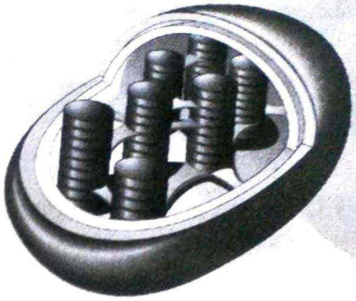
CHAPTER

11 Photosynthesis in Higher Plants



11.1. What do we Know?

1. Oxygen is not produced during photosynthesis by:
(A) *Cycas*
(B) *Nostoc*
(C) Green sulphur bacteria
(D) *Chara* **[NEET 2018]**

2. Water vapour comes out from the plant leaf through the stomatal opening. Through the same stomatal opening carbon dioxide diffuses into the plant during photosynthesis. Reason out the above statements using the following options.
(A) Both processes can happen together because the diffusion coefficient of water and CO_2 is different.
(B) The above processes happen only during night time.
(C) One process occurs during day time and the other at night.
(D) Both processes cannot happen simultaneously.
[NEET Phase-I 2016]

3. Anoxygenic photosynthesis is a characteristic of:
(A) *Rhodospirillum* (B) *Spirogyra*
(C) *Chlamydomonas* (D) *Ulva.* **[AIPMT 2014]**

4. Oxygenic photosynthesis occurs in:
(A) *Chromatium* (B) *Oscillatoria*
(C) *Rhodospirillum* (D) *Chlorobium*
[AIPMT Screening 2009]

5. Organisms which obtain energy by the oxidation of reduced inorganic compounds are called:
(A) photoautotrophs (B) chemoautotrophs
(C) saprozoic (D) coproheterotrophs.
[AIPMT 2002]

6. Protochlorophyll differs from chlorophyll in lacking:
(A) 2 hydrogen atoms in one of its pyrrole rings
(B) 2 hydrogen atoms in two of its pyrrole rings
(C) 4 hydrogen atoms in one of its pyrrole rings
(D) 4 hydrogen atoms in two of its pyrrole rings.
[AIPMT 1998]

7. Most plants are green in colour because:
(A) the atmosphere filters out all the colours of the visible light spectrum except green.
(B) green light is the most effective wavelength region of the visible spectrum in sunlight for photosynthesis.
(C) chlorophyll is least effective in absorbing green light.
(D) green light allows maximum photosynthesis.
[AIPMT 1997]

8. Nine-tenth of all photosynthesis of world (85-90%) is carried out by:
(A) large trees with millions of branches and leaves
(B) algae of the ocean
(C) chlorophyll containing ferns of the forest
(D) scientists in the laboratories **[AIPMT 1994]**

9. All types of plastids possess essentially the same structure because they:
(A) perform the same function
(B) store food materials like starch, fat and protein
(C) occur in aerial parts
(D) can transform from one form to another.
[AIPMT 1992]

11.2. Early Experiments

10. Emerson's enhancement effect and red drop have been instrumental in the discovery of:
(A) two photosystems operating simultaneously
(B) photophosphorylation and cyclic electron transport
(C) oxidative phosphorylation
(D) photophosphorylation and non-cyclic electron transport. **[NEET Phase-I 2016]**

11.3. Where does Photosynthesis take Place?

11. In chloroplast, the highest number of protons are found in:
(A) lumen of thylakoids (B) inter membrane space
(C) antennae complex (D) stroma
[NEET Phase-I 2016]

12. In photosynthesis, the light-independent reactions take place at:
(A) thylakoid lumen (B) photosystem I
(C) photosystem II (D) stromal matrix.
[AIPMT Latest July 2015]

13. Stroma in the chloroplasts of higher plants contain:
(A) light-independent reaction enzymes
(B) light-dependent reaction enzymes
(C) ribosomes
(D) chlorophyll **[AIPMT 2009 Screening]**

14. In chloroplasts, chlorophyll is present in the:
(A) outer membrane (B) inner membrane
(C) thylakoids (D) stroma
[AIPMT 2005, 04]

15. The size of chlorophyll molecule is:
(A) head 15 ×15Å, tail 25Å
(B) head 20 ×20Å, tail 25Å
(C) head 15 ×15Å, tail 20Å
(D) head 10 ×12Å, tail 25Å. **[AIPMT 1994]**

11.4. How many Pigments are involved in Photosynthesis?

16. Water soluble pigments found in plant cell vacuoles are:
(A) Xanthophylls (B) Chlorophylls
(C) Carotenoids (D) Anthocyanins.
[NEET 2016]

17. Chromatophores take part in:
(A) photosynthesis (B) growth
(C) movement (D) respiration.
[AIPMT Latest July 2015]

18. Pigment-containing membranous extensions in some cyanobacteria are:
(A) Basal bodies (B) Pneumatophores
(C) Chromatophores (D) Heterocysts **[NEET 2013]**

19. The wavelength of light absorbed by P_r form of phytochrome:
(A) 680 nm (B) 620 nm
(C) 720 nm (D) 640 nm **[AIPMT 2007]**

20. Which fractions of the visible spectrum of solar radiations are primarily absorbed by carotenoids of the higher plants?
(A) Blue and green (B) Green and red
(C) Red and violet (D) Violet and blue
[AIPMT 2003]

21. The pigment, that absorbs red and far red light in plants, is:
(A) xanthophyll (B) cytochrome
(C) phytochrome (D) carotene
[AIPMT 2002, 1997, 95]

22. Chlorophyll 'a' molecule at its carbon atom 3 of the pyrrole ring II has one of the following:
(A) aldehyde group (B) methyl group
(C) carboxyl group (D) magnesium
[AIPMT 1997]

23. Photosynthetic pigments found in the chloroplasts occur in:
(A) thylakoid membranes
(B) plastoglobules
(C) matrix
(D) chloroplast envelope **[AIPMT 1991]**

11.5. What is Light Reaction?

24. Which of the following are required for the light reaction of Photosynthesis?
(I) CO_2 (II) O_2
(III) H_2O (IV) Chlorophyll
(V) Light
Choose the correct answer form the options given below:
(A) (I), (III), (IV) and (V) only
(B) (III), (IV) and (V) only
(C) (I) and (II) only
(D) (I), (III) and (V) only **[Re-NEET 2024]**

25. The reaction centre in PS II has an absorption maxima at:
(A) 660 nm (B) 780 nm
(C) 680 nm (D) 700 nm **[NEET 2023]**

26. In light reaction, plastoquinone facilitates the transfer of electrons from:
(A) Cyt-b_6f complex to PS-I
(B) PS-I to $NADP^+$
(C) PS-I to ATP synthase
(D) PS-II to Cyt-b_6f complex. **[NEET Sept. 2020]**

27. Which of the following is not a product of light reaction of photosynthesis?
(A) NADPH (B) NADH
(C) ATP (D) Oxygen **[NEET 2018]**

28. Electrons from excited chlorophyll molecule of photosystem-II are accepted first by:
(A) cytochrome-b (B) cytochrome-f
(C) quinone (D) ferredoxin.
[AIPMT Screening 2008, 2007]

29. In photosystem-I, the first electron acceptor is:
(A) an iron-sulphur protein
(B) ferredoxin
(C) cytochrome
(D) plastocyanin. **[AIPMT 2006]**

11.6. The Electron Transport

30. Which of the following combinations is required for chemiosmosis?
(A) Proton pump, electron gradient, ATP synthase.
(B) Proton pump, electron gradient, NADP synthase.
(C) Membrane, proton pump, proton gradient, ATP synthase.
(D) Membrane, proton pump, proton gradient, NADP synthase. **[NEET 2023]**

31. Which one of the following is not true regarding the release of energy during ATP synthesis through chemiosmosis? It involves:
(A) Breakdown of electron gradient.
(B) Movement of protons across the membrane to the stroma.
(C) Reduction of NADP to NADPH, on the stroma side of the membrane.
(D) Breakdown of proton gradient. **[NEET 2022]**

32. Which of the following statements is incorrect?
(A) Both ATP and NADPH + H^+ are synthesised during non-cyclic photophosphorylation.
(B) Stroma lamellae have PS I only and lack NADP reductase.
(C) Grana lamellae have both PS I and PS II.
(D) Cyclic photophosphorylation involves both PS I and PS II. **[NEET 2021]**

33. During non-cyclic photophosphorylation, when electrons are lost from the reaction centre at PS II, what is the source which replaces these electrons?
(A) Oxygen (B) Water
(C) Carbon dioxide (D) Light **[NEET Oct. 2020]**

34. Read the following four statements.
(I) Both, photophosphorylation and oxidative phosphorylation involve uphill transport of protons across the membrane.
(II) In dicot stems, a new cambium originates from cells of pericycle at the time of secondary growth.
(III) Stamens in flowers of *Gloriosa* and *Petunia* are polyandrous.
(IV) Symbiotic nitrogen fixers occur in free living state also in soil.
How many of the above statements are right?
(A) Two (B) Three
(C) Four (D) One **[AIPMT Mains 2012]**

35. Read the following four statements I, II, III and IV and select the right option having both correct statements.
(I) Z scheme of light reaction takes place in the presence of PS I only.
(II) Only PS I is functional in cyclic photophosphorylation.
(III) Cyclic photophosphorylation results into synthesis of ATP and $NADPH_2$.
(IV) Stroma lamellae lack PS II as well as NADP.
Options:
(A) (II) and (IV) (B) (I) and (II)
(C) (II) and (III) (D) (III) and (IV) **[AIPMT Mains 2010]**

36. Cyclic-photophosphorylation results in the formation of:
(A) NADPH
(B) ATP and NADPH
(C) ATP, NADPH and O_2
(D) ATP **[AIPMT Screening 2009]**

37. The first step of photosynthesis is:
(A) excitation of electron of chlorophyll by photon of light
(B) formation of ATP
(C) attachment of CO_2 to 5 carbon sugar
(D) ionisation of water **[AIPMT 2000]**

38. Photochemical reactions in the chloroplast are directly involved in:
(A) formation of phosphoglyceric acid
(B) fixation of carbon dioxide
(C) synthesis of glucose and starch
(D) photolysis of water and phosphorylation of ADP to ATP. **[AIPMT 2000]**

39. Which one of the following statements about cytochrome P_{450} is wrong?
(A) It contains iron.
(B) It is an enzyme involved in oxidation reaction.
(C) It is a coloured cell.
(D) It has an important role in metabolism. **[AIPMT 1998]**

40. NADPH is generated through:
(A) photosystem I (B) photosystem II
(C) anerobic respiration (D) glycolysis **[AIPMT 1997]**

41. Pigment acting as a reaction centre during photosynthesis is:
(A) carotene (B) phytochrome
(C) P_{700} (D) cytochrome **[AIPMT 1994]**

42. A photosynthesising plant is releasing 18O more than the normal. The plant must have been supplied with:
(A) O_3 (B) H_2O with 18O
(C) CO_2 with 18O (D) $C_6H_{12}O_6$ with 18O **[AIPMT 1993]**

43. Photosystem II occurs in:
(A) stroma (B) cytochrome
(C) grana thylakoids (D) mitochondrial surface **[AIPMT 1992]**

44. Formation of ATP in photosynthesis and respiration is an oxidation process which utilises the energy from:

(A) cytochromes (B) ferredoxin

(C) electrons (D) carbon dioxide

[AIPMT 1992]

45. Ferredoxin is a constituent of:

(A) PS I (B) PS II

(C) Hill reaction (D) P_{680} **[AIPMT 1991]**

11.7. Where are the ATP and NADPH Used?

46. Which one of the following products diffuses out on chloroplast during photosynthesis?

(A) ADP (B) NADPH

(C) O_2 (D) ATP **[Re-NEET 2024]**

47. How many molecules of ATP and NADPH required for every molecule of CO_2 fixed in the Calvin cycle?

(A) 2 molecules of ATP and 2 molecules NADPH

(B) 3 molecules of ATP and 3 molecules NADPH

(C) 3 molecules of ATP and 2 molecules NADPH

(D) 2 molecules of ATP and 3 molecules NADPH

[NEET 2024]

48. Which of the following are required for the dark reaction of photosynthesis?

(I) Light (II) Chlorophyll

(III) CO_2 (IV) ATP

(V) NADPH

Choose the correct answer from the options given below:

(A) (II), (III) and (IV) only

(B) (III), (IV) and (V) only

(C) (IV) and (V) only

(D) (I), (II) and (III) only **[NEET 2024]**

49. How many ATP and $NADPH_2$ are required for the synthesis of one molecule of Glucose during Calvin cycle?

(A) 12 ATP and 16 $NADPH_2$

(B) 18 ATP and 16 $NADPH_2$

(C) 12 ATP and 12 $NADPH_2$

(D) 18 ATP and 12 $NADPH_2$ **[NEET 2023]**

50. The first stable product of CO_2 fixation in *Sorghum* is:

(A) Pyruvic acid

(B) Oxaloacetic acid

(C) Succinic acid

(D) Phosphoglyceric acid. **[NEET 2021]**

51. Which of the following statement is incorrect?

(A) RuBisCO is a bifunctional enzyme.

(B) In C_4 plants the site of RuBisCO activity is mesophyll cell.

(C) The substrate molecule for RuBisCO activity is a 5-carbon compound.

(D) RuBisCO action requires ATP and NADPH.

[NEET Oct. 2020]

52. PGA as the first CO_2 fixation product was discovered in photosynthesis of:

(A) bryophyte (B) gymnosperm

(C) angiosperm (D) algae

[AIPMT Screening 2010]

53. In C_3 plants, the first stable product of photosynthesis during the dark reaction is:

(A) malic acid

(B) oxaloacetic acid

(C) 3-phosphoglyceric acid

(D) phosphoglyceraldehyde **[AIPMT 2004]**

54. Which one of the following concerns photophosphorylation?

(A) ADP + AMP $\xrightarrow{\text{Light energy}}$ ATP

(B) ADP + Inorganic PO_4 $\xrightarrow{\text{Light energy}}$ ATP

(C) ADP + Inorganic PO_4 $\longrightarrow$ ATP

(D) AMP + Inorganic PO_4 $\xrightarrow{\text{Light energy}}$ ATP

[AIPMT 2003]

55. In photosynthesis, energy from light reaction to dark reaction is transferred in the form of:

(A) ADP (B) ATP

(C) RuBP (C) chlorophyll

[AIPMT 2002]

56. For assimilation of one CO_2 molecule, the energy required in form of ATP and $NADPH_2$ are:

(A) 2 ATP and 2 $NADPH_2$

(B) 5 ATP and 3 $NADPH_2$

(C) 3 ATP and 2 $NADPH_2$

(D) 18 ATP and 12 $NADPH_2$ **[AIPMT 2000]**

11.8. The C_4 Pathway

57. Given below are two statements:

Statement I: In C_3 plants, some O_2 binds to RuBisCO, hence CO_2 fixation is decreased.

Statement II: In C_4 plants, mesophyll cells show very little photorespiration while bundle sheath cells do not show photorespiration.

In the light of the above statements, choose the correct answer from the options given below:

(A) Both Statement I and Statement II are false.

(B) Statement I is true but Statement II is false.

(C) Statement I is false but Statement II is true.

(D) Both Statement I and Statement II are true.

[NEET 2024]

58. What is the role of large bundle sheath cell found around the vascular bundles in plants?

(A) To increase the number of chloroplast for the operation of Calvin cycle.

(B) To enable the plant to tolerate high temperature.

(C) To protect the vascular tissue from high light intensity.

(D) To provide the site for photoresiratory pathway.

[NEET 2022]

59. Given below are two statements:

Statement I: The primary CO_2 acceptor in C_4 plants is phosphoenolpyruvate and is found in the mesophyll cells.

Statement II: Mesophyll cells of C_4 plants lack RuBisCO enzyme.

In the light of the above statements, choose the correct answer from the options given below:

(A) Both Statement I and Statement II are incorrect.

(B) Statement I is correct but Statement II is incorrect.

(C) Statement I is incorrect but Statement II is correct.

(D) Both Statement I and Statement II are correct.

[NEET 2022]

60. In Hatch and Slack pathway, the primary CO_2 acceptor is:

(A) oxaloacetic acid

(B) phosphoglyceric acid

(C) phosphoenol pyruvate

(D) RuBisCO **[NEET Odisha 2019]**

61. Phosphoenol pyruvate (PEP) is the primary CO_2 acceptor in:

(A) C_3-plants (B) C_4-plants

(C) C_2-plants (D) C_3 and C_4 -plants

[NEET 2017]

62. A plant in your garden avoids photorespiratory losses, has improved water use efficiency, shows high rate of photosynthesis at high temperature and has improved efficiency of nitrogen utilisation. In which of the following physiological groups would you assign this plant?

(A) C_4 (B) CAM

(C) Nitrogen-fixer (D) C_3 **[NEET Phase-I 2016]**

63. Bundle sheath cells:

(A) are rich in PEP carboxylase

(B) lack RuBisCO

(C) lack both RuBisCO and PEP carboxylase

(D) are rich in RuBisCO **[NEET Karnataka 2013]**

64. In Kranz anatomy, the bundle sheath cells have:

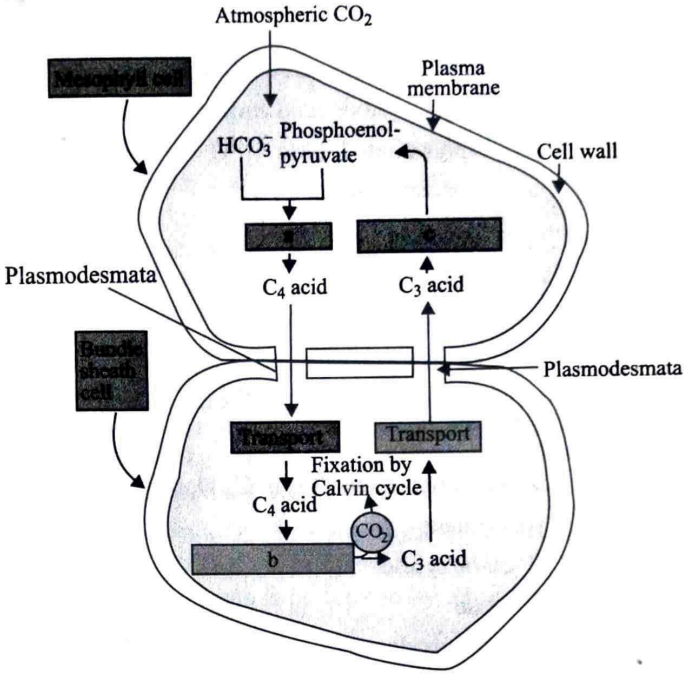
(A) thin walls, many intercellular spaces and no chloroplasts.

(B) thick walls, no intercellular spaces and large number of chloroplasts.

(C) thin walls, no intercellular spaces and several chloroplasts.

(D) thick walls, many intercellular spaces and few chloroplasts. **[AIPMT Mains 2011]**

65. Study the pathway given below:



In which of the following options, correct words for all the three blanks a, b and c are indicated?

	a	b	c
(A)	Decarboxylation	Reduction	Regeneration
(B)	Fixation	Transamination	Regeneration
(C)	Fixation	Decarboxylation	Regeneration
(D)	Carboxylation	Decarboxylation	Reduction

[AIPMT Mains 2010]

66. The C_4 plants are photosynthetically more efficient than C_3 – plants because:

(A) the CO_2 compensation point is more.

(B) CO_2 generated during photorespiration is trapped and recycled through PEP carboxylase.

(C) the CO_2 efflux is not prevented.

(D) they have more chloroplasts.

[AIPMT Screening 2008]

67. In leaves of C_4 plants malic acid synthesis during CO_2 fixation occurs in:

(A) epidermal cells (B) mesophyll cells

(C) bundle sheath (D) guard cells

[AIPMT Screening 2008, 07]

68. Photosynthesis in C_4 plants is relatively less limited by atmospheric CO_2 levels because:

(A) there is effective pumping of CO_2 into bundle sheath cells.

(B) RuBisCO in C_4 plants has higher affinity for CO_2.

(C) four carbon acids has the primary initial CO_2 fixation products.

(D) the primary fixation of CO_2 is mediated via PEP carboxylase. **[AIPMT 2005]**

69. In sugarcane plant $^{14}CO_2$ is fixed in malic acid, in which the enzyme that fixes CO_2 is:

(A) ribulose biphosphate carboxylase

(B) phosphoenol pyruvic acid carboxylase

(C) ribulose phosphate kinase

(D) fructose phosphatase **[AIPMT 2004]**

70. Which pair is wrong?

(A) C_3 – Maize

(B) C_4 – Kranz anatomy

(C) Calvin cycle – PGA

(D) Hatch and Slack Pathway – Oxaloacetic acid

[AIPMT 2003]

71. The enzyme which fixes CO_2 in C_4 plants is:

(A) Hydrogenase

(B) PEP carboxylase

(C) Reductase

(D) RuBP carboxylase **[AIPMT 2001]**

72. In C_4 plants, CO_2 fixation is done by:

(A) sclerenchyma

(B) chlorenchyma and hypodermis

(C) mesophyll cells

(D) guard cells **[AIPMT 1996]**

73. A very efficient converter of solar energy with net productivity of 2-4 kg/m^2 or more is the crop of:

(A) wheat (B) sugarcane

(C) rice (D) bajra **[AIPMT 1989]**

11.9. Photorespiration

74. The oxygenation activity of RuBisCO enzyme in photorespiration leads to the formation of:

(A) 1 molecule of 3-C compound

(B) 1 molecule of 6-C compound

(C) 1 molecule of 4-C compound and 1 molecule of 2-C compound

(D) 2 molecules of 3-C compound. **[NEET Sept. 2020]**

75. The process which makes major difference between C_3 and C_4 plants is:

(A) glycolysis

(B) Calvin cycle

(C) photorespiration

(D) respiration.

[NEET Phase-II 2016, AIPMT Screening 2012]

76. The correct sequence of cell organelles during photorespiration is:

(A) chloroplast-Golgi bodies-mitochondria

(B) chloroplast-rough endoplasmic reticulum-dictyosomes

(C) chloroplast-mitochondria-peroxisome

(D) chloroplast-vacuole-peroxisome.

[AIPMT Screening 2012]

77. During photorespiration, the oxygen consuming reaction (s) occur in:

(A) stroma of chloroplasts

(B) stroma of chloroplasts and mitochondria

(C) stroma of chloroplasts and peroxisomes

(D) grana of chloroplasts and peroxisomes.

[AIPMT 2006]

78. Which one of the following is wrong in relation to photorespiration?

(A) It occurs in chloroplast.

(B) It occurs in day time only.

(C) It is a characteristic of C_4 plants.

(D) It is a characteristic of C_3 plants. **[AIPMT 2003]**

79. The substrate for photorespiration is:

(A) Phosphoglyceric acid

(B) Glycolate

(C) Serine

(D) Glycine **[AIPMT 1989]**

11.10. Factors Affecting Photosynthesis

80. With reference to factors affecting the rate of photosynthesis, which of the following statements is not correct?

(A) Light saturation for CO_2 fixation occurs at 10% of full sunlight.

(B) Increasing atmospheric CO_2 concentration upto 0.05% can enhance CO_2 fixation rate.

(C) C_3 plants respond to higher temperature with enhanced photosynthesis, while C_4 plants have much lower temperature optimum.

(D) Tomato is a greenhouse crop, which can be grown in CO_2 enriched atmosphere for higher yield.

[NEET 2017]

81. During monsoon, the rice crop of Eastern states of India shows lesser yield due to limiting factor of:

(A) CO_2 (B) light

(C) temperature (D) water **[AIPMT 1991]**

SOLUTIONS

1. (C) Green sulphur bacteria is an anaerobic bacteria. They do not evolve oxygen during photosynthesis. Instead of using water, they use hydrogen sulphide as electron donor.

$$\underset{\text{Hydrogen sulphide}}{H_2S} \longrightarrow 2[H] + \underset{\text{Sulphur}}{S}$$

Cycas is a gymnosperm, *Nostoc* is a blue-green algae and *Chara* is a green algae. They release oxygen during photosynthesis.

Related Theory

Anaerobic phototrophs have photosynthetic pigments called bacteriochlorophylls, similar to chlorophyll found in eukaryotes. Bacteriochlorophyll a and b have wavelengths of maximum absorption at 775 nm and 790 nm, respectively. Unlike oxygenic phototrophs, anoxygenic photosynthesis only functions using either one of the two possible types of photosystem. This restricts them to cyclic electron flow; they are therefore unable to produce O_2 from the oxidisation of H_2O.

2. (A) Diffusion of gases and water have different diffusion coefficient, *i.e.*, both the processes can co-exist independently. Both processes occur all the time, in night as well as during the day.

3. (A) Anoxygenic photosynthesis is the phototrophic process where light energy is converted to ATP, without the production of oxygen, as water is not used as an electron donor. Certain bacteria, like green sulphur bacteria, phototrophic purple bacteria, phototrophic acidobacteria, and *Rhodospirillum,* show anoxygenic photosynthesis.

Related Theory

Phototrophic heliobacteria also undergo anoxygenic photosynthesis.

4. (B) *Oscillatoria* is a photosynthetic cyanobacterium. *Chromatium* is a purple sulphur non-oxygenic photosynthetic bacterium. *Rhodospirillum* and *Chlorobium* are purple non-sulphur and green-sulphur bacteria, respectively and are non-oxygenic photosynthetic.

Related Theory

Oxygenic photosynthesis is more common in plants, algae and cyanobacteria. During this process, electrons are transferred from water to carbon dioxide by light energy, to produce energy. During this transfer of electrons, carbon dioxide is reduced, while water is oxidised, and oxygen is produced along with carbohydrates. During this process, plants take in carbon dioxide and expel oxygen into the atmosphere.

5. (B) Chemotrophs are organisms that obtain energy by the oxidation of reduced compounds. Chemoautotrophs use inorganic energy sources and are known as chemolithoautotrophs or lithoautotrophs.

Related Theory

Chemolithoheterotrophs or lithotrophs *are a special kind of chemotrophs that use inorganic compounds as an energy source and reduced organic compounds as a carbon source. Chemotrophs use fermentation and respiration to obtain energy.*

6. (A) Protochlorophyll lacks two hydrogens at the 7^{th} and 8^{th} positions at the porphyrin part of the pyrrole ring. It is an oxidation product of chlorophyll a. In the presence of light, it is reduced and esterified with phytol group to produce chlorophyll in the presence of enzyme chlorophyllase.

7. (C) Chlorophyll traps the light, it absorbs all the constituent colours present in the white light except for the green colour. The green colour is reflected in the atmosphere, due to this reason, the leaves of the plants appear green in colour.

8. (B) About 80 to 90 % of photosynthesis is carried out by aquatic plants specially the algae. Only 10% of total photosynthesis is performed by terrestrial plants.

Related Theory

Like terrestrial plants, phytoplanktons have chlorophyll to capture sunlight, and they use photosynthesis to turn it into chemical energy. They consume carbon dioxide, and release oxygen. All phytoplanktons photosynthesise, but some get additional energy by consuming other organisms.

9. (D) All plastids have the same structure because they can modify into another type of plastid depending upon the requirements of the cell.

10. (A) Emerson performed photosynthetic experiment on *Chlorella*. He provided monochromatic light of more than 680 nm and observed decrease in the rate of photosynthesis as red drop. Later, he provided synchronised light of 680 nm and 700 nm and observed the increase in the rate of photosynthesis. This effect is known as enhancement effect. This led to the discovery of PS I and PS II photosystem in plants.

11. (A) During photosynthesis, photolysis of water occurs in the lumen of thylakoids, resulting in increase in H^+ ions or protons. These potons are pumped into the stroma and the NADP reductase activity occurs. Hence, the highest number of protons are found in the lumen of thylakoids.

12. (D) The light independent reactions (or dark reactions) occur in stroma of the chloroplast, while the light reactions take place in the thylakoid discs. Photosystems are the functional units for photosynthesis found in the thylakoid membranes. It helps in the absorption and transfer of light energy by the transfer of electrons.

Related Theory

NADH are used in catabolic pathways (i.e., respiration), while NADPH are used in anabolic pathways (i.e., photosynthesis).

13. (A) In higher plants, enzymes for light independent reactions (dark reactions) are present in the stroma of chloroplasts. Light dependent reaction enzymes occur in the grana of chloroplasts. Ribosomes are involved in protein synthesis. Chlorophyll is a green photosynthetic pigment found in chloroplasts.

Related Theory

During this transfer of electrons, carbon dioxide is reduced, while water is oxidised, and oxygen is produced along with carbohydrates. During this process, plants take in carbon dioxide and expel oxygen into the atmosphere.

14. (C) The green pigment chlorophyll is located within the thylakoid membrane in the grana. The space between the thylakoid and the chloroplast membranes is called the stroma.

15. (C) The structure of chlorophyll-a looks like a tadpole. It has a porphyrin head and a phytol tail. The size of porphyrin head is 15×15Å. It is hydrophilic and acidic in nature. The size of phytol tail is 20Å long. It is hydrophobic and alcoholic in nature. The tail remains embedded in the lipid bilayer of thylakoid membrane.

16. (D) Anthocyanins are pigments that dissolve in water. These can be found in vacuoles. Depending on the pH, these can be of different colours, like red, blue, or purple.

17. (A) Chromatophores, found in some forms of photosynthetic bacteria, contain bacteriochlorophyll pigments and carotenoids. The pigments of chromatophores take part in the process of photosynthesis.

18. (C) Cyanobacteria have chromatophores, a unique compartment in their cytoplasm. It includes a variety of photosynthetic pigments required for photosynthesis. Chlorophyll a, carotenes, and xanthophylls are some these pigments.

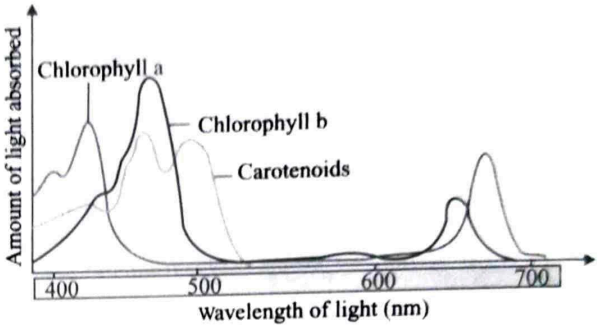
19. (A) Phytochrome occurs in leaves and is responsible for photoperiodic responses. When P_r absorbs red light (660–685 nm), it is converted to the P_{fr} form and when P_{fr} absorbs far red light (730–735 nm), it is converted to the P_r form. The P_{fr} form of pigment gradually changes into P_r form in dark.

$$P_r \underset{740\ nm}{\overset{660\ nm}{\rightleftharpoons}} P_{fr}$$

20. (D) The pigments of the chloroplasts are broadly classified into two types: Chlorophylls and carotenoids. As these pigments are involved in the process of photosynthesis, they are also known as photosynthetic pigments. The action spectrum shows that the maximum photosynthesis occurs in the blue-violet and red parts of the light.

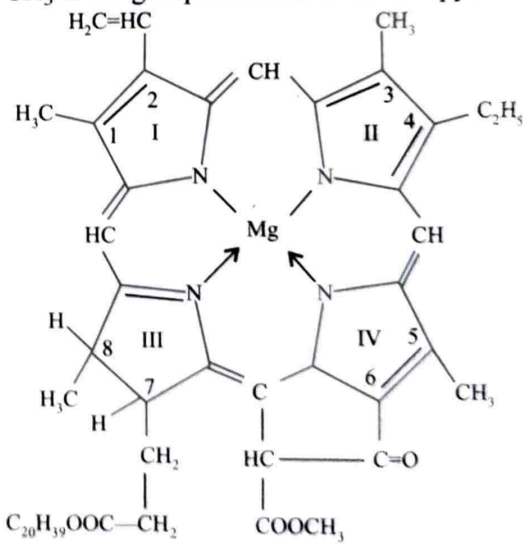
Related Theory

The absorption spectra of chlorophyll a and b show that maximum light is absorbed by chlorophyll pigments in the blue-violet and red wavelengths. The absorption spectra of chlorophyll a and b are different. Chlorophyll b has an absorption spectrum shifted towards the green wavelengths. Therefore, chlorophyll b can absorb photons that chlorophyll a cannot, greatly increasing the proportion of the photons that plants can harvest, during photosynthesis.



21. (C) A light-sensitive pigment found in some bacteria, fungi, and plants is called phytochrome. There are two interchangeable variants of it: P_r and P_{fr}. P_{fr} reflects far red light with a wavelength of 730 nm. It transforms back into its native state, P_r when it absorbs far red light.

22. (B) CH_3 is the group attachted to the 2nd pyrrole ring.



23. (A) Photosynthetic or chloroplasts pigments that are found in the thylakoid membrane absorb light of specific wavelengths in the visible region like, chlorophyll a and b, carotenoids and xanthophylls.

24. (B) For the light reaction of photosynthesis the required raw materials are water, light, and chlorophyll. CO_2 is used during the 2nd stage of photosynthesis *i.e.*, dark reaction.

25. (C) The reaction center in Photosystem II (PS II) has an absorption maxima at 680 nm. This is the wavelength of light that is most efficiently absorbed by the chlorophyll pigments in the reaction center of PS II.

During photosynthesis, the absorbed light energy is used to drive the transfer of electrons from water to plastoquinone (PQ), which is the first step in the light-dependent reactions of photosynthesis. The oxygen produced in this process is a byproduct of water splitting and is released into the atmosphere.

Caution

Students might get confused with option (C) and (D). In PS I, the reaction centre has an absorption peak at 700 nm, and hence, is called P700, while in PS II, reaction centre has an absorption peak at 680 nm and is called P680.

26. (D) In light reaction, plastoquinone facilitates the transfer of electrons from PS II to cytochrome b_6f complex and reduces to plastocyanin. Non-cyclic photophosphorylation process of light reaction starts with PS II (680 nm). When sunlight falls on the reaction centre (chlorophyll a), it absorbs wavelength of 680 nm (red light) causing excitation of electron. The excited electrons are picked up by electron acceptor, which passes them to electron transport system containing $Cytb_6F$ omplex.

27. (B) During light reaction of photosynthesis, NADPH, ATP and oxygen are formed. NADH is formed during respiration.

Related Theory

In plants, the light reaction takes place in the thylakoid membrane of chloroplast. The ATP and NADPH from the light-dependent reactions are used to make sugars in the Calvin cycle. In another form of the light reaction, called cyclic photophosphorylation, electrons follow a different circular path and only ATP (no NADPH) is produced. The transfer of electrons from PS II to PS I, and from PS I to NADPH, are energy-releasing, and thus, spontaneous because electrons in P_{680} and P_{700} are boosted to very high energy levels by absorption of energy from light.

Caution

Students might get confused between NADH and NADPH most of the time. They must understand that NADH is mainly involved in catabolic reactions, whereas NADPH is involved in anabolic reactions. NADH takes part in respiration by accepting and donating electrons, with the energy flowing from the cellular citric acid cycle. On the other hand, NADPH is involved in the synthesis of carbohydrates in Calvin cycle during photosynthesis.

28. (C) Electrons from excited chlorophyll molecule of photosystem II are accepted first by quinone. Photosystem II is a photosynthetic pigment system along with some electron carriers that is located in the appressed part of the grana thylakoids. Photosystem II has chlorophyll a, b and carotenoids. Other components of PS II are phaeophytin, plastoquinone (PQ), cytochrome complex and blue coloured copper containing plastocyanin.

Caution

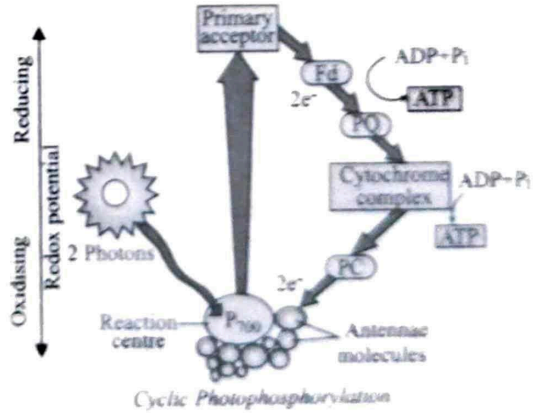
Students should remember that the first electron acceptor in the case of photosystem I is cytochrome.

29. (A) In photosystem I, the primary electron acceptor is probably a Fe–S protein. The reduced primary acceptor transfers the electrons to the secondary electron acceptor P_{430}. The reduced P_{430} passes its electrons to ferredoxin (Fd) present at the outer surface of the thylakoid membrane.

30. (C) In chemiosmosis, ATP is synthesised by the enzyme ATP synthase using the energy of a proton gradient across a membrane. This proton gradient is established by the action of a proton pump, which pumps protons across the membrane, creating a proton concentration gradient and a charge imbalance across the membrane. The membrane can be the inner mitochondrial membrane or the thylakoid membrane in chloroplasts. The proton gradient generated by the proton pump is used by the ATP synthase to power the synthesis of ATP.

31. (A) Chemiosmosis is the passage of ions down their concentration gradients through a semipermeable membrane bound structure. It involves the production of adenosine triphosphate (ATP), as a result of the passage of hydrogen ions (H^+) across a membrane throughout photosynthesis or cellular respiration. So, it does not involves the breakdown of electron gradient.

32. (D) In cyclic photophosphorylation, the high energy electron is free from P_{700} to PS I flow down to a cyclic pathway. While in non-cyclic photo-phosphorylation, $NADP^+$ does not take the electrons; they are instead sent back to cytochrome b_6f complex.



Cyclic Photophosphorylation

Caution

Students should remember that photophosphorylation happens on the stroma lamellae or frets.

33. (B) During non-cyclic photophosphorylation, electrons expelled by the excited PS II photocentre does

not return to it. Therefore, it requires an external electron donor and that purpose is served by water. H_2O undergo photolysis and the electrons thus released are picked up by PS II (P_{680}) and handed to PS I (P_{700}).

34. (A) Polyandrous is a condition having large and indefinite number of stamens found in *Gloriosa* (family Liliaceae) and *Petunia* (family Solanaceae). Biological nitrogen fixation is performed by both free living and symbiotic bacteria. Symbiotic nitrogen fixers occur in association with roots of higher plants. For *e.g.*, *Rhizobium* and *Frankia*. Both *Rhizobium* and *Frankia* live freely as aerobes in the soil and develop the ability to fix nitrogen only as symbionts when they become anaerobic.

35. (A) Cyclic photophosphorylation involves the use of only one photosystem (PS I) and does not involve the reduction of $NADP^+$. When light is absorbed by Photosystem I, the excited electron may enter into an electron transport chain to produce ATP. Following this, the de-energised electron returns to the photosystem, restoring its electron supply (hence, cyclic). As the electron returns to the photosystem, $NADP^+$ is not reduced and water is not needed to replenish the electron supply. Stroma lamellae contains PS-I only. Three major protein complexes involved in Z scheme are:

(1) Photosystem II

(2) Cytochrome b_6 f complex (containing Cyt b_6; FeS; and Cyt f)

(3) Photosystem I.

36. (D) During cyclic photophosphorylation, the electrons are transferred back to P_{700} instead of moving into the NADP from the electron acceptor. This downward movement of electrons from an acceptor to P_{700} results in the formation of ATP molecules. In this process, plant cells just accomplish the ADP to ATP for immediate energy for the cells. This process usually takes place in the thylakoid membrane and uses Photosystem I and the chlorophyll P_{700}.

37. (A) The first step in photosynthesis is the photo excitation of chlorophyll by a photon of light.

38. (D) Chloroplasts contain light trapping chlorophyll molecules. The chlorophyll molecules are an essential requirement for light reaction. The light energy is trapped by chlorophyll molecules for carrying out photolysis of water, *i.e.*, light dependent splitting of water, molecules.

39. (C) A group of protein having heme metallic prosthetic group is called cytochrome. Cytochrome P_{450} is a colourless cell.

40. (A) NADPH is the reduced form of $NADP^+$ that is generally produced during the process of non-cyclic phosphorylation by photosystem I (PS I).

41. (C) The single chlorophyll a forms reaction centre and is different for both photosystems. In PS I the reaction centre has an absorption peak at 700 nm, and hence, is called P_{700} and for PS II, it is 680 nm and is called P_{680}.

42. (B) Water has 18 O and thus, the presence of 18 O is an amount greater than normal. It was found much later that oxygen involved in the process of photosynthesis comes from H_2O and there is no need of CO_2.

43. (C) The initial protein complex in the light-dependent processes of oxygenic photosynthesis is called Photosystem II. It is found in plants, algae, and cyanobacteria's grana of the thylakoid membrane.

44. (C) After losing an electron in the reaction center's electron transport pathway, the expelled electron undergoes a series of carriers. where it loses enough energy to produce ATP from ADP and inorganic phosphate, as well as during aerobic respiration.

45. (A) Ferredoxin is a soluble protein, which acts as an electron carrier and forms a constituent of PS I. Ferredoxin passes electrons to reductase complex, which helps in reducing $NADP^+$ to NADPH.

46. (C) ATP, NADPH and O_2 are product of light reaction, out of these Oxygen diffuses out of the chloroplast while ATP and NADPH are used to operate the processes which lead to the synthesis of sugars.

47. (C) In the Calvin cycle, for every molecule of CO_2 that is fixed, it requires 3 ATP and 2 NADPH. During the reduction phase, it involves utilisation of 2 ATP for phosphorylation and 2 NADPH for reduction per CO_2 molecule fixed. During the regeneration phase, 1 ATP for phosphorylation to form RuBP is required.

Caution

Students should remember that the Calvin cycle must run six times to produce one glucose molecule. This means that the cycle uses 18 ATP and 12 NADPH in total to produce one glucose molecule. Some students forget this and calculate the energy requirement for only one turn of the cycle.

48. (B) Besides CO_2 and H_2O, the products of the light reaction, *i.e.*, ATP and NADPH, are required for the dark reaction or biosynthetic phase of photosynthesis. This process does not directly depend on the presence of light.

49. (D) During the Calvin cycle, 6 molecules of CO_2 are used to synthesise one molecule of glucose. The overall reaction of the Calvin cycle can be simplified as follows:

$$6\,CO_2 + 18\,ATP + 12\,NADPH + 12\,H_2O \rightarrow C_6H_{12}O_6 + 18\,ADP + 18\,P_i + 12\,NADP + 6\,H^+$$

Therefore, it requires 18 ATP and 12 $NADPH_2$ to synthesise one molecule of glucose during the Calvin cycle.

50. (B) In CAM plants, carbon dioxide acceptor is Phosphoenol pyruvate (PEP) during the night and Ribulose bisphosphate (RuBP) is carbon dioxide acceptor during day time. In both plants, PEP carboxylase enzyme acts on carbon dioxide acceptor and forms Oxalo Acetic Acid (OAA), which is the first stable product.

51. (B) In C_4 plants, Kranz anatomy of leaf is found due to the presence of two types of cells, mesophyll cells and bundle sheath cells. The mesophyll cells are specialised to perform light reaction, form OAA, evolve O_2 and produce assimilatory energy. The bundle sheath cell possesses RuBisCO, and thus, perform the RuBisCO activity at the site.

Related Theory

RuBisCO (Ribulose-1, 5-bisphosphate carboxylase oxygenase) catalyses the carboxylation of RuBP, which is the fixation of CO_2 in the synthesis of glucose in the Calvin cycle. It also has an affinity for O_2 and shows oxygenase activity during photorespiration. It is responsible for photosynthetic carbon assimilation in catalysing the reaction of CO_2 with ribulose-1, 5-bisphosphate (RuBP) to form two molecules of 3-phosphoglyceric acid (PGA).

Caution

Students should always remember, RuBisCO activity in C_4 plants occur in bundle sheath cell, whereas in C_3, plants, it occurs in mesophyll cells.

52. (D) Calvin worked on algae *Chlorella* and *Scenedesmus* with radioactive, ^{14}C in carbon dioxide. The path of CO_2 fixation was traced when algal suspension was illuminated and photosynthesis was carried out with normal carbon dioxide supply ($^{14}CO_2$). The algae was killed at intervals in near boiling methanol. It immediately stopped photosynthesis activity due to denaturation of enzymes. Alcohol was evaporated and after crushing the algae, the product was made into paste. The paste was placed on paper chromatogram and the different compounds were separated by two-dimensional chromatography. The radioactive compounds were identified by comparing their position on the chromatogram with standard chemicals. After three seconds, radioactivity appeared in phosphoglyceric acid or PGA. Phosphoglyceric acid is, therefore, the first stable product of photosynthesis.

53. (C) The first stable product of CO_2 fixation in C_3 plants is a three-carbon organic acid. The enzyme ribulose-1, 5-bisphosphate carboxylase–oxygenase (RuBisCO) combines CO_2 with the ribulose-1, 5-bisphosphate to form two molecules of 3-phosphoglyceric acid.

Related Theory

ADP, NADP, and glucose are the end products of the C_3 cycle. ADP and NADP are produced in the first stage of C_3 cycle. In the second stage, glucose is produced

54. (B) Photophosphorylation is the process in which ATP is produced, which is called energy currency of the cell. During this process, ADP is phosphorylated to give ATP in the presence of light energy.

Related Theory

During photophosphorylation, electrons move from water through PS II, intermediate chain of carriers, through PS I, and finally to $NADP^+$ causing its reduction into $NADPH_2$ and flow of electrons through the carriers linking PS II and PS I pump protons into the thylakoid lumen.

55. (B) As a result of light reaction, oxygen, NADPH and ATP are formed. Oxygen is released into the atmosphere, while NADPH and ATP are utilised for reduction of CO_2 to carbohydrate in dark reaction.

Related Theory

In the light reactions, light energy is converted into the chemical energy of ATP, while water is broken down for its hydrogen atoms. The ATP and hydrogen atoms are fed to the dark reaction, which uses them to produce glucose sugar from carbon dioxide. Ultimately the light energy ends up in the glucose, but it does not get there easily. The light reaction trap the solar energy and transfer it to the dark reaction via ATP so that the dark reaction had the energy to make glucose. Essentially, the solar energy is being packaged into the chemical energy of glucose.

56. (C) Carbon dioxide fixation or carbon dioxide assimilation is the process by which inorganic carbon is converted to organic compounds by living organisms. Carbon dioxide fixation occurs during C_3 cycle or Calvin cycle. In order to fix one carbon dioxide molecule, plants need energy in the form of ATP and $NADPH_2$. Totally 3 ATP molecules and 2 $NADPH_2$ molecules are used for carbon dioxide fixation.

57. (B) In C_3 plants, some O_2 does bind to RuBisCO, and hence, CO_2 fixation is decreased. Here the RuBP instead of being converted to 2 molecules of PGA, binds with O_2 to form one molecule of phosphoglycerate and phosphoglycolate (2 Carbon) in a pathway called photorespiration.

In C_4 plants, photorespiration does not occur. This is because they have a mechanism that increases the concentration of CO_2 at the enzyme site.

Caution

Some students mistakenly believe that RuBisCO only binds with CO_2. RuBisCO plays a crucial role in photosynthesis, but it can also lead to photorespiration in C_3 plants when it binds with O_2.

58. (A) In C_4 plants, the bundle sheath cells contain chloroplasts and are the site of the Calvin cycle. These cells form several layers around the vascular bundles and are characterised by the presence of a large number of chloroplasts.

59. (D) Primary CO_2 acceptor, PEP is found in mesophyll cells of C_4 plants. RuBisCO enzyme is absent in mesophyll cells of C_4 plants, but present in mesophyll cells of C_3 plants.

60. (C) In Hatch and Slack pathway (or C_4 cycle), the primary CO_2 acceptor is phosphoenolpyruvate. PEP accepts CO_2 and forms oxaloacetic acid.

61. (B) Phosphoenolpyruvate is found in the mesophyll cell, which accepts atmospheric CO_2 in C_4 plants and converts it to oxaloacetic acid, the first stable compound of C_4 plants. RuBisCO is found in mesophyll cells, which are responsible for the CO_2 fixation. In C_3 plants, RuBisCO is the primary acceptor of CO_2 in the mesophyll cells and involve direct carbon fixation.

Related Theory

C_4 plant is better adapted than a C_3 plant in an environment with high daytime temperatures, intense sunlight, drought, or nitrogen or CO_2 limitation. C_4 plants have a special leaf anatomy called Kranz anatomy in which the vascular bundles are surrounded by bundle sheath cells. CO_2 is fixed in the mesophyll cells, which is then transported to the bundle sheath cells in which it is decarboxylated and the CO_2 is re-fixed via the C_3 pathway.

Caution

Students should remember that the Calvin cycle of photosynthesis is similar in both C_3 and C_4 plants.

62. (A) C_4 plants avoid photorespiration by using enzyme called PEP carboxylase during the first step of carbon fixation. This step takes place in the mesophyll cells that are located close to the stomata where carbon dioxide and oxygen enter the plant. C_3 plants show photorespiration, but only C_4 shows high rate of photosynthesis at high temperature.

Caution

In a case study type question, one should read the paragraph carefully. Most of the time, the hint to the answer lies within the paragraph only. More practice and clear concepts help in solving such questions more easily and accurately.

Mnemonics

Ramesh Fixes Mango, Delhi to Banglore

Ramesh Fixes Mango — Regeneration & Fixation occurs in Mesophyll cells

Delhi to Banglore — Decarboxylation occurs in Bundle sheath cells

63. (D) In C_4 plants with Kranz anatomy, the mesophyll is undifferentiated and its cells occur in concentric layers around vascular bundles. The vascular bundles are surrounded by several layers of specialised large sized cells called bundle sheath cells. The C_4 cycle involves two carboxylation reactions, one taking place in chloroplasts of mesophyll cells and another in chloroplasts of bundle sheath cells.

In C_4 plants, the first step of carbon dioxide fixation takes place in the chloroplasts of mesophyll cells containing PEP, while bundle sheath cells contain RuBisCO.

Related Theory

The C_4 plants consume more energy (i.e., two additional molecules of ATP) during the fixation of carbon dioxide. The mesophyll cells of the C_4 plants are closely packed, which provide smaller area for better utilisation of the available water. This also reduces the intensity of solar radiations. This makes the C_4 plants better adapted to the conditions of tropical climate. They do not show photorespiration. Thus, their photosynthetic rate is quite high.

64. (B) The C_4 plants are adapted to dry tropical regions and have greater productivity of biomass. Kranz anatomy is a specialised structure in C_4 plants where the mesophyll cells are clustered around the bundle-sheath cells in a ring-like fashion. The number of chloroplasts in the bundle-sheath cells is more than that in the mesophyll cell along with thick walls impervious to gaseous exchange and no intercellular spaces. This is found in C_4 grasses, such as maize and a few dicots.

Caution

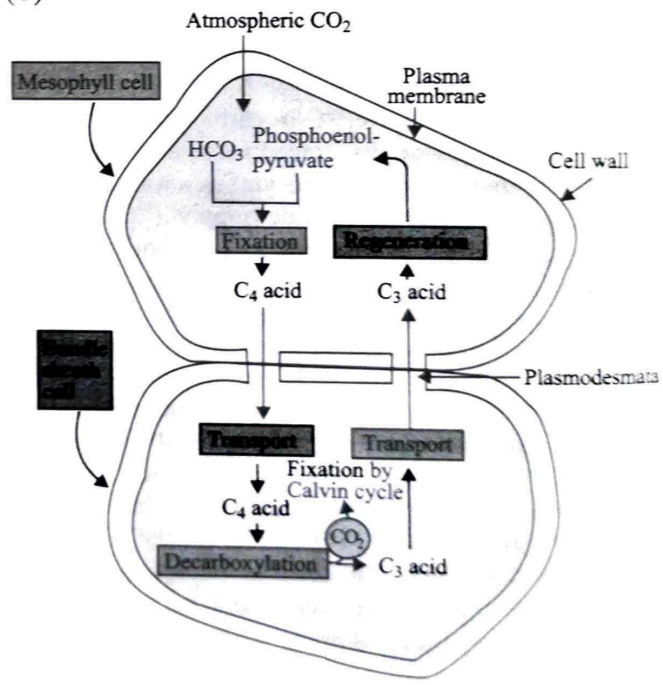
Students should know that the main differences between the C_3 and C_4 plants:

(1) The bundle sheath cells of C_3 plants do not contain chloroplast, whereas the bundle sheath cells of C_4 plants do.

(2) Carbon dioxide fixation in C_3 plants takes place only once, whereas that in C_4 plants takes twice.

(3) Kranz anatomy is only found in C_4 plants, not C_3.

65. (C)



C_4 Pathway or Hatch and Slack Pathway

66. (D) C_4 plant contain two types of chloroplasts, *i.e.*, bundle sheath chloroplasts and mesophyll chloroplasts. So, such plants operate a dicarboxylic acid cycle in addition to Calvin cycle. CO_2 acceptor molecule is PEP present in large bundle sheath cells, which have higher efficiency in picking up CO_2. Thus, photosynthesis continues even at low CO_2 concentration and the rate of photorespiration is also negligible. C_4 plants have very low CO_2 compensation point.

67. (B) C_4 plants show Kranz anatomy. C_4 pathway involves two carboxylation reaction. The initial fixation occurs in mesophyll cells, where primary CO_2 acceptor is phosphoenolpyruvate and forms oxaloacetate. The oxaloacetate is reduced to malic acid. From chloroplasts of mesophyll cells, the malic acid is transferred to chloroplast of bundle sheath cells and decarboxylated to form pyruvic acid. The CO_2 is again fixed by C_3 cycle.

Caution

Students should always remember that, RuBisCO activity in C_4 plants occur in bundle sheath cell, in C_3, plants, it occurs in mesophyll cells.

68. (D) In C_4 plants, initial fixation of carbon dioxide occurs in mesophyll cells. The primary acceptor of CO_2 is phosphoenolpyruvate or PEP. It combines with carbon dioxide in the presence of PEP carboxylase or PEPcase to form oxaloacetate. C_4 plants are more efficient in picking up CO_2 even when it is found in low concentration because of the high affinity of PEPcase.

69. (B) In C_4 plant, in chloroplasts of mesophyll cells PEP carboxylase is the key enzyme used in carbon fixation. Due to this enzyme PEP and CO_2 is converted into oxaloacetic acid.

$$CO_2 + PEP \xrightarrow[\text{(Mesophyll cells of } C_4\text{-plant)}]{\text{PEP carboxylase}} \text{Oxaloacetic acid} \xrightarrow[\text{genase}]{\text{Dehydro-}} \text{NADPH}$$

Malic acid + $NADP^+$

70. (A) Maize is a C_4 plant adopting Kranz anatomy.

71. (B) PEP carboxylase fixes CO_2 in C_4 plants in mesophyll cells, while in C_3 plants, this work is done by RuBisCO.

72. (C) The C_4 plants have a special leaf anatomy called Kranz anatomy. In these plants, two types of chloroplasts are present - bundle sheath chloroplasts and mesophyll chloroplasts. In C_4 plants, there are two carboxylation reactions which occur first in mesophyll chloroplasts and then in bundle sheath chloroplasts.

73. (B) As C_3 plants experience photorespiration, C_4 plants are more productive. The Kranz anatomy aids in C_4 metabolism, preventing energy loss from photorespiration. A C_4 plant is sugarcane. Therefore, it is more productive.

74. (A) Oxygenation activity of RuBisCO enzyme in photorespiration leads to the formation of 1 molecule of 3 carbon compound, *i.e.*, phosphoglycerate. This reaction occurs at high concentration of oxygen and temperature.

Related Theory

Photorespiration is the light dependent utilisation of oxygen and release of carbon dioxide by the photosynthetic organs of a plant.

75. (C) Photorespiration is a process, which involves loss of fixed carbon as CO_2 in plants in the presence of light. It is also known as C_2 cycle. It is initiated in chloroplasts, but it occurs in peroxisomes. Photorespiration occurs usually when there is a high concentration of oxygen. The rate of photorespiration is higher in C_3 than C_4 plants.

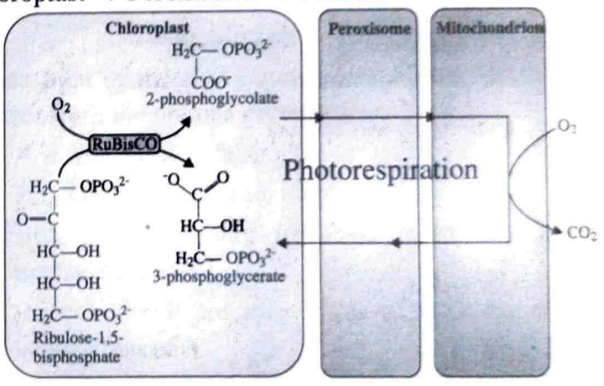
Related Theory

Photorespiration is the process of light-dependent uptake of oxygen concomitant with release of carbon dioxide (CO_2) from organic compounds. It resembles respiration and is the reverse of photosynthesis, where CO_2 is fixed and O_2 is released. It reduces the efficiency of photosynthesis because the carbon is oxidised and hence, it is less available to be fixed during photosynthesis. Also, it is now necessary to resynthesise the ribulose bisphosphate and to reduce the phosphoglycolate.

76. (None of the option is correct).

Photorespiration occurs as:

Chloroplast → Peroxisome → Mitochondria



Photorespiration

77. (C) The first reaction of photorespiration occurs in the stroma of chloroplasts. In this reaction, RuBisCO in the presence of oxygen, shows oxygenase activity. In peroxisomes, the glycolate transferred from chloroplasts takes up O_2 and forms the glyoxylate, whereas H_2O_2 is released as a by-product.

78. (C) Photorespiration is seen in C_3 cycle. The process of photorespiration is also known as Photosynthetic Carbon Oxidation (PCO) cycle and involves three organelles: Chloroplasts, peroxisomes and mitochondria.

79. (B) Photorespiration is a type of respiration that takes place in the presence of light between three organelles- chloroplasts, peroxisomes, and mitochondria. It occurs when the concentration of carbon dioxide (CO_2) is low and the concentration of oxygen (O_2) is high in C_3 plants. During photorespiration, RuBisCO reacts with

oxygen instead of carbon dioxide to ribulose 1,5 bisphosphate to produce phosphoglycolate as the first product. The phosphoglycolate is dephosphorylated to generate glycolate, which is the actual substrate of photorespiration.

80. (C) At high temperature and light, oxygen has a higher affinity for the enzyme RuBisCO. Oxygen binds to RuBisCO instead of carbon dioxide, and thus, reduces C_3 plant photosynthetic efficiency and water use efficiency. Thus, in environments with high temperature and light, C_4 plants show initial carbon fixation in mesophyll cells where PEP, combines with carbon dioxide to form OAA around the RuBisCO enzyme in bundle sheath cells, which is further processed significantly improving the plants photosynthetic and water use efficiency. As a result in high light and temperature environment, C_4 plants tend to be more productive than C_3 plants.

81. (B) During monsoon season, the cloudy day condition decreases the light intensity for the plants due to which the photosynthetic yield decreases. Limiting factor is the factor that can affect the rate of photosynthesis when other factors are constant. Therefore, the limiting factor is light.

Related Theory

➥ *Rate of photosynthetic yield is dependent on light intensity. Maximum rate of photosynthesis occur when light is brightest.*