glucose 6-phosphate may also be metabolised by glucose 6-phosphate dehydrogenase (G6PD); it will then enter the pentose phosphate pathway (PPP) to increase the oxygen absorption of cells such as red blood cells. Finally, glucose 6-phosphate can be converted into glucose 1-phosphate by phosphoglucomutase, the first step in glycogen synthesis.

b. Identify **one** structural difference between the four enzymes mentioned in the information above and explain the importance of the structural difference. (2 marks)

Each enzyme has a differently shaped active site. 1 mark

The substrates (glucose and glucose 6-phosphate) and other factors (coenzymes and/or cofactors) have complementary shapes that fit into specific active sites and ultimately form different products. 1 mark

Space for Personal Notes

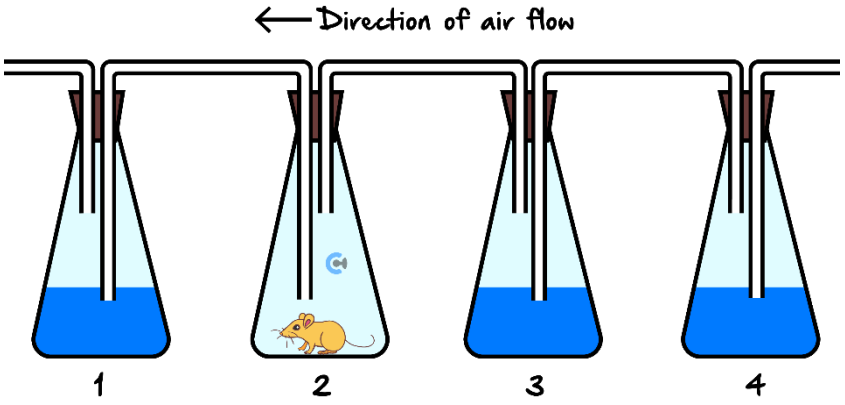
Sub-Section [2.2.6]: Apply Experimental Design Principles to Create Methodologies to Test Factors That Affect Cellular Respiration

Question 28 (7 marks)

A group of scientists set up an experiment to test the rate of aerobic cellular respiration.

This experiment involved the use of four sealed conical flasks. Distilled water, two drops of ammonia and phenol red indicator were placed into flasks 1, 3, and 4. A mouse was placed into flask 2. If carbon dioxide is produced during the course of the experiment it will dissolve in the water producing carbonic acid.

Phenol red is an indicator that is yellow under acidic conditions and pink under basic conditions. The fluid in the three flasks containing water is initially pink.



a. After 24 hours the solution in flasks 3 and 4 remained pink while the solution in flask 1 had turned yellow. Explain why the colour change occurred in flask 1. (2 marks)

The indicator becomes yellow when the conditions in the flask are acidic.

1 mark

AND

Carbon dioxide is a product of cellular respiration, and is produced by the mouse in flask 2. It dissolves in water producing carbonic acid which causes the indicator to change colour.

1 mark

b. Explain why the extent of colour change in flask 1 can be used to estimate the rate of aerobic respiration. (2 marks)

The extent of colour change is a direct indication of the pH of the solution.

1 mark

AND

The pH of the solution is a direct indication of the amount of carbon dioxide that has dissolved. As carbon dioxide is a product of aerobic respiration, the amount of carbon dioxide being produced indicates the rate of aerobic respiration. The time taken for the indicator to change colour indicates the rate of aerobic respiration.

1 mark

c. The process of aerobic respiration is a metabolic pathway that includes several stages, each of which consists of a variety of reactions. Which stage is responsible for producing the greatest amount of ATP? Explain. (2 marks)

The electron transport chain.

1 mark

AND

Two ATP molecules are produced per glucose molecule during the Kreb's cycle. The electron transport chain involves high energy electrons being transferred along a series of molecules. At each point energy is released, which catalyses the phosphorylation of ATP from ADP. The theoretical maximum amount of ATP produced by the electron transport chain is 34 ATP per glucose molecule.

1 mark

d. Aerobic respiration is enzyme catalysed. The enzymes that catalyse this reaction are highly specific. Explain the advantage of specificity. (1 mark)

If enzymes are not specific then they would catalyse many different reactions. The advantage of specificity is that reactions only occur when they are supposed to occur.

Space for Personal Notes

Sub-Section [2.2.7] & [2.2.8]: Describe the Importance of Breaking Down Biomass Into Simple Sugars for Biofuel Production; Explain How Yeast Can be Used to Produce Bioethanol From Biomass

Question 29 (1 mark)

Biofuels are an alternative to traditional energy sources that are finite, such as fossil fuels. Which of the following is an implication that should be considered with the use of biofuels?

A. Excess carbon dioxide will be produced through the fermentation pathway.

B. Not everyone will have access to biofuels.

C. Contamination from other products mixed with the initial fuel source.

D. All the above.

Carbon dioxide is a by-product of fermentation, and if there is not sufficient plant material to absorb the carbon dioxide, this would be released to the atmosphere. Access to any new technology creates implications for equity and contamination of fuel sources may also occur.

Question 30 (1 mark)

Some species of bacteria can be added to biomass to produce bioethanol, a renewable energy source. The production of bioethanol involves the breakdown of starch:

A. By glycolysis followed by alcoholic fermentation.

B. Via aerobic respiration followed by carbon dioxide production.

C. Through the Krebs cycle followed by lactic acid fermentation.

D. In the presence of oxygen followed by fermentation.

Question 31 (1 mark)

Why does yeast perform fermentation during bioethanol production?

A. To oxidise glucose into carbon dioxide and ethanol.

B. To regenerate NAD^+ for glycolysis in the absence of oxygen.

C. To produce ATP through the Electron Transport Chain.

D. To directly convert ethanol into ATP.

Question 32 (1 mark)

Why must biomass be broken down into simple sugars for bioethanol production?

A. Simple sugars are the only substrates yeast can ferment into ethanol.

B. Simple sugars release more oxygen during combustion.

C. Complex carbohydrates inhibit fermentation enzymes.

D. Biomass cannot store energy unless converted to glucose.

Question 33 (6 marks)

a. Bioethanol and biodiesel are 2 biofuels produced from biomass. For biomass to be converted into a usable energy source for commercial use a series of steps must occur.

Complete the following table outlining what occurs at each step of the bioethanol production. (4 marks)

Steps	Key Events
Pre-treatment	Surface area of biomass increased by grinding substrate (1)
Enzymatic Hydrolysis	Enzymes added to break the bonds between monomers (1)
Fermentation	Oxygen removed to allow fermentation to occur (1)
Distillation and Purification	Water is removed to create a usable biofuel (1)

b. Is bioethanol renewable? Explain with reference to its definition. (2 marks)

Bioethanol is produced from renewable biological sources such as crops (e.g., corn, sugarcane, or wheat). These crops are grown annually, and their sugars are fermented to produce bioethanol. Since the source (biomass) can be replenished each year through planting, bioethanol is considered a renewable energy source. Additionally, the carbon dioxide released when bioethanol is burned is absorbed by plants during photosynthesis, completing a continuous carbon cycle.

CONTOUREDUCATION

Website: contoureducation.com.au | **Phone:** 1800 888 300 | **Email:** hello@contoureducation.com.au

VCE Biology ¾

Free 1-on-1 Support

Be Sure to Make The Most of These (Free) Services!

- Experienced Contour tutors (45+ raw scores, 99+ ATARs).
- For fully enrolled Contour students with up-to-date fees.
- After school weekdays and all-day weekends.

1-on-1 Video Consults	Text-Based Support
Book via bit.ly/contour-biology-consult-2025 (or QR code below). One active booking at a time (must attend before booking the next).	Message +61 440 137 387 with questions. Save the contact as "Contour Biology".

Booking Link for Consults
bit.ly/contour-biology-consult-2025

Number for Text-Based Support
+61 440 137 387