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VCE Biology ¾
AOS 2 Revision [2.0]
Experimental SAC 1 Solutions

40 Marks. 5 Minutes Reading. 65 Minutes Writing.

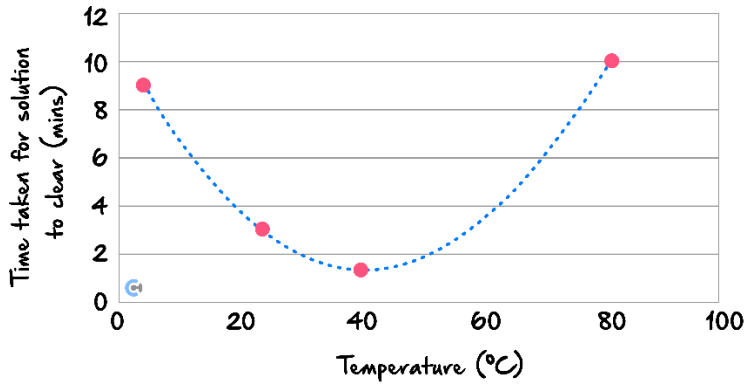
Section A: SAC Questions (40 Marks)

Question 1 (6 marks)

Recently you investigated the effect of a change in temperature on the rate of a chemical reaction catalysed by the enzyme Trypsin. The results of this investigation are in the table below.

Temperature (°C)	**Time taken for solution to clear (minutes)**
4°C	9 *mins*
24°C	3 *mins*
40°C	1.2 *mins*
80°C	$>$ 10 *mins*
Control (no trypsin added)	$>$ 10 *mins*

The results of the 4 temperatures are shown in the figure below. (Note: The control has not been included in this graph.)



The effect of changing temperature on the rate of reaction, as measured by how long it took for the solution to clear.

a. Describe the relationship between temperature and the time taken for the solution to clear. (2 marks)

As temperature increases the time taken to clear decreases until it is fastest at 40 degrees where it takes 1.2minutes to clear. (1)
At 80 degrees the time taken to clear is longest at greater than 10 minutes (1).

b. Explain the results at 4°C, compared to the results at 80°C. Predict what would happen once both tubes returned to room temperature. (3 marks)

At 4 degrees the enzymes are inactive as there is less energy and thus less collisions between active site and substrate. (1)
At 80 degrees the enzymes are denatured and thus the shape of the active site has changed so the substrate can no longer bind. (1)
When the tubes return to room temperature the reaction will recommence (0.5) whereas the 80-degree tube will remain cloudy as the enzymes are permanently denatured (0.5)

c. What was the purpose of the control in this experiment? (1 mark)

To act as a comparison

To determine the effect of the IV on the DV.

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Question 2 (2 marks)

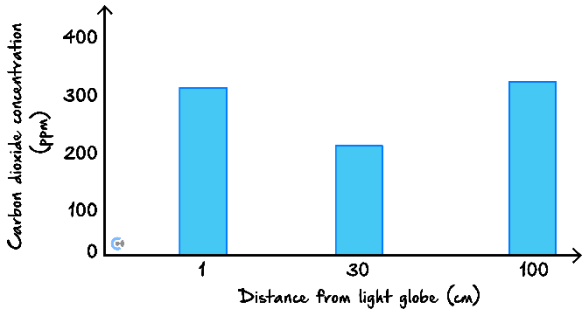
Students performed an experiment to test the effect of light intensity on the rate of photosynthesis in different light intensities. They purchased 15 small Button fern C3 plants *(Pellaea rotundifolia)* from Bunnings and placed each in a small conical flask which was fully sealed so that no gases could enter or leave the flask.

Each flask was placed near a light globe. Five flasks were placed 1 *cm* from the light globe. Five flasks were placed 30 *cm* from the light globe. Five flasks were placed 1 *m* from the light globe.

A carbon dioxide probe was placed inside each flask to measure the concentration of atmospheric carbon dioxide.

The plants were left in the flask for 30 minutes and then the carbon dioxide concentration was measured and averaged. It was noted by the students that the results at each light intensity were very precise.

The results of this experiment are displayed in the figure below.



CO_2 *Cone in conical flasks after* 30 *minutes.*

a. What was the independent variable in this experiment? (1 mark)

Light intensity/ Distance from light source

b. Suggest an explanation for the fact that the CO_2 concentration in the conical flask 1 *cm* from the light globe was higher than the CO_2 concentration in the flask 30 *cm* from the light globe. (1 mark)

Flasks at 1cm have been so heated up by proximity to light globe that these plants have started to photoresphire making photosynthesis less efficient than plants at 30cm from light globe.

Question 3 (17 marks)

Wheat is the largest grain crop in Australia, with regions in the west of Victoria, including the Wimmera, Central goldfields and Mallee forming part of Australia's wheat belt.

As a C3 plant, wheat does not have any adaptations to overcome changes in photosynthetic rate that can occur at high temperatures.

a. Photosynthesis can be described as occurring in two stages. These stages are referred to as the light-dependent and light-independent stages.

Fill in the table below by listing **one** of the major chemical inputs and outputs at **each stage** of photosynthesis (use words or appropriate chemical symbols). (2 marks)

Stage of photosynthesis	Input	Output
Light Dependent	H_2O (water)	Oxygen
Light Independent	CO_2	$C_6H_{12}O_6$, H_2O

b. Briefly explain how the disruption of the light-dependent phase of photosynthesis would cause a plant to die. (1 mark)

Products of light dependent stage, ATP and NADPH, required inputs for the light independent stage.

In the Wimmera and Mallee regions, temperatures can reach above 30 degrees Celsius. Wheat ready for harvest can be exposed to these high temperatures.

c. Describe, at a molecular level, what is occurring within the chloroplast at high temperatures in the wheat plant. (2 marks)

temperatures in the wheat plant.
Chlorophyll is a protein and at high temp it will denature (1) and the tertiary structure will irreversibly change(1) and substrate unable to bind to the active site.(1)
or
O_2 is binding to Rubisco at a higher rate (1) increasing the rate of Photorespiration and decreasing the rate of photosynthesis (1)
Rubisco will limit the rate of Photosynthesis

Rubisco is an enzyme that plays an important role in photosynthetic organisms. Exposure to high temperatures over time can impact the effectiveness of the enzyme Rubisco in C3 plants.

d. Explain why a decrease in the effectiveness of Rubisco will limit the rate of photosynthesis. (2 marks)

Rubisco is an enzyme in the Light Independent stage (Calvin Cycle) of Photosynthesis. (1)
Decrease in the light independent stage will decrease the production of glucose in photosynthesis (1)

CRISPR Cas9 technologies can be used to increase crop yield. Altering Rubisco to increase its affinity to carbon dioxide is one such option.

e. Referring to the use of CRISPR technology on wheat, outline an ethical issue and describe how an ethical concept should be considered before making decisions. (3 marks)

Respect (1) – does wheat have an intrinsic value? (1). Wheat plants must be respected and their role in the ecosystem considered (1)
Non-maleficence (1) – Is there harm being done? (1). No other organisms should be harmed when using CRISPR technology (1)
Justice (1) – consider competing claims (1). Do all farmers have access to the technology? (1)
Integrity (1) – Is all data accurately reported (1). Data from trials must be available publicly (1)
Beneficence (1) – Is there maximise benefits and minimise risk when considering outcomes? (1).
More people/ organisms should benefit from the technology with the cost being minimal (1)

A farmer decided to grow maise, a C4 plant that is a starchier version of a typical sweet corn, in place of wheat.

f. Describe how the process of carbon fixation would differ in the wheat, a C3 plant, and the maise plant at high temperatures. (3 marks)

the maize plant at high temperatures?
a. Carbon fixation in maize would occur initially in mesophyll before moving to the bundle sheath cells, whereas in C3 it occurs in the mesophyll (1).
b. C3 plants produce a 3-carbon molecule whereas C4 plants produce a 4-carbon molecule(malate)(1),
c. PEP carboxylase is the fixation enzyme in C4 plants, whilst Rubisco is the fixation enzyme in C3 plants (1).
d. C4 plants are more efficient than C3 plants at high temperatures (1).
e. C4 initial carbon fixation can occur at night whilst C3 plants fix carbon during daylight
Any 3

The Sonoran Cactus use the CAM pathway to carry out photosynthesis.

g. What primary advantage does a Sonoran Cactus have in using the CAM pathway compared to C3 plants such as wheat? (1 mark)

reduces loss of water during the day by only opening stomata at night
Reduces photorespiration.

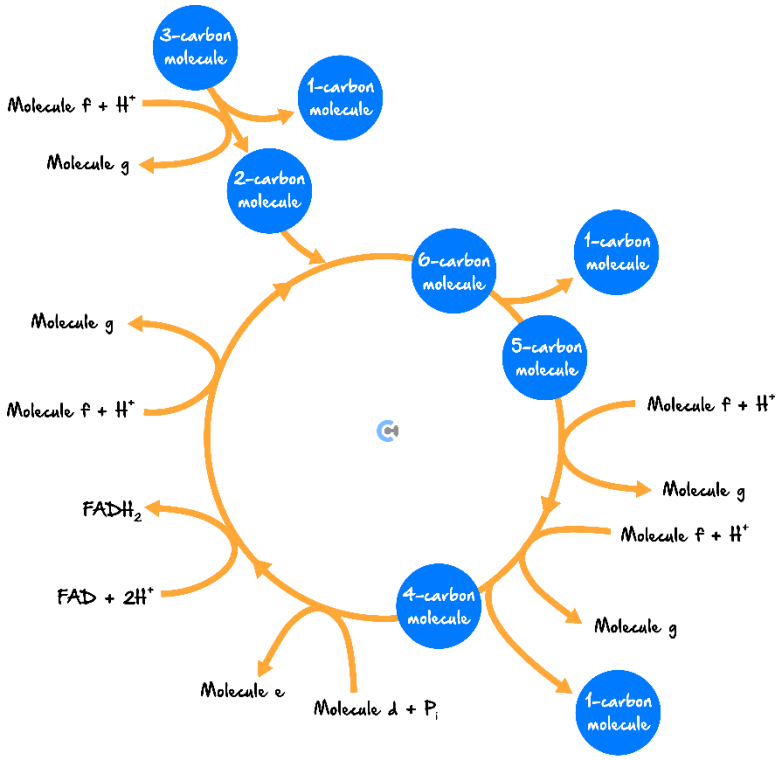
In recent years, Sugar Cane crops have been grown in northern Queensland to explore their potential for bioethanol production. Yeast cells are used to ferment the Sugar Cane biomass to produce bioethanol.

h. Explain how yeast cells can produce bioethanol and outline the benefits of producing bioethanol from sugar cane biomass. (3 marks)

- yeast can create ethanol by fermenting the sugars in the plant
Advantages (two of):
- can create biofuels quickly
- used as replacement for fossil fuels in transport industry
- cleaner for environment than fossil fuel production
- using waste material and doesn't impact food production

Question 4 (15 marks)

The diagram below represents one of three stages of aerobic cellular respiration.



One of the biochemical processes involved in cellular respiration.

a. What name is given to the process above? (1 mark)

Krebs cycle.

b. One of the coenzymes involved in the process is FAD and it's charged from $FADH_2$ which are labelled on the diagram. Two other coenzymes are also involved in the process. Referring to the diagram in the figure above, complete the following table to show the names of these coenzymes. (2 marks)

Label	Molecule name
Molecule *d*	ADP
Molecule *e*	ATP
Molecule *f*	NAD^+
Molecule *g*	NADH

c. In the diagram several carbon-containing molecules are shown with the number of carbons they contain indicated. The 2-carbon molecule is acetyl-CoA.

i. What is the name of the 3-carbon molecule? (1 mark)

Pyruvate

ii. What name is given to the 1-carbon molecule? (1 mark)

Carbon dioxide

d. Where, within a eukaryote cell does the process depicted in the figure above take place? (1 mark)

Mitochondria/Matrix

e. Explain the purpose of producing $FADH_2$ in this stage of cellular respiration. (1 mark)

Carries electrons to cristae for electron transport chain.

Glucose is first broken down in the process of glycolysis in cellular respiration.

f. Describe the process of glycolysis. (2 marks)

Glycolysis is the metabolic pathway that converts glucose, into pyruvate that occurs in the cytosol of a cell and one of:
Hydrogen is used reduce NAD to NADH.
A net gain of two ATP.
Two pyruvates molecules are produced at the end of glycolysis.

A biochemical pathway is a series of enzyme-mediated reactions where the product of one reaction is used as the substrate in the next.
Aerobic cellular respiration is an example of a common biochemical pathway found within the body:

g. Inhibitors can alter the rate of an enzyme-driven chemical reaction. Describe the action of each type of inhibitor listed below and the effect of the rate of reaction if the concentration of substrate increased.

i. A competitive inhibitor. (3 marks)

Competitive inhibitors bind to the active site of an enzyme (**1**) preventing the substrate from binding from binding (**1**). Increasing substrate can increase the rate of reaction OR increase in competitve inhibitors can decrease reaction rate (**1**).

ii. A non-competitive inhibitor. (3 marks)

Non-competitive inhibitors bind to the allosteric site of an enzyme (**1**) causing a conformational change in the shape of the active site – preventing the substrate from binding (**1**). Adding more substrates will not change the rate of reaction (**1**).

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