Chapter: Photosynthesis in Higher Plants

Exercises:

Question 1. By looking at a plant externally can you tell whether a plant is C_3 or C_4? Why and how?

Answer: Externally, it is impossible to tell whether a plant is C_3 or C_4 by looking at its leaves and other morphological traits. Unlike C_3 plants, C_4 plants' leaves feature a unique anatomy known as Kranz anatomy, which can only be seen at the cellular level. Wheat, for example, is a C_3 plant, whereas maize is a C_4 plant, despite the fact that both are grasses.

Question 2. By looking at which internal structure of a plant can you tell whether a plant is C_3 or C_4? Explain.

Answer: C_4 plants' leaves have a unique anatomy known as Kranz anatomy. This distinguishes them from C_3 plants. The vascular bundles are surrounded by special cells known as bundle-sheath cells. There are a lot of chloroplasts in these cells. There are no intercellular voids and they have solid walls. They're also resistant to gas exchange. All of these anatomical traits contribute to C_4 plants' ability to photosynthesize by preventing photorespiration.

Question 3. Even though a very few cells in a C_4 plant carry out the biosynthetic – Calvin pathway, yet they are highly productive. Can you discuss why?

Answer: The rate at which a plant photosynthesises is used to determine its productivity. The rate of photosynthesis is directly related to the amount of carbon dioxide present in a plant. C_4 plants contain a mechanism for raising carbon dioxide concentration. The Calvin cycle takes place in the bundle-sheath cells of C_4 plants. In the bundle sheath cells, the C_4 component (malic acid) from the mesophyll cells is broken down. CO_2 is released as a result. The rise in CO_2 causes the enzyme RuBisCo to behave as a carboxylase rather than an oxygenase. This reduces photorespiration and boosts photosynthetic rates. Thus, C_4 plants are highly productive.

Question 4. RuBisCo is an enzyme that acts both as a carboxylase and oxygenase. Why do you think RuBisCo carries out more carboxylation in C_4 plants?

Answer: C_4 plants lack the enzyme RuBisCo in their mesophyll cells. It's found in the cells that surround the vascular bundles, called bundle-sheath cells. The Calvin cycle takes place in the bundle-sheath cells of C_4 plants. Phosphoenol pyruvate, a three-carbon molecule, is the major CO_2 acceptor in mesophyll cells. It is transformed into oxaloacetic acid, a four-carbon molecule OAA . Malic acid is formed after OAA has been transformed. The Calvin cycle transports malic acid to the bundle-sheath cells, where it conducts decarboxylation and CO_2 fixation. The enzyme RuBisCo can no longer function as an oxygenase as a result of this.

Question 5. Suppose there were plants that had a high concentration of Chlorophyll-b, but lackedchlorophyll-a, would it carry out photosynthesis? Then why do plants have chlorophyll-band other accessory pigments?

Answer: Antenna molecules are chlorophyll-a molecules. During cyclic and non-cyclic photophosphorylations, they are stimulated by absorbing light and release electrons. Both photosystems I and II have reaction centers in them. Accessory pigments include chlorophyll-b and other photosynthetic pigments like carotenoids and xanthophylls. They are responsible for absorbing energy and transferring it to chlorophyll-a. The chlorophyll molecule is additionally protected from photo-oxidation by carotenoids and xanthophylls.

As a result, chlorophyll-a is required for photosynthesis to occur.

If a plant lacks chlorophyll-a but has a high quantity of chlorophyll-b, it will not be able to perform photosynthesis.

Question 6.Why is the colour of a leaf kept in the dark frequently yellow, or pale green? Which pigment do you think is more stable?

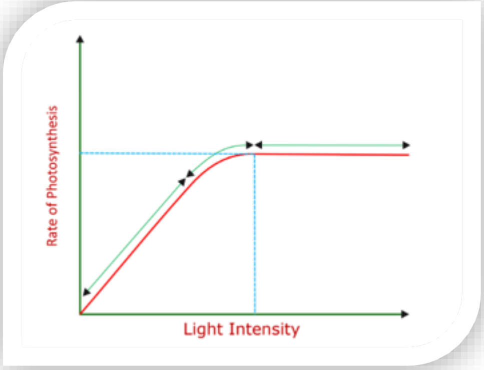
Answer: Because leaves require light to accomplish photosynthesis, their color changes from a deeper to a lighter shade of green when they are kept in the dark. It can also turn yellow at times. The amount of light available determines the amount of chlorophyll pigment produced, which is required for photosynthesis. Chlorophyll-a molecule creation ceases in the absence of light, and they slowly degrade. The leaf progressively turns light green as a result of this. The xanthophyll and carotenoid pigments become prominent during this process, turning the leaf yellow. Because light is not required for the synthesis of these pigments, they are more stable. Plants contain them at all times.

Question 7. Look at leaves of the same plant on the shady side and compare it with the leaves onthe sunny side. Or, compare the potted plants kept in the sunlight with those in theshade. Which of them has leaves that are darker green? Why?

Answer: For photosynthesis, light is a limiting factor. When leaves are in the shade, they receive less light for photosynthesis. As a result, leaves or plants in the shade conduct less photosynthesis than leaves or plants in direct sunlight. The leaves in the shade have more chlorophyll pigments to boost the rate of photosynthesis. The amount of light absorbed by the leaves increases as the chlorophyll content rises, increasing the rate of photosynthesis. As a result, leaves or plants kept in the shade are greener than those kept in the sun.

Question 8. Figure 13.10 shows the effect of light on the rate of photosynthesis. Based on the graph, answer the following questions:

a. At which point/s (A, B or C) in the curve is light a limiting factor?
b. What could be the limiting factor/s in region A?
c. What do C and D represent on the curve?



Answer:

a. In most cases, light isn't a limiting element. For plants growing in the shade or under tree canopies, it becomes a limiting element. At the point when photosynthesis is the smallest in the graph, light is a limiting factor. In region A, photosynthesis has the lowest value. As a result, in this region, light is a limiting element.

b. In region A, light is a limiting element. Water, temperature, and carbon dioxide content could all be limiting variables in this area.

c. The optimum point is represented by point D, which indicates the light intensity at which maximal photosynthesis occurs. Even though the intensity of light decreases after this point, the rate of photosynthesis remains constant.

Question 9. Give comparison between the following:

(a) C_3 and C_4 pathways.

(b) Cyclic and non-cyclic photophosphorylation.

(c) Anatomy of leaf in C_3 and C_4 plants.

Answer:

a. C_3 and C_4 pathways.

	C3 pathways		C4 pathways
1.	RUBP, a six-carbon molecule, is the major CO_2 acceptor.	1.	Phosphoenol pyruvate, a three-carbon molecule, is the major CO_2 acceptor.
2.	3 phosphoglycerate is the first stable product.	2.	Oxaloacetic acid is the first stable product.
3.	It can only be found in the leaves' mesophyll cells.	3.	It's found in the leaves' mesophyll and bundle-sheath cells.

4.	Carbon fixation is a slower process, and photo-respiratory losses are considerable.	4.	It is a faster carbon fixation method with less photo-respiratory losses.

b. Cyclic and non-cyclic photophosphorylations.

Cyclic photophosphorylation		**Non-cyclic photophosphorylation**	
1.	It can only be found in photosystem I.	1.	It can be found in both photosystems I and II.
2.	It just entails the production of ATP.	2.	It entails the production of ATP and NADPH2.
3.	Photolysis of water does not occur in this procedure. As a result, no oxygen is produced.	3.	Water is photolyzed and oxygen is liberated during this process.
4.	Electrons move in a closed circle during this procedure.	4.	Electrons do not move in a closed circle during this procedure.

c. Anatomy of the leaves in C_3 and C_4 plants

C_3 **leaves**		C_4 **leaves**	
1.	There are no bundle-sheath cells.	1.	There are cells with a bundle-sheath structure.
2.	The mesophyll cells contain RuBisCo.	2.	The bundle sheath cells contain RuBisCo.
3.	3-phosphoglycerate, a three-carbon molecule, is the first stable chemical created.	3.	Oxaloacetic acid, a four-carbon molecule, is the first stable chemical created.
4.	Photorespiration takes place.	4.	There is no photorespiration.