NCERT Solutions for Class-XI Biology

Chapter-13

1. By looking at a plant externally can you tell whether a plant is C3 or C4? Why and how?

1. It is not possible to distinguish externally between a C_3 and C_4 plant, but generally tropical plants are adapted for C_4 cycle.

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

2. The leaves of C_4 plants have a special anatomy called Kranz anatomy. This makes them different from C_3 plants. Special cells, known as bundle-sheath cells, surround the vascular bundles. These cells have a large number of chloroplasts. They are thick-walled and have no intercellular spaces. They are also impervious to gaseous exchange. All these anatomical features help prevent photorespiration in C_4 plants, thereby increasing their ability to photosynthesise.

3. Even though a very few cells in a C4 plant carry out the biosynthetic – Calvin pathway, yet they are highly productive. Can you discuss why?

3. Since, through C_4 cycle, a plant can photosynthesise even in presence of very low concentration of CO_2 (upto 10 parts per million), the partial closure of stomata due to xeric conditions would not bring much effect. Therefore, the plants can adapt to grow at low water content, high temperature and bright light intensities. This cycle is specially suited to such plants which grow in dry climates of tropics and subtropics. Besides, the photosynthetic rate remains higher due to absence of photorespiration in these plants. It can be visualised that both C_4 cycle and photorespiration are the result of evolution or might have been one of the reasons of evolution for the adaptation of plants to different environments. C_4 plants are about twice to efficient as C_3 plants in converting solar energy into production of dry matter.

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?

4. The enzyme RuBisCo is absent from the mesophyll cells of C_4 plants. It is present in the bundle-sheath cells surrounding the vascular bundles. In C_4 plants, the Calvin cycle occurs in the bundle-sheath cells. The primary CO_2 acceptor in the mesophyll cells is phosphoenol pyruvate – a three-carbon compound. It is converted into the four-carbon compound oxaloacetic acid (OAA). OAA is further converted into malic acid. Malic acid is transported to the bundle-sheath cells, where it undergoes decarboxylation and CO_2 fixation occurs by the Calvin cycle. This prevents the enzyme RuBisCo from acting as an oxygenase.

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

5. Plants that do not possess chlorophyll a will not carry out photosynthesis because it is the primary pigment and act as the reaction centre. It performs the primary reactions of photosynthesis or conversion of light into chemical or electrical energy. Other photosynthetic pigments are called accessory pigments. They absorb light energy of different wavelengths and hence broaden the spectrum of light absorbed by photosynthetic pigments. These pigments hand over the absorbed energy to chlorophylla.

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?

6. Since leaves require light to perform photosynthesis, the colour of a leaf kept in the dark changes from a darker to a lighter shade of green. Sometimes, it also turns yellow. The production of the chlorophyll pigment essential for photosynthesis is directly proportional to the amount of light available. In the absence of light, the production of chlorophyll-a molecules stops and they get broken slowly. This changes the colour of the leaf gradually to light green. During this process, the xanthophyll and carotenoid pigments become predominant, causing the leaf to become yellow. These pigments are more stable as light is not essential for their production. They are always present in plants.

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

7. The leaves of the shaded side are darker green than those kept in sunlight due to two reasons:

(i) The chloroplasts occur mostly in the mesophyll cells along their walls for receiving optimum quantity of incident light.

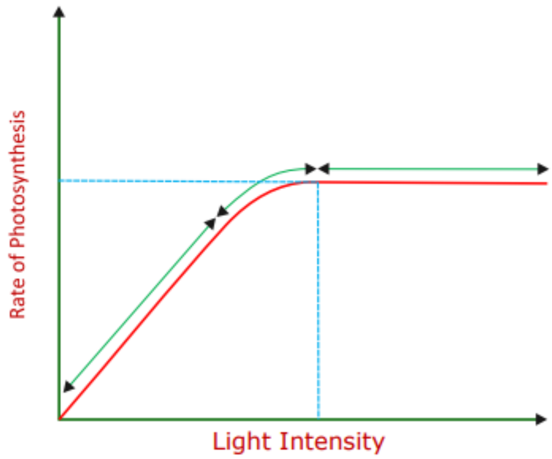
(ii) The chloroplasts align themselves in vertical position along the lateral walls of high light intensity and along tangential wails in moderate light.

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

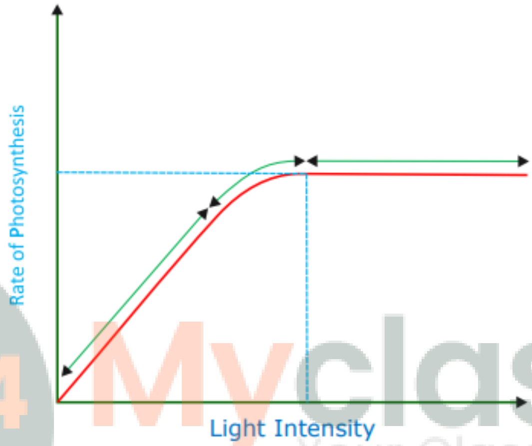
(a) At which point/s (A, B or C) in the curve is light a limiting factor?

(b) What could be the limiting factor/s in region A?

(c) What do C and D represent on the curve?



8.



(a) Generally, light is not a limiting factor. It becomes a limiting factor for plants growing in shade or under tree canopies. In the given graph, light is a limiting factor at the point where photosynthesis is the minimum. The least value for photosynthesis is in region A. Hence, light is a limiting factor in this region.
(b) Light is a limiting factor in region A. Water, temperature, and the concentration of carbon dioxide could also be limiting factors in this region.
(c) Point D represents the optimum point and gives the light intensity at which the maximum photosynthesis is recorded. The rate of photosynthesis remains constant after this point, even though the intensity of light

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

9. (a) The differences between C_3 and C_4

C_3 pathway	**C_4 pathway**
Ribulose biphosphate is the first acceptor of CO_2.	In the plants found in the tropical area, the first stable product after carbon assimilation is a 4 carbon molecule or oxalo-acetic acid instead of a 3 carbon compound. These plants are called C_4 plants and the pathway of carbon fixation is called

	the C_4 pathway.
The cells involved are mesophyll cells	The cells involved are mesophyll cells and bundle sheath cells
It is seen in all photosynthetic plants.	It is seen in tropical plants
The enzyme involved is RuBP carboxylase.	The enzyme involved: In mesophyll cells is PEP carboxylase. In bundle sheath cells is RuBP carboxylase.
	In bundle sheath cells is RuBP carboxylase.

(b) The differences between cyclic and non- cyclic photophosphorylation are as follows:

Cyclic photophosphorylation	Non-cyclic photophosphorylation
Only photosystem I is involved in cyclic photophosphorylation	Both photosystems I and II are involved in non-cyclic photophosphorylation
The active reaction centre is P700	The active reaction centre is P680
Electron transportation occurs in a cyclic manner	Electron transport occurs in a non- cyclic manner
Oxygen evolution does not occur	Oxygen is released as a by product
Only ATP is produced	Both ATP and NADPH are produced

(c) Differences between the leaf anatomy of C_3 and C_4 plants are as follows:

Anatomy of leaf in C_3 plants	Anatomy of leaf in C_4 plants
Bundle sheath cells are absent	Bundle sheath cells are present around the vascular bundles
RuBisCO is found in mesophyll cells	RuBisCO is found in bundle sheath cells
Plants do not possess 'Kranz' anatomy of leaves.	Leaves show Kranz anatomy
Chloroplasts are of a single type only	Chloroplasts are dimorphic. The chloroplasts of bundle sheath cells are larger in size and arranged centripetally.
Mesophyll cells have intercellular spaces	Mesophyll cells do not have intercellular spaces