PHOTOSYNTHESIS IN HIGHER PLANTS

BIOLOGY

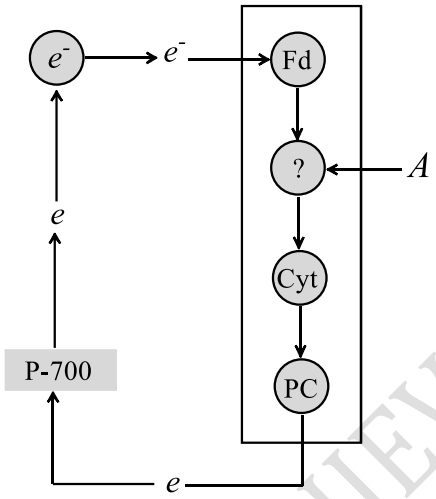
Single Correct Answer Type

1. As compound 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) 2 b) 6 c) 0 d) 12
2. Proton gradient is broken down due to
   a) Movement of electrons across the membrane to stroma
   b) Movement of electrons across the membrane to lumen
   c) Movement of proton across the membrane to lumen
   d) Movement of proton across the membrane to stroma
3. Which of the following is a simplified equation of photosynthesis?
   a) $CO_2 + 2H_2O \xrightarrow[\text{Chlorophyll}]{\text{Light energy}} C_5H_{10}O_4 + H_2O + O_2 \uparrow$ b) $CO_2 + 2H_2O \xrightarrow[\text{Chlorophyll}]{\text{Light energy}} (CH_2O)_n + O_2 \uparrow$
   c) $CO_2 + 2H_2O \xrightarrow[\text{Chlorophyll}]{\text{Light energy}} C_3H_6O_3 + CO_2 + O_2 \uparrow$ d) $CO_2 + 2H_2O \xrightarrow[\text{Chlorophyll}]{\text{Light energy}} (CH_2O)_n + H_2O + O_2 \uparrow$
4. The membrane of thylakoid is called
   a) Cell membrane b) Fret membrane
   c) Granum membrane d) Thylakoid membrane
5. The enzyme responsible for primary carboxylation in C_3-plants is
   a) Hexokinase b) Succinic dehydrogenase
   c) Pyruvate carboxylase d) RuBP carboxylase oxygenase
6. The law of limiting factors was proposed with particular reference to photosynthesis. Identify the scientise, who proposed this law?
   a) Calvin b) Weismann c) Emerson d) Blackman
7. The synthesis of one molecule of glucose during Calvin cycle requires
   a) 12 molecules of ATP and 18 molecules of $NADPH_2$
   b) 6 molecules of ATP and 12 molecules of $NADPH_2$
   c) 18 molecules of ATP and 12 molecules of $NADPH_2$
   d) 12 molecules each of ATP and $NADPH_2$
8. The enzymatic reactions incorporate CO_2 into the plants leading to the synthesis of sugar in
   a) Stroma b) Stroma lamella c) Grana d) Both (a) and (b)
9. In CAM-plants, carbon dioxide acceptor is
   a) RuBP b) PEP c) OAA d) PGA
10. PEP carboxylase
    I. is involved in atleast some CO_2 fixation in both C_3 and C_4-plants
    II. Catalyses the reaction of fixing CO_2 into pyruvic acid in bundle sheath cells
    III. is capable of fixing CO_2 more efficiently at lower atmospheric CO_2 concentration than RuBP carboxylase
    Select the correct option
    a) I and II b) II and III c) I, II and III d) Only III
11. Which factor is not limiting in normal condition for photosynthesis?
    a) Air b) Carbon dioxide c) Water d) Chlorophyll
12. PS is made up of which of the following?
    a) Reaction centre b) Antenna molecule
    c) Both (a) and (b) d) Reaction centre and H_2O

13. In higher plants, the shape of the chloroplast is
    a) Discoid b) Cup-shaped c) Girdle-shaped d) Reticulate
14. Identify the correct combination of the following

substrate	enzyme	Product
I. Phosphoen-ol pyruvate	PEP carboxylase	C_4 acid
II. Malate	Malic enzyme	C_4 acid
III. RuBP	Ribulose 5-phosphate kinase	C_3 acid
IV. Pyruvate	Pyruvate dikinase	C_3 acid

    a) III and IV b) I and II c) II and III d) I and IV
15. Cyclic photophosphorylation produces
    a) NADPH b) ATP c) ATP + $NADPH_2$ d) ATP + $NADPH_2$ + O_2
16. Phenomenon which converts light energy into chemical energy is
    a) Respiration b) Photosynthesis c) Transpiration d) None of these
17. In the given chart of photophosphorylation. What does 'A' represent?



    a) PC b) FRS c) PQ d) Cyt –a_3
18. In photosystem, antennae includes all pigments except
    a) Chlorophyll-*a* b) Chlorophyll-*b* c) Carotenoids d) Xanthophyll
19. I. Tomato
    II. Black pepper
    III. Mango
    From the above option choose the correct answer in respect of green house crops
    a) I and III b) III and II c) I, II and III d) I and II
20. Plastocyanin contains
    a) Copper b) Iron c) Calcium d) potassium
21. The two pigment system theory of photosynthesis was proposed by
    a) Blackman b) Hill c) Emerson d) Arnon
22. Which one of the following is not true about the light reactions of photosynthesis?
    a) Light energy provides energy for the photolysis of water through excitation of the reaction centre of PS-II
    b) The flow of electrons from water to NADP in non-cyclic electron transport produces one ATP
    c) Reactions of the two photosystems are needed for the reduction of NADP
    d) P_{680} and $P_{700}$are the reaction centres of PS-I and PS-II respectively

23. By which plant pigment maximum absorption of radiation takes place in the blue and red regions of absorption spectrum?
a) Chlorophyll-*a* b) Chlorophyll-*b* c) Xanthophyll d) Carotenoid

24. Factors affecting photosynthesis are
I. number and size of leaves
II. age and orientation of leaves
III. amount of chlorophyll
IV. amount of O_2 and CO_2
Select the correct option
a) I, II and IV b) II, IV and V c) IV, V and I d) I, II, III and IV

25. In an experiment, a leaf was partially covered with black paper, and other one was exposed to light. On testing these leaves for starch, in the presence of sunlight, on may conclude that photosynthesis had occurred in
a) Green part of leaves b) Black paper covered part of leaves
c) Both (a) and (b) d) None of the above

26. I. It is the characteristic of C_4-plants
II. It is the characteristic of C_3-plants
III. It occurs in chloroplast
IV. It occurs in day time
V. It occurs in night
Select the correct options in relation to photorespiration

	Correct option	Incorrect option
a)	I, IV	II, III, IV
b)	II, III, IV	I, V
c)	I, II, III	IV, V
d)	IV, V	I, II, III

27. First reaction in photosynthesis is
a) Photolysis of water b) Excitation of chlorophyll molecule
c) Formation of APT d) Fixation of CO_2

28. Kranz anatomy is a morphological diversity in the leaves of
a) C_3-plants b) C_4-plants c) Both (a) and (b) d) CAM-plants

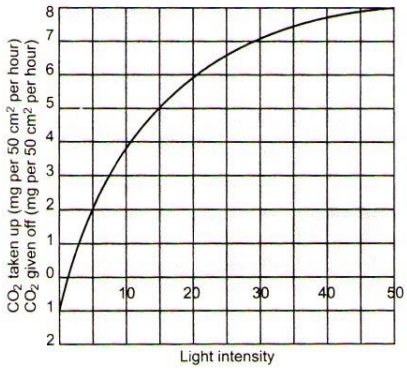
29. Which of the following is concerned with carbon dioxide fixation?
a) Krebs cycle b) Calvin cycle c) Ornithine cycle d) Glycolysis

30. Hill reaction occurs in
a) High altitude plants b) Total darkness
c) Absence of water d) Presence of ferricyanide

31. Rubisco enzyme is absent in
a) Mesophyll cell b) Bundle sheath cell c) C_3-plants d) C_4-plants

32. During the experiment in laboratory, the thylakoid is some how punctured so that the interior of the thylakoid is no longer separated from stroma. This damage will have the direction effect on
a) ATP formation b) Absorption of light
c) Flow of electrons from PS-I to PS-II d) All of the above

33. The graph below shows the relation between light intensity and the giving off and taking up of carbon dioxide by the leaves of a plant. Why is most carbon dioxide given off when the light intensity is zero units?



a) Because it is just the start of the experiment
b) Only respiration is taking place at this intensity of light
c) Only photosynthesis is taking place at this intensity of light
d) The rate of photosynthesis is equivalent to the rate of respiration

34. Cyclic photophosphorylation results only in the
a) Formation of ATP
b) Formation of $NADP^+ + H^+$ and ATP
c) Formation of $NAD^+ + H^+$
d) Formation of ADP + Pi

35. I. H_2S not H_2O is involved in photosynthesis of sulphur bacteria
II. ATP is produced during light reaction *via* chemiosmosis
III. Absence of light leads to the stoppage of photosynthesis
IV. Calvin cycle occurs in grana
Select the correct option
a) II, III and IV
b) I, III and IV
c) I, II and IV
d) I, II and III

36. Under normal condition, which one of the following is a major limiting factor?
a) Light
b) CO_2
c) Temperature
d) Chlorophyll

37. Which one is essential for the respiration as well as photosynthesis?
a) Rubisco
b) Plastocyanin
c) Ubiquinone
d) Cytochrome

38. Light Harvesting Complex (LHC) is
a) One molecule of chlorophyll-*a*
b) Very few molecule of chlorophyll-*a*
c) Hundereds of pigment molecules bound to proteins
d) Chlorophyll-*a* + chlorophyll-*c* + protein + DNA

39. Which of the following represents the correct molecular formula of chlorophyll-*b*?
a) $C_{55}H_{72}O_6N_4Mg$
b) $C_{55}H_{72}O_5N_4Mg$
c) $C_{55}H_{72}O_4N_4Mg$
d) $C_{55}H_{70}O_6N_4Mg$

40. In C_4-plants, the bundle sheath cells
a) Have thin walls to facilitate gaseous exchange
b) Have large intercellular spaces
c) Are rich in PEP carboxylase
d) Have a high density of chloroplasts

41. The following (I-IV) are the main steps of chemosynthetic ATP synthesis in the light reaction. Arrange them in correct order
I. H^+ concentration gradient established
II. H^+ diffuses through ATP synthetase
III. Carriers use energy from electrons to move H^+ across the membrane
IV. Electrons from PS-II pass along electron transport chain
V. Light excites electrons in PS-II
VI. Energy of H^+ flow is used by ATP synthetase to make ATP
a) I, II, III, IV, V, IV
b) II, IV, V, III, II, VI
c) V, IV, III, I, II, VI
d) V, VI, III, IV, II, I

42. What is the wavelength of radiations in visible sectrum?
a) 400-700 nm
b) 400-800 nm
c) 390-760 nm
d) 760-390 nm

43. Which of the following is not related to photorespiration?
a) Lysosome
b) Chloroplast
c) Peroxisome
d) Mitochondria

44. The internal factors that affects photosynthesis of plant depends on the
a) Morphological predisposition
b) Genetic predisposition

c) Temperature d) Environment predisposition

45. How many H^+ ions are formed from 12 water molecules during non-cyclic photophosphorylation?
a) 12 b) 24 c) 36 d) 48

46. In non-cyclic photophosphorylation, there is photolysis of 12 water molecules. How many H^+ are formed?
a) 24 H^+ b) 36 H^+ c) 12 H^+ d) 32 H^+

47. Maximum photosynthesis occurs in
a) Red light b) Blue light c) Green light d) Violet light

48. I. Initial CO_2 acceptor
II. Extent of photorespiration
III. Enzyme catalysing reaction that fixes CO_2
IV. Presence of Calvin cycle
V. Leaf anatomy
Which one does not differ in a C_3 and C_4-plants?
a) I and V b) Only IV c) II and III d) Only II

49. Energy transfer in photosynthesis occurs as
a) Phycoerythrin→ phycocyanin →carotenoid →chlorophyll-a
b) Chlorophyll-b →carotenoid →phycoerythrin →chlorophyll-a
c) Phycocyanin→phycoerythrin→ carotenoid→ chlorophyll-a
d) Chlorophyll-b→ carotenoid→ phycocyanin→ chlorophyll-a

50. What is true for photosynthesis?
a) Carbon dioxide is oxidised and water is reduced
b) Carbon dioxide is reduced and water is oxidised
c) Both carbon dioxide and water are reduced
d) Both carbon dioxide and water are oxidised

51. Which of the following statement is false in case of (C_4-plant)?
a) CO_2 acceptor is RuBisCo in mesosphyll cell
b) Carboxylation occurs in mesophyll cells
c) Leaves have two cell types
d) Mesophyll cells lack Rubisco

52. Chlorophyll in chloroplasts is located in
a) Grana b) Pyrenoid c) Stroma d) Both (a) and (b)

53. Which photosystem is involved in cyclic photophosphorylation?
a) PS-II b) PS-I
c) Xanthophyll and PS-II d) Xanthophyll and PS-I

54. The mechanism of ATP formation both in chloroplast and mitochondria is explained by
a) Relay pump theory of Godlewski b) Cholodny-Went's model
c) Chemiosmotic theory d) Munch's mass-flow hypothesis

55. Absorption spectrum of chlorophyll-a and the action spectrum of photosynthesis is identical because chlorophyll-a
a) Absorbs the maximum light b) Absorbs the minimum light
c) Absorbs the red and blue light d) Is found most abundantly

56. Which would do maximum harm to a tree?
a) Loss of half of its branches b) Loss of all its bark
c) Loss of all its leaves d) Loss of half of its leaves

57. $\text{Pyruvate} + \text{ATP} \xrightarrow{y} \text{PEP} + \text{AMP} + H_3PO_4$
Identify-y in the given reaction and choose the correct option
a) Phosphopyruvate dikinase b) Phosphopyruvate monokinase
c) Phosphopyruvate dikinase d) Phosphopyruvate dehydrogenase

58. A wastage process is
a) Respiration b) Photosynthesis c) Photorespiration d) Movement

59. How many molecules of glycine is required to release one CO_2 molecule in photorespiration?
a) One b) Two c) Three d) Four

60. Choose the correct statement.
a) The C_4-plants do not have RUBISCO
b) Carboxylation of RuBP leads to the formation of PGA and phosphoglycolate
c) Carboxylation of phosphoenol pyruvate results in the formation of C_4-plants
d) Decarboxylation of C_4-acids occur in the mesophyll cells

61. Conditions helpful in photorespiration are
a) More oxygen and less carbon dioxide b) Less oxygen and more carbon dioxide
c) More temperature and less oxygen d) More humidity and less temperature

62. Which of the following is/are the raw material for photosynthesis?
I. H_2O II. CO_2
III. Light IV. Chlorophyll
Choose the correct option
a) II, III and IV b) I and IV c) I, II and III d) I, II, III and IV

63. The special structure present in C_4-plants in
a) Thin cuticle b) Multi-layered epidermis
c) Kranz type body d) One-layered epidermis

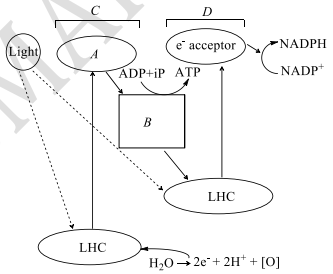
64. In which of the following form glucose is usually stored in plants?
a) Lipid b) Carbohydrates c) Protein d) Starch

65. A student sets up an experiment on photosynthesis as follow : He takes soda water in a glass tumbler and add a chlorophyll extracts into the contents and keeps the tumbler exposed sunlight hoping that he has provided necessary ingredient for photosynthesis to proceed (viz, CO_2, H_2O, chlorophyll and light). What do you think what will happen after, say few hours of exposure of light?
a) Photosynthesis will take place and glucose will produced
b) Photosynthesis will take place and starch will be produced which will turn the mixture turbid
c) Photosynthesis will not take place because CO_2 dissolves in soda water escapes into the atmosphere
d) Photosynthesis will not take place because intact chloroplasts are needed for the process

66. With respect to compensation point, which of the following is true for C_3 and C_4-plants
a) Compensation points of C_3 and C_4- plants are equal
b) Compensation points of C_3- plant is higher than C_4-plants
c) Compensation points of C_4-plant is higher than C_3-plants
d)

67. Light energy in photosynthesis is utilized in
a) H_2O converted into H_2 b) ADP converted into ATP
c) ATP converted into ADP d) None of the above

68. Identify A, B, C and D in the given diagram of z-scheme of light reaction and choose the correct option accordingly



a) A-e^- acceptor, B-ETS, C-PS-II, D-PS-I b) A-e^- acceptor, B-ETS, C-PS-I, D-PS-II
c) A-ETS, B-e^- acceptor, C-PS-I, D-PS-II d) A-ETS, B-e^- acceptor, C-PS-II, D-PS-I

69. $PEP + CO_2 + H_2O \xrightarrow{x}$ Oxaloacetic acid $+H_3PO_4$
Identify X

a) Ligase b) Oxidoreductase c) PEP carboxylase d) Lyase

70. Stroma lamellae membrane lacks
I. PS-II
II. NADP reductase
III. non-cyclic photophosphorylation
Select the correct option
a) I and II b) II and III c) III and I d) I, II and III

71. RUBISCO stands for
a) Ribulosebisphosphate carboxylase oxygenase
b) Ribulose phosphate carboxylase oxygenase
c) Ribulose phosphate carboxylic oxygenase
d) None of the above

72. In chloroplasts, chlorophyll is present in the
a) Outer membrane b) Inner membrane c) Thylakoids d) stroma

73. DCMC
a) Inhibits PS-I
b) Inhibits PS-II
c) Destroy chloroplast
d) Inhibits oxidative phosphorylation

74. Malic acid (4-C) is produced in which plant without Kranz anatomy?
a) *Bryophyllum* b) *Kalanchoe* c) *Opuntia* d) All of these

75. What is the advantage of light reactions producing ATP and $NADPH_2$ on stromal side of thylakoid membrane?
a) Calvin cycle consumes ATP and $NADPH_2$ from stroma
b) Light reaction occurs in stroma
c) Dark reaction occurs in grana need ATP + $NADPH_2$
d) CO_2 is produced in stroma

76. Generally, plants adapted to dry tropical conditions have
a) C_2 pathway b) C_3 pathway c) C_5 pathway d) C_4 pathway

77. Correct sequence of rate of photosynthesis in different light is
a) Red > Blue > Green b) Blue > Red > Green c) Green > Blue > Red d) Green > Red > Blue

78. During the light reaction, the water splits into
a) H^+, O_2 electrons b) H_2, O_2 electrons c) $2H^+, \frac{1}{2}O_2$ 2 electrons d) $\frac{1}{2}H_2, \frac{1}{2}O_2$ electrons

79. Adenosine diphosphate contains
a) One high energy bonds b) Two high energy bonds
c) Three high energy bonds d) Four high energy bonds

80. The thylakoids are aggregated to form stalks of discs called
a) Stroma b) Grana
c) Stroma thylakoids d) Intergranal thylakoids

81. Which hypothesis best explains the synthesis of ATP in chloroplast?
a) Chemosynthetic hypothesis b) Chemiosmotic hypothesis
c) Potential gradient hypothesis d) Redox gradient hypothesis

82. In dark cycle, one molecule of glucose formation needed
a) 12 ATP and 12 NADPH b) 14 ATP and 12 NADPH
c) 16 ATP and 12 NADPH d) 18 ATP and 12 NADPH

83. The main photosynthetic pigments in the plants are
a) Chlorophyll-*a* and chlorophyll-*c* b) Chlorophyll-*a* and chlorophyll-*d*
c) Chlorophyll-*b* and chlorophyll-*a* d) Chlorophyll-*b* and chlorophyll-*c*

84. Radioactive C^{14} is given to carbon dioxide and released to atmosphere. This carbon dioxide is taken by RuBP in a C_3-plants. First radioactive $C^{14}$is seen, in which compound?

a) PGAL b) PEP c) RMP d) PGA

85. Example of water soluble plant pigment is
a) Chlorophyll-α b) Chlorophyll-b c) Anthocyanin d) xanthophyll

86. PS-I and PS-II were discovered by
a) Robert Emerson b) Blackman c) Robert Mayer d) Arnon

87. Photorespiration is also called
I. Glycolate pathway
II. C_3-cycle
III. Oxidative photosynthetic carbon cycle
Select the correct option
a) I and II b) II and III c) III and I d) I, II and III

88. 'Hatch and Slack' cycle is found in
a) C_4-plants b) C_3-plants c) Both (a) and (b) d) None of these

89. Which of the following statements is true with regard to light reaction of photosynthetic mechanism in plants?
a) Chlorophyll-α occurs with peak absorption at 680 nm in photo system-I and at 700 nm in photo system-II
b) Magnesium and sodium ions are associated with photolysis of water molecules
c) O_2 is evolved during cyclic photophosphorylation
d) Photo system-I and II are both involved in non-cyclic photophosphorylation

90. Photosynthesis convert radient or solar energy into the
a) Physical energy b) Latent energy c) Chemical energy d) Oxidation energy

91. Photolysis of each water molecule in light reaction will yield
a) 2 electrons and 4 protons b) 4 electrons and 4 protons
c) 4 electrons and 3 protons d) 2 electrons and 2 protons

92. Which of the following is the first compound that accepts carbon dioxide during dark phase of photosynthesis?
a) NADP b) RuBP c) Ferredoxin d) Cytochrome

93. In a CAM-plant, the concentration of organic acid
a) Increases during the day b) Decreases or increases during the day
c) Increases during night d) Decreases during any time

94. If photosynthesising, green algae are provided with CO_2 labelled with an isotope of oxygen (O^{18}), later analysis showed that all of the following compounds produceds by the algae contains ^{18}O except
a) PGA b) RuBP c) Glucose d) O_2

95. Phytochrome occurs is two forms. In which from it promotes the germination of seeds of some species?
a) P_{fr} from b) P_r from c) Both (a) and (b) d) None of these

96. Solarisation is
a) Formation of chlorophyll b) Destruction of chlorophyll
c) Utilization of sunlight d) Effects of solar light

97. C_4-pathway is a regular mode of CO_2 fixation in
I. dicots
II. pteridophytes
III. monocots
Select the correct option
a) I and II b) I and III c) II and II d) I, II and III

98. Carboxylation (C_3-cycle) is catalysed by
a) Carboxylase b) RuBP carboxylase c) RuBP oxygenase d) Both (b) and (c)

99. The radio between 2-carbon and 3-carbon intermediates having – NH_2 group formed in photosynthetic oxidation cycle is
a) 1 : 1 b) 2 : 1 c) 3 : 2 d) 3 : 4

100. In which one of the following nitrogen is not a constituent?
a) Invertase b) Pepsin c) Idioblast d) Bacteriochlorophyll

101. If a chemical process is affected by more than one factors then its rate will be determined by
a) Two closely related factors
b) Only one factor, which is close to its minimal value
c) Only one factor, which is close to its maximum value
d) Only one factor, which is close to its appropriate value

102. I. Temperature
II. CO_2 concentration
III. Chlorophyll arrangement
IV. Water
Among the given factors, identify the external factors that affects the rate of photosynthesis and correct option accordingly
a) I, II and IV b) I, II and III c) II, III and IV d) I, III and IV

103. Which activity is performed by PS-I in light reaction?
a) Reduction of NADPH b) Reduction of $NADP^+$
c) Oxidation of $NADP^+$ d) Oxidation of NAD

104. C_4 pathway for CO_2-fixation was proposed by
a) Benson and associates b) Arnon and associates
c) Rouhani et *al.,* d) Hatch et *al.,*

105. A scientist disrupted the chloroplast and separated the stroma from lamella. For fixing CO_2 he supplied stroma with
I. ATP
II. NADPH
III. Glucose
Select the correct option
a) I and III b) III and II c) I and II d) I, II and III

106. CAM helps the plants in
a) Secondary growth b) Disease resistance c) Reproduction d) Conserving water

107. PEP is present in
a) Mesophyll cell b) Bundle sheath cell c) Meristematic cell d) Both (a) and (b)

108. The absorption spectrum of chlorophyll
a) Showa that some colours of light are absorbed more than the others
b) Approximates the action spectrum of photosynthesis
c) Explains why chlorophyll is a green pigment
d) Has all the above properties

109. PGA as the first carbon dioxide fixation product was discovered in photosynthesis of
a) Bryophyte b) Gymnosperm c) Angiosperm d) Alga

110. In C_3-plants, the first stable compound formed after carbon dioxide fixation is
a) Phosphoglyceraldehyde
b) Malic acid
c) Oxaloacetic acid
d) 3-phosphoglycerate

111. Which chemical compound/molecule supplies electrons continuously to PS-II?
a) CO_2 b) O_2 c) H_2O d) NADPH

112. Colour that we see in leaves is due to the presence of
I. Chlorophyll-*a* II. Chlorophyll-*b*
III. Xanthophyll IV. Carotenoid
a) I and II b) I, III and IV c) II, III and IV d) I, II, III and IV

113. Quantasomes occur on the surface of
a) Cristae b) Plasmalemma c) Nuclear envelope d) Thylakoids

114. First carbon dioxide acceptor in C_4- plants is
a) PEP b) PGA c) RuBP d) Pyruvic acid
115. In Calvin cycle, if one molecule of RuBP is carboxylated than how many PGA molecule will be formed?
a) 2 b) 3 c) 4 d) 5
116. The type of carbon dioxide fixation seen in many succulent plant species is
a) C_4-pathway b) C_2-pathway c) CAM-pathway d) C_3-pathway
117. Water stress causes the stomata to …A… hence reducing the …B… availability.
Here A and B refer to
a) A-open; B-H_2O b) A-close; B-H_2O c) A-close; B-CO_2 d) A-open; B-CO_2
118. Photosynthesis cannot continue for long if during light reaction, only cyclic photophosphorylation takes place. This is because
a) Only ATP is formed, $NADPH^+ + H^+$ is not formed
b) Photosystem-I stops getting excited at a wavelength of light beyond 680 nm
c) There is unidirectional cyclic movement of the electrons
d) There is no evolution of oxygen
119. Light reaction of photosynthesis occurs inside
a) Stroma b) Grana
c) Endoplasmic reticulum d) Cytoplasm
120. Bundle sheath cells are rich in which enzyme
a) PEP carboxylase b) Malate dehydrogenase
c) Phosphofructokinase d) RuBisCo
121. In sugarcane plant, $^{14}CO_2$ is fixed in a malic acid, in which the enzyme that fixes carbon dioxide is
a) Ribulose phosphate kinase b) Fructose phosphatase
c) Ribulose bisophosphate carboxylase d) Phosphoenol Pyruvic acid carboxylase
122. For yielding one molecule of glucose, the Calvin cycle turns
a) Two times b) Four times c) Six times d) Eight times
123. The light reaction of photosynthesis end up in the formation of
a) $NaDH_2$ b) ATP c) Sugar d) $NADPH_2$
124. In leaves of C_4-plants, malic acid synthesis during carbon dioxide fixation occurs in
a) Epidermal cells b) Mesophyll cells c) Bundle sheath cells d) Guard cells
125. Biosynthetic phase of photosynthesis is the formation of
a) Lipid b) Fat c) Protein d) Sugars
126. What happen to the chloroplast pigment when they absorb light?
a) They become reduced b) They become excited
c) They lose potential energy d) Calvin cycle is triggered
127. In C_4-pathway, the first product identified was
a) 3-PGA b) OAA c) 2-PGA d) 1-3DPGA
128. Law of limiting factors was given by
a) Leibig b) Blackman c) Calvin d) Arnon
129. PS-I in cyclic photophosphorylation is involved in the formation of …A… by …B… movement of electrons
What does A and B refer here?
a) A-ATP; B-down hill redox potential b) A-ADP; B-up hill redox potential
c) A-NADH + H^+; B-down hill energy d) A-NADPH + H^+; B-down hill energy
130. The green-coloured pigment present in all autotrophs was named chlorophyll by
a) Pelletier Caventou b) Julius Robert Mayer c) Jean Senebier d) Melvin Calvin
131. Within the chloroplast, there is the membranous system consisting of
I. grana
II. stroma lamellae
III. fluid stroma
Choose the correct option
a) I and II b) II and III c) I and III d) I, II and III

132. Joseph Priestley observed that when mouse alone was placed in a closed bell jar with burning candle, it was suffocated and candle burning extinguished but when mouse was placed with a mint plant in the same bell jar, that mouse stayed alive and candle continued to burn. What he concluded from this experiment?
a) Burning candle remove the air
b) Mint plant restore the air
c) Both (a) and (b)
d) CO_2 is required for burning of candle

133. Organelles involved in photorespiration is/are
I. chloroplast
II. peroxisomes
III. mitochondria
Choose the correct option
a) I and II
b) II and III
c) III and I
d) I, II and III

134. The first step in dark reaction of photosynthesis is
a) Formation of ATP
b) Ionization of water
c) Attachment of carbon dioxide to a pentose sugar
d) Excitement of electron of chlorophyll by a photon of light

135. Calvin cycle is also called
a) Calvin-Benson cycle
b) C_3-cycle
c) Reductive pentose pathway
d) All of the above

136. Plants in which the first product of CO_2 fixation is C_3 acid, *i. e.*, the …A… pathway, and those in which the first product was C_4 acid (OAA), *i. e.*, the …B… pathway
Complete the given statement by filling appropriate options in the given blanks
a) A-C_2; B-C_3
b) A-C_3; B-C_4
c) A-C_4; B-C_2
d) A-C_2; B-C_3

137. Photosynthesis is an important process for life on earth because
a) It is the primary source of all food on earth
b) It is responsible for the release the of oxygen
c) It is the only natural process responsible for the utilisation of sunlight
d) All of the above

138. The mineral involved in the photolysis of water are
I Manganese
II Calcium
III magnesium
IV Chloride
a) I and II only
b) I, II and IV only
c) I, II and II only
d) I and IV only

139. Calvin cycle represents
a) Reductive carboxylation
b) Substrate level phosphorylation
c) Dark respiration
d) Oxidative carboxylation

140. Identify the correct sequence of enzymes given below which participate in the regeneration phase of Calvin cycle.
I. Ribulose-5-phosphate isomerase
II. Ribulose-5-phosphate epimerase
III. Transketolase
IV. Triose phosphate isomerase
a) VI, I, III, II
b) III, IV, II, I
c) IV, III, I, II
d) II, I, IV, III

141. Etiolation in plants is caused when they
a) Are grown in dark
b) Have mineral deficiency
c) Are grown in intense light
d) Are grown in blue light

142. Dichlorophenyl dimethylurea inhibits
a) PS-I
b) PS-II
c) Chloroplast functioning
d) Oxidative phosphorylation

143. Photosynthetic pigments in chloroplast are embedded in the membrane of
a) Photoglobin
b) Matrix
c) Thylakoid
d) Mitochondria

144. Pigments can be separated from leaf by

a) ELISA test
b) RIA test
c) Centrifugation
d) Paper chromatography

145. In which of the following, oxygen does not evolve during photosynthesis?
a) Photosynthetic red algae
b) Photosynthetic green algae
c) Photosynthetic blue-green algae
d) Photosynthesis bacteria

146. Who proved that the organic matter is synthesised from carbon dioxide and water during the photosynthesis?
a) Liebig
b) Priestley
c) Ingen Housz
d) Von Mayer

147. Which of the following statements is true with regard to the light reaction of photosynthesis?
a) In PS-II the reaction centre chlorophyll-α has an absorption peak at 700 nm hence, is called P_{700}
b) In PS-I the reaction centre chlorophyll-α has an absorption maxima at 680 nm and is called P_{680}
c) The spitting of water molecule is associated with PS-I
d) Photosynthems-I and II are involved in Z scheme

148. In Calvin cycle, the first product identified was
a) 3-phosphoglyceric acid
b) 2-phosphoglyceric acid
c) 1-phosphoglyceric acid
d) 4-phosphoglyceric acid

149. I. Water is oxidised in PS-I not in PS-II
II. Light is needed for both PS-I and PS-II
III. Due to photolysis of water, formation of ATP and NADPH occurs
IV. Production of NADPH and H^+ is associated with PS-II not PS-I
Identify the true statement and select the correct option
a) I and II
b) II and III
c) I and IV
d) II and IV

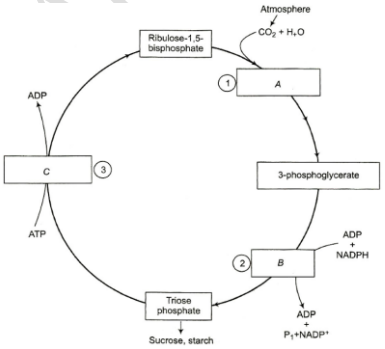
150. PS-I is located on the
a) Non-appressed part of a grana thylakoids
b) Stroma thylakoids
c) Appressed part of grana thylakoids
d) Both (a) and (b)

151. I. Chlorophyll-a
II. Chlorophyll-b
III. Anthocyanin
Select the correct option regarding water soluble pigment
a) I and II
b) Only II
c) Only II
d) I and II

152. C_4-plant minimises the photorespiration because C_4-plants
a) Use PEPcase to initiate CO_2 fixation
b) Do not carry out the Calvin cycle in low CO_2 level
c) Exclude Calvin cycle
d) Show photorespiration

153. In the process of photosynthesis, water molecule breaks during
a) Red drop
b) Photolysis
c) Phosphorylation
d) Carbon assimilation

154. Identify A, B and C in the given figure, and choose the correct option from the set (A-C) given below



a) A-Reduction, B-Carboxylation, C-Regeneration
b) A-Reduction, B-Regeneration, C-Carboxylation
c) A-Carboxylation, B-Reduction, C-Regeneration

d) A-Carboxylation, B-Regeneration, C-Reduction

155. In grana of chloroplast, the reaction ADP + P_i = ATP during day shows
a) Oxidative phosphorylation b) Photophosphorylation
c) Substrate level phosphorylation d) Dephosphorylation

156. Very strong light has a direct inhibiting effect on photosynthesis, which is known as
a) Solarization b) Etiolaration c) Chlorosis d) Defoliation

157. What is the effect of high CO_2 concentration and higher values of ATP/ADP ratio?
a) Rate of Calvin cycle increased b) Rate of Kreb cycle decreased
c) Rate of glycolate cycle decreased d) All of the above

158. pH of thylakoid lumen during photosynthesis is
a) Basic b) Neutral
c) Acidic d) Depends on H^+ concentration

159. Head portion of the chlorophyll is called …A… . Tail portion of the chlorophyll is called …B… . Fill in the with respect to A, B and tick the appropriate option
a) A-phytol, B-porphyrin b) A-porphyrin, B-phytol
c) A-pyrrole ring, B-phytol d) A-porphyrin, B-pyrrole ring

160. Members of family-Crassulaceae perform
a) C_3-photosynthesis b) CAM-photosynthesis c) C_4-photosynthesis d) All of these

161. …A… plants have the higher temperature optimum than …B… the plants adapted climate
Here A and B refer to
a) A-Desert; B-Tropical b) A-Temperature; B-Tropical
c) A-Tropical; B-Temperature d) A-Desert; B-Temperature

162. Which is not correct for ancient plants?
a) They have photosynthetic pigment
b) They are primitive algae
c) They use H_2S as hydrogen source
d) They release oxygen as byproduct

163. Which of the following cell organelles is associated with photorespiration?
a) Mitochondria b) Peroxisome c) Chloroplast d) All of these

164. The protons are transported across the thylakoid membrane into the lumen because
a) Electrons are transferred to hydrogen carrier is which is present on inner membrane
b) Electrons are transferred to electron carrier
c) Electrons are transferred to intermembrane space
d) Electrons are transferred to hydrogen carrier, which is present outer side of membrane

165. The light phase of photosynthesis is called
a) Hill reaction b) Photo action
c) Pigment action d) Chlorophyllous process

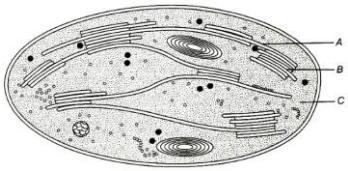
166. Which of the following statements are correct?
I. Light reaction occurs in stroma
II. Light reaction occurs in grana
III. Dark reaction occurs in stroma
IV. Dark reaction occurs in grana
Choose the correct option
a) I and II b) II and IV c) III and IV d) II and III

167. In photosynthesis, what does occur in PS-II?
a) It takes longer wavelength of light and e^- from H_2O
b) It takes shorter wavelength of light and e^- from H_2O
c) It takes longer wavelength of light and e^- from NADP
d) It takes shorter wavelength of light and e^- from NADP

168. Cyclic-photophosphorylation results in the formation of
a) NADPH b) ATP and NADPH

c) ATP, NADPH and oxygen d) ATP

169. Identify A, B and C in given figure



a) A-Stroma wall, B-Grana, C-Stroma b) A-Stroma lamella, B-Grana, C-Stroma
c) A-Stroma lamella, B-Stroma, C-Grana d) A-Starch grain, B-Stroma, C-Grana

170. In photosystem II, the reaction centre chlorophyll-a absorbs …A… nm wave length of red light causing electrone to become excited and jump into an orbit farther from the atomic nucleus. These electrons are picked up by an …B…, which passes them to an electron transport system constisting of …C…
Pick the right choice for A, B and C
a) A-680 nm, B-electron donor, C-cytochromes b) A-780 nm, B-electron acceptor, C-cytochromes
c) A-680 nm, B-electron acceptor, C-cytochromes d) A-780 nm, B-electron donor, C-cytochromes

171. Which of the following statements with regard to photosynthesis is/are correct?
I. In C_4-plants, the primary CO_2 acceptor is PEP.
II. In the photosynthetic process, PS-II absorbs energy at or just below 680 nm.
III. The pigment that is present in the Pigment System-I isP_{683}.
a) II and III only b) I only c) III only d) I and II only

172. Which one is correct for C_4-plants?

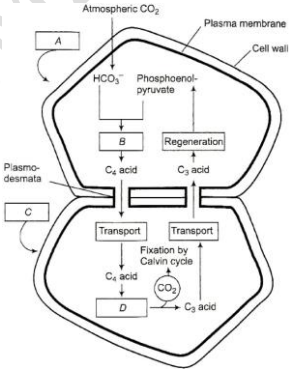
	Mesophyll	Bundle Sheath
a)	PEPcase C_4-cycle	RuBisCo C_3-cycle
b)	PEPcase Calvin cycle	RuBisCo C_4-cycle
c)	RuBisCo C_4-cycle	PEPcase C_3-cycle
d)	RuBisCo C_2-cycle	PEPcase C_3-cyce

173. Synthesis of food in C_4-pathway occurs in chlorophyll of
a) Guard cells b) Bundle sheath cells
c) Spongy mesophyll cells d) Palisade cells

174. Which one is the correct reaction of photosynthesis?
a) $6CO_2 + 6H_2O \xrightarrow[\text{Chlorophyll}]{\text{Light}} 6O_2 + C_6H_{12}O_6$
b) $6CO_2 + 12H_2O \xrightarrow[\text{Chlorophyll}]{\text{Light}} + C_6H_{12}O_6 + 6O_2 + 6H_2O$
c) $C_6H_{12}O_6 + 6O_2 + 6H_2O \xrightarrow[\text{Chlorophyll}]{\text{Light}} 6CO_2 + 12H_2O + \text{Energy}$
d) $C_6H_{12}O_6 + 6O_2 \xrightarrow[\text{Chlorophyll}]{\text{Light}} 6CO_2 + 6H_2O + \text{Energy}$

175. I. Lysosome II. Chloroplast
III. Peroxisome IV. Mitochondria
Which of the following organelles is/are not related to photorespiration?
Choose the correct option
a) Only I b) I, IV and II c) I, III and IV d) Only IV

176. Identify A, B, C and D in the given figure and choose the correct option accordingly



a) A-Mesophyll cell, B-Fixation, C-Bundle sheath cell, D-Decarboxylation

b) A- Mesophyll cell, B-Decarboxylation, C-Bundle sheath cell, D-Fixation
c) A-Chloroplast, B-Decarboxylation, C-Bundle sheath cell, D-Fixation
d) A-Chloroplast, B-Fixation, C-Bundle sheath cell, D-Fixation

177. In photosynthesis, action and absorption spectrum were related by
a) Von Helmont b) Englemann c) Emerson d) Lovoisier

178. Which of the following is the formula of chlorophyll-*a*?
a) $C_{55}H_{70}O_2N_4Mg$ b) $C_{55}H_{72}O_5N_4Mg$ c) $C_{55}H_{70}O_5N_4Mg$ d) $C_{55}H_{72}O_2N_4Mg$

179. Oxygen which is liberated during photosynthesis, comes from
a) Carbon cells b) Spongy cells c) Palisade cells d) Bundle sheath cells

180. Photosynthetic organisms remove …… of carbon/year if assumed that the photosynthetic organisms use 0.1% of incident visible light
a) 0.1015 tonn b) 0.2015 tonn c) 0.1123 tonn d) 0.03 tonn

181. Light reaction or photochemical phase includes
I. light absorption
II. water splitting
III. oxygen release
IV. ATP and NADP formation
Select the correct option
a) I, II and IV b) I, II and III c) I, III and IV d) I, II, III and IV

182. Identify A, B and C shown in a table representing the Calvin cycle

In	Out
A CO_2	One glucose
B ATP	ADP
C NADPH	NADP

Choose the correct option
a) A-5 CO_2, B-18, C-12 b) A-6 CO_2, B-12, C-18 c) A-4 CO_2, B-12, C-18 d) A-6 CO_2, B-18, C-12

183. Rate of photosynthesis is low in herbs, shurbs as compared to sun plants because
a) Herb, shrubs receive mere red light
b) Herb, shrubs receive mere blue light
c) Herb, shrubs receive mere more green light
d) Herb, shrubs receive more white light

184. PEPcase has an advantage over RuBisCo. The advantage is
a) RuBisCo combines with O_2 but PEPcase do not
b) RuBisCo combines with NO_2 but PEPcase do not
c) RuBisCo conserve energy but PEPcase do not
d) PEPcase is present in both mesophyll cells and bundle sheath cells but RuBisCo is not

185. Activator of ribulose biphosphate carboxylase oxygenase is
a) Mg^{2+} b) Zn^{2+} c) Ca^{2+} d) SO_4^{2-}

186. Photolysis of water during photosynthesis occurs with the help of
a) PS-II b) PS-I c) Ferredoxin d) Cytochrome

187. $RuBP + O_2 \xrightarrow{X} PGA + Phosphoglycolate.$
Identify *x* in the given equation and choose the correct option
a) RuBP carboxylase b) RuBP oxygenase c) RuBisCo d) PEP-carboxylase

188. Which one of the following is wrong in relation to photorespiration?
a) It is a characteristic of C_4-plants
b) It is a characteristics of C_3-plants
c) It is occurs in chloroplasts
d) It occurs in day-time only

189. Flow of electrons in non-cyclic photo phosphorylation is
a) Unidirectional (from PS-I to PS-II) b) Amphidirectional
c) Bidirectional d) Unidirectional (from PS-II to PS-I)

190. Priestley discovered oxygen in
a) 1770 b) 1774 c) 1778 d) 1782
191. Which of the following is wrongly matched?
a) Sorghum – Kranz anatomy b) PEP carboxylase – Mesophyll cells
c) Blackman – Law of limiting factors d) Photosystem-II – P_{700}
192. Transport of C_4 acid from mesophyll cells to the bundle sheath cell takes place through
a) Cell membrane b) Cell wall c) Plasmodesmata d) Osmosis
193. Maximum amount of photosynthesis occurs in
a) Light compensation point b) O_2 compensation point
c) Saturation point d) Desaturation point
194. Sunken stomata are usually found in
a) C_3 plants b) CAM plants c) Insectivorous plants d) Phanerogams
195. I. In C_3-plant, Calvin pathway takes place in mesophyll cell
II. In C_4-plant, Calvin pathway takes place in the mesophyll cell
Which of the following statements true?
Choose the correct option
a) Statement I is incorrect, II is correct b) Statement II is incorrect, I is correct
c) Both incorrect d) Both correct
196. C_3-plant show optimum photosynthesis at
a) High O_2 b) High CO_2
c) Low O_2 d) High temperature = 45°C
197. During C_4-cycle, the acid formed are
I. Picric acid II. OAA
III. Malic acid IV. Aspartic acid
Select the correct option
a) I, II, III and IV b) II, III and IV c) I, IV and II d) I, III and IV
198. Consider the following statements regarding photosynthesis.
I. ATP formation during photosynthesis is termed as photophosphorylation.
II. Kranz anatomy pertains to leaf.
III. Reduction of $NADP^+$ to NADPH occurs during Calvin cycle.
IV. In a chlorophyll molecule, magnesium is present in phytol tail.
a) I and II correct b) III and IV are correct
c) I and III are correct d) I and IV correct
199. Presence of bundle sheath is a characteristic of
a) Xerophytic plants b) Members of grass family
c) C_4-plants d) C_3-plants
200. Oxygenic photosynthesis occurs in
a) *Chromatium* b) *Oscillatoria* c) *Rhodospirillum* d) *Chlorobium*
201. I. They have special leaf anatomy
II. They tolerate high temperature
III. Lack photorespiration
IV. Greater productivity of biomass
These are the probable characters of
a) C_2-plant b) C_3-plant c) C_4-plant d) Any plant
202. In which region, most of the photosynthesis takes place?
a) Red and green region b) Violet and indigo region
c) Blue and red region d) Blue and black region
203. In an experiment demonstrating the evolution of oxygen in *Hydrilla*, sodium bicarbonate is added to water in the experimental set-up. What would happen if all other conditions are favorable?
a) Amount of oxygen evolved decreases as carbon dioxide in water is absorbed by sodium bicarbonate
b) Amount of oxygen evolved increases as the availability of carbon dioxide increases

c) Amount of oxygen evolved decreases as the availability of carbon dioxide increases
d) Amount of oxygen evolved increases as carbon dioxide in water is absorbed by sodium bicarbonate

204. Who proposed that O_2 comes from water instead from CO_2 during photosynthesis?
a) Von Neil b) Engelmann c) Blackman d) Warburg

205. Which equation is correct to prove that O_2 comes from water during photosynthesis?
a) $6CO_2{}^{18} + 12H_2O \rightarrow 6O_2{}^{18} + C_6H_{12}O_6 + 6H_2O$
b) $6CO_2 + 12H_2O^{18} \rightarrow 6O_2 + C_6H_{12}O_6 + 6H_2O^{18}$
c) $6CO_2{}^{18} + 12H_2O \rightarrow 6CO_2{}^{18} + C_6H_{12}O_6$
d) $6CO_2 + 12H_2O^{18} \rightarrow 6O_2{}^{18} + C_6H_{12}O_6 + 6H_2O$

206. The components of PS-I are located on the
a) Stroma b) Stroma thylakoid
c) Granum thylakoid d) Outer surface of stromal and granal thylakoid

207. Cyclic photophosphorylation occurs in
a) Stroma lamellae b) Appressed part of grana lamellae
c) Stroma cell wall d) Grana cell wall

208. Identify from the following, a characteristic pigment, which contains copper containing protein
a) Plastoquinone b) Ferredoxin c) Cytochrome d) Plastocyanin

209. I. The electrons that carriers photophosphorylation are located in the thylakoid membrane
II. During photophosphorylation, the chloroplast stroma becomes more acidic than the interior of thylakoid membrane
III. Protons diffuses through the protein channels which are ATP synthetase molecules
IV. ATP is formed from ADP + Pi on the stroma side of the thylakoid in the chloroplast
V. During photophosphorylation, water ionises to form H^+, yielding electrons to PS-II
Which of the following statement are false?
a) I and II b) III and IV c) IV and V d) Only II

210. Which of the following elements is an activator for both Ribulosebisphosphate carboxylase oxygenase and phosphoenol pyruvate carboxylase in photosynthetic carbon fixation?
a) Mg^{2+} b) Zn^{2+} c) Ca^{2+} d) SO_4^{2-}

211. Who experimentally proved that source of oxygen during photosynthesis is water?
a) Van Niel b) Robin Hill c) Arnon d) Emerson

212. Warburg effect is the
a) Inhibition of C_4-cycle by O_2 b) Inhibition of C_2-cycle by O_2
c) Inhibition of C_3-cycle by O_2 d) Inhibition of C_3-cycle by CO_2

213. Oxaloacetic acid changes to the malic acid by the action of
a) Oxaloacetic dehydrogenase b) Malic dehydrogenase
c) PEP dehydrogenase d) RMP dehydrogenase

214. Consider the following statements.
I. The portion of the spectrum between 300-500 nm is also referred to as Photosynthetically Active Radiation (PAR).
II. Magnesium, calcium and chloride ions play prominent roles in the photolysis of water.
III. In cyclic photophosphorylation, oxygen is not released (as there is no photolysis of water) and NADPH is also not produced.
a) I is true; but II and III are false b) I and II are false; but III is true
c) II is true; but I and III are false d) I and II are true; but III is false

215. When two photosystem (I and II) work in a series, the phosphorylation is called
a) Cyclic b) Non-cyclic c) Bicyclic d) Both (a) and (b)

216. The ATPase enzyme consists of
I. F_0 II. F_1 III. F_2
Select the correct option
a) I and III b) I and II c) Only I d) II and III

217. Chemiosmosis requires
I. a membrane
II. a proton pump
III. a proton gradient
Select the correct option
a) II and III b) I and III c) I and II d) I, II and III

218. Biosynthetic phase of photosynthesis is dependent on
I. NADPH II. NADH
III. ATP IV. $NAD^+ + H^+$
a) I and III b) IV and I c) I and VI d) IV and II

219. Kranz anatomy is the characteristics of
a) C_5-plants b) C_3-plants c) C_2-plants d) C_4-plants

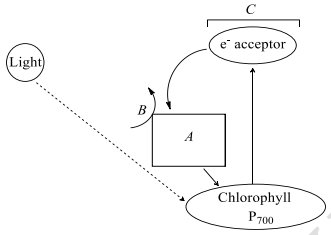
220. In which type of reactions related to plant photosynthesis peroxisomes are involved?
a) Glycolate cycle b) Calvin cycle
c) Bacterial photosynthesis d) Glyoxylate cycle

221. Photosynthesis is a
a) Catabolic process b) Anabolic process c) Amphibolic process d) Catalytic process

222. Beyond of saturation point, the photosynthesis begins to decline because of
I. Photo inbibition
II. Photo-oxidation
III. Photo-reduction
Select the/correct option which matches with statement
a) I and III b) III and II c) I, II, and III d) I and II

223. A chemical substance when irradiated with UV rays, absiorb radiations and emits visible light is called
a) Luminescent b) Fluorochrome c) Bioluminescence d) Metachrome

224. Identify A, B and C in the given figure of cyclic phosphorylation and choose the correct option accordingly



a) A-ETS, B-ADP + Pi → ATP, C-PS-II b) A-ETS, B-ADP + Pi → ATP, C-PS-I
c) A-$NADH_2$, B-ADP + Pi → ATP, C-PS-I d) A-$NADH_2$, B-ADP + Pi → ATP, C-PS-II

225. Chlorophyll-*a* and *b* differ in having
a) Chlorophyll-*a* has a methyl group and chlorophyll-*b* has aldehyde group in position X
b) Chlorophyll-*a* has an aldehyde group and chlorophyll-*b* has a methyl group in position X
c) Chlorophyll-*a* has a carboxyl group and Chlorophyll-*b* has an aldehyde group in position X
d) Chlorophyll-*a* has an ethyl group and Chlorophyll-*b* has an aldehyde group in position X

226. Of the total incident solar radiation the proportion of PAR is
a) About 60% b) Less than 50% c) More than 80% d) About 70%

227. Who discovered that light is essential for releasing oxygen in plants?
a) Stephen Hales b) Lavoisier c) Jan Ingenhousz d) Von Helmont

228. How many Calvin cycles are required to produce 5 molecules of glucose?
a) 60 b) 15 c) 30 d) 90

229. During light reaction of photosynthesis
a) ADP is phosphorylated and NADPH oxidised
b) ADP is phosphorylated and NADP reduced
c) ADP is phosphorylated and NADPH reduced
d) ATP is phosphorylated and NADPH reduced

230. The ATP production in photosynthesis is called

a) Phototropism
b) Phosphorylation
c) Photooxidation
d) Photophosphorylation

231. Who described the first action spectrum of photosynthesis?
a) Sachs
b) Engelmann
c) Arnold
d) Von Helmont

232. Who provided the evidence for the production of glucose when plant grows?
a) Julius von Sachs
b) Stephen Hales
c) Lavoisier
d) Von Helmont

233. Which of the following is used during discovery of Calvin cycle?
a) *Spirogyra*
b) *Volvox*
c) *Chlamydomonas*
d) *Chlorella*

234. The movement of electrons in ETC in light reaction is?
a) Up hill in terms of redox reaction
b) Down hill in terms of redox reaction
c) Either (a) or (b)
d) Both (a) and (b)

235. The wavelength of light absorbed by P_r from of phytochrome is
a) 640 nm
b) 680 nm
c) 720 nm
d) 620 nm

236. In C_4- plants, the carbon dioxide fixation accurs in
a) Guard cells
b) Spongy cells
c) Palisade cells
d) Bundle sheath cells

237. What is the name given to the flattened membranous sacs which are embedded in the matrix of the chloroplast?
a) Thylakoids
b) Granum
c) Stroma
d) Mesophyll cells

238. 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

239. Which of the following is maximum in chloroplast?
a) RuBP carboxylase
b) Hexokinase
c) Phosphatase
d) Nuclease

240. Photolysis of water releases
I. electron
II. proton
III. oxygen
Select the correct option
a) I and II
b) II and III
c) I and III
d) I, II and III

241. Which of the following characteristics out of I, II, III, IV are exhibited by C_4-plant?
I. Kranz anatomy
II. Oxaloacetic acid
III. Large bundle sheath cells
IV. Found only in desert area
a) I, II and III
b) I, II and IV
c) II, III and IV
d) III, I and IV

242. In C_4-plants, the bundle sheath cells
a) Have cells density of chloroplast
b) Are rich in PEPcase
c) Have large number of Rubisco
d) Are large sized having transferase

243. The Z scheme of electron transport is
a) Cyclic photophosphorylation
b) Non-cyclic photophosphorylation
c) Both (a) and (b)
d) Where only photosystem pigment-I is involved

244. Photophosphorylation in chloroplast is most similar to the
a) Mitochondrial substrate level phosphorylation
b) Mitochondrial oxidative phosphorylation
c) Mitochondrial hydrolysis of H_2O
d) All of the above

245. I. Chlorophyll-*a*
II. Chlorophyll-*b*
III. Xanthophyll

IV. Carotenoid

Separate the given pigments into the accessory and main pigments involved during photosynthesis

Main pigment Accessory Pigment

a) I II, III, IV b) II, III and IV I

c) II and III I and IV d) I and IV II and III

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

a) ADP b) ATP c) RuBP d) chlorophyll

247. RuBisCo performs oxygenase activity at

a) Low CO_2 concentration b) High CO_2 concentration

c) High H_2O concentration d) Low H_2O concentration

248. Primary acceptor of CO_2 in C_4-cycle is

a) PGA b) PEP c) RuBP d) OAA

249. In bundle, sheath cells are the large cells around the

a) Vascular bundles of C_4-plants b) Vascular bundles C_3-plants

c) Vascular bundles of C_2-plants d) All of the above

250. Which of the following is the first compound that accepts carbon dioxide during dark phase of photosynthesis?

a) NADP b) RuBP c) Ferredoxin d) Cytochrome

251. Number of carboxylation occurs in Calvin cycle is

a) Zero b) One c) Two d) Three

252. Plants adapted to low light intensity have

a) Larger photosynthetic unit size than the sun plants

b) Higher rate of carbon dioxide fixation than the sun plants

c) More extended root system

d) Leaves modified to spines

253. If green plants are incubated with O^{18} labelled water, which molecule (photosynthesis product) will become radioactive from the given options

a) O_2 b) H_2O c) CO_2 d) ATP

254. The first action spectrum of photosynthesis was described by Engelman was related to

a) Algae b) Mint plant c) Bacteria d) Bryophytes

255. To form one molecule of glyceraldehydes phosphate in Calvin cycle

a) 9 ATP and 36 NADPH are required b) 6 ATP and 6 NADPH are required

c) 3 ATP and 3 NADPH are required d) 9 ATP and 6 NADPH are required

256. Products of light reaction are ATP and O_2, of these, B… diffuses out of the chloroplast, while ATP and NADPH are used to derive the process leading to the synthesis of food more accurately, …C…,

What does the blanks A-C refers here?

a) A-NADP; B-O_2; C-lipid b) A-$NADPH_2$; B-O_2; C-amino

c) A-NAD^+; B-O_2; C-sugars d) A-NADPH + H^+; B-O_2; C-sugars

257. Light compensation point is the point where

a) Gaseous exchange occurs in photosynthesis

b) Gaseous exchange do not occur in photosynthesis

c) Gaseous exchange reduce in photosynthesis

d) Light intensity become appropriate for photosynthesis

258. During the dark reaction, the acceptor of CO_2 is

a) $NADPH_2$ b) RuBP c) H_2O d) CO_2

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

a) Stroma of chloroplasts and mitochondria

b) Stroma of chloroplasts and peroxisomes

c) Grana of chloroplasts and peroxisomes

d) Stroma of chloroplasts

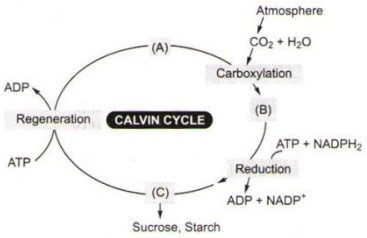
260. Which one of the following concerns Photophosphorylation?

a) $ADP + \text{Inorganic } PO_4 \rightarrow ATP$
b) $AMP + \text{Inorganic } PO_4 \xrightarrow{\text{Light energy}} ATP$
c) $ADP + AMP \xrightarrow{\text{Light energy}} ATP$
d) $ADP + \text{Inorganic } PO_4 \xrightarrow{\text{Light energy}} ATP$

261. In an experiment, chloroplasts were made acidic by soaking them in acidic solution. What will happen if this chloroplast is transferred to a solution having basic pH?

a) ATP formation takes place
b) No ATP formation takes place
c) NAD formation takes place
d) Sugar formation takes place

262. Choose the correct combination of labeling the carboxydrate molecule involved in the Calvin cycle.



a) A-RuBP, B-Triose phosphate, C-PGA
b) A-PGA, B-RuBP, C-Triose phosphate
c) A-PGA, B-Triose phosphate, C-RuBP
d) A-RuBP, B-PGA, C-Triose phosphate

263. If the light becomes unavailable during photosynthesis then

a) Immediately biosynthetic process stops
b) Biosynthetic phase does not stops
c) Biosynthetic phase stopes forever
d) Biosynthetic phase continues for some time and then stops

264. I. In photosynthesis, the proton accumulation is towards the inside of membrane of thylakoid
II. In respiration, proton accumulation occurs in the inter membrane space of the mitochondria
Select the correct option

a) Statement I is incorrect II is correct
b) Statement II is incorrect I is correct
c) Both Statement I and Statement II incorrect
d) Both Statement I and Statement II are correct

265. Chloroplasts without grana are known to occur in

a) Bundle-sheath cells of C_3-plants
b) Mesophyll cells of C_4-plants
c) Bundle-sheath cells of C_4-plants
d) Mesophyll cells of all plants

266. PGA, the first carbon dioxide fixation product was firstly discovered in

a) Bryophytes b) Pteridophytes c) Angiosperms d) Alga

267. Liberation of oxygen when green cells in water are exposed to sunlight in presence of suitable acceptor is called

a) Arnon's reaction
b) Emerson's enhance effect
c) Blackman's reaction
d) Hill's reaction

268. Fixation of one molecule of CO_2 requires how much (in C_4-plants). ATP and NADPH respectively

a) 5/2 b) 2/5 c) 2/3 d) 3/2

269. In half leaf experiment, a part of a leaf is enclosed in a test tube containing KOH soaked cotton, while the other half is exposed to air and then setup is placed in light for sometime. It was latter found that part of leaf which was exposed to air tested positive for starch. This indicates that

a) Light is essential for photosynthesis
b) Oxygen is liberated in photosynthesis
c) Water is essential for photosynthesis because in KOH soaked leaf, starch synthesis do not occurs as water reacts with KOH and it become unavailable for photosynthesis
d) Carbon dioxide is essential for photosynthesis because in KOH soaked leaf, starch synthesis do not occurs as CO_2 is absorbed by, so CO_2 is not available for photosynthesis

270. ……. Is a CAM plant.
a) Maize b) Pineapple c) Onion d) Pea

271. Every CO_2 molecule entering the Calvin cycle needs
a) 2 molecule of NADPH and 3 molecule of ATP for its fixation
b) 2 molecule of NADPH and 2 molecule of ATP for its fixation
c) Variable amount of ATP
d) Only NADPH

272. Proton gradient is very important across the membrane because
a) Building up of proton gradient release energy
b) Building up of proton gradient increase the pH towards lumen side of thylakoid membrane
c) Breakdown of proton gradient release CO_2
d) Breakdown of proton gradient release energy

273. The first acceptor of electrons from an excited chlorophyll molecule of Photo system-II is
a) Cytochrome b) Iron-sulphur protein
c) Ferredoxin d) Quinine

274. Substance which is essential for the respiration as well as photosynthesis is
a) Cytochrome b) RuBisCo c) Plastocyanin d) Ubiguinine

275. Which of the following is a 4-carbon compound?
a) Oxaloacetic acid b) Phosphoglyceric acid
c) Ribulose bisphosphate d) Phosphoenol pyruvate

276. A graph that plots the rate at which CO_2 is converted to glucose *versus* the wavelength of light illuminating a leaf is called
a) An absorption spectrum b) An adsorption spectrum
c) Pigment kinetics d) An action spectrum

277. Water stress makes plant leaves …A… thus, …B… the surface area of leaves and their metabolic activity as well
Here A and B refer to
a) A-wilt, B-increases b) A-wilt, B-decreases c) A-fall, B-decreases d) A-fall, B-increases

278. Which plant performs photosynthesis even after the closing of stomata?
a) C_2 b) C_3 c) C_4 d) C_5

279. During photorespiration, the conversion of phosphoglycolate to glycolate takes place in this cell organelle.
a) Mitochondria b) Glyoxysome c) Peroxisome d) Chloroplast

280. The chemical formula of starch is
a) $(C_6H_{10}O_5)_n$ b) $(C_6H_{12}O_6)_n$ c) $C_{12}H_{22}O_{11}$ d) CH_3COOH

281. Emerson effect explain the phenomenon of
a) Transpiration b) Absorption of water by roots
c) Photosynthesis d) Respiration

282. Which fractions of the visible spectrum of solar radiations are primarily absorbed by carotenoids of the higher plants?
a) Red and violet b) Violet and blue c) Blue and green d) Green and red

283. Photosynthesis in C_4-plants is relatively less limited by atmospheric carbon dioxide levels because
a) Four carbon acids are the initial carbon dioxide acceptors
b) The primary fixation of carbon dioxide is mediated via PEP carboxylase
c) Effective pumping of CO_2 into bundle sheath cells
d) Rubisco in C_4- plants has higher affinity for CO_2

284. CAM-plant among the following is
a) Maize b) *Kalanchoe* c) Sugarcane d) Wheat

285. Identify the 5-C compound from the given option
a) RuBP b) OAA c) 3PGA d) $NADPH_2$

286. The functions of chloroplast of membrane system is
a) Trapping of light energy b) Synthesis of ATP

c) Synthesis of NADPH d) All of these

287. Photophosphorylation differs from oxidative phosphorylation in requiring input of energy in the from of
a) Light b) Heat c) AMP d) NAD

288. Cyclic phosphorylation occurs at which wavelength
a) Wavelength beyond 800 nm b) Wavelength beyond 680 nm
c) Wavelength below 680 nm d) Wavelength below 500 nm

289. If there is mutation in cytochrome system then this will
a) Inhibit he movement of electrons from PS-II to PS-I
b) Inhibit the movement of electrons from PS-I to PS-II
c) Inhibit the photolysis of water
d) Promote ATP formation

290. Photosynthesis is correctly explained by the equation
a) $6CO_2 + 12H_2O \rightarrow C_6H_{12}O_6 + 6O_2 + 6H_2O$ b) $6CO_2 + 6H_2O \rightarrow C_6H_{12}O_6 + 6O_2 + 6H_2O$
c) $6CO_2 + 6H_2O \rightarrow C_6H_{12}O_6 + 6O_2$ d) $2CO_2 + 12H_2O \rightarrow C_6H_{12}O_6 + 2CO_2$

291. Which of the following elements are essential for the photolysis of water?
a) Ca and CI b) Mn and CI c) Zn and I d) Cu and Fe

292. The electrons in the reaction centre of PS-I are
a) Excited simultaneous with PS-II b) Excited simultaneously with P_{680}
c) Excited simultaneously with P_{700} d) Either (a) or (b)

293. In plants, glycolate metabolism takes place in
a) Low concentration of carbon dioxide b) High concentration of oxygen
c) Low concentration of oxygen d) Absence of oxygen

294. Chloroplast align themselves in the mesophyll cell in such away that their flat surface are
a) Antiparallel to the cell wall b) Perpendicular to the cell wall
c) Parallel to the cell wall d) Middle in the cell

295. How many molecules of RuBP are required to produce 20 molecules of serine in photorespiration?
a) 20 b) 40 c) 60 d) 80

296. With reference to three Calvin cycles, which of the given options is correct for the following question?
I. How many gross PGAL molecules are produces?
II. Total, how many ATP molecules are required for synthesis of PGAL molecules?
II. Total, how many $NADPH_2$ molecules are required for the synthesis of obtained PGAL molecules?
a) I-3PGAL, II-3 ATP, III-3 $NADPH_2$ b) I-6 PGAL, II-6 ATP, III-6 $NADPH_2$
c) I-18 PGAL, II-18 ATP, III-18 $NADPH_2$ d) I-9 PGAL, II-9 ATP, III-9 $NADPH_2$

297. Which of the following statements regarding C_4-plants is false?
a) The primary CO_2 acceptor is a 5-carbon molecule
b) The initial carboxylation reaction occurs in Mesophyll
c) The leaves that fix CO_2 have two cell types
d) The Mesophyll cells lack Rubisco enzyme

298. CAM pathway is observed in
a) Pineapple b) Maize c) Sunflower d) Sugarcane

299. Scientist believed that since the first product was …A… acid, the primary acceptor would be …B… carbon compound; they spent many years trying to identify a 2-carbon compound before they discovered …C… carbon compound (RuBP).
Complete the given statement with the correct combination of options
a) A-C_3; B-2, C-5 b) A-C_3; B-5, C-2 c) A-C_4; B-5, C-2 d) A-C_4; B-2, A-5

300. I. Photosystem-I is a photosynthetic pigment system located on the appressed part of grana and thylakoids
II. Photosystem-II is a photosynthesis pigment located on the non-appressed part of stroma only
Identify wheather the given statements are correct or incorrect and choose the correct accordingly
a) Statement I is correct, while II is incorrect b) Statement II is correct, while I is incorrect
c) Both statements are correct d) Both statements are incorrect

301. Biosynthetic phase is called as dark reaction because

a) It depends on the light reaction
b) It does not depends on the light reaction
c) It does not depends on NADPH
d) It does not depends on ATP

302. What percentage of solar radiation that hits the earth's atmosphere ever reaches the surface?
a) 92% b) 2% c) 42% d) 22%

303. CO_2 released in bundle sheath is used in the
a) C_4-cycle
b) C_3-cycle
c) Respiration
d) Sugar break down processes

304. Photophosphorylation is the
a) Formation of ADP in the presence of light
b) Formation of ATP in the presence of chemicals
c) Formation of ATP in the presence of light
d) Formation of ATP in the presence of reducing agents

305. During photosynthesis,
a) Oxygen evolved comes from carbon dioxide
b) ATP is formed
c) ATP is not formed
d) Water is required as medium but it does not take part in photosynthesis

306. Cytochrome oxidase is a/an
a) Exoenzyme b) Endoenzyme c) Proenzyme d) Coenzyme

307. Electrons are transferred by splitting of H_2O through ETC during light reaction and reduces
a) NAD to NADH + H^+
b) NADPH to H^+
c) $NADP^+$ to NADPH + H^+
d) NAD to NADPH + H^+

308. Cytochrome oxidase contain
a) Fe b) Mg c) Zn d) Cu

309. Basic features of Kranz anatomy of C_4-plant is presence of
a) Chloroplast in bundle sheath cells
b) Chloroplast in Mesophyll and epidermal cells
c) Typical granal chloroplasts in bundle sheath cells and rudimentary chloroplasts in mesophyll cells
d) Rudimentary chloroplasts in bundle sheath cells and typical granal chloroplasts in mesophyll cells

310. The first product of CO_2 fixation in C_4 pathway is
a) Acitic acid b) RuBP c) PGA d) Inorganic acid

311. Photochemical reactions in the chloroplasts are directly involved in
a) Fixation of carbon dioxide
b) Synthesis of glucose and starch
c) Formation of phosphoglyceric acid
d) Photolysis of water and phosphorylation of ATP to ATP

312. Which crop utilizes solar energy most efficiently?
a) Potato b) Sugarcane c) Wheat d) Rice

313. I. CO_2 is assimilated into sugars
II. RUBP is regenerated
III. ATP and NADPH are formed
Select the correct option in context to Calvin cycle
a) I and II b) II and III c) I and III d) I, II and III

314. Majority of energy carrier molecules are oxidised or reduced in the
a) Nucleus
b) Mitochondria and chloroplast
c) Nucleus
d) Golgi body

315. The water splitting complex is associated with
a) PS-I b) PS-II c) Carotenoid d) Xanthophyll

316. Photosystem I (PS-I) and Photosystem-II (PS-II) are named
a) In the sequence they work in light reaction
b) According to their molecular weight
c) In the sequence of their discovery
d) In the sequence of their constituents

317. Asymmetric labeling of glucose phosphate formed in photosynthesis is called

a) Warburg's effect b) Pasteur's effect c) Gibb's effect d) Dicken's effect

318. Protons produced by the splitting of water in light reaction of photosynthesis accumulates within the reaction of photosynthesis accumulates within the
a) Lumen of thylakoids b) Intermembrane of chloroplast
c) Stroma of chloroplast d) Outside the lumen of thylakoids

319. The molecule present in the reaction centre of photosystem is
a) Chlorophyll-*a* b) Chlorophyll-*b* c) Chlorophyll-*c* d) Chlorophyll-*d*

320. Photorespiration is the light dependent reaction in which utilisation of
a) Oxygen and release of H_2O takes place b) Oxygen and release of H^+ takes place
c) Oxygen and release of CO_2 takes place d) Oxygen and release of ATP takes place

321. Which photosynthetic pigment is called universal photosynthesis pigments?
a) Chlorophyll-*a* b) Chlorophyll-*b* c) Chlorophyll-*c* d) Chlorophyll-*d*

322. I. PS-I has more chlorophyll-*a* than chlorophyll-*b*
II. PS-II has more chlorophyll-*b* than chlorophyll-*a*
Choose the correct option
a) I statement is wrong, II is right b) II statement is wrong, I is right
c) Bot statements are wrong d) Both statements are right

323. Photosynthesis is a
a) Physico-chemical process b) Physical process
c) Chemical process d) Constructive process

324. The C_4-plants are photosynthetically more efficient than C_3-plants because
a) The carbon dioxide compensation point is more b) Carbon dioxide generated during photorespiration is trapped and recycled through PEP carboxylase
c) The carbon dioxide efflux is not prevented d) They have more chloroplasts

325. We are created by chloroplast. This statement suggest the idea
a) All the life form possesses chloroplast
b) All the life form depend on photosynthesis
c) All the life form is plant
d) Plants are the first organism on earth

326. Which of the following characteristics out of A, B and C are exhibited by C_4-plants?
V. Kranz anatomy
VI. The product of photosynthesis is oxaloacetic acid
VII. Both PEP carboxylase and ribulose-bisphosphate carboxylase act as carboxylating enzymes.
a) Only A and B, but not C b) Only B and C, but not A
c) Only A and C, but not B d) All A, B and C

327. Hexose monophosphate pathway takes place in
a) Endoplasmic reticulum b) Cristae
c) Cytoplasm d) Mitochondrial matrix

328. The energy required to hydrolyse water during photosynthesis comes from
a) Reduced chlorophyll b) Proton gradient c) Oxidised chlorophyll d) ATP

329. Chloroplast dimorphism is a characteristic feature of
a) Plants with Calvin cycle
b) C_4-plants
c) All plants
d) Only in algae

330. The trapping centre of light energy in photosystem-I is
a) P_{660} b) P_{700} c) P_{680} d) P_{630}

331. ATP and NADPH produced in light reaction by the movement of electrons in ETC are used immediatly for
a) Oxidation of carbohydrate b) Synthesis of sugar
c) Reduction of carbon dioxide d) Both (b) and (c)

332. Electrons which gets excited in PS-I must replaced. These replacement ultimately come from
a) ATP b) H_2O c) PS-II d) NAD

333. Select the correct pathway for electron transport during photosynthesis
a) $CO_2 \rightarrow$ RUBP $\rightarrow$ Glucose- ATP b) $H_2O \rightarrow$ PS-I $\rightarrow$ PS-II $\rightarrow$ NADPH $\rightarrow H^+$
c) $H_2O \rightarrow$ PS-II $\rightarrow$ PS-I $\rightarrow$ NADPH $\rightarrow H^+$ d) $H_2O \rightarrow$ PS-II $\rightarrow$ PS-I $\rightarrow$ ATP

334. Photorespiration in C_3-plants starts from
a) Phosphoglycerate b) Phosphoglycolate c) Glycerate d) Glycine

335. Photosynthesis is
I. Endergonic process
II. Exergonic process
III. Chemical process
IV. Physical process
Select the correct option
a) II, III and IV b) I, III and IV c) I, II and IV d) I, II and III

336. Compensation point refers to
a) Little photosynthesis b) Beginning of photosynthesis
c) Rate of photosynthesis equals to the rate of respiration d) None of the above

337. In Z-scheme of light reaction the, participating pigment system are
I. PS-I II. PS-II III. PS-III
IV. Carotenoid and xanthophyll
Choose the correct option
a) I and II b) I, II and III c) I, III and IV d) II and III and IV

338. Function/s of accessory pigments is/are
I. They enable wider range of wavelength of incoming light for photosynthesis
II. They absorb light and transfer the energy to chlorophyll-a
III. They protect reaction centre from photo-oxidation
Select the correct option
a) I and II b) II and III c) Only I d) I, II and III

339. In CAM-plants, carbon dioxide required for photosynthesis enters the plant body during
a) Day time through the lenticels
b) Night through the stomata, which are kept open
c) Day time when the stomata are open
d) Night when the hydathodes are open

340. Water is
a) Produced in dark reaction b) A reactant in light reaction
c) Both (a) and (b) d) Involve nowhere in photosynthesis

341. In C_3 plant, when O_2 concentration is more, the O_2 binds to Rubisco and RuBP gets changed to
a) 2 molecules of PGA
b) 2 molecules of phosphoglycerate
c) 2 molecules of phosphoglycolate
d) One molecule each of phosphoglycerate and phosphoglycolate

342. Within the chloroplast, the chlorophyll pigments are organized in the form of
a) PS-I b) PS-II c) PS-III d) Both (a) and (b)

343. Conversion of pyruvate into PEP takes place in
a) Mesophyll cell cytoplasm b) Mesophyll cell chloroplast
c) Bundle sheath cell chloroplast d) Bundle sheath cell cytoplasm

344. What is the function performed by plant pigments?
a) Absorb CO_2 b) Absorb O_2 c) Absorb H_2O d) Absorb light

345. A reduction in the quantity of oxygen evolution during photosynthesis may be observed at
a) Light having wavelength more than 680 nm

b) Light having wavelength less than 680 nm
c) Light having wavelength 560 nm
d) Light having wavelength less than 360 nm

346. Organelles associated with photorespiration are
a) Chloroplast, mitochondria, peroxisome
b) Chloroplast, mitochondria, lysosome
c) Mitochondria, peroxisome, centrosome
d) Nucleus, centrosome, peroxisome

347. Stroma in the chloroplasts of higher plants contain
a) Light-independent reaction enzymes
b) Light-dependent reaction enzymes
c) Ribosomes
d) Chlorophyll

348. The concentration of CO_2 in atmosphere is between
a) 0.03-0.04%
b) 300-400 ppm
c) 400-600 ppm
d) Either (a) or (b)

349. Red light favours the …A… accumulation. Blue light favours the …B… accumulation
Here A and B refer to
a) A-Starch; B-lipid
b) A-lipid; B-starch
c) A-carbohydrate; B-cholestrol
d) A-carbohydrate; B-protein

350. Maximum number of chloroplast are found in
a) Root
b) Stem
c) Leaves
d) Short tip

351. The net requirement of assimilatory power for the formation of 6 hexose molecules in maize plant is
a) 72 ATP, 48 NADPH
b) 90 ATP, 60 NADPH
c) 108 ATP, 72 NADPH
d) 180 ATP, 72 NADPH

352. In C_3 plants, the first stable product of photosynthesis during dark reaction is
a) PGAL
b) RuBP
c) PGA
d) OAA

353. The form of pigment which promotes germination is
a) P_{760}
b) P_{730}
c) P_{650}
d) All of these

354. Who proved that oxygen evolved in photosynthesis comes from water?
a) Calvin
b) Mayer
c) Blackman
d) Ruben, Hassid and Kamen

355. Compensation point refers to
a) Rate of photosynthesis = Rate of respiration
b) Rate of photosynthesis = Rate of H_2O splitting
c) Rate of photosynthesis = PGA formation
d) Rate of photosynthesis = RuBP formation

356. Living organisms have the capability of extracting energy from
a) Reducible substances
b) Oxidising substances
c) ADP
d) AMP

357. What happens to C_4 acid in the bundle sheath cells?
a) Aspartic acid is deaminated
b) Malic acid decarboxylated
c) Either (a) or (b)
d) Both (a) and (b)

358. Porphyrin is made up of how many pyrrole ring?
a) One
b) Two
c) Three
d) Four

359. In photorespiration, which is light induced cyclic oxidation of photosynthetic intermediates with the help of oxygen, the substrate is
a) Glycolate
b) Glucose
c) Pyruvic acid
d) Acetyl Co-A

360. Non-cyclic phosphorylation occurs in
I. stroma lamellae
II. grana lamellae
III. chloroplast membrane

Select the correct option

a) Only I b) II and III c) I and III d) Only II

361. Sugarcane show high efficiency of carbon dioxide fixation because of

a) Calvin cycle b) Hatch and Slack cycle c) TCA cycle d) Greater sunlight

362. Carboxylation (C_3-cycle) is the fixation of CO_2 into

a) Amino acid b) Cholesterol ring c) Proteins d) Organic intermediate

363. Malic acid or aspartic acid and oxaloacetic acid both are found in

a) Mesophyll cell b) Bundle sheath cell

c) Bundle sheath cell wall d) Mesophyll cell wall

364. Photorespiration could easily be detected in

a) C_3-plants b) C_4-plants c) Both (a) and (b) d) None of these

365. Maximum CO_2 fixation is done by

a) Green plants b) Phytoplanktons c) Zooplanktons d) Bacteria

366. Grana is ill developed or absent in the chloroplast in the

a) Stem of *Hydrilla* b) Leaf of sunflower

c) Bundle sheath of sugarcane leaf d) Mesophyll of grasses

367. Aldolase enzyme is present in

a) Mitochondria b) Chloroplast

c) Lysosomes d) Endoplasmic reticulum

368. Photosynthetic enhancement with flashing light was first observed by

a) Benson and Calvin b) Hill and Calvin

c) Hatch and Slack d) Emerson and Arnold

369. In C_3 cycle for the fixation of every CO_2 molecules, the reduction and regeneration steps required

a) 3 ATP and 2 $NADPH_2$ b) 2 ATP and 2 $NADPH_2$ c) 2 ATP and 3 $NADPH_2$ d) 3 ATP and 3 $NADPH_2$

370. Synthesis of one molecule of glucose requires

a) $6CO_2$, 18 ATP and 12 NADPH b) $6CO_2$, 12 ATP and 18 NADPH

c) $6CO_2$, 30 ATP and 12 NADPH d) $6CO_2$, 38 ATP and 12 NADPH

371. Main biosynthetic pathway for CO_2 fixation in C_4-plant is

a) C_4 pathway b) C_3 pathway c) C_2 pathway d) Both (a) and (b)

372. I. In biosynthetic phase (C_3-cycle), enzymes are present in the matrix of Golgi body

II. C_3 and C_4-cycle are two parts of biosynthetic phase of photosynthesis in C_3-plants

Identify wheather the given statement are correct or incorrect and choose the option accordingly

a) Both I and II are correct b) Both I and II are incorrect

c) I is correct, II is incorrect d) II is correct, I is incorrect

373. Wavelength of visible light/PAR is

a) 200-400 nm b) 700-900 nm c) 400-700 nm d) 100-200 nm

374. In Hatch and Slack pathway,

a) Chloroplasts are of same type

b) Kranz anatomy occurs where mesophyll have small chloroplasts whereas bundle sheath have granal chloroplasts

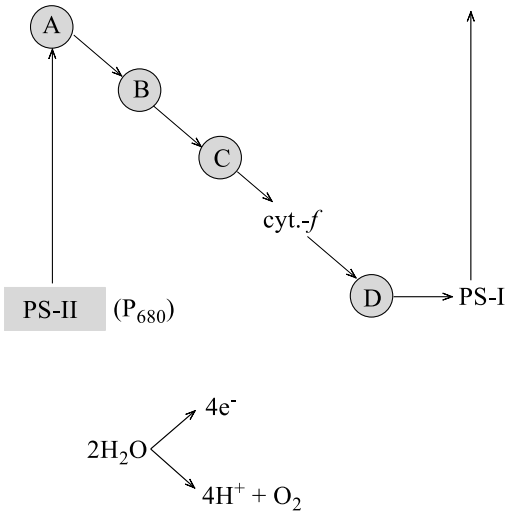
c) Kranz anatomy occurs where mesophyll have small chloroplasts whereas bundle sheath have larger agranal chloroplasts

d) Kranz anatomy where mesophyll cells are diffused

375. Photorespiration takes place only in

a) Lysosomes of plant cell b) Green parts of the plant

c) Mitochondria of plant cell d) None of the above

376. 

In the above schematic diagram , which is plastocyanin?

a) C b) D c) A d) B

377. Photochemical reactions in the chloroplast are directly involved in

a) Photolysis of water and formation of ATP b) Formation of PGA
c) Synthesis of starch and lipid d) Fixation of PEP

378. During non-cycle photophosphorylation, in which of the following $4e^-$ produced through photolysis will enter?

a) PS-II b) PC c) PQ d) PS-I

379. Most abundant protein of biological world is

a) Rubisco b) Ligase c) Permease d) RuBP

380. Core of chlorophyll is formed by

a) Iron b) Manganese c) Methyl group d) Magnesium

381. Ammonia release from

a) Photorespiration b) Dark respiration c) CAM d) All of these

382. Accessory pigments absorb light and transfer it to

a) Chlorophyll-*b* b) Chlorophyll-*a* c) Xanthophyll d) Carotenoids

383. Formation of ATP in mitochondria is called

a) Mitochondria b) Hydrolysis
c) Oxidative phosphorylation d) Photophosphorylation

384. Raphides are crystals of

a) Calcium carbonate b) Calcium oxalate
c) Magnesium carbonate d) Magnesium oxalate

385. Nucleus/core of the chlorophyll contains

a) Fe b) Mn c) Mg d) CH_3

386. $(C_5H_{10}O_5)_n$ is the formula of

a) Protein b) Fat c) Lipid d) Carbohydrate

387. C_4- plants differ from C_3-plants in respect to

a) Number of CO_2 molecules used
b) Substrate, which accept the CO_2 molecules
c) The final product
d) Number of ATP formed

388. ATP synthesis is linked to

a) Development of pressure gradient across membrane
b) Development of osmotic gradient across membrane
c) Development of proton gradient across membrane
d) Development of electron gradient across membrane

389. Which of the following is formed during photorespiration?

a) Sugar b) Phosphoglycolate c) NADPH d) ATP

390. Photosynthesis is maximum in
a) Green light b) Blue followed by red right
c) Red followed by blue light d) Blue light

391. Large number of chloroplast are present in which of the following cells?
a) Parenchymatous cell b) Mesophyll cell c) Peroxisomal cell d) Cell wall

392. What is common between chloroplasts, chromoplasts and leucoplasts?
a) Presence of pigments
b) Possession of thylakoids and grana
c) Storage of starch, proteins and lipids
d) Ability to multiply by a fission-like process

393. Which of the following is true for photosynthesis?
a) Reduction of CO_2 and water b) Oxidation of CO_2 and water
c) Reduction of CO_2 and oxidation of water d) Oxidation of CO_2 and reduction of water

394. RuBisCo is found in
a) Cytoplasm b) Nucleus c) Mitochondria d) Chloroplast

395. In C_4-plants the bundle sheath cells
a) Have thin walls to facilitate gaseous exchange
b) Have large intercellular spaces
c) Are rich in PEP carboxylase
d) Have a high density of chloroplasts

396. Find out the reason that creates an important difference between C_3 and C_4-plant
a) Photorespiration b) Calvin cycle c) Glycolysis d) Pressure of cuticle

397. ATPase has
a) Channel that allows H^+ diffusion b) Has channel that allows electron diffusion
c) Channel that allows diffusion O_2 molecule diffusion d) Channel that allows CO_2 molecule

398. In dark reaction, regeneration of RuBP needs
a) 2 molecule of ATP b) 1 molecule of ATP c) 3 molecule of ATP d) 4 molecule of ATP

399. Rubisco has the active site that binds to
a) CO_2 b) O_2 c) Either (a) or (b) d) NO_2

400. $RuBP + CO_2 \xrightarrow{\text{Rubisco}} x$. In the given
Identify x in the given
a) 2×2 PGA b) 2×3 PGA c) 2×4 PGA d) 2×1 PGA

401. I. Cyclic photophosphorylation needs PS-I and PS-II
II. Cyclic photophosphorylation produced NADPH + H^+ and ATP
III. Cyclic photophosphorylation involves H_2O
IV. Electrons are recycled in cyclic photophosphorylation
Identify the correct and incorrect statement and select the option accordingly
a) I, II and III are incorrect, IV in correct b) I, II and IV are incorrect, III is correct
c) I, II and III are incorrect, II in correct d) IV, III and Ii are incorrect, I in correct

402. Which statement about photosynthesis is false?
a) The electron carriers involved in photophosphorylation are located on the thylakoid membranes
b) Photosynthesis is a redox process, in which water is oxidized and carbon dioxide is reduced
c) The enzymes required for carbon fixation are located only in the grana of chloroplasts
d) In green plants, both PS-I and PS-II are required for the formation of NADPH $+H^+$

403. The C_4-plants are different from the C_3-plants with reference to the
a) Types of pigments involved in photosynthesis b) The number of NADPH that are consumed in preparing sugar
c) Types of end product of photosynthesis d) The substance that accepts carbon dioxide in

carbon assimilation and first stable product

404. Identify the incorrect statement with respect to Calvin cycle.
a) The carboxylation of RuBP is catalysed by Rubisco
b) The first stable intermediate compound formed is phosphoglycerate
c) 18 molecules of ATP molecules of ATP are synthesized during carbon fixation
d) $NADPH + H^+$ produced in light reaction is used to reduce diphosphoglycerate

405. NADP reductase enzyme is present on the
a) Lumen side of membrane
b) Lamellae side of membrane
c) Stroma side of membrane
d) Cell membrane of chloroplast membrane

406. Cyclic photophosphorylation links to
a) PS-II b) PS-I c) Dark reaction d) Both (a) and (b)

407. In photorespiration, what is the role of peroxisome?
a) Helps in oxidation of glyocolate
b) Helps in oxygenation of glycolate
c) Helps in synthesis of PGA
d) Helps in reduction of glyoxylate

408. Calvin cycle can be described under three stages. These stages are
I. carboxylation
II. ligation
III. reduction
IV. regeneration
Select the correct option
a) II, III and IV b) I, III and IV c) I, II and IV d) I, II and III

409. In which of the following wavelengths, photosystem-I is inactive?
a) 780 nm b) 680 nm c) 690 nm d) 550 nm

410. Bacterial photosynthesis involves
a) Both PS-I and PS-II b) Either PS-I or PS-II c) PS-I only d) PS-II only

411. The first carbon dioxide acceptor in C_4 cycle is
a) RuBP b) PEP c) PGA d) OAA

412. In photo system-I, the first electron acceptor is
a) Ferredoxin
b) Cytochrome
c) Plastocyanin
d) An iron-sulphur protein

413. Fixation of six molecules of CO_2 needs
a) 5 turns of Calvin cycle b) 6 turns of Calvin cycle c) 3 turns of Calvin cycle d) 2 turns of Calvin cycle

414. Energy is …A… to pump protons across a membrane, to create a gradient or high concentration of protons within the thylakoid …B… ATPase has a channel that allows diffusion of protons back across the membrane. This releases enough energy to activate …C… enzyme that catalyses the formation of ATP.
Complete the given NCERT statement by filling appropriate option in the given blanks
a) A-released, B-lumen, C-ligase
b) A-used, B-lumen, C-ligase
c) A-used, B-lumen, C-ATPase
d) A-released, B-lumen, C-ATPase

415. Photosynthesis and respiration are similar because
I. in eukaryotes, both processes occur in specialised organelles
II. ATP synthesis in both is explained by chemiosmotic theory
III. both use ETC
Select the correct option
a) I and II b) II and III c) I and III d) I, II and III

416. Which one does not occur in cyclic photophosphorylation?
a) Oxygen is not given off
b) Water is not consumed
c) Only photosystem-I is involved
d) $NADPH_2$formation

417. Quantum yield of photosynthesis is
a) 33 % b) 9 % c) 12 % d) 8 %

418. A plant with low carbon dioxide compensation point is
a) *Atriplex patula*
b) *Leucopoa kingii*

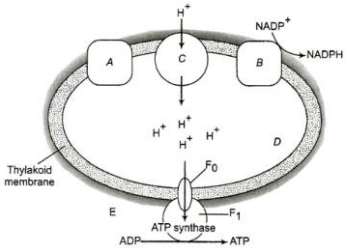
c) *Gossypium hirsutum* d) *Tidestromia oblongifolia*

419. Select the wrongly matched pair with regard to C_4 cycle.
   a) Primary CO_2 fixation-PGA product
   b) Site of initial-Mesophyll cells carboxylation
   c) Primary CO_2 acceptor-PEP
   d) C_4 plant-Maize

420. ATP synthesised by cells in
   I. chloroplast II. Mitochondria
   III. Golgi body
   Select the correct option
   a) I and III b) I and II c) II and III d) I, II and III

421. In which cells of leaf, pyruvate is converted to PEP in C_4 pathway?
   a) Epidermal cells b) Mesophyll cells
   c) Bundle sheath cells d) Guard cells

422. Identify A, B, C, D and E from the given figure and choose the correct option accordingly



   a) A-PS-I, B-PS-II, C-cytochrome-*b* and *c*, D-Lumen stroma, E-Stroma
   b) A-PS-I, B-PS-II, C-cytochrome-*b* and *c*, D- Stroma, E- Lumen
   c) A-PS-II, B-PS-I, C-cytochrome-*b* and *c*, D-Stroma, E- Lumen
   d) A-PS-II, B-PS-I, C-cytochrome-*b* and *c*, D- Lumen, E-Stroma

423. 3-PGA is first stable product in
   a) Carbon-reduction cycle b) Photorespiration
   c) Light reaction d) All of these

PHOTOSYNTHESIS IN HIGHER PLANTS

BIOLOGY

: ANSWER KEY :

1)	d	2)	d	3)	d	4)	c	173)	b	174)	b	175)	a	176)	a
5)	d	6)	d	7)	c	8)	a	177)	b	178)	b	179)	b	180)	a
9)	b	10)	d	11)	a	12)	c	181)	d	182)	d	183)	c	184)	a
13)	a	14)	b	15)	b	16)	b	185)	a	186)	a	187)	b	188)	a
17)	c	18)	a	19)	d	20)	a	189)	d	190)	b	191)	d	192)	c
21)	c	22)	d	23)	a	24)	d	193)	c	194)	b	195)	b	196)	b
25)	a	26)	b	27)	b	28)	b	197)	b	198)	a	199)	c	200)	b
29)	b	30)	d	31)	a	32)	a	201)	c	202)	c	203)	b	204)	a
33)	b	34)	a	35)	d	36)	b	205)	d	206)	d	207)	a	208)	d
37)	d	38)	c	39)	d	40)	d	209)	d	210)	c	211)	b	212)	c
41)	c	42)	c	43)	a	44)	b	213)	b	214)	b	215)	b	216)	b
45)	a	46)	c	47)	a	48)	b	217)	d	218)	a	219)	d	220)	a
49)	a	50)	b	51)	a	52)	a	221)	b	222)	c	223)	b	224)	b
53)	b	54)	c	55)	c	56)	c	225)	a	226)	b	227)	c	228)	c
57)	c	58)	c	59)	b	60)	c	229)	b	230)	d	231)	b	232)	a
61)	a	62)	d	63)	c	64)	d	233)	d	234)	b	235)	b	236)	d
65)	d	66)	d	67)	b	68)	a	237)	a	238)	b	239)	a	240)	c
69)	c	70)	d	71)	a	72)	c	241)	a	242)	c	243)	b	244)	b
73)	b	74)	a	75)	a	76)	d	245)	a	246)	b	247)	a	248)	b
77)	a	78)	c	79)	a	80)	b	249)	a	250)	b	251)	b	252)	a
81)	b	82)	d	83)	c	84)	d	253)	a	254)	a	255)	d	256)	d
85)	c	86)	a	87)	c	88)	a	257)	b	258)	b	259)	b	260)	d
89)	d	90)	c	91)	b	92)	b	261)	a	262)	d	263)	d	264)	d
93)	c	94)	d	95)	a	96)	b	265)	c	266)	d	267)	d	268)	a
97)	b	98)	b	99)	b	100)	c	269)	d	270)	b	271)	a	272)	d
101)	b	102)	a	103)	b	104)	d	273)	d	274)	a	275)	a	276)	a
105)	c	106)	d	107)	a	108)	d	277)	b	278)	c	279)	d	280)	a
109)	d	110)	d	111)	c	112)	d	281)	c	282)	b	283)	b	284)	b
113)	d	114)	a	115)	a	116)	c	285)	a	286)	d	287)	a	288)	b
117)	c	118)	a	119)	b	120)	d	289)	a	290)	a	291)	b	292)	d
121)	d	122)	c	123)	d	124)	b	293)	a	294)	c	295)	b	296)	d
125)	d	126)	b	127)	b	128)	b	297)	a	298)	a	299)	a	300)	d
129)	d	130)	b	131)	a	132)	c	301)	a	302)	c	303)	b	304)	c
133)	d	134)	c	135)	d	136)	b	305)	b	306)	b	307)	c	308)	a
137)	c	138)	d	139)	a	140)	c	309)	d	310)	a	311)	d	312)	b
141)	a	142)	b	143)	c	144)	d	313)	a	314)	b	315)	b	316)	c
145)	d	146)	a	147)	d	148)	a	317)	c	318)	a	319)	a	320)	c
149)	b	150)	d	151)	b	152)	a	321)	a	322)	b	323)	a	324)	d
153)	b	154)	c	155)	b	156)	a	325)	b	326)	c	327)	c	328)	c
157)	d	158)	c	159)	b	160)	b	329)	b	330)	b	331)	d	332)	b
161)	c	162)	d	163)	d	164)	a	333)	c	334)	b	335)	b	336)	c
165)	a	166)	d	167)	b	168)	d	337)	a	338)	d	339)	b	340)	c
169)	b	170)	a	171)	d	172)	a	341)	d	342)	d	343)	b	344)	d

345)	**a**	**346)**	**a**	**347)**	**a**	**348)**	**d**
349)	**d**	**350)**	**c**	**351)**	**d**	**352)**	**c**
353)	**c**	**354)**	**d**	**355)**	**a**	**356)**	**b**
357)	**c**	**358)**	**d**	**359)**	**a**	**360)**	**d**
361)	**b**	**362)**	**d**	**363)**	**a**	**364)**	**a**
365)	**b**	**366)**	**c**	**367)**	**b**	**368)**	**d**
369)	**a**	**370)**	**a**	**371)**	**b**	**372)**	**d**
373)	**c**	**374)**	**c**	**375)**	**b**	**376)**	**b**
377)	**a**	**378)**	**a**	**379)**	**a**	**380)**	**d**
381)	**a**	**382)**	**b**	**383)**	**c**	**384)**	**b**
385)	**c**	**386)**	**d**	**387)**	**b**	**388)**	**c**
389)	**b**	**390)**	**c**	**391)**	**b**	**392)**	**d**
393)	**c**	**394)**	**d**	**395)**	**d**	**396)**	**a**
397)	**a**	**398)**	**b**	**399)**	**c**	**400)**	**b**
401)	**a**	**402)**	**c**	**403)**	**d**	**404)**	**c**
405)	**c**	**406)**	**b**	**407)**	**a**	**408)**	**b**
409)	**a**	**410)**	**c**	**411)**	**b**	**412)**	**d**
413)	**b**	**414)**	**c**	**415)**	**b**	**416)**	**d**
417)	**c**	**418)**	**d**	**419)**	**a**	**420)**	**b**
421)	**b**	**422)**	**d**	**423)**	**a**		

PHOTOSYNTHESIS IN HIGHER PLANTS

BIOLOGY

: HINTS AND SOLUTIONS :

1 **(d)**
12 extra ATP molecules are needed for production of one molecule of one molecule of hexose sugar in C_4-plant.

2 **(d)**
Movement of protons across the membrane to stroma.
Proton gradient is important because it is the break down of this gradient that leads to release of energy. The gradient is broken down due to movement of protons across the membrane to the stroma through the transmembrane channel of the F_0 of the ATPase.
The energy released during the breaking down of proton gradient is used in formation of ATP

3 **(d)**
Chemical equation for photosynthesis can be shown as

$$CO_2 + 2H_2O \xrightarrow[\text{Chlorophyll}]{\text{Light energy (hv)}} (CH_2O)_n + H_2O + O_2 \uparrow$$

or $6CO_2 + 12H_2O \xrightarrow[\text{Chlorophyll}]{\text{(hv)}} C_6H_{12}O_6 + 6H_2O + 6O_2 \uparrow$

Glucose

4 **(c)**
Thylakoid membrane

5 **(d)**
RuBP carboxylase/ oxygenase (RUBISCO) is an enzyme present in the stroma of chloroplast. This enzyme is responsible for primary carboxylation in C_3-plants as a 5C sugar RuBP acts as carbon dioxide acceptor in the presence of this enzyme and produces 6C unstable compound which then splits into two molecules of 3-phosphoglyceric acid (3C compound), the first stable product of C_3-cycle.

6 **(d)**
Law of limiting factor was proposed by **F F Blackman** (1905). It stated that 'when a process is conditioned as to its rapidity by a number of separate factors, the rate of the process is limited by the pace of the slowest factor' (*i.e.*, factor present minimum amount).

7 **(c)**
Assimilation and reduction of carbon dioxide takes place during Calvin cycle. This cycle takes in only one carbon (as CO_2) at a time so it takes six turns to produce a hexose or glucose molecule (6 carbon). In Calvin cycle, for formation of one mole of hexose sugar (glucose) 18 ATP and 12 $NADPH_2$ are used. The assimilatory power ($NADPH_2$ and ATP) are generated in light reaction of photosynrthesis.

8 **(a)**
In stroma, enzymatic reactions incorporate CO_2 into the plant leading to the synthesis of sugar, which in turn forms the starch

9 **(b)**
The process of photosynthesis in C_4-plants and CAM (crassulacean Acid Metabolism) is same. But instead of spatial separation of initial PEP case fixation and final RUBISCO fixation of carbon dioxide, the two steps occurs in the same cells but at different times, night and day, *e.g.*,*Opuntia*, pineapple, *Vanilla*. **PEP** (Phosphoenol Pyruvic Acid) is the first acceptor of carbon dioxide in CAM-plants like C_4-plants.

10 **(d)**
PEP carboxylase or pepco is the special enzyme, which is found in the mesophyll cells of C_4-plant. Pepco is capable of fixing CO_2 more efficiently in C_4-plant than Rubisco, even in low CO_2 concentration

11 **(a)**
Law of limiting factor was proposed by **Blackman** in 1905. He started that when a process is conditional as to its rapidly by a number of separate factors, then the rate of the process is determined by the pace of slowest factor. Carbon dioxide is usually a limiting factor in photosynthesis under field conditions particularly on clear summer days under adequate water supply.

12 **(c)**

PS or Photosystem is made of a reaction centre and an antenna an molecule

13 **(a)**
Chloroplasts are the green plastids which take part in photosynthesis and temporary or permanent storage of starch. These are discoid (disc-shaped) in higher plants with diameter of 4-6 μm and thickness of 2-4μm.

14 **(b)**
RuBPfirals one CO_2 molecule in C_3 plants with the help of enzyme Rubisco.

15 **(b)**
Cyclic photophosphorylation involves only photo system-I and a few electron carriers. During cyclic photophosphorylation, ATP is formed but NADPH does not formed.

16 **(b)**
Photosynthesis involves the conversion of light energy to chemical energy by photosynthetic pigments using water and carbon dioxide and producing carbohydrate.

17 **(c)**
Plastoquinone transfer electron from photo system-II to photo system-I. Electrons released from P_{700} or photo system-I moves through Fe-S, plastoquinone, cytochrome and plastocyanin and are recycled to P_{700}. In this process, only ATP is produced but no oxygen produced.

19 **(d)**
The fact that C_3-plants respond to higher CO_2 concentration by showing increased rates of photosynthesis leading to higher productivity has been used for some greenhouse crops such as tomatoes and bell pepper.
They are allowed to grow in carbon dioxide enriched atmosphere that leads to higher yields

20 **(a)**
Copper is component or activator of ptastocyanin, cytochrome oxidase, RuBP carboxylase and many other enzymes. It has major role in electron transfer, maintenance of carbohydrate, nitrogen balance and chlorophyll synthesis.

21 **(c)**
The two pigment system theory of photosynthesis was proposed by **Emerson***et. al.*

22 **(d)**
In photosystem-I, the photocentre is a special chlorophyll-a molecule called P_{700}, which is active in both red and far-red light, while a very small amount of special from of chlorophyll-a called P_{680}, constitutes the reaction centre of photo system-II. PS-II is inactive in far-red light (beyond 680 nm).

23 **(a)**
Chlorophyll-*a*

24 **(d)**
The rate of photosynthesis is very important in determining the yield of plants including crop plants. Photosynthesis is under the influence of several factors, both internal (plant) and external. The plant factors includes the number, size, age and orientation of leaves, mesophyll cells and chloroplast, internal CO_2 concentration and the amount of chlorophyll. The plant or internal factors are dependent on the genetic predisposition and the growth of the plant

25 **(a)**
In the experiment for starch synthesis in green leaves, two leaves, a variegated leaf or a leaf that was partially covered with black paper and other one that was exposed to light were taken. On testing these leaves for starch, it was clear, that photosynthesis had occurred only in the green parts of the leaves in the presence of light

26 **(b)**
The process of photorespiration was firstly discovered in tobacco plant. It is the light dependent day time process of oxygenation of RuBP. It takes place in the chloroplast and characteristic of C_3-plants

27 **(b)**
Photosynthesis is manufacture of organic compounds inside the chlorophyll containing cells from CO_2 and water with the help of sunlight. Photosynthetic unit occur in the form of two distinct groups called pigment systems. The first reaction in photosynthesis is excitation of chlorophyll molecule.

28 **(b)**
C_4-plants show Kranz anatomy. In Kranz anatomy, bundle sheath cells are arranged radially around the vascular bundles, which look like a ring or wreath. The chloroplasts in C_4-leaves are dimorphic.

29 **(b)**
Conversion of carbon dioxide to simple (reduced) organic compounds is called carbon dioxide fixation or carbon dioxide assimilation or carbon fixation. This fixation pathway was elucidated by **Melvin Calvin** and is often called as Calvin cycle.

30 **(d)**
Hill reaction was discovered by **Robert Hill** in

1939. It involves the release of oxygen from isolated illuminated chloroplasts when suitable electrons acceptors (*e.g.*, **potassium ferricyanide**) are added to the surrounding water.

31 **(a)**
In mesophyll cells the PEP carboxylase is present and RuBisCo is absent.
In bundle sheath cells the RuBisCo is present and PEP carboxylase is absent

32 **(a)**
Due to the punctured thylakoid membrane, the interior of thylakoid is no longer separated from stroma that leads to the disturbed proton gradient.
The proton concentration between the thylakoid membrane and stroma becomes the same. Hence, no ATP formation takes place as ATP formation takes place due to the proton gradient

33 **(b)**
Because only respiration is taking place at this intensity of light.

34 **(a)**
During the cyclic phosphorylation, the electrons does not pass to the $NADP^+$ but cycled back to PS-I through electron transport chain. This cyclic flow hence, results only in the synthesis of ATP but no of $NADPH + H^+$. Cyclic photophosphorylation occurs when only light of wavelength beyond 700 nm is available for excitation

35 **(d)**
Calvin cycle occurs in the stroma not grana.
During the Calvin cycle, synthesis of starch takes place
Photosynthetic reaction in purple sulphur bacteria

$$2H_2S + CO_2 \xrightarrow{\text{Light}} 2S + CH_2O + H_2O$$

Absence of light leads to the stoppage of splitting of water which causes stoppage of photosynthesis

36 **(b)**
Carbon dioxide is usually a limiting factor in photosynthesis under normal conditions particularly, clear summer days under adequate water supply

37 **(d)**
Cytochromes are iron containing pigments. These act as electron transporter or electron acceptor in respiration and photosynthesis both.

38 **(c)**
The light harvesting complex is made up of hundreds of pigment molecules bounded to proteins

39 **(d)**
Molecular formula of chlorophyll-*a* and *b* are as follow:
$C_{55}H_{72}O_5N_4Mg$-Chlorophyll-*a*
$C_{55}H_{70}O_6N_4Mg$-Chlorophyll-*b*

40 **(d)**
In the leaves of C_4-plants, the vascular bundles are surrounded by bundle sheath of larger parenchymatous cells, which in turn are surrounded by mesophyll cells. Bundle sheath cells have a high density of larger chloroplasts which always lack grana, whereas chloroplasts of mesophyll cells are smaller.

41 **(c)**
Steps in chemosynthetic ATP synthesis are
(i) Light excites electron in PS-II
(ii) Electrons from PS-II pass along electron to move H^+ across the membranes
(iii) Carriers use energy from electrons to move H^+ across the membrane
(iv) H^+ concentration gradients is established
(v) H^+ diffuses through ATP synthesis
(vi) Energy of H^+ flow is used by ATP synthesis to make ATP

42 **(c)**
Visible light consists of radiation having a wavelength between 390-760 nm (or 3900-7600 A). It can be resolved into light of different colours. Namely, violet (390-430 nm), blue (430-470 nm) blue-green (470-500 nm), green (500-580 nm), yellow (580-600 nm), orange (600-650 nm), red (650-660 nm), red (660-760 nm)
Red light above 760 nm is called infrared and the light radiation shorter than the violet is called ultraviolet light

43 **(a)**
The site for photorespiration is chloroplast. Peroxisome and mitochondria are required for completing the process. This happen at high temperature and high oxygen concentration.

44 **(b)**
Genetic predisposition.
The rate of photosynthesis is very important in determining the yield of plants including crop plants. Photosynthesis is under the influence of several factors, both internal (plant) and external. The plant factors includes the number, size, age and orientation of leaves, mesophyll cells and chloroplast, internal CO_2 concentration and the

amount of chlorophyll. The plant or internal factors are dependent on the genetic predisposition and the growth of the plant

45 **(a)**

Each water molecule on photolysis yields one H^+ and OH^- ion

$H_2O \rightarrow 2H^+ + [O] + 2e^-$

So, by $12H_2O$ molecule in photolysis 24 H^+ will product

46 **(c)**

In non-cyclic photophosphorylation, evolutions of oxygen take place. It becomes possible due to photolysis of water molecules into H^+ and OH^- ions. Later on OH^- ion reassociate and form water and oxygen, while H^+ ions go to $NADP^+$ (a hydrogen acceptor).

Each water molecule on photolysis yields one H^+ and OH^- ion

$H_2O \rightleftharpoons HO^-H^+$

$2OH + 2OH \rightleftharpoons 2H_2O + O_2 \uparrow$

So, $12\ H_2O \rightleftharpoons 12OH^- + 12H^+$

47 **(a)**

Red light

48 **(b)**

The Calvin cycle is common between the C_3 and C_4-cycle. In C_4, it takes place in bundle sheath and in C_4, it takes place in mesophyll cells

49 **(a)**

Chlorophyll is the principle pigment involved in photosynthesis. Chlorophyll-*a* is the major pigment involved in trapping light energy and converting it into electrical and chemical energy. Chlorophyll-*b* molecules also act as accessory pigment. Other accessory pigments are phycoerythrin, phycocyanin, carotenoids, etc. the accessory pigment and reaction centre together from photo system.

50 **(b)**

In photosynthesis, carbon dioxide is reduced and water is oxidised.

51 **(a)**

C_4-plants have Kranz anatomy, which includes bundle sheath cells and mesophyll cells. In case of C_4 plants, the primary CO_2 acceptor is a 3-carbon molecule. *i.e.*, phosphoenol pyruvate and is present in the mesophyll cells

52 **(a)**

Chloroplast, which is a cytoplasmic cell organelle, is found only in eukaryotic plant cells. These structures help in the manufacture of food through photosynthesis. Chlorophyll is a specialized light absorbing pigment, which is found in the inner wall of granum. Each granum is a flat, sac-like structure, in which light reaction of photosynthesis takes place.

53 **(b)**

ATP is synthesised by cells (in mitochondria and chloroplast) and the process is named as phosphorylation. Photophosphorylation is the synthesis of ATP from ADP and inorganic phosphate in the presence of light. When the two photosystems work in a series, first PS-II and then the PS-I, a process called non-cyclic photophosphorylation occurs. The two photosystem are connected through an electron transport chain, as seen earlier- in the Z scheme. Both ATP and $NADPH + H^+$ are synthesised by this kind of electron flow. When only PS-I is functional, the electron is circulated within the photosystem and the phosphorylation occurs due to the cyclic flow of electrons

54 **(c)**

As per Peter Mitchell's Chemiosmotic coupling hypothesis, outward pumping of protons across the inner chloroplast or mitochondrial membrane results in accumulation of protons between outer membrane and inner membrane. A proton gradient is thus established. As protons now flow back passively down the gradient, the proton motive force is utilised to synthesis ATP.

55 **(c)**

Action Spectrum is the curve depicting the relative rate of photosynthesis at different wave-length of light. It shows that the maximum photosynthesis occur at the blue red region. These regions are the absorption region of chlorophyll-*a*. So, the action spectrum of photosynthesis is almost identical to the absorption spectrum of chlorophyll-*a*

56 **(c)**

Loss of all leaves would do maximum harm to a tree. Due to this, the rate of photosynthesis will decreased, which results in the decrease of metabolic activities.

57 **(c)**

Regeneration of PEP takes place in mesophyll cells by the action of phosphopyruvate kinase

$$\text{Pyruvate} + \text{ATP} \xrightarrow[\text{Kinase}]{\text{Phosphopyruvate}} \text{PEP} + \text{AMP} + H_3PO_4$$

58 **(c)**

Loss of energy occurs during **photorespiration**.

Photorespiration is light induced oxidation of photosynthetic intermediates with the help of oxygen and release of carbon dioxide. Energy is not released during photorespiration.

59 **(b)**

Two molecules of glycine condense to from a molecule of serine and carbon dioxide and ammonia are released.

60 **(c)**

C_4Plants have Rubisco-enzyme. In C_3plants Carboxylation of RuBP leads to formation of PGA.

61 **(a)**

Photorespiration is the light dependent process of oxygenation of ribulosebiphosphate (RuBP) and release of carbon dioxide by the photosynthetic organs of a plant. More oxygen and less carbon dioxide is helpful in photorespiration.

62 **(d)**

H_2O, CO_2, light, chlorophyll are the raw material for photosynthesis

$$6CO_2 + 12H_2O \xrightarrow[\text{Chlorophyll}]{\text{Light}} C_6H_{12}O_6 + 6O_2 + 6H_2O$$

63 **(c)**

In C_4-plants, characteristics Kranz anatomy is found. Vascular bundles are surrounded by two rings of cells-

1. Bundle sheath cell contains starch rich chloroplast, lacking grana.
2. Mesophyll cell, which does not distinguished into palisade and spongy parenchyma.

64 **(d)**

Starch.

Julius von Sachs provided evidence for the production of glucose when plants grow. Glucose is usually stored as starch. His later studies showed that the green substance in plants (chlorophyll as we know it now) is located in special bodies (later called chloroplast) within plant cells.

He found that the green parts in plants are where glucose is made, and that the glucose is usually stored as starch

65 **(d)**

Photosynthesis is a process, in which green plants manufacture their own food with help of carbon dioxide and water in presence of sunlight and takes place in chloroplast. In the question, no photosynthesis takes place because the chloroplast is not intact.

66 **(d)**

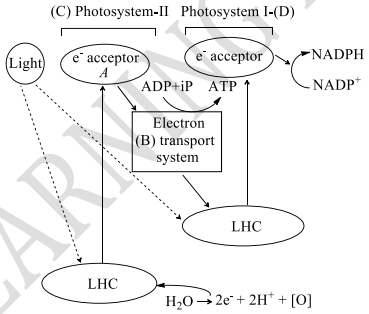
The value of carbon dioxide compensation point is 25-100 ppm in C_3-plants and less than 5 ppm in C_4-plants. Thus, compensation point of C_3-plants is higher than C_4-plants.

67 **(b)**

During downhill movement, the electrons releases energy, which converted ADP into ATP.

68 **(a)**

Transport of electrons in photosynthesis takes place from the PS-II to PS-I through electrons transport system. In the electron transport system, there are various cytochrome, which carries electrons to the down hill potential of redox scale



69 **(c)**

PEP carboxylase.

In C_4-plants the initial fixation of carbon dioxide occurs in mesophyll cell. The primary acceptor of CO_2 is phosphoenol pyruvate or PEP. It combines with carbon dioxide in presence of PEP carboxylase or PEPcase to form oxaloacetic acid or oxaloacetate

$$PEP + CO_2 + H_2O \xrightarrow{\text{PEP carboxylase}} \text{Oxaloacetic acid} + H_3PO_4$$

70 **(d)**

Stroma lamellae lacks both PS-II and NADP reductase due to the occurrence of cyclic photophosphorylation

71 **(a)**

Rubisco stands for ribulosebisophosphate carboxylase oxygenase. Ribulose 1, 5-biphosphate (RuBP)is carbon dioxide acceptor in C_3-plants.

72 **(c)**

The thylakoids of chloroplast are flattened vesicles arranged as a membranous network within the stroma. 50% chloroplast proteins and various components involved (namely chlorophyll, carotenoids and plastoquinone) are present in thylakoids membranes that are

involved in photosynthesis.

73 **(b)**
DUMC (Dichlorophenyl Dimethyl Urea) is a herbicide, which inhibits oxygen evolution and non-cyclic Photophosphorylation. Oxygen evolution and non-cyclic Photophosphorylation, both are involve in PS-II.

74 **(a)**
In CAM-plants, malic acid is formed during night without Kranz anatomy.

75 **(a)**
Energy formed on the stroma side thylakoids membrane during light reaction, *i.e.,* NADPH $+H^+$ of ATP, is used by the Calvin cycle or dark reaction to form the starch or carbohydrates

76 **(d)**
Plants that are adapted to dry tropical regions generally have the C_4 pathway. Though these plants have the C_4-oxaloacetic acid as the first CO_2 fixation product they use the C_3 pathway or the Calvin cycle as the main biosynthetic pathway

77 **(a)**
Maximum photosynthesis rate has been observed in the full spectrum. Regarding the effect of different wavelengths, maximum photosynthesis occurs in red light (660 nm), second maximum in blue (440 nm) and minimum in green

78 **(c)**
During the light reaction, the splitting of water gives two proton, one oxygen and two electrons. Protons are used in the formation of protein gradient across the thylakoid membrane. Oxygen is liberated as byproduct. Electrons goes to the PS-II and to the electron transport chain

79 **(a)**
Adenosine diphosphate (ADP) contains one high energy bond. The second phosphate bond of ADP can release 7300 calorie of free energy per mol on hydrolysis. Adenosine triphosphate (ATP) has two high energy bonds.

80 **(b)**
At places, the thylakoids are aggregated to form stacks of discs called grana. A granum may have 20-50 thylakoid discs. The thylakoids lying outside the grana are called stroma thylakoids on intergranal thylakoids (lamellae)

81 **(b)**
The chemiosmotic hypothesis explains the ATP synthesis mechanism. Like in respiration, in photosynthesis too, ATP synthesis is linked to the development of proton gradient across the membrane. This time these are the membranes of the thylakoid. There is one difference that in photosynthesis the proton accumulation is towards the inside of membrane, *i.e.*, in the lumen. In respiration, proton accumulate in the intermembrane of the mitochondria when electrons move through the ETS (Electron Transport System)

82 **(d)**
Glucose molecule contains-6 carbon. For fixing one carbon (CO_2). Calvin cycle needs 3 ATP and 2 NADPH. Then for fixing six carbon ($C_6H_{12}O_6$), Calvin cycle needs 18 ATP and 12 NADPH.
The net reaction of C_3 dark fixation of CO_2 is
$6\ RuBP + 6\ CO_2 + 18\ ATP + 12\ NADPH$

83 **(c)**
Five types of chlorophyll are present in plants namely *a, b, c, d, e* out of these, only two chlorophyll, *i.e.* ; *a* and *b* occurs in all chloroplast of higher plants. Thus, they are called the main plant photosynthesis pigments

84 **(d)**
C^{14}Is an isotope of carbon. It has been used to draw the path of carbon fixation in the process of photosynthesis.
This lebelledC^{14} becomes incorporated with $^{14}CO_2$, which is accepted by RuBP and 3 carbon compounds, phosphoglyceric acid (3-PGA) is formed. 3-PGA is the first stable compound.

85 **(c)**
Anthocyanin is a water sholuble pigment. It constitute a class of natural phenolic product. These provide colour to petals and fruits.

86 **(a)**
Robert Emerson discovered Pigment System-I (PS-I) and Pigment System-II (PS-II).

87 **(c)**
Photorespiration is also called the glycolate or oxidative photosynthetic carbon cycle

88 **(a)**
M D Hatch and **C R Slack** found that in certain plants growing in tropical climates, the first product of photosynthesis i*s a C_4-compound instead of a C_3-compound. These plants are now known as C_4 − plants or Hatch and Slack type plants. The C_4*-plants show Kranz type anatomy, *e.g.*, sugarcane, Corn, *Euphorbia*, etc.

89 **(d)**
Both PS-I and PS-II are involved in non-cyclic photophosphorylation.

90 **(c)**
Photosynthesis converts radiant energy or the solar energy into chemical energy. Some energy gets stored in the organic food between different atoms. Photosynthetic products provide energy to all organisms to carry out their life activities

91 **(b)**
The phenomenon of breaking up of water into hydrogen and oxygen in the illuminated chloroplasts is called photolysis. Light energy, an oxygen evolving complex and an electron carrier Y_z are required. Electron carrier Y_z transfer the released electrons toP_{680}. The oxidisedP_{680}regains its electrons by the photolysis of water into $2H^+$, $2e^-$and oxygen. Oxygen is given out.

$$H_2O \rightarrow 2H^+ + \frac{1}{2}O_2 + 2e^-$$

Water Proton Electron

92 **(b)**
Dark phase of photosynthesis of Calvin cycle takes place in the stroma of chloroplast. First step of dark phase is Carboxylation. In Carboxylation, carbon dioxide is combined with RuBP to from first stable compound.

$6RuBP + 6CO_2 \xrightarrow{\text{RuBP carboxylase}}$ 12 phosphoglyceric acid

93 **(c)**
In CAM-plants, carbon dioxide enters into the leaf and fixed to oxaloacetic acid, which is then converted to malic acid at night when stomata are open. This malic acid is stored in cells during night. So, in CAM-plants, organic acids accumulate (or their concentration increases) in the dark (*i.e.*, at night) in vacuoles.

94 **(d)**
Oxygen evolved by the splitting of H_2O

$2H_2O \rightarrow 4H^+ + 4e^- + O_2$

So, the isotopic oxygen (O^{18}) molecule in CO_2 will be incorporated into the PGA, RuBP, glucose. Isotopic O^{18} is not found in oxygen liberation

95 **(a)**
P_{fr}From, induces the seed germination.

96 **(b)**
Photosynthesis starts at quite low intensity of light but very high intensity cause solarisation, *i.e.*, disintegration of chlorophyll molecules. Solarisation may reduce the photosynthetic activity.

97 **(b)**
C_4 pathway is seen in angiosperms (dicot and monocots). It is absent in the lower forms of plants, like Pteridophyta or Bryophyta or algae

98 **(b)**
RuBP carboxylase oxygenase

99 **(b)**
During photorespiration in Peroxisome, two molecules of glycine ($2H_2NCH_2 - CO_2$) are transferred into mitochondrion, where they are converted into one molecule of serine ($HOCH_2 - H_2NCH - CO_2$). Thus, the ratio between 2C and 3C intermediates having – NH_2 group is 2:1.

100 **(c)**
Idioblast seems to the most appropriate choice. Invertaseand pepsin are enzyme proteins (contain nitrogen) and bacteriochlorophyll also contains nitrogen. Idioblasts are cells having crystals of calcium oxalate, called raphides.

101 **(b)**
Only on factor, which is close to the minimal value.
Law of limiting factor was proposed by F. F. Blackman. (1905). It stated that when a process is conditioned as to its rapidly by number of separate factors, the rate of the process is limited by the pace of the slowest factor (*i.e.*, the factor present in minimum amount)

102 **(a)**
The external factors would include the availability of sunlight, temperature, CO_2 concentration and water. As a plant photosynthesises, all these factors will simultaneously affect its rate. Hence, through several factors interact and simultaneously affect photosynthesis or CO_2 fixation, usually one factor is the major cause or is the one that limits the rate. Hence, at any point the rate will be determined by the factor available at sub-optimal levels

103 **(b)**
Reduce $NADP^+$.
Light reaction begins with the PS-II. In photosystem-II the reaction centre chlorophyll-*a* absorb 680 nm. wavelength of red light causing electrons to become excited and jump into orbit further from the nucleus. These electrons are picked up by an electron acceptor, which passes them to an electron system consisting of cytochromes.
The movement of electrons in ETS of photosynthesis is down hill in terms of oxidation reduction or redox potential scale. The electrons

are not used up as they pass through the electron transport chain, but they passed on the pigments of photosystem I. Simultaneously, electrons in the reaction centre of PS-I are also excited, when they receive red light of wavelength 700 nm and are transferred to another acceptor molecule that has greater redox potential. These electrons than are moved down hill again this time to a molecule of energy rich $NADP^+$. The addition of these electrons reduces the $NADP^+$ to $NADPH + H^+$

104 **(d)**
The detailed study of C_4-cycle was introduced by **M D Hatch** and **C R Slack** (1966).

105 **(c)**
In stroma, the fixing of CO_2 takes place by expanding $NADPH_2$ and ATP formed by light reaction. So, scientist should have supplied $NADPH_2$ and ATP to intact stroma for CO_2 fixation

106 **(d)**
CAM plants are mostly succulent xerophytes. The stomata in these plants remain closed during the day. They help to check the transpiration. In this way, water is conserved.

107 **(a)**
PEP (Phosphoenol pyruvate) present in mesophyll cell

108 **(d)**
Absorption spectrum of chlorophyll explain the green colour of chlorophyll. It is approximate to action spectrum of photosynthesis and the rate is different at different colour.

109 **(d)**
The use of radioactive ^{14}C by Melvin Calvin in algal (*Chlorella*) photosynthesis studies led to the discovery that the first carbon dioxide fixation product was a 3-carbon organic acid. The first product identified was 3-phosphoglyceric acid (PGA).

110 **(d)**
The first step or Calvin Cycle or C_3-pathway is Carboxylation in which a 5 C sugar RuBP acts as carbon dioxide acceptor in the presence of enzyme RUBISCO and produces 6C unstable compound. This unstable 6C compound splits into molecules of 3-phosphoglyceric acid (3C-compound), which is the first stable product of this pathway.

111 **(c)**
H_2O.
Electron excited by PS-I used in the formation of $NADPH + H^+$. These electrons come ultimately from H_2O through photosynthesis

112 **(d)**
A chromatographic separation of the leaf pigment shows that the colour that we see in leaves is not due to the single pigment but due to four pigments. They are Chlorophyll-*a* (bright or blue green in chromatogram),
Chlorophyll-*b* (yellow green),
Xanthophyll (yellow)
Carotenoids (yellow to yellow orange)

113 **(d)**
Quantasomes are present on inner membrance of thylakoids. Each quantasomehave 230 molecules of chlorophyll.

114 **(a)**
In C_4-plants, leaf shows Kranz anatomy. In these plants, the carbon dioxide first accepted in the mesophyll cells by **PEP** (phosphoenol pyruvate) and form a four carbon compound oxaloacetic acid.

115 **(a)**
Carboxylation of one molecule of RuBP leads to the formation of 2 molecules of PGA
$RuBP + CO_2 \xrightarrow[\text{carboxylase}]{\text{RuBP}} 2-\text{carboxyl 3-keto 1-5,}$ bisphosphoribotol.
2-carboxyl 3-Keto 1-5-bisphosphoribotol $+H_2O \rightarrow$ 2PGA

116 **(c)**
CAM-pathway (Crassulacean Acid Metabolism) is a mechanism of photosynthesis involving double fixation of carbon dioxide, which occurs in succulents belonging to Crassulaceae, cacti, euphorbias and some other plants of dry habitats where the stomata remain closed during the daytime and open only at night.

117 **(c)**
A-Close, B-CO_2. Water stress causes the stomata to close hence, reducing the CO_2 availability

118 **(a)**
Assimilatory power, i.e., ATP and $NADPH_2$ should produced during light reaction of photosynthesis.

119 **(b)**
Grana are the stacks of thylakoids which contain photosynthetic pigments. Therefore, grana are the sites of light reaction.

120 **(d)**
In bundle sheath cell C_3-cycle performed. So, these cells have high number of RuBisCo as compared to other cells

121 **(d)**

In C_4-plants, carbon dioxide is picked up by phosphoenol pyruvate (PEP) and the reaction being catalysed by **PEP carboxylase**.

122 **(c)**
Conversion of carbon dioxide to simple (reduced) organic compounds is called carbon dioxide assimilation or carbon dioxide fixation or carbon fixation. This fixation pathway was elucidated in the early 1950s by **Melvin Calvin** and coworkers and is often called as Calvin cycle.
Since, one molecule of carbon is fixed in one turn of the Calvin cycle. So, **six** turns of the cycle are required to fix the glucose molecule containing six carbon atmos.

123 **(d)**
The light reaction of photosynthesis ends up in the formation of $NADPH_2$ from $NADP^+$

124 **(b)**
In C_4-plants, the Hatch and Slack pathway involves two carboxylation reaction, one taking place in chloroplast of mesophyll cells and other in chloroplast of bundle sheath cells.

125 **(d)**
Synthesis of sugars or carbohydrates is called the biosynthetic phase of photosynthesis. This process does not directly depends on the presence of light but is dependent on the products of the light reaction, *i.e.*, ATP and NADPH, besides CO_2 and H_2O. This could be verified immediately after light becomes unavailable. The biosynthetic process continues for sometime and then stops. If then, light is made available, the synthesis starts again

126 **(b)**
Light reaction begins with the PS-II. In photosystem-II the reaction centre chlorophyll-*a* absorb 680 nm. wavelength of red light causing electrons to become excited and jump into orbit further from the nucleus. These electrons are picked up by an electron acceptor, which passes them to an electron system consisting of cytochromes

127 **(b)**
CO_2 assimilation during photosynthesis generally takes place in two ways in plants
(i) **C_3 pathway** Those plants in which the first product of CO_2 fixation is a C_3 acid (PGA), *i.e.*, the C_3 pathway
(ii) **C_4 pathway** Those plants in which the first product C_4 acid (OAA), *i.e.*, the C_4 pathway

128 **(b)**
Blackman (1905) extended the law of minimum to formulate the law of limiting factors, which in his own words is 'when a process is conditioned as to its rapidity by a number of separate factors, the rate of the process is limited by the pace of slowest factor.'

129 **(d)**
Only PS-I is involved in cyclic photophosphorylation the formation of ATP when the electrons move down hill in term of redox potential

130 **(b)**
Julius Robert Mayer gave name chlorophyll to green pigment present in autotrophs.

131 **(a)**
Within the chloroplast, there is the membranous system (grana, stroma lamellae) and fluid it is called stroma

132 **(c)**
Joseph Priestley observed that a candle burning in a closed, a bell jar, soon gets extinguished.
Similarly, a mouse would soon suffocate in a closed space. He conclude that a burning candle or an animal that breathe the air, both somehow, damage the air.
But when he placed a mint plant in the same bell jar, he found that the mouse stayed alive and the candle continued to burn. Priestly hypothesised that plants restore to the air whatever breathing animals and burning candles remove

133 **(d)**
In photorespiration, the three subcellular compartments namely, the chloroplast, peroxisomes and mitochondria are involved

134 **(c)**
The first step in dark reaction of photosynthesis is Carboxylation, in which six molecules of carbon dioxide Carboxylation, in which six molecules of carbon dioxide combine with six molecules of ribulose 1, 5-biphosphate (RuBP) to form six molecules of unstable six carbon compound. Carboxylation of RuBP is catalysed by the enzyme RuBP carboxylase or **RUBISCO**.

135 **(d)**
The other names for Calvin cycle are Calvin Benson Cycle, C_3-cycle, and reductive pentose phosphate pathway

136 **(b)**
CO_2 assimilation during photosynthesis generally takes place in two ways in plants
(i) **C_3 pathway** Those plants in which the first

product of CO_2 fixation is a C_3 acid (PGA), *i.e.*, the C_3 pathway

(ii) **C_4 pathway** Those plants in which the first product C_4 acid (OAA), *i.e.*, the C_4 pathway

137 **(c)**

Ultimately, all living forms on the earth depends on sunlight for energy. The use of energy from sunlight by the plants for doing photosynthesis is the basis of life on earth. Photosynthesis is important due to two reasons. It is the primary source of food on earth and it is responsible for the release of oxygen into the atmosphere by green plants

138 **(d)**

Photolysis of water involves the splitting of water molecules into OH^- and H^+ ions in the presence of light. This phenomenon is associated with pigment system-II and is catalysed by the presence of Mn^{2+} and CI^- ions.

139 **(a)**

Calvin cycle or dark reaction is the reductive carboxylation leading to the formation of sugar. That's way, it is also called the reductive pentose pathway

140 **(c)**

Triose phosphate isomerase enzyme converts glyceraldehydes-3 phase molecule into dihydroxy acetone phosphate. Then an enzyme **transketolase** comes, which acts on sedoheptulose-7-phosphate molecule and changes it into ribulose-5-phosphate and xylulose-5-phosphate. Then ribulose-5-phosphate isomerase enzyme comes and acts on ribulose-5-phosphate. This reactionhas a molecule of ribulose-5-phosphate, while xylulose-5-phosphate molecule is also converted into ribulose-5-phosphate by ab other enzyme, ribulose-5-phosphate epimerase.

141 **(a)**

Etiolation involves the destruction of chloroplasts and, hence all the chlorophyll when the plants are grown in dark.

142 **(b)**

DCMU (Dichlorophenyl dimethylurea) is a herbicide, which inhibits oxygen evolution and non-cyclic photophosphorylation. Oxygen evolution and non-cyclic photophosphorylation, both are involved in PS-II

143 **(c)**

Pigments are embedded in thylakoids. According to **Emerson**, there are two systems, PS-I lies on outer surface and PS-II in inner surface of thylakoids.

144 **(d)**

The Russian botanist Mikhail Tswett is credited with the original development of a separation technique that we now recognise as a form of chromatography. In 1903, he reported the successful separation of plant pigments by using a column of calcium carbonate

145 **(d)**

Like green plants, some purple and green sulphur bacteria are capable of synthesising their organic food in presence of light, which is known as **bacterial photosynthesis.**

146 **(a)**

In 1845, Liebig proved that organic matter synthesised during photosynthesis is derived from carbon dioxide and water

147 **(d)**

Photophosphorylation is the synthesis of ATP from ADP and inorganic phosphate in the presence of sun-light. When the two photosystems work in series, first PS-II and then the PS-I, a process called non-cyclic Photophosphorylation occurs. The two photosystems are connected through an electron transport chain in the Z-scheme (due to the shape of path of electrons flow). Both ATP and $NADH+H^+$ are synthesized by this kind of electron flow.

148 **(a)**

Melvin Calvin used radioactive ^{14}C in algal photosynthesis, which led to the discovery that the first CO_2 fixation product was a 3-carbon organic acid. He also contributed to working out the complete biosynthetic pathway; hence it was called **Calvin cycle** after him.

The first product identified was **3-phosphoglyceric** acid or **PGA.** For this, he was awarded Nobel Prize

149 **(b)**

Water is oxidised by PS-II, the reaction is

$2H_2O \rightarrow 4H^+ + O_2 + 4e^-$

These electrons goes to the PS-I one by one through ETS (Electron Transport System) on reaching to the PS-I. They reduces $NADP^+$ to $NADPH + H^+$

150 **(d)**

PS-I is present on both the non-appressed part of

grana thylakoids as well as on stroma thylakoids

151 **(b)**

Anthocyanin is water soluble pigment. It constitutes a class of natural phenolic product. These provide colour to petals and fruit. Chlorophyll-*a* and *b* are water insoluble pigments. They are soluble in organic solvents

152 **(a)**

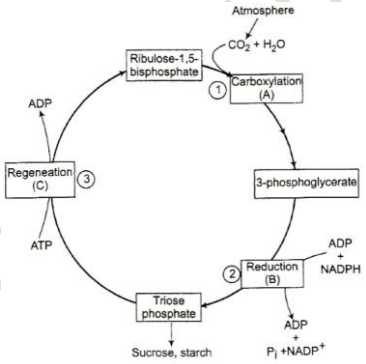
C_4-plants have very little photorespiration because its initial carbon fixation is done by PEP carboxylase not by Rubisco. Beside this, C_4-plant generate their own CO_2 by decarboxylation of C_4 acids in bundle sheath. Due to these reasons, the C_4-plants minimise photorespiration

153 **(b)**

Photolysis is the phenomenon of breaking up of water into hydrogen and oxygen in the illuminated chloroplasts. It is also called, photocatalytic splitting of water. It requires light energy, an oxygen evolving complex and an electron carrier. It also requires the ions, CI^-, Mn^{2+}

154 **(c)**

The Calvin cycle proceeds in three stages (1) carboxylation, during which CO_2 combines with ribulose 1, 5-bisphosphate; (2) reduction, during which carbohydrate are formed at the expense of the photochemically made ATP and NADPH; and (3) regeneration during, CO_2 acceptor is ribulose 1, 5-bisphosphate is formed again so that the cycle continues. Regeneration of the CO_2 acceptor molecule, RuBP is crucial if the cycle is to continue uninterrupted. The regeneration steps require one ATP for phosphorylation to form RuBP



155 **(b)**

During Photophosphorylation, ATP is formed.

156 **(a)**

Usually with increase in light intensity the rate of photosynthesis increased. At very high light intensity the cells exhibit photooxidation by the process of solarization and if continues for few hours, the photosynthetic apparatus is destroyed.

157 **(d)**

Due to the higher value of CO_2 and ATP, the rate of Calvin cycle increases to form carbohydrate (starch). This leads to inhibition of photorespiration (glycolate cycle) and Kreb's cycle

158 **(c)**

During the photosynthesis within chloroplast protons in the stroma decreases in number, while in lumen there is accumulation on protons. This create a proton gradient across the thylakoid membrane as well as a measurable decrease in pH (acidic) in the lumen

159 **(b)**

Chlorophyll structure was studied by Wilstatler, Stoll and Fisher in 1912. It has a tadpole like structure with head called porphyrin and a tail made up of long chain alcohol called phytol. Porphyrin head is made up of four pyrrole rings, which are linked by methane a bridges $(-CH=)$

160 **(b)**

Members of family-Crassulaceae perform CAM photosynthesis.

161 **(c)**

A-Tropical, B-Temperate. Tropical plants have a higher temperature optimum than the plants adopted to temperate climate

162 **(d)**

Ancient plants were like cyanobacteria. These plants used hydrogen source other than water and, therefore, did not release oxygen from photolysis of water.

163 **(d)**

Photorespiration (C_2cycle) is a special type of respiration shown by many green plants (C_3plants) when they are exposed to light. It is a light dependent process during which oxygen is used and carbon dioxide is released. The process of photorespiration takes place only in chlorophyllous tissues of plants. Therefore, the main site for photorespiration is chloroplast. But mitochondria and peroxisomes are peroxisomes are also required to complete the process.

164 **(a)**

Electrons are transferred to hydrogen carrier, which is located towards the outer side of the membrane

165 **(a)**

Hill reaction also called light reaction is a photochemical reaction. In this, reduced enzymes

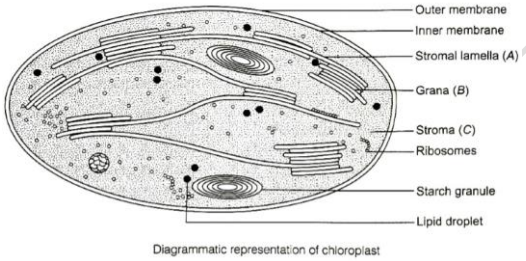
and phosphate bond energy (ATP) are produced.

166 **(d)**
In chloroplast, the light reaction occurs in grana and dark reaction in stroma

167 **(b)**
PS-II absorbs maximum 680 nm wavelength of light, thus reaction centreis P_{680}.P_{680} (PS-II) extracts an electron from water, returning to its unexcited state because hydrolysis of water occurs in PS-II. Oxygen evolved in PS-II comes from water.

168 **(d)**
Cyclic-photophosphorylation involves only pigment system-I. When the photons activate PS-I, a pair of electrons are raised to higher energy level. They are captured by primary acceptor, which passes them on to ferredoxin, plastoquinone, cytochrome complex, plastocyanin and finally back to reaction centre of PS-I, *i.e.,*P_{700}. At each step of electron transfer, the electrons lose potential energy. Their trip down hill is caused by the transport chain to pump H^+ across the thylakoids membrane. The proton gradient thus established is responsible for forming ATP (2 molecules). But no reduction of NADP to NADPH+H^+ takes place.

169 **(b)**
A-Stroma lamella, B-Grana, C-Stroma



Diagrammatic representation of chloroplast

170 **(a)**
A-680 nm, B-electron donor, C-cytochromes

171 **(d)**
C_4-plants show Kranz anatomy. In these plants, the primary carbon dioxide acceptor in mesophyll cells is phosphoenol pyruvate (PEP).
In light reaction of photosynthesis, PS-II absorbs energy at or just below 680 nm, while PS-I absorbs energy at 700 nm.

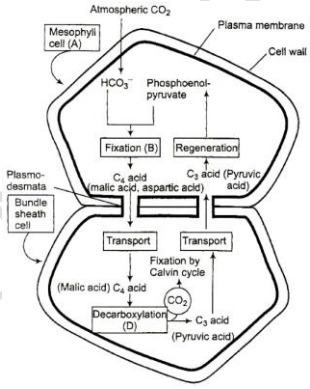
172 **(a)**
In C_4-plants, the PEP case is present in mesophyll cells (C_4-cycle) and RuBisCo is present bundle sheath cells (c_3-cycle)

173 **(b)**
C_4-pathway occurs in some tropical plants having Kranz anatomy (undifferentiated mesophyll around vascular bundles with chloroplast containing bundle sheath). The final CO_2 fixation occurs in bundle sheath cells.

174 **(b)**
The correct equation that would represent the overall process of photosynthesis is
$$6CO_2 + 12H_2O \xrightarrow{\text{Light}} C_6H_{12}O_6 + 6H_2O + 6O_2$$

175 **(a)**
The site for photorespiration is chloroplast. Peroxisomes and mitochondria are required for completing the process. This happens at high temperature and high oxygen concentration. Lysosome are not involved in photorespiration

176 **(a)**
In the hatch and Slack pathway (C_4-cycle), the first stable compound is C_4 organic acid called oxaloacetic acid



177 **(b)**
Englemann studied the effect of different region of the visible spectrum on the rate of photosynthesis of different algae. The amount of oxygen release was found to be maximum in blue and red absorption bands of chlorophyll.

178 **(b)**
The empirical formula of chlorophyll-a is$C_{55}H_{72}O_5N_4Mg$.

179 **(b)**
Oxygen, which is liberated during photosynthesis comes from water.
$$4H_2O \rightleftharpoons 4H^+ + 4OH^-$$
$$4OH^- \xrightarrow{Mn^+,CI^-} 2H_2O + O_2 \uparrow + 4e^-$$

180 **(a)**
It is estimated that photosynthetic organism remove 100 × 1015 grams (.1015 + tonn) of carbon/year (Houghton and Wood well 1990)

181 **(d)**
Light reaction starts when solar radiation or light falls on the PS-II. Light reaction is also called photochemical phase, which includes light absorption, water splitting, oxygen release and

formation of high energy chemical inter mediates like ATP and NADPH

182 **(d)**

In	Out
Six CO_2	One glucose
18 ATP	18 ADP
12 NADPH	12 NADP

183 **(c)**

Minimum photosynthesis occur in the green wavelength. Plants grow under the canopy like herbs and shrubs receive very little red and blue-violet light because of its absorption by leaves of the canopy. They receive more of green light that is transmitted through leaves. As a result, the photosynthesis in herbs and shrubs is comparatively low

184 **(a)**

PEPcase has an advantage over the RuBisCo because PEPcase does not bind to the oxygen. But RuBisCo binds with oxygen and does the photorespiration, which is a harmful and wastage process and leads to decrease in photosynthetic yields

185 **(a)**

RuBisco (Ribulose, 1-5 biphosphatase carboxylase and oxygenase) is the main critical enzymes in photosynthetic carbon fixation. Mg^{2+} is an activator of RuBisCo

186 **(a)**

The phenomenon of photolysis of water during photosynthesis is associated wit photosystem-II and catalysed by presence ofMn^{2+} and CI^{-} ions. When PS-II is active, the water molecules split into OH^{-} and H^{+} ions.

187 **(b)**

RuBisCo.

RuBisCo is the most abundant enzyme in the world. It is characterised by the fact that active sites can bind to both CO_2 and O_2. This binding is competitive. It is the relative concentration of O_2 and CO_2 that determines, which of two (CO_2 and O_2) will bind to enzyme

188 **(a)**

Dicker and **Tio** (1959) discovered photorespiration in tobacco plant. It is a light dependent process of oxygenation of ribulosebisphosphate (RuBP). During this process, carbon dioxide is liberated and oxygen is consumed. C_4-plants avoid photorespiration by following Hatch-Slack pathway.

189 **(d)**

Flow of electrons in the non-cyclic photophosphorylation is always unidirectionally, from PS-II to the PS-I

190 **(b)**

Joseph Priestley (1733-1804) in 1770 performed a series of experiment that revealed the essential role of air in growth of green plant. He also discovered oxygen in 1774

191 **(d)**

Pigment system-II (PS-II) has absorption maxima at 680 nm and is called P_{680}.

192 **(c)**

Mesophyll cells and bundle sheath cells which are connected through plasmodesmata, through which organic acid like malic acid, pyruvic acid can translocate. Malic acid translocate from the mesophyll cells to bundle sheath cell and pyruvic acid translocate from the bundle sheath cells to mesophyll cells

193 **(c)**

The light intensity at which a plant can achieve maximum amount of photosynthesis is called saturation point

194 **(b)**

Sunken stomata are usually found in crassulacean acid metabolic plants. Such automata remain situated below the epidermis and open at night.

195 **(b)**

In C_4-plants the Calvin cycle takes place in bundle sheath cells

196 **(b)**

The C_3-plant shows optimum photosynthesis at high CO_2 concentration

197 **(b)**

During C_4-cycle, the first C_4 acid formed is oxaloacetic acid in chlorophyll of mesophyll cells. Then this oxaloacetic acid changes into another C_4 acids like malic and aspartic acid in mesophyll and bundle sheath cells respectively

198 **(a)**

Reduction of $NADP^{+}$ to NADPH occurs during non-cyclic Photophosphorylation of light reaction, while oxidation of NADPH takes place during Calvin cycle.

Teporphyrin ring of chlorophyll a flat, square, structure of alternating single and double bonds containing four smaller pyrrole rings with a magnesium atom at the centre.

199 **(c)**

C_4-plants have Kranz anatomy in their leaves. In this leaf, the vascular bundle is surrounded by

bundle sheath and mesophyll cells. Chloroplasts in the bundle sheath cells lack grana, while mesophyll chloroplasts are normal, *e.g. sugarcane, maize, Euphorbia, Amaranthus, Sorghum, Portulaca*and *Chenopodium.*

200 **(b)**

Oscillatoria is a photosynthetic cyanobacterium. In this, photosynthesis water is electron donor and oxygen is a byproduct, *i.e.*, oxygenic photosynthesis occurs. *Rhodospirillum* and *Chlorobium* are non-oxygenic photosynthetic, purple non-sulphur and green-sulphur bacteria. *Chromatium* is purple sulphur bacterium and also non-oxygenic photosynthetic.

201 **(c)**

C_4-**plants are special** They have a special type of leaf anatomy, they tolerate higher temperature, they show a response to high light intensities, they lack a process called photorespiration and have greater productivity of biomass

202 **(c)**

Most of the photosynthesis takes place in blue and red region

203 **(b)**

The addition of $NaHCO_3$ to water in the given experimental set-up causes the availability of more carbon dioxide for photosynthesis. Thus, amount of oxygen evolved increases.

204 **(a)**

Cornelius van Niel (1897-1985) who based on his studies on purple and green bacteria, demonstrated that photosynthesis is essentially a light dependent reaction in which hydrogen from a suitable oxidisable compound reduces carbon dioxide to carbohydrate. *This can be expressed by*

$$2H_2A + CO_2 \xrightarrow{\text{Light}} 2A + CH_2O + H_2O$$

In green plants, H_2O is the hydrogen donor and is oxidised to O_2 photosynthesis. Some organism do not release O_2 during photosynthesis. When H_2S instead is the hydrogen donor for purple and sulphur bacteria, the oxidation product is sulphur or sulphate depending on the organism and not O_2. Hence, he inferred that O_2 evolved by green plant comes from H_2O, not from carbon dioxide

205 **(d)**

Ruben and Kamen (1941) and Ruben *et al* (1941) suspended *Chlorella* in water having non-radioactive heavy isotope of oxygen ^{18}O, instead of natural oxygen (^{16}O). The suspension was illuminated. Oxygen evolved was tested by means of mass spectrometer. It was found to be having isotope, O^{18}. This is possible only if, oxygen evolved during photosynthesis comes from splitting of water

$$6CO_2 + 12H_2O^{18} \xrightarrow[\text{Chlorophyll}]{\text{Light}} C_6H_{12}O_6 + 6H_2O + 6\,O_2^{18}$$

206 **(d)**

Photosystem-I is located on both the non-appressed part of grana thylakoids as well as stroma thylakoids, while photo system-II is located in the appressed part of the grana thylakoids.

207 **(a)**

A possible location for the cyclic phosphorylation is the stroma lamellae because stroma lamellae lacks PS-II as well as the NADP reductase enzyme

208 **(d)**

Plastocyanin is a small (10.5 KDa), water soluble, copper containing protein that transfer electrons between the cytochrome-$b_6 - f$ complex and P_{700}.

209 **(d)**

During phosphorylation, the chloroplast stroma is less acidic than the interior of thylakoid membrane because accumulation of protons during electron transport chain occurs in the lumen of thylakoid

210 **(c)**

Ribulose bisophosphate carboxylase oxygenase and phosphoenol pyruvate carboxylase are critical enzymes in photosynthetic carbon fixation. Mg^{2+}Is an activator for both the enzymes?

211 **(b)**

In 1939, **Robin Hill** demonstrated photolysis of water by isolated chloroplast in the presence of suitable electron acceptor.

212 **(c)**

Ottowarburg made an observation that O_2 inhibits photosynthesis in C_3-plants. This phenomenon is originally known as the Warburg effect. It was latter recognised as the light dependent release of CO_2 due to oxygenase activity of RuBisCo called photorespiration

213 **(b)**

After the fixing of CO_2 to Oxaloacetic Acid (OAA) in C_4 cycle, the oxaloacetic acid changes into the malic aspartic acid

$$OAA + NADPH \xrightarrow{\text{Malic acid dehydrogenase}} \text{Malic acid} + NADP^+$$

$OAA + NH_3 + NADPH \xrightarrow{\text{Transaminase}}$ Aspartic acid $+ NADP^+ + H_2O$

Both of these reactions occur in mesophyll cell

214 **(b)**

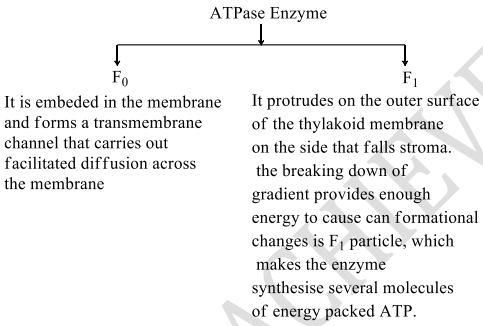
The portion of spectrum between 400-700 nm is referred to as Photosynthetically Active Radiation. Manganese and chloride ions play prominent role in photolysis of water.

215 **(b)**

ATP is synthesised by cells (in mitochondria and chloroplasts) and the process is named as phosphorylation. Photophosphorylation is the synthesis of ATP from ADP and inorganic phosphate in the presence of light. When the two photosystems work in a series, first PS-II and then the PS-I, a process called non-cyclic photophosphorylation occurs. The two photosystem are connected through an electron transport chain, as seen earlier- in the Z scheme. Both ATP and NADPH + H^+ are synthesised by this kind of electron flow. When only PS-I is functional, the electron is circulated within the photosystem and the phosphorylation occurs due to the cyclic flow of electrons

216 **(b)**

I and II.



217 **(d)**

Chemiosmosis requires a membrane, a proton pump, a proton gradient for making ATP through ATPase enzyme

218 **(a)**

Biosynthetic phase of photosynthesis depend on the NADPH and ATP. Both are used directly in the synthesis of glucose.

The energy required to hydrolyse the water comes from oxidising chlorophyll. Oxidation of chlorophyll occurs due to the release a high energy electrons from the chlorophyll

219 **(d)**

Kranz anatomy is the characteristics of C_4-plants. The vertical section of leaves of C_3 and C_4 show differences. The C_4 leaves have particularly large cells around the vascular bundles of C_4 pathway plants called bundle sheath cells and the leaves which have such kind of anatomy are said to have 'Kranz-anatomy'. 'Kranz' means wreath and is reflection of arrangement of cells

220 **(a)**

The process of photorespiration have the involvement of chloroplasts, peroxisomes and mitochondria. Biochemical mechanism for photorespiration is also called **glycolate cycle.**

221 **(b)**

Photosynthesis (*photos-light*; *synthesis*-putting together) is an anabolic process of manufacturing organic compounds inside the chlorophyll containing cells from carbon dioxide and water with the help of sunlight as the source of energy

222 **(c)**

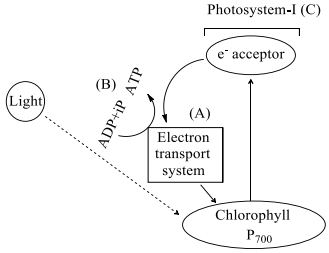
Beyond the saturation point (seldom seen in C_4-plants), the rate of photosynthesis begin to decline. This process is called solarisation. It is due to the reduction in hydration and closure of stoma (photo-inhibition) or oxidation of photosynthetic pigment (photoxidation)

223 **(b)**

A chemical substance, when irradiated with UV rays, absorbs radiation and emits visible light is called **fluorochrome**.

224 **(b)**

In cyclic photophosphorylation, only PS-I is functional and the formation of ATP takes place (not NADPH). The possible location of cyclic photophosphorylation is stroma lamella



225 **(a)**

Chlorophylls are magnesium porphyrin compounds. Chlorophyll-*a* ($C_{55}H_{72}O_6N_4Mg$) and chlorophyll-b ($C_{55}H_{70}O_6N_4Mg$), both consist of magnesium porphyrin head, which is hydrophilic and a phytol tail, which is lipophilic but chlorophyll-*b* differs from chlorophyll-*a* only in one of the functional groups bonded to porphyrin. Actually in chlorophyll-*b*, there is – CHO(aldehyde) group instead of – CH_3(methyl) group at the third C-atom in second pyrrole ring.

226 **(b)**

PAR (Photosynthetically active radiation) designates the spectral range of solar radiation from 400 to 700 nm that photosynthetic organisms are able to use in the process of photosynthesis. Of the total incident solar radiation the proportion of PAR is less than 50%

227 **(c)**

Using a similar set up as used by Priestley but by placing it once in a dark and once in a sunlight, Jan Ingen Housz (1730-1799) showed that sunlight is essential to plant process that purifies air

228 **(c)**

Glucose is a hexose sugar. It's one molecule contains six carbon atoms. As Calvin cycle takes in only one carbon (as CO_2) at a time, six turns of this cycle will be required to produce one molecule of glucose (6C).

Hence, for producing 5 molecules of glucose (30 molecules of carbon), 30 turns of Calvin cycle are required.

229 **(b)**

During the light reaction

(i) Formation of ATP from ADP takes place or phosphorylation of ADP to ATP takes place

(ii) Reduction of $NADP^+$ to NADPH + H^+ takes place by PS-I through electron transport system

230 **(d)**

ATP made when energy is used to bond another phosphate to ADP, a process called **phosphorylation**. In photosynthesis, the energy is supplied by light and the process is, therefore, called **photophosphorylation**.

231 **(b)**

TW Engelmann (1843-1909) performed an interesting experiment using a prism. He split light into its spectral components and then illuminated a green alga, *Cladophora*, placed in a suspension of aerobic bacteria.

The bacteria were used to detect the sites of O_2 evolution. He observed that the bacteria accumulated mainly in the region of blue and red light of the split spectrum. A first action spectrum of photosynthesis was thus described

232 **(a)**

Julius von Sachs provided evidence for the production of glucose when plants grow. Glucose is usually stored as starch. His later studies showed that the green substance in plants (chlorophyll as we know it now) is located in special bodies (later called chloroplast) within plant cells.

He found that the green parts in plants are where glucose is made, and that the glucose is usually stored as starch

233 **(d)**

Calvin cycle (C_3-cycle) was discovered by **Calvin, Benson** and their associates, which fed *Chlorella* and *Scenedesmus* with radioactive carbon (C^{14}) in carbon dioxide.

234 **(b)**

The movement of electrons in ETS of photosynthesis is down hill in terms of oxidation reduction or redox potential scale. The electrons are not used up as they pass through the electron transport chain, but they passed on the pigments of photosystem I. Simultaneously, electrons in the reaction centre of PS-I are also excited, when they receive red light of wavelength 700 nm and are transferred to another acceptor molecule that has greater redox potential. These electrons than are moved down hill again this time to a molecule of energy rich $NADP^+$. The addition of these electrons reduces the $NADP^+$ to NADPH + H^+

235 **(b)**

When $P_r$absorbs red light (660-665 nm) it is converted into P_{fr} from and when P_{fr} absorbs far red light (730-735 nm)it is converted into P_r from.

236 **(d)**

Kranz anatomy is a characteristic feature of the leaves of C_4-plants like sugarcane, maize, etc. in this type of anatomy, mesophyll cells are not differentiated into spongy and palisade cells and have chloroplasts with large grana. These are involved in the initial fixation of carbon dioxide. Bundle sheath chloroplasts are large and agranal and are highly efficient in carbon dioxide fixation, therefore, abundant starch grains are produced in these cells.

237 **(a)**

In the matrix or stroma, there are embedded a number of flattened membranous sacs called thylakoids or lamellae. Membranes of thylakoids are called fret membranes. They are made up of both proteins and unsaturated lipids, roughly in the ratio of 50:50

238 **(b)**

C_4-plants are more efficient in photosynthesis than C_3-plants but use more energy. They possess the larger number of chloroplasts in the leaf cells. In the leaves of C_4- plants, the vascular bundles are surrounded by bundle sheath of larger

parenchymatous cells, which in turn are surrounded by mesophyll cells. Chloroplasts in bundle sheath cells are larger and always contain grana, whereas chloroplasts in mesophyll cells are smaller.

239 **(a)**
RuBPcarboxylase (RUBISCO) is the most abundant protein in chloroplasts and probably on earth. It catalyses the carboxylation of ribulose 1-5 bisphosphate to form two molecules of 3-phosphoglyceric acid in C_3-cycle of photosynthesis.

240 **(c)**
During the photolysis of water, the release of electrons, protons and oxygen takes place. Reaction during the photolysis of water is follows
$2H_2O \rightarrow 4H^+ + O_2 + 4e^-$

241 **(a)**
Kranz anatomy, *i.e.*, chloroplast containing mesophyll cells and bundle sheath cells. The phosphoenol pyruvate in mesophyll cells combine with CO_2 in presence of PEP carboxylase and forms oxaloacetic acid and large bundle sheath are the characters of C_4 plants

242 **(c)**
In the leaves of C_4-plants, the bundle sheath consists of thick walled cylindrical cells. These cells have a granal chloroplast so density is low

243 **(b)**
Scheme of transfer of electrons, starting from the PS-II, uphill to the acceptor, down the electron transport chain to PS-I, excitation of electrons, transfer to another acceptor and finally down hill to $NADP^+$ causing it to be reduced to NADPH + H^+ is called the Z scheme, due to its characteristic shape. This shape is formed when all the carriers are placed in a sequence on a redox potential scale

244 **(b)**
Photophosphorylation in chloroplast is similar to the mitochondrial oxidative phosphorylation. In both of them, the proton gradient plays a significant role in chloroplast the proton gradient develops in the lumen and in mitochondria the proton gradient develops in the intermitochondrial space. Rest of the mechanism of phosphorylation remains the same in both the organelle

246 **(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 carbon dioxide to carbohydrate in dark reaction.

247 **(a)**
At the low CO_2 and high O_2 concentration RuBisCo oxygenese activity increases. Binding with oxygen leads to the formation of 2-phosphoglycolate and 3 phosphoglycerate

248 **(b)**
In C_4-plants the initial fixation of carbon dioxide occurs in mesophyll cell. The primary acceptor of CO_2 is phosphoenol pyruvate or PEP. It combines with carbon dioxide in presence of PEP carboxylase or PEPcase to form oxaloacetic acid or oxaloacetate

$PEP + CO_2 + H_2O \xrightarrow{\text{PEP carboxylase}}$ Oxaloacetic acid $+ H_3PO_4$

249 **(a)**
The vertical section of leaves of C_3 and C_4 show differences. The C_4 leaves have particularly large cells around the vascular bundles of C_4 pathway plants called bundle sheath cells and the leaves which have such kind of anatomy are said to have 'Kranz-anatomy'. 'Kranz' means wreath and is reflection of arrangement of cells

250 **(b)**
Dark phase of photosynthesis or Calvin cycle takes place in stroma of chloroplast. First step of dark phase is Carboxylation. In Carboxylation, carbon dioxide is combined with RuBP to form first stable compound.

$6RuBP + 6CO_2 \xrightarrow{\text{RuBP carboxylase}}$ 12 phosphoglyceric acid

$NADP^+$acts as hydrogen acceptor.

251 **(b)**
The Calvin cycle occurs in the stroma of chloroplast of C_3 plants and consists of three main parts, i.e., carboxylation, reduct5ion and regeneration. Carboxylation involves addition of carbon dioxide to ribulose 1,5-bisphosphate in presence of **RUBISCO** enzyme to form 3-PGA (3-phosphoglyceric acid), *i.e.*, single carboxylation occurs in Calvin cycle.

252 **(a)**
Plants adapted to low light intensity have larger photosynthetic unit size than the sun plants.

253 **(a)**
Oxygen evolves by the oxidation of water molecule in the process called photosynthesis. Thus, it water is O^{18} labelled then oxygen

liberated by process called photosynthesis must also be labelled

254 **(a)**
Algae (*Clodophora*).
Julius von Sachs provided evidence for the production of glucose when plants grow. Glucose is usually stored as starch. His later studies showed that the green substance in plants (chlorophyll as we know it now) is located in special bodies (later called chloroplast) within plant cells.
He found that the green parts in plants are where glucose is made, and that the glucose is usually stored as starch

255 **(d)**
Three molecules of carbon dioxide must be converted to glyceraldehydes 3-phosphate (three carbon molecules), three ATP and two NADPH are required for each carbon dioxide to be converted to glyceraldehydes-3-phosphate.
$3CO_2 + 6NADPH + 9ATP \rightarrow$Glyceraldehyde 3-photophate $+ 6NADPH^+ + 9ADP + P_i$

256 **(d)**
Product of light reactions are ATP, NADPH and O_2. Of these O_2 diffuse out of the chloroplast, while ATP and NADPH are used to drive the process leading to synthesis of food, sugars. NADPH + H^+, O_2, etc.

257 **(b)**
There is a point in the light intensity, where there is no gaseous exchange in photosynthesis. It is called light compensation point

258 **(b)**
During the dark reaction the acceptor of CO_2 is RuBP (Ribulose 1-5 diphosphate). After accepting, it forms the intermediately six carbon compound, which breaks down into two three carbon stable compound. It is called 3 PGA

259 **(b)**
The first reaction of photorespiration occurs in **stroma** of chloroplast. In this reaction, the RuBP (Ribulose 1, 5-biphophate) consumes one oxygen molecules in presence of enzyme RUBISCO. In **peroxisome**, the glycolate transferred from chloroplast, takes up oxygen and formed the glyoxylate whereas the H_2O_2 release as byproduct.

260 **(d)**
Phosphorylation refers to the process, in which ATP is made, when energy is used to bond another phosphate to ADP. In photosynthesis, they energy is supplied by light and the process is, therefore, called photophosphorylation.

261 **(a)**
Due to the difference in the pH of the two medium (outside and inside), there is development of proton gradient, which leads to the formation of ATP

263 **(d)**
If light becomes unavailable then the biosynthetic phase continues for sometime and then stops. Product of light reactions are ATP, NADPH and O_2. Of these O_2 diffuse out of the chloroplast, while ATP and NADPH are used to drive the process leading to synthesis of food, sugars. NADPH + H^+, O_2, etc.

264 **(d)**
During photosynthesis, the proton accumulation is towards the inside of the membrane, *i.e.*, in the lumen. In respiration, protons accumulate in the intermembrane space of the mitochondria when electrons move through the ETS

265 **(c)**
The C_4-plants have **dimorphic chloroplasts-granal** and **agranal**. Chloroplasts in mesophyll cells are granal, *i.e.*, they contain thylakoids that are stacked to form grana, as in C_3 −plants. Chloroplasts of **bundle sheath cells** are agranal, *i.e.*, grana are absent and the thylakoids are present only as stroma lamellae.

266 **(d)**
The uses of radioactive ^{14}C by Malvin-Calvin in algal (*Chlorella*) photosynthesis studies, led to the discovery that first carbon dioxide fixation product was 3-carbon organic acid. This first product was identified as 3-Phosphoglyceric Acid (3PGA)

267 **(d)**
Hill's reaction/photochemical/light reaction is initiated when specific light is absorbed by group of chlorophyll molecules primarily concerned with light harvesting.

268 **(a)**
Fixing of one molecule of CO_2 or carbon needs 5 ATP and 2 NADPH in C_4-plants. C_4-plants takes 2 more ATP than C_3-plants. But, the photorespiration is absent in C_4-plants, thus C_4-plants are more economical than C_3-plant

269 **(d)**
CO_2 is required for photosynthesis is demonstrated by half-leaf experiment in which a

part of a leaf is enclosed in a test tube containing some KOH soaked cotton (which absorbs CO_2), while the other half is exposed to air. The setup is then placed in light for some time.
On testing for starch later in the two halves of the leaf, the exposed part of the leaf tested positive for starch while the portion that was in the tube, tested negative. This showed that CO_2 is required for photosynthesis

270 **(b)**
Pineapple is a CAM (Crassulacean Acid Metabolic)plant, in this, the process of photosynthesis takes place in two different places, *i.e.*, light and dark

271 **(a)**
For every CO_2 molecule entering the Calvin cycle, 3 molecule of ATP and 2 molecule of NADPH are required. The difference in the number of ATP and NADPH used in dark reaction is overcome by cyclic phosphorylation

272 **(d)**
Proton gradient is important because it is the break down of this gradient that leads to release of energy. The gradient is broken down due to movement of protons across the membrane to the stroma through the transmembrane channel of the F_0 of the ATPase.
The energy released during the breaking down of proton gradient is used in formation of ATP

273 **(d)**
Plastoquinone is the first acceptor of electrons from an excited chlorophyll molecule of photo system-II.

274 **(a)**
Cytochromes are iron containing pigments. These acts as electron transporter or electron acceptor in respiration and photosynthesis

275 **(a)**
Oxaloacetic acid is a ^4C-compound. In C_4-plants, oxaloacetic acid is the first carbon dioxide fixation product.

276 **(a)**
Action spectrum.
Though chlorophyll-*a* is the major pigment responsible for trapping light, other thylakoid pigments like chlorophyll-*b*, xanthophylls and carotenoids, which are called accessory pigments, also absorb light and transfer the energy to chlorophyll-*a*. Indeed, they not only enable a wider range of wavelength of incoming light to be utilised for photosynthesis but also protect chlorophyll-*a* from photooxidation

277 **(b)**
A-with, B-decrease. Water stages leaves with thus reducing the surface area of leaves and their metabolic activity as well

278 **(c)**
Even after the closing, the stomata of C_4-plants performs photosynthesis because they can produce their own CO_2 by decarboxylation of malic acid, which is used in Calvin cycle like in C_3-plants

279 **(d)**
Photorespiration is the uptake of oxygen and release of carbon dioxide in light that results from the biosynthesis of glycolate in chloroplast and subsequent metabolism of glycolic acid in the same leaf cell through other two cell organelles (*i.e.*, peroxisome and mitochondria). Conversion of phosphoglycolate to glycolate takes place in **chloroplast**.

280 **(a)**
The chemical formula of starch is $(C_6H_{10}O_5)_n$.

281 **(c)**
Emerson *et al*, (1957) discovered that far red light (above 680 nm), which is Photosynthetically inefficient can be made efficient by supplementing it with a beam of shorter wavelength (red beam below 680 nm). Further the quantum yield in combined beam (far red+red) is more than sum total of quantum yields in two separate beam. This enhancement in quantum yield by supplementing far red light with red light is called **Emerson enhancement effect**.

282 **(b)**
Carotenoids are a group of yellow, red and orange pigments, which function as accessory pigments and protect chlorophyll molecules from destruction by intensive light rays. Carotenoids have three absorption peaks in the **blue-violet** range of the spectrum.

283 **(b)**
The fixation of carbon dioxide in C_4-plants takes place in two places and by two different organic compounds. Phosphoenol pyruvate (PEP) is found in mesophyll cells, which primarily fixes atmospheric carbon dioxide into oxaloacetic acid (4C). RUBISCO is present in bundle sheath cells, where final fixation of carbon dioxide in hexose sugar takes place. Carbon dioxide is primarily fixed by PEP carboxylase because this enzyme has greater affinity to carbon dioxide than RUBISCO.

284 **(b)**
CAM plants store large quantities of CO_2 at night and release it later during the day for use by the photosynthetic carbon reduction cycle.
Example-*Kalanchoe, Agave, Opuntia,* etc.

285 **(a)**
RuBP (Ribulose, 1-5 diphosphate) is the 5 carbon compound in which the ribose sugar is present

286 **(d)**
The membranous system is responsible for trapping the light energy that make ATP and NADPH necessary for the starch synthesis

287 **(a)**
Photophosphorylation is differ from oxidative phosphorylation in requiring the input of energy in the form of light to create a good electron donor.

288 **(b)**
Cyclic phosphorylation occurs only when wavelength beyond 680 nm is available for excitation.
Non-cyclic phosphorylation occurs in the membrane or lamellae of grana. Because membrane or lamellae of grana have both photosystem (PS-I and PS-II) and in non-cyclic phosphorylation both PS-I and PS-II participates

289 **(a)**
Cytochrome are the electrons carrier between the PS-II to PS-I in photosynthesis. If there is a mutation in cytochrome then the movements of electrons from PS-II to PS-I is inhibited

290 **(a)**
$6CO_2 + 12H_2O \rightarrow C_6H_{12}O_6 + 6O_2 + 6H_2O$

291 **(b)**
Photolysis of water means breakdown of water in the presence of sun light. This generates oxygen. Photolysis of water takes place in light reaction and it requires **chloride** and **manganese** ions as catalyst.

292 **(d)**
Excited simultaneously with PS-II (P_{680}).
The movement of electrons in ETS of photosynthesis is down hill in terms of oxidation reduction or redox potential scale. The electrons are not used up as they pass through the electron transport chain, but they passed on the pigments of photosystem I. Simultaneously, electrons in the reaction centre of PS-I are also excited, when they received red light of wavelength 700 nm and are transferred to another acceptor molecule that has greater redox potential. These electrons than are moved down hill again this time to a molecule of energy rich $NADP^+$. The addition of these electrons reduces the $NADP^+$ to $NADPH + H^+$

293 **(a)**
In low carbon dioxide concentration, glycolic acid or glycolate is formed, which is the substrate for photorespiration or C_2-cycle or glycolate metabolism.

294 **(c)**
Usually, the chloroplasts align themselves along the walls of mesophyll cells, such that they get the optimum quantity of the incident light

295 **(b)**
Photorespiration required chloroplast, mitochondria and peroxisome to complete the process. At high temperature and high oxygen concentration, RuBPoxygenase oxidizes RuBP to produce phosphoglycolate then glyoxylate and then glycine. Two glycine molecule in addition to α-ketoglutarate produce serine molecule. Therefore, to produce 20 serine molecules, 40 RuBP molecules are required.

296 **(d)**
In Calvin cycle, ribulose 1-5 biphosphate ultimately produces two molecules of 3 PGAL, *i.e.*, total 6 molecules by three Calvin cycles. In the same one ATP for each 3 PGAL molecules is phosphorylated (Total 6 ATP).

297 **(a)**
In C_4plants, primary CO_2acceptor is 3C-compound, phosphoenol pyruvate (PEP) and is present in the mesophyll cells. The enzyme responsible for this fixation is PEP carboxylase or PEPcase.

298 **(a)**
CAM plants fix CO_2at night and from malate which stored in large vacuole of mesophyll cells till next day. These plants use PEP carboxylase. The malate release CO_2 in day for use in Calvin cycle in same cell, e.g., family-Euphorbiaceae, Asclepiadaceae, etc.

299 **(a)**
A-C_3, B-2, C-5

300 **(d)**
PS-I (photosystem-I) is a photosynthetic pigment system along which some electron carriers that is located on both the non-appressed parts of grana thylakoids as well as stroma thylakoids.
PS-II (Photosystem-II) is the photosynthetic pigment system along with some electrons carriers that is located in the appressed part of

grana thylakoid

301 **(a)**
Calling the biosynthetic phase as the dark reaction is misnomer because without the light, the dark reaction cannot sustain fore long. For the sake of simplicity, it is been called dark reaction

302 **(c)**
About 42% of solar radiation hits the earth's atmosphere.

303 **(b)**
The CO_2 formed in the bundle sheath cells by decarboxylation of malic acid used in the Calvin cycle. In that way, C_4-plants have their own CO_2 for the Calvin cycle. That's why C_4-plants can perform Calvin cycle even in very low CO_2 concentration

304 **(c)**
Photophosphorylation is the formation of ATP from ADP and inorganic phosphate in the presence of light. When the two phosphates work in a series. (first PS-II and then PS-I) then non-cyclic photophosphorylation occurs.
The two photosystems are connected through an electron transport chain. Both ATP and NADPH are synthesised by this kind of electron flow

305 **(b)**
ATP is formed during photophosphorylation.
Water does takes part in photosynthesis-oxygen comes from water not from carbon dioxide.

306 **(b)**
Cytochrome oxidase is an **endoenzyme**. This enzyme plays very important role in ETS of photosynthesis as well as respiration.

307 **(c)**
$NADP^+$ to $NADPH + H^+$.
During the light reaction
(i) Formation of ATP from ADP takes place or phosphorylation of ADP to ATP takes place
(ii) Reduction of $NADP^+$ to $NADPH + H^+$ takes place by PS-I through electron transport system

308 **(a)**
Cytochroma oxidase is an iron-containing key enzyme of mitochondrial respiration. Cytochrome oxidase (complex IV) is a large enzyme of inner mitochondrial membrane.

309 **(d)**
Kranz anatomy shows presence of rudimentary chloroplasts in bundle sheath cells and typical granal chloroplasts in mesophyll cells.

310 **(a)**
Oxaloacetic acid.
Plants that are adapted to dry tropical regions generally have the C_4 pathway. Though these plants have the C_4-oxaloacetic acid as the first CO_2 fixation product they use the C_3 pathway or the Calvin cycle as the main biosynthetic pathway

311 **(d)**
Photochemical reaction is also known as **light reaction** because it takes place in the presence of light in the grana portion of chloroplast. In this reaction, photolysis of water takes place, which generates oxygen,
simultaneously,**photophosphorylation** takes place which generates ATP and NADPH.

312 **(b)**
C_4-plants utilise solar energy more efficiently because photosynthesis rate is very high in C_4-plants, *e.g.*,**sugarcane, maize**, etc.

313 **(a)**
ATP and NADPH are consumed in the dark reaction for the formation of carbohydrates or starch with the help of RuBP

314 **(b)**
Mitochondria and chloroplast are the organelle, which forms ATP in the living system. In both the system the electron transport system is present through, which electrons are carried by carrier molecule down hill to redox. That's way carrier molecules are oxidised or reduced in chloroplast and mitochondria

315 **(b)**
The electrons that were moved from photosystem II must be replaced. This is achieved by electrons available due to splitting of water. The splitting of water is associated with the PS-II. Water is split into H^+, O and electrons. This creates oxygen, one of the net products of photosynthesis. The electrons that are needed to replace those removed from photosystem-I are provided by photosystem-II
$2H_2O \rightarrow 4H^+ + O_2 + 4e^-$

316 **(c)**
The pigments are organised into two discrete photochemical Light Harvesting Completes (LHC) within the Photosystem I (PS-I) and Photosystem II (PS-I). These are named in the sequence of their discovery, and not in the sequence in which they function during the light reaction. The LHC are made up of hundreds of pigment molecules bounded to proteins. Each photosystem has all the pigments (except one molecule of chlorophyll-*a*) forming a light harvesting system known as

antenna

317 **(c)**
Glucose phosphates formed in photosynthesis are asymmetrically labelled, it is called **Gibb's effect**.

318 **(a)**
Steps that causes proton gradient to develop during photophosphorylation are as follows
(i) protons or hydrogen ions that are produced by the splitting of water accumulates within the lumen of the thylakoids
(ii) As electrons move through the photosystems, protons are transported across the membrane. This, happens because the primary acceptor of electron, which is located towards the outer side of the membrane transfers its electrons not to an electron carrier but to an H^+ carrier. Hence, this molecule removes a proton from stroma, while electrons transporting
(iii) The NADP reducetase enzyme is located on the stroma side of the membrane. Along with electron, reduction of $NADP^+$ to $NADPH + H^+$ takes place. By this way, the proton removes from stromal side of the thylakoid.
Proton gradient is important because it is the break down of this gradient that leads to release of energy. The gradient is broken down due to movement of protons across the membrane to the stroma through the transmembrane channel of the F_0 of the ATPase.
The energy released during the breaking down of proton gradient is used in formation of ATP

319 **(a)**
Chlorophyll-*a*.
The pigments are organised into two discrete photochemical Light Harvesting Completes (LHC) within the Photosystem I (PS-I) and Photosystem II (PS-I). These are named in the sequence of their discovery, and not in the sequence in which they function during the light reaction. The LHC are made up of hundreds of pigment molecules bounded to proteins. Each photosystem has all the pigments (except one molecule of chlorophyll-*a*) forming a light harvesting system known as antenna

320 **(c)**
Oxygen and release of CO_2 takes place.
Photorespiration is a light dependent utilisation of oxygen and release of carbon dioxide by photosynthetic organs of plant. Normally, photosynthetic organs do the reverse in the light, *i.e.*, uptake of CO_2 and release of O_2

321 **(a)**
Chlorophyll-*a* is found in all photosynthetic plants. Hence, it is termed as universal photosynthetic pigment. Bacteriochlorophyll are present in bacteria and bacteriochlorophyll-*a* resembles with chlorophyll-*a* in plants

322 **(b)**
(i) PS-I has more (about twice) chlorophyll-*a* than chlorophyll-*b.* PS-II has about equal amount of chlorophyll-*a* and chlorophyll-*b*

323 **(a)**
All animals including human beings depend on plants for their food. Green plants synthesize the food they need and all other organisms depend on them for their needs. Green plants carry out photosynthesis, a **physico-chemical** process by which they use light energy to drive the synthesis of organic compounds

324 **(d)**
In C_4-plants, chloroplasts are found in both bundle sheath and mesophyll cells. Chloroplasts in bundle sheath cells are larger and does not contain grana, whereas chloroplasts in mesophyll cells are smaller and have grana.

325 **(b)**
All the life forms are supported by the plants, whether, it is herbivore or carnivore. Chloroplast present in plants traps the solar energy and changes it to starch. This process is called photosynthesis. So, we are created by chloroplast means that all life forms depends on photosynthesis

326 **(c)**
C_4-plants are characterized by Kranz type of anatomy, i.e., chloroplast containing mesophyll cells and bundle sheath cells. The phosphoenol pyruvate in mesophyll cells combine carbon dioxide in presence of PEP carboxylase and forms oxaloacetic acid. The product of photosynthesis is starch.

327 **(c)**
HMP pathway occurs in **cytoplasm** of cell.

328 **(c)**
The energy required to hydrolyse the water comes from oxidising chlorophyll. Oxidation of chlorophyll occurs due to the release a high energy electrons from the chlorophyll

329 **(b)**
The chloroplasts in C_4-plants are dimorphic (two morphologically distinct types). The chloroplasts of bundle sheath cells are large in size and

arranged centripetally. They mesophyll cells, on the other hand, contain normal type of chloroplasts.

330 **(b)**
PS-I is driven by far red light and PS-II by red light. The main components of PS-I are chl.-*a* (P_{700}), chl.-*b* and β-carotene.

331 **(d)**
Along with the NADPH produced by the movement of electrons, the ATP will be used immediately in the biosynthetic reaction taking place in the stroma, responsible for fixing CO_2 (reduction) and synthesis of sugars

332 **(b)**
Electron excited by PS-I used in the formation of $NADPH + H^+$. These electrons come ultimately from H_2O through photosynthesis

333 **(c)**
Electrons during photosynthesis goes from the H_2O to the PS-II then by various cytochrome carrier. It reaches to PS-I then reaches to the $NADP^+$ and reduces it in the presence of H^+ to form $NADPH + H^+$

334 **(b)**
Photorespiration is the light dependent process, in which utilisation of oxygen and release of carbon dioxide by the photosynthetic organs of a plant takes place. Normally, photosynthetic organs are reverse in the light, i.e., uptake carbon dioxide and release oxygen. This process is pronounced in C_3-plants and negligible in C_4-plants. At high temperature, RuBP carboxylase functions as oxygenase and instead of fixing carbon dioxide, oxidises ribulose 1, 5-biphosphate to produce phosphoglyceric acid and phosphoglycolate (starting substrate). On hydrolyzing, it forms glycolate and then glyoxylate, glycine and serine respectively.

335 **(b)**
Photosynthesis is the endergonic used*, i.e.*, energy is used during physiochemical process in which the light gets converted into the high energy. Chemical bonds are used in the formation of sugar

336 **(c)**
Compensation point refers to alight intensity at which the rate of respiration by a photosynthetic cell or organ is equal the rate of photosynthesis. There is no net gain or loss of oxygen or carbon dioxide from the structure.

337 **(a)**
In *Z*-scheme of light reaction, the participating photosystem are PS-II and PS-I. Electrons are transported from PS-II to the PS-I through electron transport system by cytochromes

338 **(d)**
Though chlorophyll-*a* is the major pigment responsible for trapping light, other thylakoid pigments like chlorophyll-*b*, xanthophylls and carotenoids, which are called accessory pigments, also absorb light and transfer the energy to chlorophyll-*a*. Indeed, they not only enable a wider range of wavelength of incoming light to be utilised for photosynthesis but also protect chlorophyll-*a* from photooxidation

339 **(b)**
In CAM-plants, the stomata open at night. This allows the entry of carbon dioxide in the leaves. The carbohydrates stored in plants are converted to PEP by Glycolysis, which is carboxylated to malic acid. Thus, carbon dioxide is fused in plants as malic acid, which stored inside vacuole. In the day time, stomata close and the malate transported to chloroplast, undergoes decarboxylation and the released carbon dioxide is fixed by Calvin cycle.

340 **(c)**
Water is one of the reactant in the light reaction. The effect of water on photosynthesis is seen in the stress condition when water availability is very low. Water is also produced in dark reaction of photosynthesis. Water stress causes the stomata to close hence reducing, the availability

341 **(d)**
The site for photorespiration is chloroplast. RuBP carboxylase function as oxygenase and instead of fixing carbon dioxide, it convert oxidase ribulose 1-5 biphosphate (RuBP) to produce phosphoglycerate and phosphoglycolate

$$RuBP + O_2 \xrightarrow[\text{Oxygenase}]{\text{RuBP}} PGA + \text{Phosphoglycolate}$$

342 **(d)**
The pigments are organised into two discrete photochemical light harvesting complexes (LHC) within the photosystem-I (PS-I) and photosystem II (PS-II)

343 **(b)**
Regeneration of PEP from pyruvate takes place in the bundle sheath cells and conversion of pyruvate in PEP takes plants in mesophyll cells

$$\text{Pyruvate} + ATP \xrightarrow[\text{Kinase}]{\text{Phosphopyruvate}} PEP + AMP + H_3PO_4$$

344 **(d)**
Pigments are substances that have an ability to absorb light at specific wavelength. Among all pigments, chlorophyll-*a* absorb the maximum wavelength in the blue and red region. In these region, the chlorophyll-*a* does the maximum photosynthesis. Thus, chlorophyll-*a* is called the main photosynthetic pigment

345 **(a)**
In far-rad light (wavelength more than 680 nm), there is a reduction in the quantity of O_2 evolution.

346 **(a)**
Photorespiration is the light dependent utilization of $O_2$and release of CO_2 by photosynthetic organs of a plant Photo respiration involves chloroplast, Peroxisome and mitochondria to complete the process.

347 **(a)**
In higher plants, enzymes for light independent reactions (dark reactions) are present in the stroma of chloroplasts. Light dependent reaction occurs in grana of chloroplast.
Ribosomes are necessary for protein synthesis.
Chlorophyll is green photosynthetic pigment found in chloroplasts.

348 **(d)**
Carbon dioxide is the major limiting factor for photosynthesis. The concentration of CO_2 is very low in the atmosphere (Between 0.03 to 0.04% or 300-400 ppm). Increase in concentration up to 0.05% can cause an increase in CO_2 fixation rates. Beyond this, the levels can become damaging over longer periods

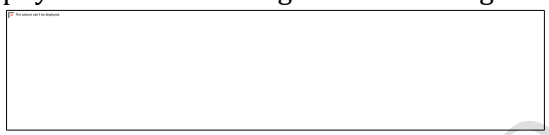
349 **(d)**
Maximum photosynthesis occurs in the blue-violet and red region of light spectrum. Red light favours the carbohydrate accumulation, while blue light stimulates protein synthesis

350 **(c)**
Maximum number of chloroplast is found in leaves

351 **(d)**
C_4-plants (maize) require 30 ATP and 12 NADPH for synthesis of one hexose molecule. Therefore, synthesis of six hexose molecules requires 180 ATP and 72 NADPH.

352 **(c)**
The first step in dark reaction of C_3plants is carboxylation of ribulose 1-5 biposphate by atmosphere CO_2 in presenic of enzyme, Rubisco to form PGA Ribulose 1-5 bisphosphate+CO_2 + $H_2O \rightarrow$ 3 PGA.

353 **(c)**
The seed germination is promoted by red wavelength (650 nm), this is due to the pigment phytochrome behaving in the following manner.



354 **(d)**
Ruben, **Hassid** and **Kamen** proved that oxygen evolved in photosynthesis comes from water.

355 **(a)**
Compensation point refers to the light intensity, at which the rate of respiration by photosynthetic cell or organ is equal to the rate of photosynthesis. There is no net gain or loss of oxygen or carbon dioxide from the structure

356 **(b)**
Living organisms have the capability of extracting energy from oxidisable substances and store this the in form of bond energy. Special substances like ATP, carry this energy in their chemical bonds. The process through which ATP is synthesised by cells (in mitochondria and chloroplast) is named oxidative phosphorylation

357 **(c)**
Malic acid or aspartic acid is translocated to bundle sheath cells through plasmodesmata. Inside the bundle sheath cell they are decarboxylated (malic acid) or deaminated. In case of aspartic acid to form CO_2 and pyruvate. After the fixing of CO_2 to Oxaloacetic Acid (OAA) in C_4 cycle, the oxaloacetic acid changes into the malic aspartic acid

$$OAA + NADPH \xrightarrow{\text{Malic acid dehydrogenase}} \text{Malic acid} + NADP^+$$

$$OAA + NH_3 + NADPH \xrightarrow{\text{Transaminase}} \text{Aspartic acid} + NADP^+ + H_2O$$

Both of these reactions occur in mesophyll cell

358 **(d)**
Four pyrrole ring.
Chlorophyll-*a*

359 **(a)**
The substrate for the photorespiration is the **glycolate**. The process of photorespiration takes place in peroxisomes.

360 **(d)**
Non-cyclic phosphorylation occurs in the membrane or lamellae of grana. Because

membrane or lamellae of grana have both photosystem (PS-I and PS-II) and in non-cyclic phosphorylation both PS-I and PS-II participates

361 **(b)**

Sugarcane is a C_4- plant, which shows high efficiency of carbon dioxide fixation due to **Hatch** and **Slack cycle**.

362 **(d)**

Carboxylation (In C_3-cycle) It is the fixation of CO_2 into a stable organic intermediate. Carboxylation is the most crucial step of the Calvin cycle, where CO_2 is utilised for the carboxylation of RuBP. This reaction is catalysed by the enzyme RuBP carboxylase, which results in the formation of two molecules of 3-PGA. Since, this enzyme also has an oxygenation activity. It would be more correct to call it RuBP **carboxylase-oxygenase** or RuBisCo

363 **(a)**

Mesophyll cell.

After the fixing of CO_2 to Oxaloacetic Acid (OAA) in C_4 cycle, the oxaloacetic acid changes into the malic aspartic acid

$$OAA + NADPH \xrightarrow{\text{Malic acid dehydrogenase}} \text{Malic acid} + NADP^+$$

$$OAA + NH_3 + NADPH \xrightarrow{\text{Transaminase}} \text{Aspartic acid} + NADP^+ + H_2O$$

Both of these reactions occur in mesophyll cell

364 **(a)**

Photorespiration takes place only in C_3-plants.

365 **(b)**

90% photosynthesis (CO_2 assimilation) in the world is done by algae (photoplanktons).

366 **(c)**

In C_4-plants, agranal chloroplast is present in bundle sheath cells, *e.g.*, sugarcane leaf.

367 **(b)**

Aldolase enzyme is found in chloroplast.

368 **(d)**

Emerson and **Arnold** (1932) established light and dark phases in photosynthesis with the help of flashing light and Emerson concluded two distinct photochemical process in light reaction of photosynthesis.

369 **(a)**

For every CO_2 molecule entering the Calvin cycle (the reduction and regeneration steps), three molecules of ATP and two molecules of $NADPH+H^+$ are required.

370 **(a)**

In Calvin cycle for every carbon dioxide molecule, 3 molecules of ATP and 2 NADPH are required. To make one molecule of glucose 6 turns of the cycle are required. Thus, 18 ATP and 12 NADPH molecules will be required to make one molecule of glucose through Calvin cycle.

371 **(b)**

C_3-pathway.

Plants that are adapted to dry tropical regions generally have the C_4 pathway. Though these plants have the C_4-oxaloacetic acid as the first CO_2 fixation product they use the C_3 pathway or the Calvin cycle as the main biosynthetic pathway

372 **(d)**

C_3 and C_4-cycle are the two parts of biosynthetic phase of photosynthesis in C_4-plant but in C_3-plant, only C_3 cycle occurs. The enzyme in these two cycles are present in chloroplast not in Golgi bodies

373 **(c)**

Photosynthetically Active Radiation (PAR) is 400-700 nm.

374 **(c)**

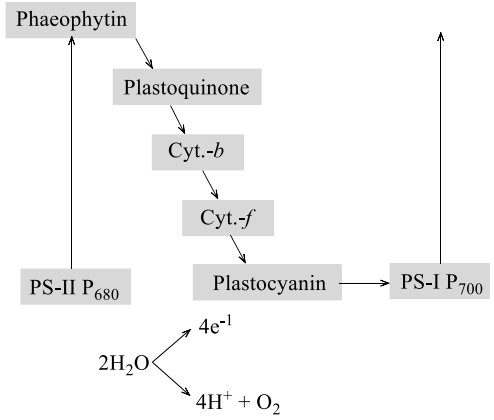
C_4Plants have 'Kranz type' anatomy. Vascular bundles are surrounded by bundle sheath cells. The chloroplasts are dimorphic. The cells of bundle sheath have very large chloroplasts. They lack grana and contain starch grains. They are centripetally arranged white mesophyll cells have small and granal chloroplast.

375 **(b)**

Photorespiration takes place in the photosynthetic cells, *eg*, green parts of plant in the presence of light.

376 **(b)**

In the given schematic diagram, D is representing plastocyanin.



377 **(a)**

Photochemical reaction is also known as light reaction because it takes place in the presence of

light in the grana portion of chloroplast. In this reaction, photolysis of water takes place, which generates ATP and NADPH

378 **(a)**

Non-cyclic photophosphorylation includes both photo system II and I. The process requires an external electron donor. The electrons released during photolysis of water are picked up by photocentre of PS-II calledP_{680}. The flow of electrons is unidirectional. Electrons are not cycled back and are used in the reduction of NADP to$NADPH_2$. In this, high energy electrons released from 'P_{680}' do not return to 'P_{680}' but pass through phaeophytin, plastoquinone, cytochrome-$b_6 - f$ complex, plastocyanion and then enterP_{700}. In transfer of electrons from PQ to Cytochrome-$b_6 - f$ complex, ATP is synthesised.

379 **(a)**

RuBisCo is the most abundant protein of the biological world. It constitutes 16% of the chloroplast proteins. Rubisco is located on the outer surface of thylakoid membrane

380 **(d)**

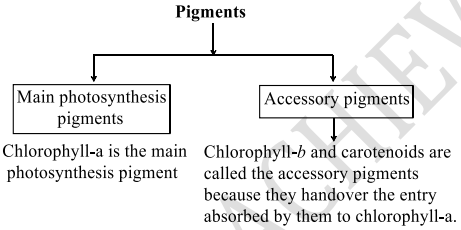
The chlorophylls are basically chelate salts of **magnesium (Mg)**.

381 **(a)**

Ammonia is released from photorespiration.

382 **(b)**

Chlorophyll-*a*.



383 **(c)**

Formation of ATP in mitochondria is called oxidative phosphorylation.

The electrons that were moved from photosystem II must be replaced. This is achieved by electrons available due to splitting of water. The splitting of water is associated with the PS-II. Water is split into H^+, O and electrons. This creates oxygen, one of the net products of photosynthesis. The electrons that are needed to replace those removed from photosystem-I are provided by photosystem-II

$2H_2O \rightarrow 4H^+ + O_2 + 4e^-$

384 **(b)**

Raphids are needle-like long slender **calcium oxalate** crystals usually lying parallel to each other in a bundle, which is sometimes found in a special sac-like cell. Raphidsare commonly found in *Alocasia, Colocasia, Pistia,* etc.

385 **(c)**

Nucleus/core of chlorophyll contains magnesium. The chlorophylls are basically chelate salts of magnesium (Mg)

386 **(d)**

During the dark reaction, the starch (carbohydrates) synthesis takes place. The starch is the polymers of glucose having the formula $(C_5H_{10}O_5)_n$

387 **(b)**

In C_3-plants, carbon dioxide combines with RuBP to form phosphoglyceric acid, on the other hand in C_4-plants, carbon dioxide is first picked up by phosphoenol pyruvate (PEP) to form oxaloacetic acid.

388 **(c)**

Development of proton gradient across the membrane.

During the cyclic phosphorylation, the electrons does not pass to the $NADP^+$ but cycled back to PS-I through electron transport chain. This cyclic flow hence, results only in the synthesis of ATP but no of $NADPH + H^+$. Cyclic photophosphorylation occurs when only light of wavelength beyond 700 nm is available for excitation

389 **(b)**

In photorespiration, the RuBP instead of being converted to two molecules of PGA binds with O_2 to form one molecules of PGA and phosphoglycolate. In the phosphorespiratory pathway, there is neither synthesis of sugars, nor of ATP. In this pathway there is no synthesis of ATP or NADPH. Therefore, it is a wasterful process.

390 **(c)**

Maximum photosynthetic rate has been observed in the full spectrum. Regarding the effect of the different wavelengths, maximum photosynthesis occurs in **red** light (660 nm) second maximum in **blue** (440 nm) and minimum in **green**.

391 **(b)**

Chloroplasts are found in the mesophyll cells of the leaves. Leaves have a maximum number of chloroplasts

392 **(d)**

New plastids arise from proplastids by a fission-like process.

393 **(c)**
Photosynthesis is an anabolic process of manufacturing of organic compounds. It is characterized by reduction of CO_2 and oxidation of water. It decreases the concentration of CO_2 in atmosphere but increases the concentration ofO_2.

394 **(d)**
RuBisCo is present in chloroplast

395 **(d)**
The leaves of C_4-plants have Kranz anatomy. In the leaf, vascular bundle is surrounded by bundle sheath and mesophyll cells. The bundle sheath consists of thick walled cylindrical cell. The chloroplasts of bundle sheath are larger than mesophyll cells. Most of the PEP carboxylase occurs in mesophyll cells, while most of ribulose 1-5 diphosphate carboxylase and malic enzyme in bundle sheath cells.

396 **(a)**
In C_3-plants, photorespiration takes place but this pathway is absent in C_4-plants

397 **(a)**
ATPase has two parts-F_0 and F_1. F_0 part has channels through, which the diffusion of protons takes place

398 **(b)**
The Calvin cycle proceeds in three stages (1) carboxylation, during which CO_2 combines with ribulose 1, 5-bisphosphate; (2) reduction, during which carbohydrate are formed at the expense of the photochemically made ATP and NADPH; and (3) regeneration during, CO_2 acceptor is ribulose 1, 5-bisphosphate is formed again so that the cycle continues. Regeneration of the CO_2 acceptor molecule, RuBP is crucial if the cycle is to continue uninterrupted. The regeneration steps require one ATP for phosphorylation to form RuBP

399 **(c)**
RuBisCo is the most abundant enzyme in the world. It is characterised by the fact that active sites can bind to both CO_2 and O_2. This binding is competitive. It is the relative concentration of O_2 and CO_2 that determines, which of two (CO_2 and O_2) will bind to enzyme

400 **(b)**
In the Calvin cycle, the RuBP combines with the CO_2 to form 2 molecules of 3 phosphoglyceric acid and the reaction is catalysed by RuBisCo

$$RuBP + CO_2 \xrightarrow{RuBisCo} 2 \times 3PGA$$

401 **(a)**
Cyclic phosphorylation operates only by PS-I during cyclic phosphorylation only. ATP formation takes place and recyclation of electrons also occurs. Unlike, the non-cyclic phosphorylation, splitting of H_2O does not take place in the cyclic phosphorylation

402 **(c)**
The carbon dioxide fixation takes place in the stroma of chloroplasts because it has enzymes essential for fixation of carbon dioxide and synthesis of sugar.

403 **(d)**
Some differences in C_3 and C_4 plants.

C_3-plants	C_4-plants
Algae (Chlorella), sunflower, beans, mustard, etc.	Maize, sorghum, sugarcane and other graminaceous plants.
Plants have Calvin cycle.	Plants have Hatch and Slack cycle.
The first stable product of photosynthesis is 3-C compound, phosphoglyceric acid (PGA).	The first stable product is 4-C compound, oxaloacetic acid or malic acid in succulents.
There is only one carbon dioxide acceptor, e.g., ribulose 1-5, diphosphate.	There are two carbon dioxide acceptor, e.g., phosphoenol pyruvic acid and RuDP.
Kranz anatomy is absent.	The leaves have Kranz anatomy.
The optimum temperature lies between 10-25°C.	The optimum temp. lies between 30-45°C.
Photorespiration occurs, which reduces the photosynthetic yield.	No photorespiration.
Chloroplast have PS-I and PS-II	Bundle sheath chloroplast lack photosystem-II, therefore, depends upon mesophyll for supply of $NADPH + H^+$.

404 **(c)**
In Calvin cycle, 18 molecules of ATP are used in carbon fixation. The overall reaction of Calvin cycle represents as

$$6RuBP + 6CO_2 + 18ATP + 12NADPH \rightarrow 6RuBP + C_6H_{12}O_6 + 18ADP + 18P + 12NADP^+$$

405 **(c)**
Stroma side of membrane

406 **(b)**
Cyclic Photophosphorylation involves only PS-I and in this electron expelled by excited photocentre is returned to it after passing over a chain of electron carriers. Two molecules of ATP are synthesized in this process.

407 **(a)**
The site for photorespiration is chloroplast. Peroxisome and mitochondria are required for completion of the process. It is a cyclic process. Glycolate is formed in chloroplast, which usually passes into peroxisome of the mesophyll cell where it is oxidised to glyoxylate. Glyoxylate is aminated and gives rise to amino acid glycine that enters to mitochondrion.

408 **(b)**
For the ease of understanding Calvin cycle can be described under three stages
(i) **Carboxylation** is the fixation of CO_2 into stable organic intermediate
(ii) **Reduction** is a series of reactions that lead to the formation of glucose
(iii) **Regeneration** of CO_2 acceptor molecule, RuBP is main, part of this stage

409 **(a)**
In 780 nm of wavelength, photosystem-I is inactive. In photo system-I, the photocentre is special chlorophyll-a molecule called P_{700}.

410 **(c)**
Bacterial photosynthesis involves only **photosystem-I**(PS-I) and cyclic photophosphorylation. It is not connected with photolysis of water, therefore, oxygen is not evolved. This synthesizes only ATP.

411 **(b)**
In C_4-plants, fixation of carbon dioxide occurs in mesophyll cells. The primary acceptor of carbon dioxide is phosphoenol pyruvate (PEP). It combines with carbon dioxide in the presence of PEP carboxylase to form oxaloacetate or oxaloacetic acid (OAA).

412 **(d)**
In photosystem-I, the primary electron acceptor is probably a Fe-S protein. The reduced primary acceptor transfers the electrons to secondary electrons acceptor (most probably ferradoxin).

413 **(b)**
Reduction These are series of reactions that lead to the formation of glucose. The steps involved are: utilisation of 2 molecules of ATP for phosphorylation and two molecules of NADPH for the reduction per CO_2 molecule fixed. The fixation of six molecules of CO_2, 6 turns of the cycle the required for the removal of one molecule of glucose from the pathway

414 **(c)**
A-Released, B-Lumen, C-ATPase

415 **(b)**
Photosynthesis and respiration are similar because both organelles make ATP and are explained by chemiosmotic theory. During the formation or ATP, both organelle uses Electrons Transport Channels (ETC)

416 **(d)**
Cyclic Photophosphorylation in performed by PS-I only. It involves a cyclic electron flow, in which the photoexcited electrons from PS-I are occasionally shunted back to chlorophyll via the electron transport chain. This cyclic electron flow supplements the supply of ATP but produces no NADPH. Non-cyclic Photophosphorylation involves both PS-I and PS-II. Splitting of water, release of oxygen and production of NADPH takes place during it.

417 **(c)**
Quantum yield of photosynthesis is carbohydrate or dry mass, formed by plant by using carbon dioxide from air. It is about 12% in C_3 −plants.

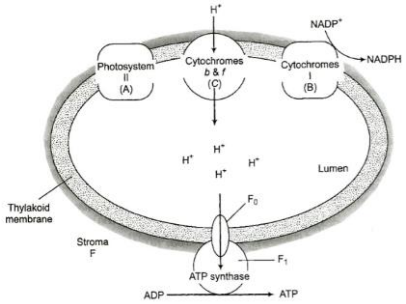
419 **(a)**
The primary CO_2 fixation product in C_4cycle is oxaloacetic acid (OAA) in the mesophyll cells. It then from the other 4-carbon compounds like malic acid or aspartic acid in the mesophyll cells itself, which are transported to the bundle sheath cells.

420 **(b)**
ATP synthesised by chloroplast and mitochondria in the cell.
The electrons that were moved from photosystem II must be replaced. This is achieved by electrons available due to splitting of water. The splitting of water is associated with the PS-II. Water is split into H^+, O and electrons. This creates oxygen, one of the net products of photosynthesis. The electrons that are needed to replace those removed from photosystem-I are provided by photosystem-II
$2H_2O \rightarrow 4H^+ + O_2 + 4e^-$

421 **(b)**
In C_4-plants, initial fixation of CO_2 occurs in **mesophyll cells.**The primary acceptor of CO_2 is phosphoenol pyruvate (PEP). CO_2Is again fixed inside bundle sheath cells through Calvin cycle. The pyruvate is sent back to mesophyll cells where it is changed to phosphoenol pyruvate (PEP).

422 **(d)**
Proton gradient develops inside the lumen, due to

the accumulation of protons by the transportation of electrons through electron transport system. This leads to the formation of ATP by ATPase complex



423 **(a)**

3-phosphoglyceric acid (3-PGA) is the first stable product of Calvin-Bensen cycle or C_3-cycle or **carbon-reduction cycle**.