CHAPTER 13

Photosynthesis in Higher Plants

13.2 Early Experiments

1. One scientist cultured *Cladophora* in a suspension of *Azotobacter* and illuminated the culture by splitting light through a prism. He observed that bacteria accumulated mainly in the region of
   (a) violet and green light
   (b) indigo and green light
   (c) orange and yellow light
   (d) blue and red light. *(Odisha NEET 2019)*

2. Oxygen is not produced during photosynthesis by
   (a) Green sulphur bacteria
   (b) *Nostoc*
   (c) *Cycas*
   (d) *Chara.* *(NEET 2018)*

3. Anoxygenic photosynthesis is characteristic of
   (a) *Rhodospirillum* (b) *Spirogyra*
   (c) *Chlamydomonas* (d) *Ulva.* *(2014)*

4. Oxygenic photosynthesis occurs in
   (a) *Oscillatoria* (b) *Rhodospirillum*
   (c) *Chlorobium* (d) *Chromatium.* *(2009)*

13.3 Where does Photosynthesis Take Place?

5. Stroma in the chloroplasts of higher plant contains
   (a) light-dependent reaction enzymes
   (b) ribosomes (c) chlorophyll
   (d) light-independent reaction enzymes. *(2009)*

13.4 How Many Types of Pigments are Involved in Photosynthesis?

6. Emerson's enhancement effect and Red drop have been instrumental in the discovery of
   (a) photophosphorylation and cyclic electron transport
   (b) oxidative phosphorylation
   (c) photophosphorylation and non-cyclic electron transport
   (d) two photosystems operating simultaneously.
   (NEET-I 2016)

7. Chromatophores take part in
   (a) movement (b) respiration
   (c) photosynthesis (d) growth. *(2015)*

8. 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 *(2003)*

9. Which element is located at the centre of the porphyrin ring in chlorophyll?
   (a) Calcium (b) Magnesium
   (c) Potassium (d) Manganese *(2003)*

10. Chlorophyll *a* molecule at its carbon atom 3 of the pyrrole ring II has one of the following
    (a) carboxylic group (b) magnesium
    (c) aldehyde group (d) methyl group. *(1997)*

11. The core metal of chlorophyll is
    (a) Ni (b) Cu
    (c) Fe (d) Mg. *(1997)*

12. Chlorophyll *a* occurs in
    (a) all photosynthetic autotrophs
    (b) in all higher plants
    (c) all oxygen liberating autotrophs
    (d) all plants except fungi. (1992)

13. Photosynthetic pigments found in the chloroplasts occur in
    (a) thylakoid membranes
    (b) plastoglobules
    (c) matrix
    (d) chloroplast envelope. *(1991)*

14. The size of chlorophyll molecule is
    (a) head 15 × 15 Å, tail 25 Å
    (b) head 20 × 20 Å, tail 25 Å
    (c) head 15 × 15 Å, tail 20 Å
    (d) head 10 × 12 Å, tail 25 Å. *(1989)*

13.5 What is Light Reaction?

15. Which of the following is not a product of light reaction of photosynthesis?
(a) ATP (b) NADH
(c) NADPH (d) Oxygen *(NEET 2018)*

16. Which of the following absorb light energy for photosynthesis?
(a) Chlorophyll (b) Water molecule
(c) O_2 (d) RuBP *(2002)*

17. The first step for initiation of photosynthesis will be
(a) photolysis of water
(b) excitement of chlorophyll molecules due to absorption of light
(c) ATP formation
(d) glucose formation. *(2000)*

18. $NADPH_2$ is generated through
(a) photosystem II (b) anaerobic respiration
(c) glycolysis (d) photosystem I. *(1997)*

19. Which of the following pigments acts as a reaction-centre during photosynthesis?
(a) Carotene (b) Phytochrome
(c) P_{700} (d) Cytochrome *(1994)*

20. Ferredoxin is a constituent of
(a) PS I (b) PS II
(c) Hill reaction (d) P_{680}. *(1991)*

13.6 The Electron Transport

21. In light reaction, plastoquinone facilitates the transfer of electrons from
(a) PS-II to Cytb_6f complex
(b) Cytb_6f complex to PS-I
(c) PS-I to $NADP^+$
(d) PS-I to ATP synthase. *(NEET 2020)*

22. In a chloroplast the highest number of protons are found in
(a) intermembrane space
(b) antennae complex
(c) stroma
(d) lumen of thylakoids. *(NEET-I 2016)*

23. Read the following four statements (A – D).
(A) Both photophosphorylation and oxidative phosphorylation involve uphill transport of protons across the membrane.
(B) In dicot stems, a new cambium originates from cells of pericycle at the time of secondary growth.
(C) Stamens in flowers of *Gloriosa* and *Petunia* are polyandrous.
(D) 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 *(Mains 2012)*

24. Which one of the following is essential for photolysis of water?
(a) Manganese (b) Zinc
(c) Copper (d) Boron *(Mains 2011)*

25. Read the following four statements, (i), (ii), (iii) and (iv) and select the right option having both correct statements.
Statements :
(i) Z scheme of light reaction takes place in presence of PSI only.
(ii) Only PSI is functional in cyclic photophosphorylation.
(iii) Cyclic photophosphorylation results into synthesis of ATP and $NADPH_2$.
(iv) Stroma lamellae lack PSII as well as NADP.
(a) (ii) and (iv) (b) (i) and (ii)
(c) (ii) and (iii) (d) (iii) and (iv)
(Mains 2010)

26. Cyclic photophosphorylation results in the formation of
(a) ATP and NADPH (b) ATP, NADPH and O_2
(c) ATP (d) NADPH. *(2009)*

27. Electrons from excited chlorophyll molecule of photosystem II are accepted first by
(a) quinone (b) ferredoxin
(c) cytochrome-*b* (d) cytochrome-*f*. *(2008)*

28. The first acceptor of electrons from an excited chlorophyll molecule of photosystem II is
(a) iron-sulphur protein (b) ferredoxin
(c) quinone (d) cytochrome. *(2007)*

29. In photosystem I, the first electron acceptor is
(a) an iron-sulphur protein
(b) ferredoxin
(c) cytochrome
(d) plastocyanin. *(2006)*

30. Which one of the following concerns photophosphorylation ?
(a) $ADP + AMP \xrightarrow{\text{Light energy}} ATP$
(b) $ADP + \text{Inorganic } PO_4 \xrightarrow{\text{Light energy}} ATP$
(c) $ADP + \text{Inorganic } PO_4 \longrightarrow ATP$
(d) $AMP + \text{Inorganic } PO_4 \xrightarrow{\text{Light energy}} ATP$ *(2003)*

31. In photosynthesis energy from light reaction to dark reaction is transferred in the form of
(a) ADP (b) ATP
(c) RuDP (d) chlorophyll. *(2002)*

32. Which pigment system is inactivated in red drop?
(a) PS-I and PS-II (b) PS-I
(c) PS-II (d) None of these
(2001)

33. During light reaction of photosynthesis, which of the following phenomenon is observed during cyclic phosphorylation as well as non-cyclic phosphorylation?
(a) Release of O_2
(b) Formation of ATP
(c) Formation of NADPH
(d) Involvement of PS I and PS II pigment systems
(1994)

34. A photosynthesising plant is releasing ^{18}O more than the normal. The plant must have been supplied with
(a) O_3 (b) H_2O with ^{18}O
(c) CO_2 with ^{18}O (d) $C_6H_{12}O_6$ with ^{18}O.
(1993)

35. Photosystem II occurs in
(a) stroma (b) cytochrome
(c) grana
(d) mitochondrial surface. *(1992)*

36. $NADP^+$ is reduced to NADPH in
(a) PS I (b) PS II
(c) Calvin cycle
(d) noncyclic photophosphorylation. *(1988)*

13.7 Where are the ATP and NADPH Used?

37. In photosynthesis, the light-independent reactions take place at
(a) photosystem II (b) stromal matrix
(c) thylakoid lumen (d) photosystem I. *(2015)*

38. Which one of the following organisms is correctly matched with its three characteristics?
(a) Pea: C_3 pathway, endospermic seed, vexillary aestivation
(b) Tomato: twisted aestivation, axile placentation, berry
(c) Onion: bulb, imbricate aestivation, axile placentation
(d) Maize: C_3 pathway, closed vascular bundles, scutellum *(Mains 2012)*

39. PGA as the first CO_2 fixation product was discovered in photosynthesis of
(a) bryophyte (b) gymnosperm
(c) angiosperm (d) alga. *(2010)*

40. The chemiosmotic coupling hypothesis of oxidative phosphorylation proposes that adenosine triphosphate (ATP) is formed because
(a) a proton gradient forms across the inner membrane
(b) there is a change in the permeability of the inner mitochondrial membrane toward adenosine diphosphate (ADP)
(c) high energy bonds are formed in mitochondrial proteins
(d) ADP is pumped out of the matrix into the intermembrane space. *(2008)*

41. Chemiosmotic theory of ATP synthesis in the chloroplasts and mitochondria is based on
(a) membrane potential
(b) accumulation of Na^+ ions
(c) accumulation of K^+ ions
(d) proton gradient. *(2005)*

42. 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. *(2004)*

43. 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 $NADPH_2$. *(2000)*

44. For the synthesis of one glucose molecule the Calvin cycle operates for
(a) 2 times (b) 4 times
(c) 6 times (d) 8 times. *(2000)*

45. Carbon dioxide acceptor in C_3-plants is
(a) PGA (b) PEP
(c) RuDP (d) none of these. *(1999)*

46. The mechanism of ATP formation both in chloroplast and mitochondria is explained by
(a) chemiosmotic theory
(b) Munch's hypothesis (mass flow model)
(c) relay pump theory of Godlewski
(d) Cholodny-Wont's model. *(1997)*

47. What will be the number of Calvin cycles to generate one molecule of hexose?
(a) 8 (b) 9
(c) 4 (d) 6 *(1996)*

48. The primary acceptor, during CO_2 fixation in C_3 plants, is
(a) phosphoenolpyruvate (PEP)
(b) ribulose 1, 5-diphosphate (RuDP)
(c) phosphoglyceric acid (PGA)
(d) ribulose monophosphate (RMP). *(1995)*

49. The carbon dioxide acceptor in Calvin cycle/ C_3-plants is
(a) phosphoenol pyruvate (PEP)
(b) ribulose 1, 5-diphosphate (RuDP)
(c) phosphoglyceric acid (PGA)
(d) ribulose monophosphate (RMP). *(1993)*

50. Which technique has helped in investigation of Calvin cycle?
(a) X-ray crystallography
(b) X-ray technique
(c) Radioactive isotope technique
(d) Intermittent light *(1991)*

51. Dark reactions of photosynthesis occur in
(a) granal thylakoid membranes
(b) stromal lamella membranes
(c) stroma outside photosynthetic lamellae
(d) periplastidial space. *(1991)*

52. Carbon dioxide joins the photosynthetic pathway in
(a) PS I (b) PS II
(c) light reaction (d) dark reaction. *(1988)*

13.8 The C_4 Pathway

53. Phosphoenol pyruvate (PEP) is the primary CO_2 acceptor in
(a) C_4 plants (b) C_2 plants
(c) C_3 and C_4 plants (d) C_3 plants.
(NEET 2017)

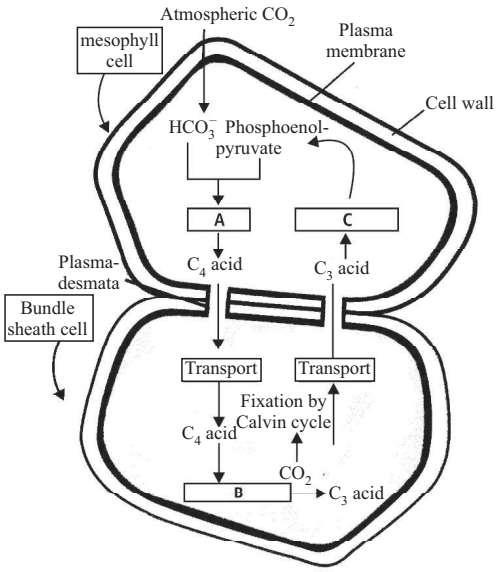
54. A plant in your garden avoids photorespiratory losses, has improved water use efficiency, shows high rates of photosynthesis at high temperatures and has improved efficiency of nitrogen utilisation. In which of the following physiological groups would you assign this plant?
(a) CAM (b) Nitrogen fixer
(c) C_3 (d) C_4 *(NEET-I 2016)*

55. Bundle sheath cells
(a) are rich in PEP carboxylase
(b) lack RuBisCO
(c) lack both RuBisCO and PEP carboxylase
(d) are rich in RuBisCO. *(Karnataka NEET 2013)*

56. CAM helps the plants in
(a) conserving water (b) secondary growth
(c) disease resistance (d) reproduction. *(2011)*

57. 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. *(Mains 2011)*

58. 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

(Mains 2010)

59. Kranz anatomy is one of the characteristics of the leaves of
(a) potato (b) wheat
(c) sugarcane (d) mustard. *(Mains 2010)*

60. The C_4 plants are photosynthetically more efficient than C_3 plants because
(a) the CO_2 efflux is not prevented
(b) they have more chloroplasts
(c) the CO_2 compensation point is more
(d) CO_2 generated during photorespiration is trapped and recycled through PEP carboxylase.
(2008)

61. In leaves of C_4 plants, malic acid synthesis during CO_2 fixation occurs in
(a) bundle sheath (b) guard cells
(c) epidermal cells (d) mesophyll cells. *(2008)*

62. In the leaves of C_4 plants, malic acid formation during CO_2 fixation occurs in the cells of
(a) bundle sheath (b) phloem
(c) epidermis (d) mesophyll. *(2007)*

63. As compared to a C_3-plant, how many additional molecules of ATP are needed for net production of one molecule of hexose sugar by C_4-plants?
(a) Two (b) Six
(c) Twelve (d) Zero *(2005)*

64. Photosynthesis in C_4 plants is relatively less limited by atmospheric CO_2 levels because
(a) 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 are the primary initial CO_2 fixation products
(d) the primary fixation of CO_2 is mediated *via* PEP carboxylase. *(2005)*

65. In sugarcane plant $^{14}CO_2$ is fixed to 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. *(2003)*

66. Stomata of CAM plants
(a) are always open
(b) open during the day and close at night
(c) open during the night and close during the day
(d) never open. *(2003)*

67. Which pair is wrong?
(a) C_3-maize (b) C_4-kranz anatomy
(c) Calvin cycle-PGA
(d) Hatch and Slack cycle - OAA *(2001)*

68. Which is the first CO_2 acceptor enzyme in C_4 plants?
(a) RuDP carboxylase (b) Phosphoric acid
(c) RuBisCO (d) PEP- carboxylase *(2000)*

69. In C_4 plants, CO_2 combines with
(a) phosphoenol pyruvate
(b) phosphoglyceraldehyde
(c) phosphoglyceric acid
(d) ribulose diphosphate. *(1996)*

70. In C_4 plants, CO_2 fixation is done by
(a) sclerenchyma
(b) chlorenchyma and hypodermis
(c) mesophyll cells
(d) guard cells. *(1996)*

71. The CO_2 fixation during C_4 pathway occurs in the chloroplast of
(a) guard cells
(b) bundle sheath cells
(c) mesophyll cells
(d) spongy parenchyma. *(1995)*

72. Which one is a C_4-plant?
(a) Papaya (b) Pea
(c) Potato (d) Maize/corn *(1993)*

73. The enzyme that catalyses carbon dioxide fixation in C_4 plants is
(a) RuBP carboxylase (b) PEP carboxylase
(c) carbonic anhydrase (d) carboxydismutase. *(1992)*

74. The first carbon dioxide acceptor in C_4-plants is
(a) phosphoenol-pyruvate
(b) ribulose 1, 5-diphosphate
(c) oxaloacetic acid
(d) phosphoglyceric acid. *(1992, 1990)*

75. Kranz anatomy is typical of
(a) C_4 plants (b) C_3 plants
(c) C_2 plants (d) CAM plants. *(1990)*

76. In C_4 plants, Calvin cycle operates in
(a) stroma of bundle sheath chloroplasts
(b) grana of bundle sheath chloroplasts
(c) grana of mesophyll chloroplasts
(d) stroma of mesophyll chloroplasts. *(1989)*

13.9 Photorespiration

77. The oxygenation activity of RuBisCO enzyme in photorespiration leads to the formation of
(a) 2 molecules of 3-C compound
(b) 1 molecule of 3-C compound
(c) 1 molecule of 6-C compound
(d) 1 molecule of 4-C compound and 1 molecule of 2-C compound *(NEET 2020)*

78. The process which makes major difference between C_3 and C_4 plants is
(a) glycolysis (b) Calvin cycle
(c) photorespiration (d) respiration. *(NEET-II 2016)*

79. A process that makes important difference between C_3 and C_4 plants is
(a) transpiration (b) glycolysis
(c) photosynthesis (d) photorespiration. *(2012)*

80. 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. *(2012)*

81. C_4 plants are more efficient in photosynthesis than C_3 plants due to
(a) higher leaf area

(b) presence of larger number of chloroplasts in the leaf cells
(c) presence of thin cuticle
(d) lower rate of photorespiration. *(2010)*

82. 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. *(2006)*

83. 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. *(2003)*

84. Photorespiration is favoured by
(a) high temperature and low O_2
(b) high humidity and temperature
(c) high O_2 and low CO_2
(d) high CO_2 and low O_2. *(1996)*

85. The substrate for photorespiration is
(a) phosphoglyceric acid
(b) glycolate
(c) serine
(d) glycine. *(1989)*

13.10 Factors Affecting Photosynthesis

86. With reference to factors affecting the rate of photosynthesis, which of the following statements is not correct?
(a) Increasing atmospheric CO_2 concentration up to 0.05% can enhance CO_2 fixation rate.
(b) C_3 plants respond to higher temperature with enhanced photosynthesis while C_4 plants have much lower temperature optimum.
(c) Tomato is a greenhouse crop which can be grown in CO_2-enriched atmosphere for higher yield.
(d) Light saturation for CO_2 fixation occurs at 10% of full sunlight.
(NEET 2017)

87. Plants adapted to low light intensity have
(a) larger photosynthetic unit size than the sun plants
(b) higher rate of CO_2 fixation than the sun plants
(c) more extended root system
(d) leaves modified to spines. *(2004)*

88. The rate of photosynthesis is higher in
(a) very high light (b) continuous light
(c) red light (d) green light.
(1999)

89. 'The law of limiting factors' was proposed by
(a) Leibig (b) Hatch and Slack
(c) Blackman (d) Arnon. *(1996)*

90. At a temperature above 35°C
(a) rate of photosynthesis will decline earlier than that of respiration
(b) rate of respiration will decline earlier than that of photosynthesis
(c) there is no fixed pattern
(d) both decline simultaneously. *(1992)*

91. 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. *(1991)*

ANSWER KEY

1.	(d)	**2.**	(a)	**3.**	(a)	**4.**	(a)	**5.**	(d)	**6.**	(d)	**7.**	(c)	**8.**	(d)	**9.**	(b)	**10.**	(d)
11.	(d)	**12.**	(c)	**13.**	(a)	**14.**	(c)	**15.**	(b)	**16.**	(a)	**17.**	(b)	**18.**	(d)	**19.**	(c)	**20.**	(a)
21.	(a)	**22.**	(d)	**23.**	(a)	**24.**	(a)	**25.**	(a)	**26.**	(c)	**27.**	(a)	**28.**	(c)	**29.**	(a)	**30.**	(b)
31.	(b)	**32.**	(c)	**33.**	(b)	**34.**	(b)	**35.**	(c)	**36.**	(d)	**37.**	(b)	**38.**	(c)	**39.**	(d)	**40.**	(a)
41.	(d)	**42.**	(c)	**43.**	(c)	**44.**	(c)	**45.**	(c)	**46.**	(a)	**47.**	(d)	**48.**	(b)	**49.**	(b)	**50.**	(c)
51.	(c)	**52.**	(d)	**53.**	(a)	**54.**	(d)	**55.**	(d)	**56.**	(a)	**57.**	(b)	**58.**	(c)	**59.**	(c)	**60.**	(b)
61.	(d)	**62.**	(d)	**63.**	(c)	**64.**	(d)	**65.**	(b)	**66.**	(c)	**67.**	(a)	**68.**	(d)	**69.**	(a)	**70.**	(c)
71.	(c)	**72.**	(d)	**73.**	(b)	**74.**	(a)	**75.**	(a)	**76.**	(a)	**77.**	(b)	**78.**	(c)	**79.**	(d)	**80.**	(c)
81.	(d)	**82.**	(c)	**83.**	(c)	**84.**	(c)	**85.**	(b)	**86.**	(b)	**87.**	(a)	**88.**	(c)	**89.**	(c)	**90.**	(a)
91.	(b)																		