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VCE Biology ¾

Photosynthesis & Biochemical Pathways [2.1]

Test

46 Marks. 1 Minute Reading. 37 Minutes Writing.

Results:

Test Questions	_____ / 42
Extension Question	_____ / 4

Section A: Test Questions (42 Marks)

Question 1 (5 marks)

Tick whether the following statements are **True** or **False**.

	True	False
a. The light-dependent stage of photosynthesis occurs in the thylakoid membranes of the chloroplast.		
b. The light-independent stage (Calvin Cycle) occurs in the stroma of the chloroplast.		
c. Rubisco exclusively binds CO_2 during the Calvin Cycle.		
d. CAM plants open their stomata at night to fix CO_2 into malate and store it in vacuoles.		
e. C_4 plants are adapted to cold environments with low temperatures.		
f. Photorespiration increases in hot, dry conditions due to stomatal closure, reducing CO_2 levels.		
g. Green light is absorbed efficiently during photosynthesis.		
h. ATP and NADPH are both products of the light-dependent stage and are used in the Calvin Cycle.		
i. CRISPR-Cas9 can be used to modify plants to improve photosynthetic efficiency and crop yields.		
j. C_3 plants experience minimal photorespiration under all conditions.		

Space for Personal Notes

Question 2 (1 mark)

The chloroplast is the organelle responsible for photosynthesis in eukaryotic cells.

In chloroplasts:

A. The light independent reactions require water as the initial reactant.

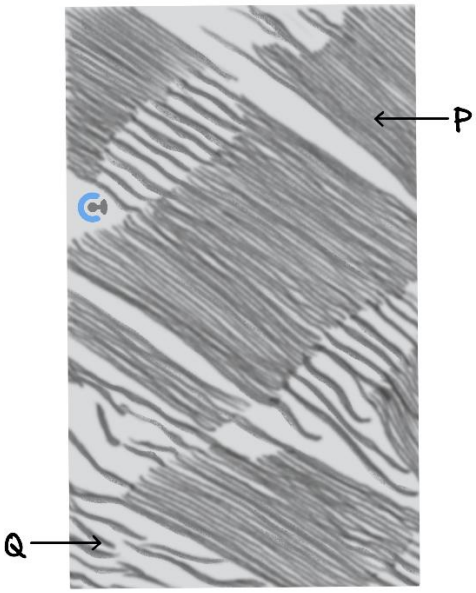
B. The light independent reactions occur in the inner membrane area.

C. The final product of the light reaction is glucose.

D. The light reactions occur in the grana.

Question 3 (1 mark)

The following image shows a portion of an electron photomicrograph of a chloroplast.



Light-dependent reactions occur in region P and the Calvin cycle reactions occur in region Q.

Considering events that occur in a chloroplast during photosynthesis, it is reasonable to claim that:

A. Oxygen is an input to reactions at P.

B. Carbon dioxide is an input to reactions at Q.

C. Chlorophyll is essential for reactions that occur at Q

D. ADP produced during the events at P is used by events at Q.

Question 4 (1 mark)

The coenzymes used in the light-independent reaction of photosynthesis include:

A. ATP and NADH.

B. ADP and NADPH.

C. ADP and NADH.

D. ATP and NADPH.

Question 5 (1 mark)

Certain plants combine carbon dioxide with a three-carbon compound (C3) to produce a four-carbon compound (C4) during the night, which can be used in photosynthesis during daylight hours.

This kind of plant is called a:

A. C3 plant.

B. CAM plant.

C. C4 plant.

D. Rubisco plant.

Space for Personal Notes

Question 6 (1 mark)

Consider the process of photosynthesis.

Which of the following shows correct information about each of the two stages of photosynthesis?

	Light-dependent stage	Light-independent stage
A.	Produces oxygen.	Produces carbon dioxide.
B.	Requires water.	Requires NADH.
C.	Occurs in the stroma.	Occurs in the grana.
D.	Energy is provided by light.	Energy is provided by ATP molecules.

Space for Personal Notes

Question 7 (5 marks)

a. A chloroplast is surrounded by a double membrane.

i. Name two molecules, as inputs for photosynthesis, that would need to diffuse from the cytosol of the plant cell across the chloroplast membranes and into the chloroplast. (1 mark)

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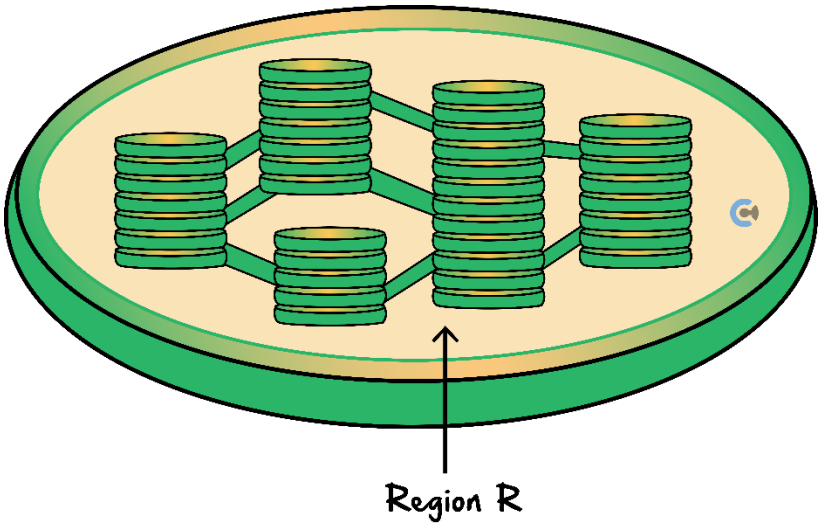
ii. Under high magnification, the internal structure of a chloroplast is visible. The diagram below shows part of this structure.



A higher concentration of oxygen is found in Region *R* when a plant is photosynthesising compared to when it is not photosynthesising.

Account for the differences in oxygen concentrations found in this region. (2 marks)

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b. Describe the role played by each of the coenzymes NADPH and ATP in photosynthesis. (2 marks)

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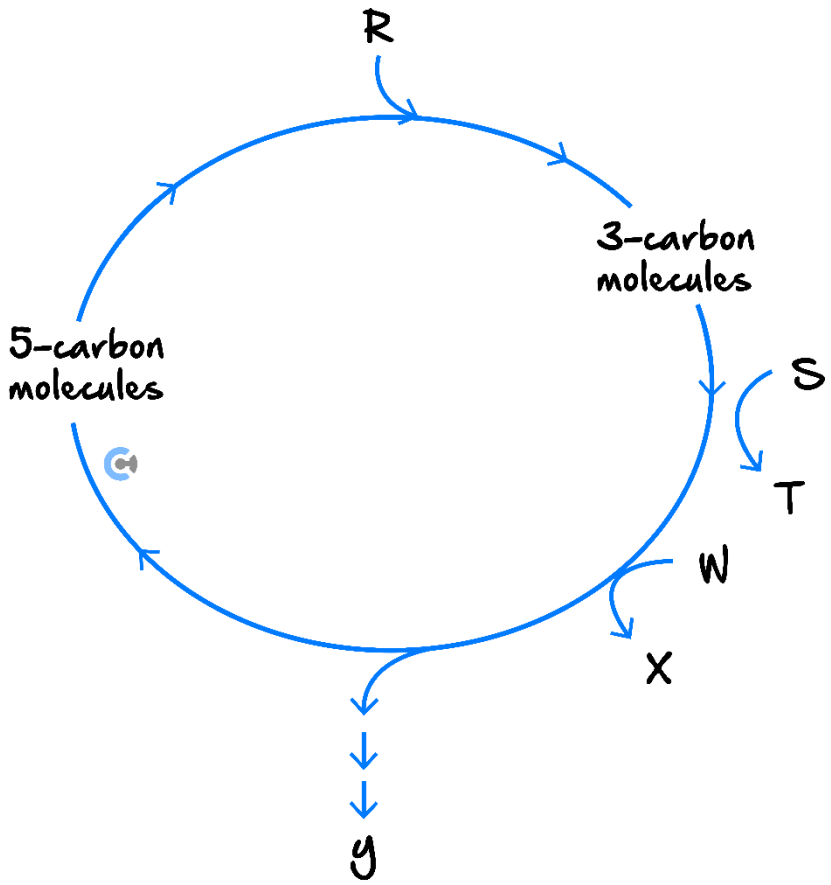
Question 8 (6 marks)

The diagram below is a simplified flow diagram of a series of chemical reactions that occur during photosynthesis.



a. Name the cycle that is represented by the flow diagram above, and state exactly where it takes place. (1 mark)

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b. Complete the following table for the letters on the flow diagram above. (4 marks)

Letter	Name or Chemical symbol
R	
S	
T	
W	
X	
Y	

c. What is the source of the chemical substances *S* and *W*? (1 mark)

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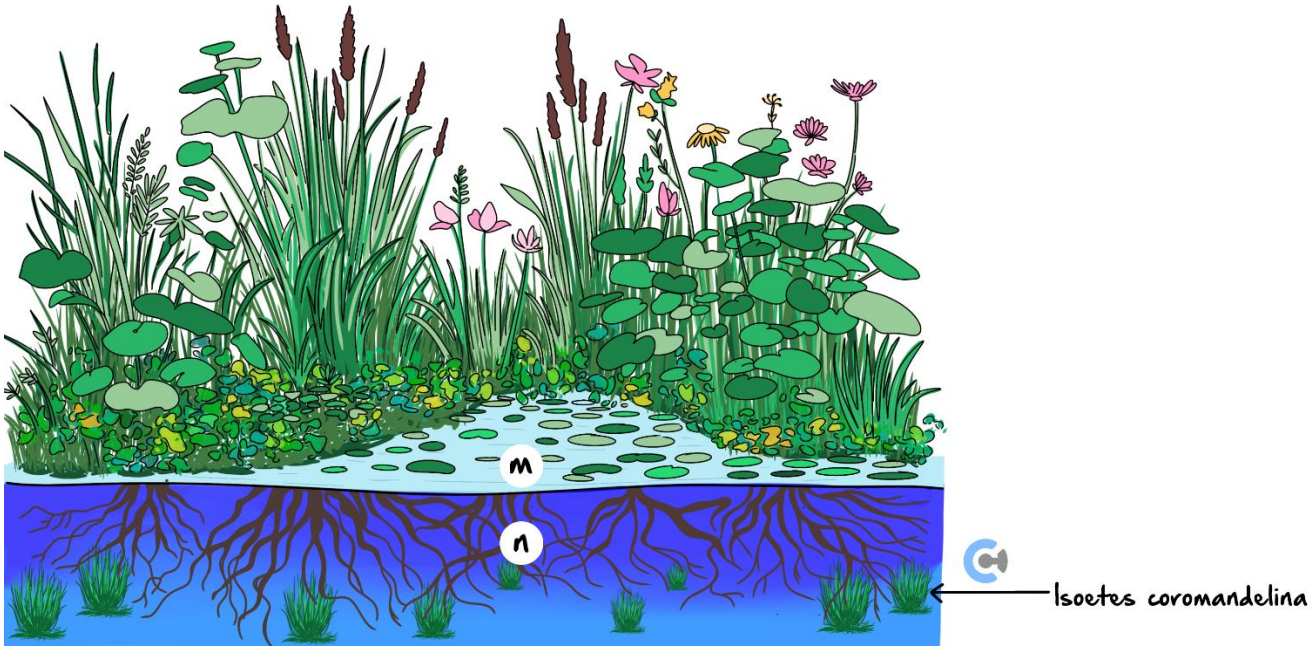
Question 9 (6 marks)

Swamps in the Northern Territory of Australia are heavily vegetated. The water typically supports a great variety of plants such as lilies and duckweed as well as abundant green algae which is suspended in the water. Most freshwater plants and green algae use the C3 photosynthetic pathway.

The image below represents a typical vegetation profile of a Northern Territory swamp.



A biologist measured the intensity of various light wavelengths at the water surface (m) and at the benthic floor (n) at noon, He recorded that the intensity of blue light was greater at m than at n.

a. Explain the biologist's results. (1 mark)

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He decided to also record the CO_2 concentration in the water at the surface (m) and at the benthic floor (n) at noon.

b. Predict what the results will show, about the relative CO_2 concentration at these two locations at noon. Explain your prediction. (1 mark)

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The biologist repeated the measurement, but this time, he recorded the CO_2 concentration at m and n at midnight.

c. Predict what the results will show, about the relative CO_2 concentration at these two locations at midnight. Explain your prediction. (1 mark)

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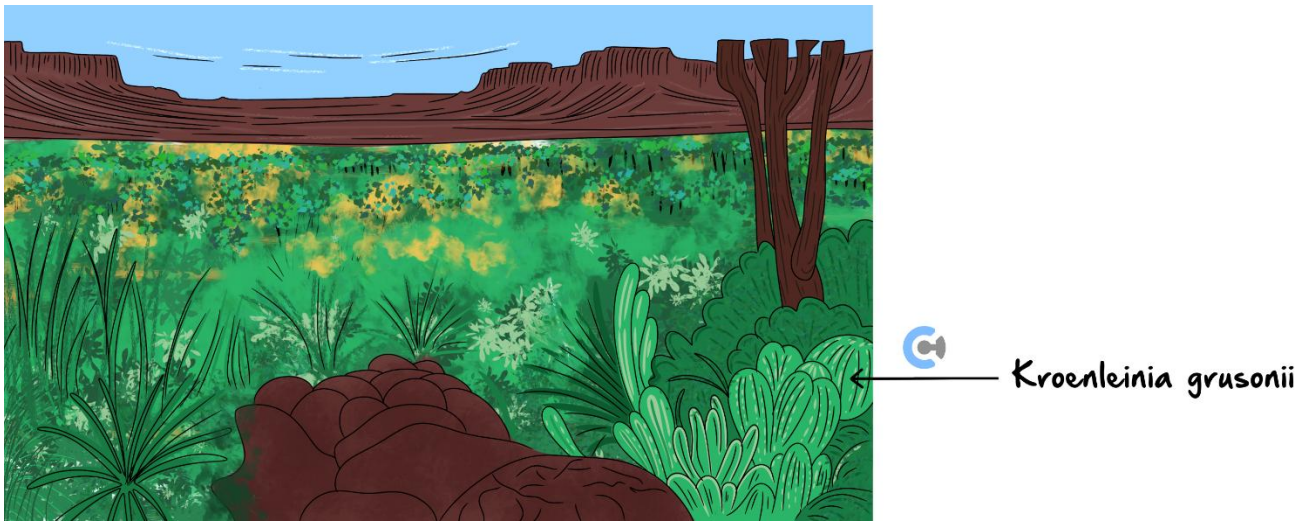
Other plants live in a desert habitat where it is both hot and arid (dry). Many desert plants such as the golden barrel cactus (*Kroenleinia grusonii*) use CAM photosynthesis instead of C3 photosynthesis.

This is an adaptation to both heat and aridity.



d. Explain how CAM photosynthesis enables *K. grusonii* to thrive in its arid habitat. (1 mark)

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e. Explain how CAM photosynthesis enables *K. grusonii* to thrive in a hot environment. (1 mark)

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A small number of aquatic plants such as the Australian quillwort (*Isoetes coromandelina*) are also CAM plants. *Isoetes coromandelina* is labelled in the figure above.

Even though CAM photosynthesis is usually seen as an adaptation to an arid environment, that is not the case for *I. coromandelina* since it grows in water.

f. What advantage would CAM photosynthesis have for an aquatic swamp plant like *Isoetes coromandelina*? (1 mark)

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Space for Personal Notes

Question 10 (5 marks)

James discovered an unusual plant species in a strange arid environment and wanted to determine its photosynthetic pathway. They conducted experiments to measure glucose production under varying temperatures, humidity levels, and the time of stomatal opening (day or night). The results are summarised in the table below.

Temperature (℃)	**CO_2**(%)	**Humidity** (%)	**Time (Day/Night)**	**Glucose Produced (mg/day)**
20	5	80	Night	40
20	5	10	Night	50
40	5	80	Night	50
40	5	10	Night	70
50	5	80	Night	30
50	5	10	Night	60

a. Based on the information provided, state whether the unknown plant is a C3, C4 or CAM plant. Justify your response. (3 marks)

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b. In reference to the pathway chosen for **part a.**, explain why it is suited to those conditions. (2 marks)

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Question 11 (10 marks)

Scientists carried out an experiment to investigate the photosynthetic efficiency of 2 different plant types by measuring the amount of oxygen produced (arbitrary units) at 30 minutes in varying temperatures. The results are shown in Table 2 below.

Temperature °C	Rate of photosynthesis (arbitrary units)
Plant 1	
10 °C	15
20 °C	20
30 °C	15
40 °C	10
Plant 2	
10 °C	5
20 °C	20
30 °C	35
40 °C	30

Table 2: Rate of photosynthesis production (arbitrary units) of two plants subjected to increasing temperatures

a. Using Figure 13, plot a graph of the data collected in Table 2. (4 marks)

b. Analyse the graph of the data collected with reference to the type of photosynthetic pathway undertaken in each plant. Explain. (6 marks)

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Space for Personal Notes

Section B: Extension Question (4 Marks)

Question 12 (4 marks)

Angad discovered an unusual plant species in a strange arid environment and wanted to determine its photosynthetic pathway. They conducted experiments to measure glucose production under varying temperatures, humidity levels, and light sources, whilst measuring the amount of O_2 that was produced). The results are summarised in the table below.

Temperature (°C)	**Light Source**	**CO_2** (%)	**Humidity** (%)	**Oxygen Output (mg/day)**
20	White	5	75	60
20	Blue	5	75	55
20	Green	5	75	20
40	White	5	30	30
40	Blue	5	30	25
40	Green	5	30	10

Analyse the information provided, stating whether the unknown plant is a C3, C4 or CAM plant. Justify your response.

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