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

VCE Biology ¾
Photosynthesis & Biochemical Pathways [2.1]
Homework

Homework Outline:

Compulsory Questions	Pg 2 – Pg 33

Section A: Compulsory Questions (70 Marks)

Sub-Section [2.1.1]: Recall the Inputs, Outputs & Locations & the Relationship between Both Stages of Photosynthesis

Question 1

Definitions:

a. Photosynthesis:

_____

_____

b. Light-dependent stage:

_____

_____

c. Light-independent stage (Calvin Cycle):

_____

_____

d. Thylakoid membrane:

_____

_____

e. Stroma:

_____

_____

f. ATP (Adenosine triphosphate):

_____

_____

g. NADPH:

_____

_____

h. Photolysis:

_____

_____

i. Glucose:

_____

_____

Space for Personal Notes

Question 2 (3 marks)

a. Light-Dependent Stage

Inputs	Outputs	Location

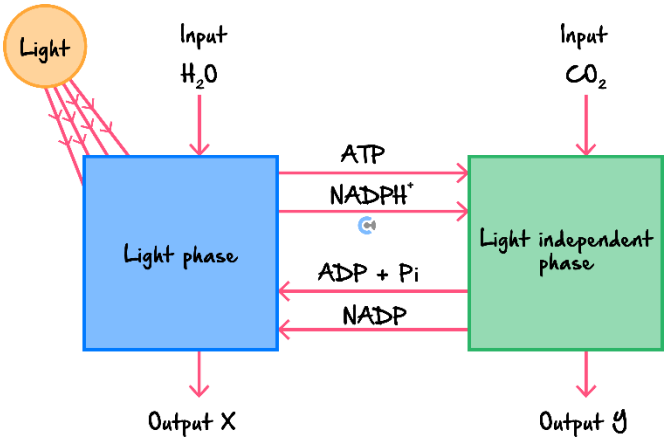
b. Light-Independent Stage

Inputs	Outputs	Location

c. Describe the relationship between the light-dependent and independent stages of photosynthesis. (3 marks)

Question 3 (5 marks)

a. Although photosynthesis is often summarised by a single equation, in fact, the process occurs in two distinct phases; the light phase and another phase called the carbon fixation phase or the light-independent phase. These two phases can be summarised in diagrammatic form as follows.



The diagram shows outputs *X* and *Y*.

i. What is output *X*? (1 mark)

_____

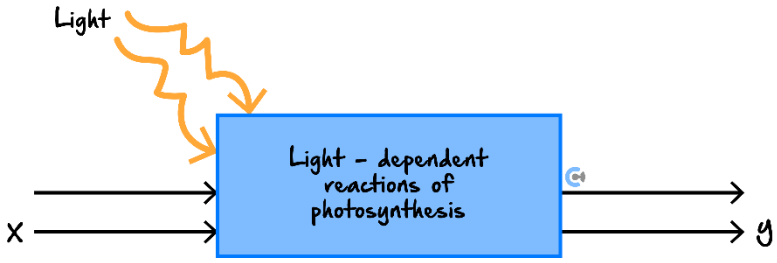
ii. How is output *X* produced? (1 mark)

_____

iii. What is output *Y*? (1 mark)

_____

b. The following diagram shows a simplified representation of the first stage of photosynthesis.



i. Name one input item that ***X*** could represent. (1 mark)

_____

ii. Name one input item that ***Y*** could represent. (1 mark)

_____

Space for Personal Notes

Sub-Section [2.1.2]: Explain the Role of Enzymes & Coenzymes on the Process of Photosynthesis

Question 4

Definitions:

a. Enzyme:

_____

_____

b. Rubisco (Ribulose-1, 5-bisphosphate carboxylase/oxygenase):

_____

_____

c. PEP carboxylase:

_____

_____

d. Coenzyme:

_____

_____

e. $NADP^+$ (Nicotinamide adenine dinucleotide phosphate):

_____

_____

f. Active site:

_____

_____

g. Substrate:

_____

_____

Question 5

A researcher identifies a plant mutation where $NADP^+$ cannot be reduced to NADPH during the light-dependent stage. What is the most immediate consequence for the Calvin Cycle?

A. RuBP will fail to regenerate, halting the cycle.

B. 3-PGA will not be reduced to G3P, preventing glucose synthesis.

C. CO_2 will no longer bind to Rubisco for fixation.

D. ATP synthesis in the thylakoid membrane will completely stop.

Question 6

How do enzymes contribute to the efficiency of photosynthesis?

A. By directly capturing and storing light energy in glucose molecules.

B. By reducing the activation energy needed for key biochemical reactions.

C. By transporting electrons through the thylakoid membrane.

D. By absorbing light energy required for photolysis.

Space for Personal Notes

Question 7 (3 marks)

Describe the role of coenzymes in the process of photosynthesis.

Space for Personal Notes

Sub-Section [2.1.3]: Explain the Function of Rubisco in Photosynthesis & Describe the Factors that Increase Its Affinity for O_2

Question 8

Definitions:

a. Rubisco:

_____

_____

b. Photorespiration:

_____

_____

c. Affinity:

_____

_____

d. RuBP (Ribulose-1, 5−bisphosphate):

_____

_____

e. Carboxylase:

_____

_____

f. Oxygenase:

_____

_____

g. Stomata:

_____

_____

Question 9

Which characteristic makes PEP carboxylase is more effective than Rubisco under low CO_2 conditions?

A. It has no oxygenase activity, so it avoids binding O_2.

B. It fixes CO_2 directly into glucose without needing the Calvin Cycle.

C. It is active only during high light intensity conditions.

D. It requires less energy than ATP for catalysis.

Question 10

Why is Rubisco considered inefficient under high temperatures?

A. It denatures and stops functioning.

B. It preferentially binds O_2 instead of CO_2, leading to photorespiration.

C. It requires more ATP at higher temperatures.

D. It cannot bind CO_2 under low humidity conditions.

Space for Personal Notes

Question 11 (1 mark)

What is the consequence of photorespiration on photosynthesis?

A. It increases the production of glucose.

B. It enhances CO_2 fixation by Rubisco.

C. It reduces photosynthetic efficiency by wasting energy.

D. It generates additional ATP for the Calvin Cycle.

Question 12 (1 mark)

Which environmental condition is most likely to increase Rubisco's oxygenase activity?

A. High CO_2 concentration.

B. Low temperature.

C. High O_2 concentration and high temperature.

D. High humidity and moderate light.

Question 13 (3 marks)

a. What is the function of Rubisco? (1 mark)

_____

_____

b. Rubisco can undergo another process called photorespiration. When is photorespiration most likely to occur? (2 marks)

_____

_____

_____

_____

Sub-Section [2.1.4]: Describe the Adaptations of C_4 & CAM Plants for Reducing Photorespiration, as Compared to C_3 Plants, Including Structural & Physiological Differences

Question 14

Definitions:

a. C_3 plants:

_____

_____

b. C_4 plants:

_____

_____

c. CAM plants:

_____

_____

d. PEP carboxylase:

_____

_____

e. Spatial separation:

_____

_____

f. Temporal separation:

_____

_____

g. Photorespiration:

_____

_____

Question 15

How do C_4 plants minimise photorespiration?

A. By opening their stomata only at night to conserve water.

B. By using spatial separation of CO_2 fixation and the Calvin Cycle.

C. By increasing Rubisco's affinity for CO_2.

D. By relying solely on the Calvin Cycle for photosynthesis.

Question 16

What is the key difference between C_4 and CAM plants?

A. CAM plants fix CO_2 in the mesophyll cells, while C_4 plants fix CO_2 in the stroma.

B. CAM plants separate CO_2 fixation and the Calvin Cycle by space, while C_4 plants separate them by time.

C. C_4 plants open their stomata at night, while CAM plants open their stomata during the day.

D. CAM plants separate CO_2 fixation and the Calvin Cycle by time, while C_4 plants separate them by space.

Space for Personal Notes

Question 17

Why are C_3 plants more susceptible to photorespiration compared to C_4 and CAM plants?

A. They lack the enzyme Rubisco.

B. They perform photosynthesis only at night.

C. They rely on Rubisco for direct CO_2 fixation without any adaptations to minimise O_2 binding.

D. They do not use chlorophyll for photosynthesis.

Question 18

Photorespiration is more likely to occur in a leaf when:

A. The level of carbon dioxide is higher than the level of oxygen.

B. The level of oxygen is higher than the level of carbon dioxide.

C. There is a surplus of water and a lack of carbon dioxide.

D. The sun goes down and the stomata close.

Space for Personal Notes

Question 19 (5 marks)

Compare the photosynthetic pathways of C_3, C_4 and CAM plants.

Space for Personal Notes

Sub-Section [2.1.5]: Use Data to Identify an Unknown Plant as C_3, C_4 or CAM With Reference to Conditions Where They Perform Photosynthesis Best

Question 20

A plant demonstrates high glucose production at 25°C but shows a sharp decline at 40°C. Which pathway does it most likely use?

A. C_3 photosynthesis.

B. C_4 photosynthesis.

C. CAM photosynthesis.

D. Photorespiration.

Question 21

A plant produces more glucose at 40°C and low humidity compared to 25°C and high humidity. What type of photosynthesis does it use?

A. C_3.

B. C_4.

C. CAM.

D. Both C_4 and CAM.

Question 22

A desert plant performs most of its photosynthesis at night. What photosynthetic pathway is this plant using?

A. C_3.

B. C_4.

C. CAM.

D. None of the above.

Question 23

In a controlled experiment, a researcher measures the photosynthetic rate of a plant at 40°C and 2% humidity. The plant shows no significant decrease in photosynthesis. What adaptation likely allows this?

A. Temporal separation of CO_2 fixation and the Calvin Cycle.

B. High Rubisco activity in mesophyll cells.

C. Spatial separation of CO_2 fixation in bundle sheath cells.

D. High stomatal opening during the day.

Space for Personal Notes

Question 24

A group of scientists conducted experiments investigating the photosynthetic output of a newly discovered plant species. The plants were exposed to differing environmental conditions in an enclosed greenhouse. Light and water availability were kept the same. The amount of glucose produced was measured and recorded in the table below. Plants of the same size were used in each of these experiments.

Air temperature (℃)	**Carbon dioxide in surrounding air (%)**	**Relative humidity of surrounding air (%)**	**Quantity of glucose produced (mg/day)**
20	5	80	85
20	2	80	50
30	5	80	70
30	2	60	45
40	5	30	35
40	2	30	20

Plants can be placed into three main groups, C_3, C_4 or CAM plants, based on their photosynthetic adaptations.

To which of these groups would this newly discovered plant species most likely belong? Justify your answer.

Space for Personal Notes

Sub-Section [2.1.6]: Identify & Explain the Factors - Light Colour, Intensity, CO_2 Concentration, Temperature, Water Availability - that Affect the Efficiency of Photosynthesis

Question 25

Definitions:

a. Light intensity:

_____

_____

b. Light wavelength:

_____

_____

c. CO_2 concentration:

_____

_____

d. Temperature:

_____

_____

e. Water availability:

_____

_____

Question 26

Why is red light more effective than green light for photosynthesis?

A. Red light penetrates deeper into the leaf.

B. Chlorophyll absorbs red light more effectively than green light.

C. Red light stimulates photolysis directly.

D. Green light inhibits chlorophyll production.

Question 27

Identify the factor that affects the rate of photosynthesis shown in the figure below:

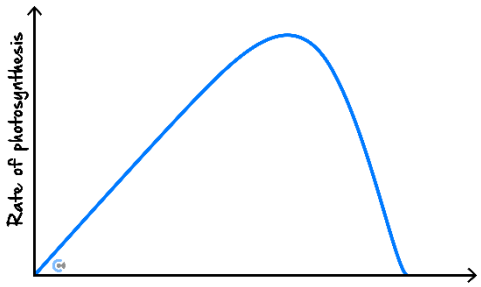


Figure 4: The changing rate of photosynthesis.

A. Temperature.

B. Light intensity.

C. Availability of water.

D. Carbon dioxide concentration.

Question 28

Identify which one of the following will increase the rate of photosynthesis:

A. Increasing water.

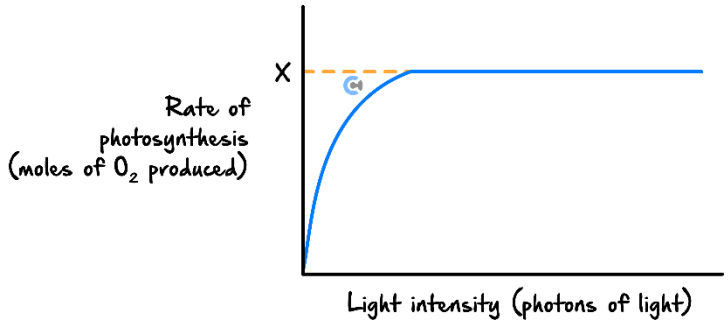
B. Decreasing temperature.

C. Decreasing oxygen.

D. Increasing light.

Question 29

A student shone a light on a green leaf and measured the rate of photosynthesis. The student varied the intensity of the light and graphed the findings as shown below. *X* was the maximum rate of photosynthesis detected by the student.



Which one of the following conditions will increase the value of *X*?

A. Adding a filter to the light used.

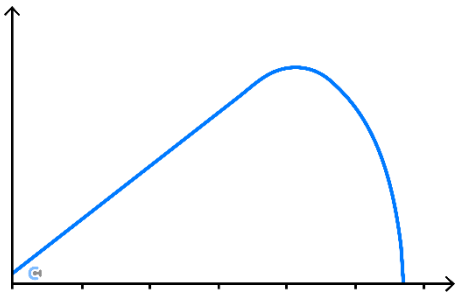
B. Using a leaf that contains more chloroplasts.

C. Moving the light further away from the leaf.

D. Decreasing the temperature of the leaf's environment.

Question 30

A student conducted an experiment investigating factors that affect the rate of photosynthesis. They produced the following graph but forgot to label the axis. The most likely labels would be:



A. *x*-axis: pH; *y*-axis: Rate of reaction.

B. *x*-axis: Temperature; *y*-axis: Rate of reaction.

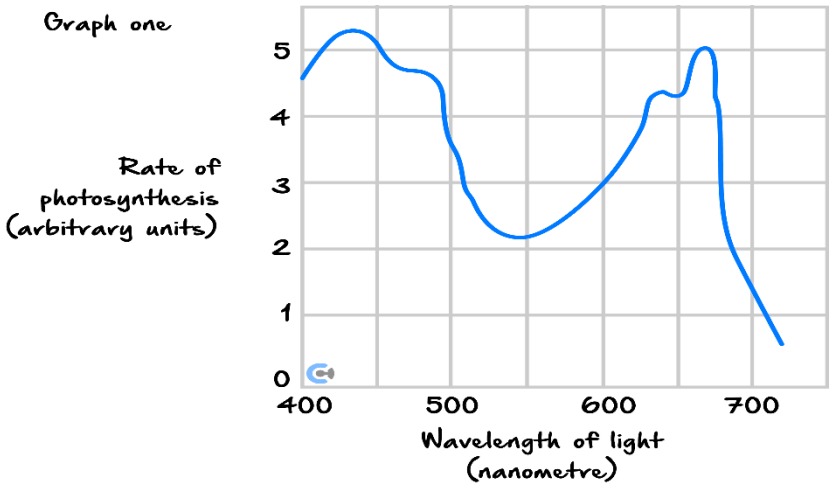
C. *x*-axis: Rate of reaction; *y*-axis: pH.

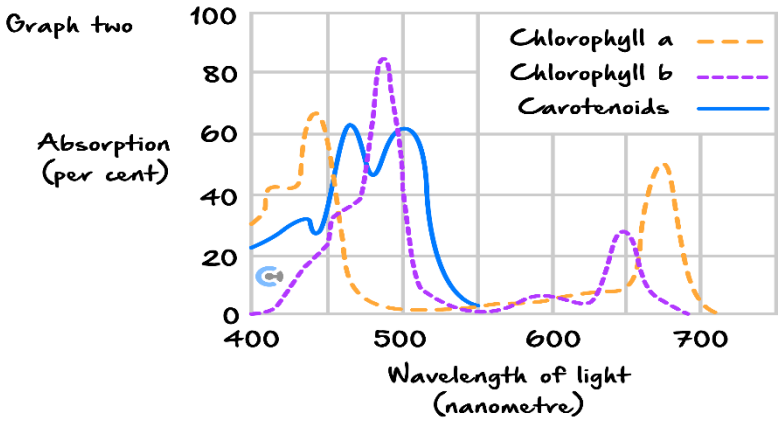
D. *x*-axis: Rate of reaction; *y*-axis: Temperature.

Question 31 (5 marks)

a. The following diagrams show:

- **Graph one:** The rate of photosynthesis in a green plant at different wavelengths of light.
- **Graph two:** The estimated absorption of the different wavelengths of light by the different plant pigments.





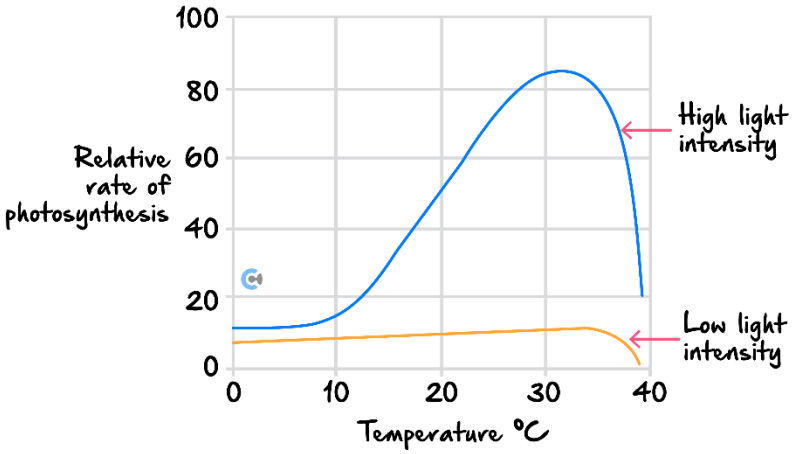
Explain why the graph showing the rate of photosynthesis has approximately the same shape as the absorption graphs of the plant pigments. (1 mark)

_____

_____

_____

b. Scientists exposed two groups of identical plants to a range of temperatures. One group was kept in a low-light intensity and the other in a high-light intensity environment. The following graph summarises the results obtained by the scientists.



Account for the difference in the rate of photosynthesis for the two groups of plants over the range of temperatures shown. (2 marks)

c. A light is placed near a plant and the rate of photosynthesis is measured. The intensity of the light is increased over time as shown in the figure below.

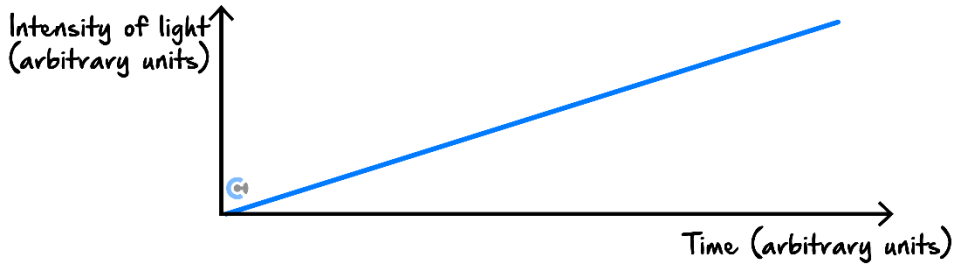


Figure 9

List the three possible limiting factors that may stop the rate of photosynthesis from increasing, even though the light intensity continues to increase. (2 marks)

_____

_____

_____

_____

Space for Personal Notes

Sub-Section [2.1.7]: Apply Experimental Principles to Investigate Factors Affecting the Rate of Photosynthesis

Question 32

A student investigates the effect of light intensity on the rate of photosynthesis using pondweed in water. Which of the following is the most appropriate dependent variable for this experiment?

A. The number of oxygen bubbles released per minute.

B. The distance of the light source from the pondweed.

C. The amount of water added to the container.

D. The wavelength of light used in the experiment.

Question 33

A researcher is testing how CO_2 concentration affects photosynthesis. What is the most suitable independent variable?

A. The glucose concentration in plant tissues.

B. The rate of water loss through stomata.

C. The level of CO_2 in the experimental setup.

D. The amount of sunlight received by the plant.

Question 34

In an experiment testing the effect of temperature on photosynthesis, what control variable should be maintained?

A. The type of plant used in the experiment.

B. The intensity and wavelength of light.

C. The CO_2 concentration in the environment.

D. All of the above.

Question 35

A student designs an experiment to measure the effect of different light wavelengths on photosynthesis. What is the most appropriate tool to measure the dependent variable?

A. A spectrophotometer to measure chlorophyll absorbance.

B. A dissolved oxygen sensor to measure oxygen production.

C. A thermometer to measure heat generated by the light source.

D. A hygrometer to measure humidity changes.

Question 36

In an experiment, a student observes that increasing light intensity initially increases the rate of photosynthesis, but eventually the rate plateaus. What is the best explanation for this observation?

A. CO_2 concentration becomes the limiting factor.

B. The chloroplasts become damaged by excess light.

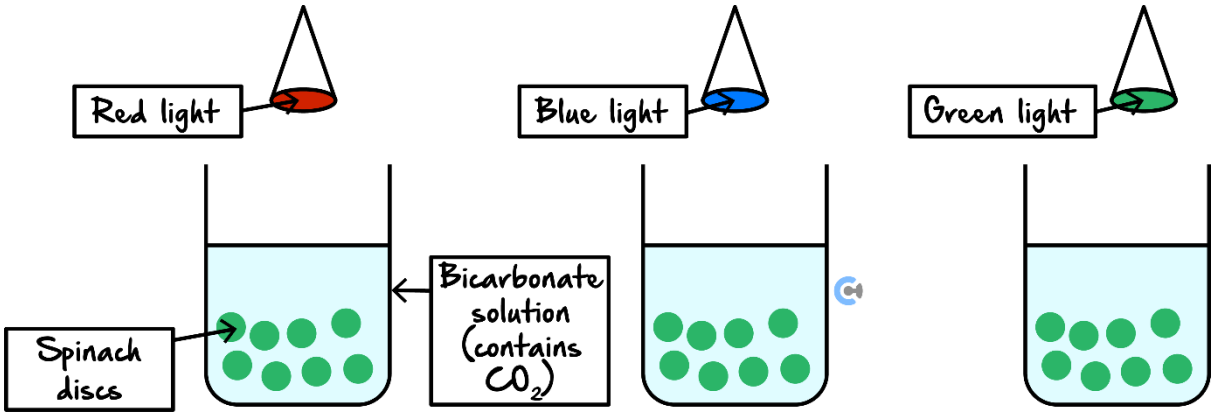
C. ATP production stops in the light-dependent stage.

D. The plant uses green light, which is less effective.

Space for Personal Notes

Question 37 (9 marks)

A scientist carries out an investigation into how different wavelengths of light affect the rate of photosynthesis. She takes small discs of spinach and removes the air from them using a syringe. These are then placed into beakers with bicarbonate solution (a source of carbon dioxide) and exposed to either green, red or blue light, as shown below. She leaves them for 10 minutes and counts the number of discs that have risen every minute.



a. Why does the rate of rising of the leaf discs allow the scientist to determine the extent of photosynthesis? (2 marks)

b. Write a suitable hypothesis for this experiment. Explain your hypothesis. (2 marks)

c. What would be the suitable control for this experiment? (1 mark)

d. This experiment relies on one of the stages of photosynthesis occurring correctly. Identify this stage and state what is produced as a result of this stage. (2 marks)

_____

_____

_____

_____

e. The scientist predicted that the levels of glucose produced by the cells in each experiment would be the same. Is she correct? Explain your reasoning. (2 marks)

_____

_____

_____

_____

Space for Personal Notes

Sub-Section [2.1.8]: Explain How CRISPR-Cas9 Can Be Used to Increase Photosynthetic Efficiency

Question 38

Definitions:

a. CRISPR-Cas9:

_____

_____

b. Genome editing:

_____

_____

c. Rubisco efficiency:

_____

_____

d. Drought tolerance :

_____

_____

e. Crop yield:

_____

_____

f. Photorespiration reduction:

_____

_____

Question 39

How can CRISPR-Cas9 be used to reduce photorespiration in plants?

A. By increasing the expression of Rubisco.

B. By editing Rubisco genes to improve CO_2 specificity and reduce O_2 binding.

C. By modifying chlorophyll molecules to absorb more light.

D. By introducing genes for PEP carboxylase into C_3 plants.

Question 40

Which of the following is a key advantage of using CRISPR-Cas9 in improving photosynthesis?

A. It can directly increase glucose production in all plants.

B. It allows for precise editing of genes involved in photosynthetic pathways.

C. It enables plants to perform photosynthesis without sunlight.

D. It eliminates the need for the Calvin Cycle.

Space for Personal Notes

Question 41

A researcher uses CRISPR-Cas9 to introduce genes for C_4 photosynthesis into a C_3 plant. What is the expected outcome?

A. The C_3 plant will increase photorespiration.

B. The C_3 plant will perform photosynthesis more efficiently at high temperatures.

C. The C_3 plant will only perform photosynthesis at night.

D. The C_3 plant will switch to CAM photosynthesis.

Question 42

Which of the following traits can be targeted using CRISPR-Cas9 to improve photosynthesis in crops?

A. Increasing Rubisco's affinity for O_2.

B. Enhancing the water-use efficiency of plants.

C. Eliminating the need for light in photosynthesis.

D. Shortening the Calvin Cycle to produce glucose faster.

Space for Personal Notes

Question 43 (4 marks)

Describe the steps used in using CRISPR to edit plants.

Space for Personal Notes

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