AQA-A-Level-Photosynthesis-Respiration -Year- 13 -Biology -

Questions -Answers

Prepared by University Lecturer and private tutor NadaLotfi-Baker

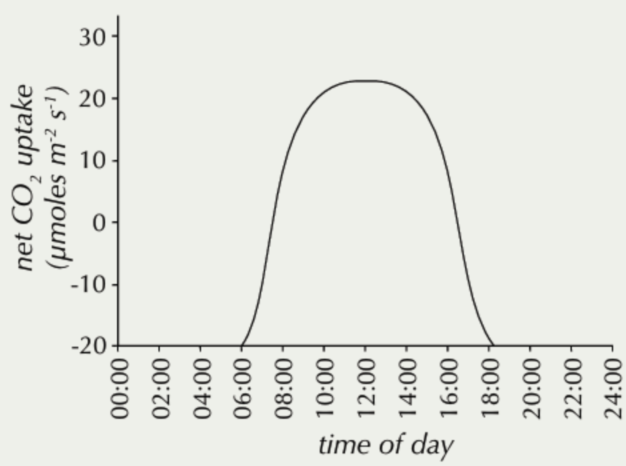
Owner of

www.onlinetutors.xyz

Q1 The graph on the right shows the CO_2 uptake of a plant over the course of a day in early spring.

a) Give the times when compensation points occur.

b) Suggest and explain why the compensation points occur at these particular times.

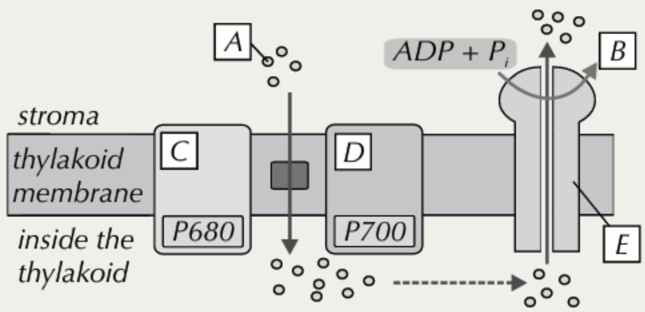


Q1 a) 07:30 and 16:30

Anything between 07:20 and 07:40 would be acceptable for the first compensation point. Anything between 16:20 and 16:40 would be OK for the second one.

b) The rate of photosynthesis depends partly on the intensity of light. 07:30 is not long after the Sun has risen. The light intensity has increased to a level where the rate of photosynthesis has increased to match the rate of respiration. 16:30 is not long before the Sun completely sets. The light intensity has decreased to a level where the rate of photosynthesis has decreased to match the rate of respiration.

Q1 This diagram on the right shows a process in the light-dependent reaction.



a) The object labelled A in the diagram is transported across the thylakoid membrane, so that its concentration is higher in the thylakoid than in the stroma.

i) What is the name of object A?

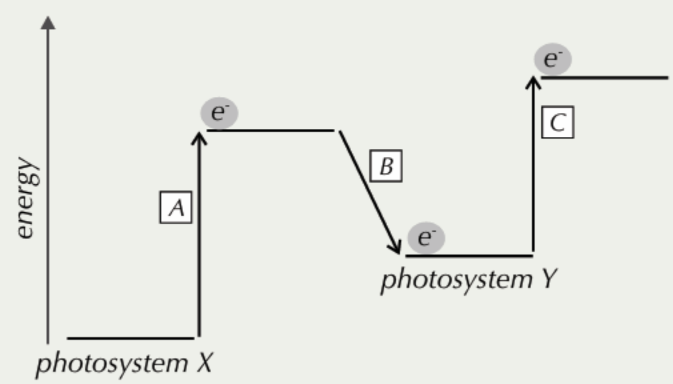
ii) Explain why it is important that the concentration of object A is higher inside the thylakoid than in the stroma.

b) What is the name of structure C?

c) Which structure, C or D, is involved in cyclic photophosphorylation?

d) What does cyclic photophosphorylation produce?

Q2 The diagram below shows the energy levels of electrons at different stages of the light-dependent reaction of photosynthesis.



a) What are the correct names of photosystems X and Y?

b) Explain what is happening at stage A on the diagram.

c) Electrons lose energy at stage B in the diagram. What is this energy used for?

d) At point C in the diagram, electrons reach their highest energy level. What happens to the electrons after this point in non-cyclic photophosphorylation?

Q1 a) i) proton/hydrogen ion/H^+

ii) Because this forms a proton gradient across the membrane. Protons move down their concentration gradient, into the stroma, via an enzyme called ATP synthase. The energy from this movement combines ADP and inorganic phosphate (P_i) to form ATP.

b) PSII / photosystem II

c) D

d) ATP

Cyclic photophosphorylation doesn't produce any reduced NADP or O_2 — just ATP.

Q2 a) photosystem X = photosystem II/PSII
photosystem Y = photosystem I/PSI

b) Light energy absorbed by PSII excites electrons in chlorophyll. This causes the electrons to move to a higher energy level (i.e. they have more energy).

c) To transport protons into the thylakoid.

In this way a proton gradient is formed across the thylakoid membrane. As the protons move down this concentration gradient, back into the stroma, ATP is formed by ATP synthase.

d) The electrons are transferred to NADP, along with a proton from the stroma, to form reduced NADP.

Q1 a) What are photosynthetic pigments?

b) Give one example of a photosynthetic pigment.

Q2 NADP is a coenzyme used in photosynthesis.
What chemical group does it transfer between molecules?

Q3 Where in the chloroplast does the light-dependent reaction take place?

Q4 Describe what happens during the photoionisation of chlorophyll.

Q5 Which products of the light-dependent reaction are needed in the light-independent reaction?

Q6 What is photophosphorylation?

Q7 What is the electron transport chain?

Q8 a) Name the products of the photolysis of water.

b) What is the purpose of photolysis in the light-dependent reaction?

Q9 Excited electrons lose energy as they move down the electron transport chain. Explain how this leads to ATP synthesis.

Q10 Name the products of:

a) non-cyclic photophosphorylation,

b) cyclic photophosphorylation.

Q1 a) Coloured substances that absorb the light energy needed for photosynthesis.

b) E.g. chlorophyll a / chlorophyll b / carotene.

Q2 hydrogen

Q3 the thylakoid membranes

Q4 Light energy excites the electrons in the chlorophyll molecule, giving them more energy, which eventually causes them to be released from the chlorophyll. The chlorophyll is left as a positively charged ion.

Q5 ATP and reduced NADP
Q6 The process of adding phosphate to a molecule using light.
Q7 A chain of proteins down which excited electrons flow.
Q8 a) protons, electrons and oxygen
b) To replace excited electrons in PSII.
Q9 This energy is used to transport protons into the thylakoid so that the thylakoid has a higher concentration of protons than the stroma. This forms a proton gradient across the membrane. Protons move down their concentration gradient, into the stroma, via an enzyme called ATP synthase. The energy from this movement combines ADP and inorganic phosphate (P_i) to form ATP.
Q10 a) ATP, reduced NADP and oxygen
b) ATP

Q1 Rubisco is an enzyme that catalyses the first reaction in the Calvin cycle. Some scientists are trying to genetically modify rubisco to try to increase the speed at which it works. They believe if they can make rubisco work faster then plants will be able to produce organic substances, such as glucose, more quickly. Use your knowledge of photosynthesis to explain how increasing the speed of rubisco could increase the speed of glucose production.

Q2 Phosphoribulokinase is an enzyme involved in the regeneration of ribulose bisphosphate. If this enzyme stopped working properly, suggest what effect it would have on the light-independent reaction of photosynthesis in a plant. Explain your answer.

Q1 Increasing the speed of rubisco could increase the production rate of glycerate 3-phosphate from ribulose bisphosphate and carbon dioxide, as rubisco catalyses this reaction. The increased production rate of glycerate 3-phosphate would increase the production rate of triose phosphate, which in turn could be converted into organic substances such as glucose more quickly.
Q2 The rate of the light-independent reaction would slow down, because the amount of ribulose bisphosphate that could be regenerated in the Calvin cycle would decrease.

Q1 a) What is the name of the 5-carbon compound that combines with carbon dioxide to form an unstable 6-carbon compound in the first reaction of the Calvin cycle?

b) The 6-carbon compound produced only exists fleetingly before it breaks down into two molecules of a 3-carbon compound. What is the name of this 3-carbon compound?

Q2 a) Write out a word equation to show the formation of two molecules of triose phosphate.

b) Is this reaction an oxidation or reduction reaction?

Q3 Describe the role of ATP in the Calvin cycle.

Q4 If six molecules of triose phosphate (TP) are produced by the Calvin cycle, how many of these will be used to regenerate ribulose bisphosphate?

Q5 To make one hexose sugar:

a) How many turns of the Calvin cycle are needed?

b) How many molecules of ATP are needed?

c) How many molecules of reduced NADP are needed?

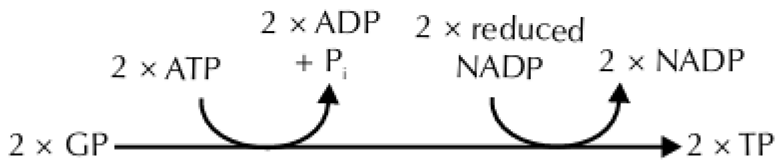
Q6 Describe how the products of the Calvin cycle are used to make:

a) large carbohydrates   b) lipids

Q1 a) ribulose bisphosphate (RuBP)

b) glycerate 3-phosphate (GP)

Q2 a)



(GP is glycerate 3-phosphate and TP is triose phosphate)

b) reduction

Q3 In the Calvin cycle ATP is needed for the reduction of glycerate 3-phosphate (GP) to triose phosphate (TP). It's also needed for the regeneration of ribulose bisphosphate (RuBP) from triose phosphate.

Q4 five

Q5 a) six

Six turns of the Calvin cycle produces 12 molecules of triose phosphate (TP). Ten of these molecules (5 out of every 6) are used to make ribulose bisphosphate (RuBP) and two are used to make one hexose sugar.

b) 18

Six turns of cycle × 3 ATP molecules per turn = 18 ATP

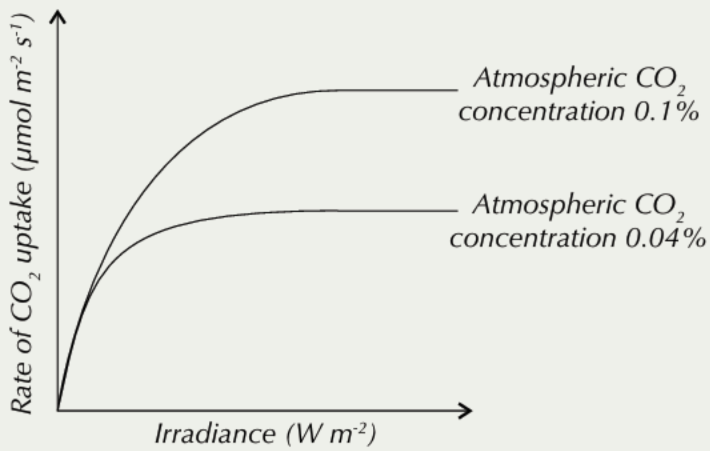
c) 12

Six turns of cycle × 2 reduced NADP molecules per turn = 12 reduced NADP

Q6 a) Two triose phosphate molecules are joined together to produce a hexose sugar. Large carbohydrates are then made by joining the hexose sugars together.

b) Lipids are made from glycerol and fatty acids. Glycerol is synthesised from triose phosphate, while fatty acids are made from glycerate 3-phosphate.

Q1 An agricultural scientist is investigating the effect of irradiance (the amount of light energy hitting a surface) and increasing atmospheric CO_2 concentration on the rate of CO_2 uptake by a tomato crop. The results are shown in the graph below. The plants were grown in laboratory conditions, in which temperature was kept constant.



a) Explain why the rate of CO_2 uptake initially increases with increasing irradiance.

b) Explain why both lines on the graph eventually level off.

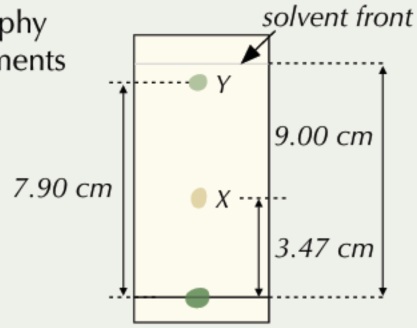
c) The scientist concluded that using a paraffin heater to increase the CO_2 in a glasshouse would improve the tomato yield. Evaluate how far the data supports this conclusion.

Q1 a) Increased irradiance results in an increased rate of photosynthesis, which means that more CO_2 is needed, so uptake increases.

b) Because the CO_2 concentration becomes the limiting factor for photosynthesis. As the rate of photosynthesis is no longer increasing, the rate of CO_2 uptake remains the same.

c) E.g. the data suggests that increasing the atmospheric CO_2 concentration increases CO_2 uptake. This suggests that the rate of photosynthesis also increases. An increased rate of photosynthesis would lead to an increase in the production of sugars/glucose for respiration and so an increase in ATP production. In turn, this could lead to an increased growth rate — but there is nothing in the data to suggest that this would improve the yield of tomatoes (e.g. the plants themselves may grow bigger, but the number of tomatoes they produce might stay the same). This data was also collected under laboratory conditions, in which the temperature was kept constant — this may be harder to do in a glasshouse and using a paraffin heater, which may mean that these results wouldn't apply in glasshouse conditions.

Q1 A scientist uses thin-layer chromatography to separate out the photosynthetic pigments from a mixture obtained from plant leaves. The chromatogram that he produces is shown on the right.



a) Explain why the different pigments separate as they travel up the plate.

b) Calculate the R_f value of spot X.

Q1 a) Different pigments will spend different amounts of time in the mobile phase, so they will travel different distances up the plate in the same amount of time, which separates them out.

b) $R_f \text{ value} = \dfrac{\text{distance travelled by spot}}{\text{distance travelled by solvent}}$

$= 3.47 \text{ cm} \div 9.00 \text{ cm} =$ **0.386** (3 s.f.)

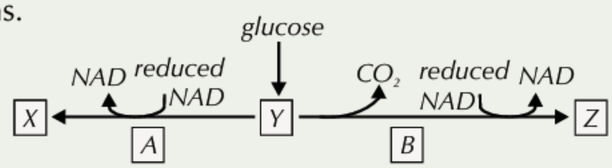
Respiration

Q1 Hexokinase is an enzyme that catalyses the production of glucose phosphate.

a) Suggest and explain how hexokinase is involved in glycolysis.

b) Suggest a benefit of hexokinase being inhibited by the product of this reaction.

Q2 The diagram below shows two possible fates of glucose in anaerobic conditions.



a) What is the name of substance:

i) X? ii) Y? iii) Z?

b) Which process, A or B:

i) is lactate fermentation? ii) happens in plant cells?

iii) can happen in bacterial cells?

Q1 a) It catalyses the phosphorylation of glucose to glucose phosphate, using a phosphate from ATP.

b) E.g. it may help to stop the over-production of glucose phosphate.

Q2 a) i) lactate/lactic acid

ii) pyruvate

iii) ethanol

b) i) A

ii) B

iii) A

Q1 What is ATP used for in glycolysis?

Q2 What role does the coenzyme NAD play in glycolysis?

Q3 If five molecules of glucose enter the process of glycolysis, how many molecules of pyruvate will be produced?

Q4 During fermentation, reduced NAD is oxidised to NAD. What happens to this oxidised NAD?

Q5 What is the final product of anaerobic respiration by animal cells?

Q1 ATP is used to phosphorylate glucose, making triose phosphate.

Q2 In the oxidation of triose phosphate to pyruvate, NAD collects the hydrogen ions from triose phosphate, forming reduced NAD.

Q3 10

Two molecules of pyruvate are made for every molecule of glucose that enters glycolysis.

Q4 It is used in glycolysis (to collect the hydrogen ions lost from triose phosphate in the production of pyruvate).

Q5 lactate/lactic acid

Q1 The diagram below shows part of the Krebs cycle:

acetyl CoA + oxaloacetate ⟶ *citrate* ⟶ *5C-intermediate*

a) How many carbon atoms do oxaloacetate and citrate each have?

b) What happens to turn the 5C-intermediate back into oxaloacetate?

Q2 If six molecules of glucose were respired, how many molecules of CO_2 would be produced from the Krebs cycle?

Q3 Fats can be broken down and converted into acetyl coenzyme A. Explain how this allows fats to be respired.

Q1 a) oxaloacetate = 4C, citrate = 6C

b) Decarboxylation and dehydrogenation occur, producing one molecule of reduced FAD and two of reduced NAD. ATP is produced by substrate level phosphorylation.

Q2 24

Two molecules of carbon dioxide are produced per turn of the Krebs cycle and the Krebs cycle turns twice for each molecule of glucose. So for one molecule of glucose four molecules of carbon dioxide are produced. Therefore if six molecules of glucose were respired, 24 (6 x 4) molecules of carbon dioxide would be produced in the Krebs cycle.

Q3 Acetyl coenzyme A can enter the Krebs cycle, leading to the formation of reduced coenzymes, which are then used in oxidative phosphorylation.

Q1 Antimycin A inhibits carrier 2 in the electron transport chain of oxidative phosphorylation.

a) If antimycin A was added to isolated mitochondria, what state (oxidised or reduced) would carriers 1 and 3 be in after its addition? Explain your answers.

b) Suggest why antimycin A can be used as a fish poison.

Q2 Dicyclohexylcarbodiimide (DCC) is an inhibitor that binds to ATP synthase and prevents protons moving through it. When mitochondria are treated with DCC they stop synthesising ATP. Explain how this provides evidence for the chemiosmotic theory.

Q1 a) Carrier 1 will be in a reduced state because it has received electrons from reduced NAD but can't pass them on. Carrier 3 will be in an oxidised state because it has passed its electrons onto oxygen, but hasn't received any more from carrier 2.

If a substance gains electrons it is reduced. If a substance loses electrons it is oxidised.

b) Antimycin A inhibits carrier 2 and so stops electrons moving down the electron transport chain. This means no more energy will be lost from electrons moving down the chain, so H+ ions will not be transported across the inner mitochondrial membrane and the electrochemical gradient across the membrane won't be maintained. This means the synthesis of ATP by ATP synthase will stop. If a fish can't produce ATP it will die as energy from ATP is needed to fuel all biological processes.

Q2 The fact that ATP synthesis stops when DCC is added suggests that the movement of protons through the ATP synthase is essential for ATP production. This supports the chemiosmotic theory because it suggests that the proton gradient is being used to synthesise ATP.

Q1 a) In the link reaction, pyruvate is converted into acetate. Describe how this happens.

b) The second stage of the link reaction relies on coenzyme A. What is the role of coenzyme A in the link reaction?

c) State what happens to the products of the link reaction.

Q2 In one turn of the Krebs cycle:

a) how many molecules of CO_2 are released, and where are they released from?

b) how many molecules of reduced FAD are made?

Q3 During the Krebs cycle ATP is produced by the direct transfer of a phosphate group from an intermediate compound to ADP. What name is given to this process?

Q4 After each turn of the Krebs cycle, what happens to:

a) coenzyme A?

b) oxaloacetate?

Q5 During oxidative phosphorylation, what happens to electrons as they move down the electron transport chain?

Q6 What is said to be the final electron acceptor in oxidative phosphorylation?

Q7 Give one example of a decarboxylation reaction in respiration.

Q8 Draw out the table below and fill it in with crosses to show where the following substances are made in respiration.

Substance	***Glycolysis***	***Link reaction***	***Krebs cycle***	***Oxidative phosphorylation***
ATP				
reduced NAD				
reduced FAD				
CO_2				

Q1 a) Pyruvate is decarboxylated — one carbon atom is removed from pyruvate in the form of carbon dioxide. Then NAD is reduced — it collects hydrogen from pyruvate. Pyruvate becomes oxidised and acetate is formed.

b) It combines with acetate to form acetyl coenzyme A.

c) Acetyl coenzyme A enters the Krebs cycle. Reduced NAD is used in oxidative phosphorylation. Carbon dioxide is released as a waste product.

Q2 a) Two molecules of CO_2 are released — one CO_2 is released from the conversion of citrate to a 5-carbon compound and the other CO_2 is released from the conversion of the 5-carbon compound to oxaloacetate.

b) one

Q3 substrate-level phosphorylation

Q4 a) It is reused in the link reaction.

b) It is regenerated for use in the next Krebs cycle.

Q5 They lose energy.

Q6 oxygen

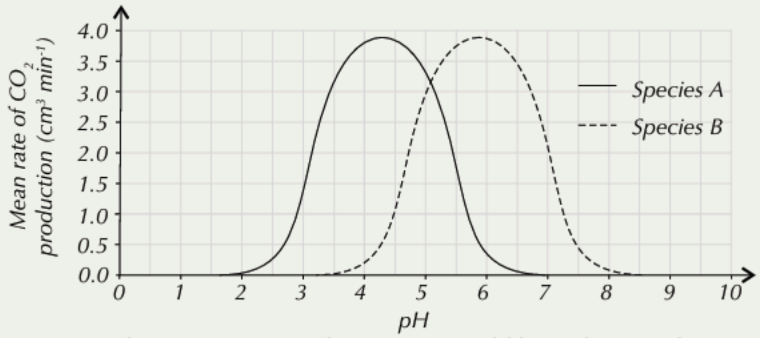
Q7 E.g. the conversion of pyruvate to acetate in the link reaction. / The conversion of citrate to the 5-carbon compound in the Krebs cycle. / The conversion of the 5-carbon compound to oxaloacetate in the Krebs cycle.

Every time CO_2 is lost in a reaction, decarboxylation is happening.

Q8

Substance	*Glycolysis*	*Link reaction*	*Krebs cycle*	*Oxidative phosphorylation*
ATP	*X*		*X*	*X*
reduced NAD	*X*	*X*	*X*	
reduced FAD			*X*	
CO_2		*X*	*X*	

Q1 A scientist is investigating the effect of pH on aerobic respiration in two different species of yeast. The mean rate of CO_2 production is indicative of the respiration rate. Her results are shown in the graph below.



a) Describe an experiment the scientist could have done to obtain the results shown in the graph.

b) The results show that each species has a different optimum pH. Suggest an explanation for this.

c) At pH 5.5, how much faster is the mean rate of CO_2 production by species B than species A? Give your answer as a percentage.

d) The scientist also carried out the same experiment using boiled yeast of each species. Explain why.

Q1 a) E.g. the scientist could have set up a test tube containing a known volume and concentration of substrate (e.g. glucose) solution and a buffer solution at specific pH. She could then have added a known mass of dried yeast of species A to the tube and stirred until the yeast dissolved. Next, she could have sealed the test tube with a bung and attached it via a tube to a gas syringe in order to catch the CO_2 produced by the respiring yeast. At regular intervals (e.g. every minute) for a set amount of time (e.g. 10 minutes), the scientist could have recorded the volume of gas present in the gas syringe. By repeating the experiment (e.g. three times) at this pH, she could then have calculated the mean rate of CO_2 production at this pH. She could then have repeated the experiment at a range of pH levels by using buffer solutions of different pH levels. She could have done the same thing for species B.

b) Respiration is a series of reactions controlled by enzymes. The enzymes used in respiration by the different species of yeast may have different optimum pH levels, at which they are able to catalyse the reactions most effectively.

c) Mean rate of CO_2 production of species A at pH 5.5 = 1.75 $cm^3\ min^{-1}$

Anything between 1.7 and 1.8 cm^3 would be acceptable here.

Mean rate of CO_2 production of species B at pH 5.5 = 3.75 $cm^3\ min^{-1}$

Anything between 3.7 and 3.8 cm^3 would be acceptable here.

Percentage change in rate from species A to species B = $((1.75 - 3.75) \div 1.75) \times 100$ **= 114% faster**

Your final answer may differ a little depending on what you got for the mean rates of CO_2 production for the two species.

d) Boiled yeast won't respire as the boiling will have killed it. Therefore, it acts as a negative control to show that the CO_2 production is a result of the respiring yeast and not any other reactions that may be happening in the tube.

Q1 If you were measuring anaerobic respiration in yeast, why would you add a layer of liquid paraffin to the yeast solution in the test tube before sealing the tube with a rubber bung?

Q2 Suggest a negative control experiment that could be included when measuring the rate of respiration of yeast in a test tube.

Q3 If you were using a respirometer to measure the oxygen consumed by germinating peas with a mass of 10 g, what mass of glass beads would you have in the control tube?

Q1 To stop oxygen getting into the yeast solution, forcing the yeast to respire anaerobically.

Q2 Prepare and treat a test tube in the same way as the others in the investigation, but do not put any yeast in it.

Q3 10 g

You know the answer here is 10 g because the mass of the peas and the mass of the glass beads in the control tube have to be the same.

1 Petite mutants are yeast cells that have mutations in genes that are importa
mitochondrial function. They are called petite mutants because they grow a
divide to form unusually small colonies when grown in medium with a low gl
concentration.

1.1 Petite mutants are unable to produce mitochondrial proteins. Suggest how this could stop the mitochondria from producing ATP.

1.2 Petite mutants lack functioning mitochondria but they can still produce ATP by glycolysis. Explain why.

1.3 Triose phosphate is an intermediate compound in glycolysis. Describe how two triose phosphate molecules are formed from a molecule of glucose.

1.4 Describe the role of the coenzyme NAD in glycolysis.

1.1 E.g. if the mitochondria can't produce proteins, they won't be able to produce the enzymes needed to make ATP (e.g. ATP synthase) ***(1 mark)***. / They won't be able to produce proteins that form part of the electron transport chain, which is needed to make ATP ***(1 mark)***.

1.2 Because glycolysis takes place in the cytoplasm of the cell ***(1 mark)***.

Because glycolysis takes place in the cytoplasm and not the mitochondria, it doesn't matter whether you have functioning mitochondria or not — glycolysis can still happen.

1.3 Glucose is phosphorylated using ATP to create glucose phosphate ***(1 mark)***. Glucose phosphate is phosphorylated using ATP to form hexose bisphosphate/a six carbon intermediate ***(1 mark)***, which is split to form two molecules of triose phosphate ***(1 mark)***.

1.4 In the oxidation of triose phosphate to pyruvate, NAD collects the hydrogen ions from triose phosphate ***(1 mark)***, forming reduced NAD ***(1 mark)***.

2 DCPIP is an artificial hydrogen acceptor that can be used to measure the rate of photosynthesis. When DCPIP is reduced it turns from blue to colourless. In the presence of NADP, DCPIP is reduced first. A scientist used DCPIP to investigate the rate of photosynthesis in plant chloroplasts at three different temperatures. DCPIP was incubated with liquid extracts of chloroplasts for 10 minutes. Every minute, the absorbance of the solution was measured. All conditions except the temperature were kept the same. The results are shown in **Figure 1**.

2.1 Suggest how the absorbance of the solution was measured.

(2 marks)

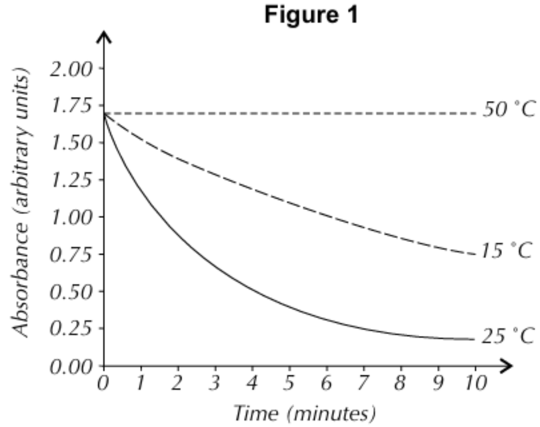
2.2 Why was measuring the absorbance of the solution over time a suitable way of indicating the rate of photosynthesis?

(3 marks)

2.3 Suggest why the absorbance doesn't change at 50 ˚C.

(3 marks)

Figure 1



2.1 A sample of the solution could have been placed in a cuvette ***(1 mark)*** and put in a colorimeter, a machine that measures absorbance ***(1 mark)***.

2.2 As DCPIP is reduced and loses its blue colour, the absorbance of the solution will decrease ***(1 mark)***. When photosynthesis occurs at a faster rate, DCPIP will be reduced at a faster rate ***(1 mark)***, and absorbance will decrease faster as a result ***(1 mark)***.

2.3 Because the high temperature has denatured the enzymes involved in photosynthesis, meaning that photosynthesis cannot occur ***(1 mark)***. As a result, the colour of the DCPIP won't change and neither will the absorbance ***(1 mark)***.

3 In oxidative phosphorylation hydrogen atoms are released from reduced NAD and reduced FAD.

3.1 Describe the reactions in respiration in which these reduced coenzymes are produced.

(5 marks)

3.2 The hydrogen atoms split up into hydrogen ions and electrons. Describe the movement of electrons in oxidative phosphorylation.

(2 marks)

3.3 DNP is an uncoupler. This means it carries H^+ ions from the intermembrane space back into the matrix of mitochondria during oxidative phosphorylation. Describe and explain the effect that DNP would have on the production of ATP in animal cells.

(4 marks)

3.1 The oxidation of triose phosphate to pyruvate produces one molecule of reduced NAD ***(1 mark)***. The conversion of pyruvate to acetate produces one molecule of reduced NAD ***(1 mark)***. The conversion of citrate to a 5-carbon compound in the Krebs cycle produces one molecule of reduced NAD ***(1 mark)***. The conversion of this 5-carbon compound to oxaloacetate produces another two molecules of reduced NAD ***(1 mark)*** and one molecule of reduced FAD ***(1 mark)***.

3.2 The electrons move down the electron transport chain, losing energy at each electron carrier ***(1 mark)***. Finally they are passed onto oxygen as it is the final electron acceptor ***(1 mark)***.

3.3 There would be no electrochemical gradient produced across the inner mitochondrial membrane ***(1 mark)***. This means there would be no movement of ions across the mitochondrial membrane to drive ATP synthase ***(1 mark)*** so no ATP would be made ***(1 mark)***. The cells would only get ATP from anaerobic respiration ***(1 mark)***.

Even though H^+ ions will still be pumped across the inner mitochondrial membrane into the intermembrane space, the uncoupler will be moving them back into the matrix at the same

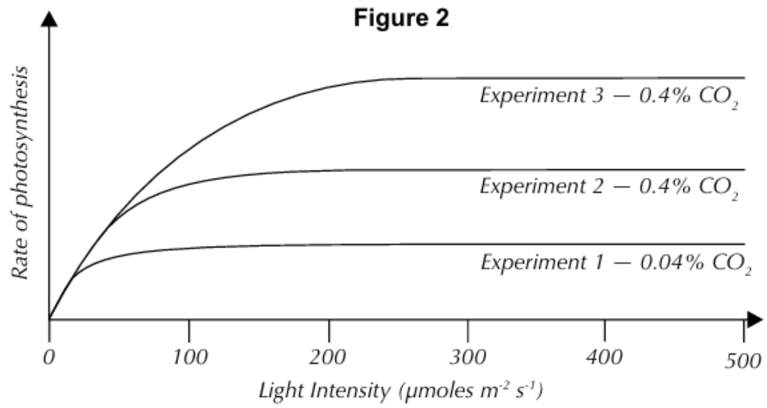
4 A student carried out a study into the effect of different factors on the rate of photosynthesis in a certain species of plant.

4.1 The student calculated the rate of photosynthesis by measuring how much oxygen was released by the plants over a period of time. Explain why this is not an accurate way of calculating the rate of photosynthesis.

(2 marks)

The student carried out three experiments in his study — the results of which are shown in **Figure 2**. In each experiment the plants had an adequate supply of water.

Figure 2



4.2 What is the limiting factor of photosynthesis in experiment 2? Explain your answer.

(2 marks)

4.3 The student extended experiment 2 by measuring the amount of RuBP and TP produced by the plant over time. After 5 minutes, the student lowered the CO_2 concentration of the plants to 0.04%. Describe and explain what effect the lowering of CO_2 concentration had on the levels of RuBP and TP in the plants.

(3 marks)

4.1 The student hasn't taken into account the amount of oxygen that the plant has used for respiration ***(1 mark)***, so less oxygen will be released by the plant than it has actually produced during photosynthesis ***(1 mark)***.

4.2 The limiting factor in experiment 2 must be temperature because the graph for experiment 3 levels off at a higher point ***(1 mark)*** but experiment 3 had the same light intensity and CO_2 concentration as experiment 2 ***(1 mark)***.

4.3 The level of RuBP will have increased because there would have been less CO_2 to combine with RuBP to form GP ***(1 mark)***. The level of TP will have decreased because less GP would have been made and so less converted to TP ***(1 mark)***. As TP was made into useful organic substances this will have decreased the level of TP further ***(1 mark)***.

If you get a question like this in the exam, make sure you think of the substances before the reactant in the cycle as well as those that come after it.

Q1 a) Pyruvate is decarboxylated — one carbon atom is removed from pyruvate in the form of carbon dioxide. Then NAD is reduced — it collects hydrogen from pyruvate. Pyruvate becomes oxidised and acetate is formed.

b) It combines with acetate to form acetyl coenzyme A.

c) Acetyl coenzyme A enters the Krebs cycle. Reduced NAD is used in oxidative phosphorylation. Carbon dioxide is released as a waste product.

Q2 a) Two molecules of CO_2 are released — one CO_2 is released from the conversion of citrate to a 5-carbon compound and the other CO_2 is released from the conversion of the 5-carbon compound to oxaloacetate.

b) one

Q3 substrate-level phosphorylation

Q4 a) It is reused in the link reaction.

b) It is regenerated for use in the next Krebs cycle.

Q5 They lose energy.

Q6 oxygen

Q7 E.g. the conversion of pyruvate to acetate in the link reaction. / The conversion of citrate to the 5-carbon compound in the Krebs cycle. / The conversion of the 5-carbon compound to oxaloacetate in the Krebs cycle.

Every time CO_2 is lost in a reaction, decarboxylation is happening.

Q8

Substance	*Glycolysis*	*Link reaction*	*Krebs cycle*	*Oxidative phosphorylation*
ATP	*X*		*X*	*X*
reduced NAD	*X*	*X*	*X*	
reduced FAD			*X*	
CO_2		*X*	*X*	