12. PHOTOSYNTHESIS

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1. Choose correct option

A. A cell that lacks chloroplast does not

a. evolve carbon dioxide

b. liberate oxygen

c. require water

d. utilize carbohydrates.

B. Energy is transferred from the light reaction step to the dark reaction step by

a. chlorophyll

b. ADP

c. ATP

d. RuBP

C. Which one is wrong in photorespiration

a. It occurs in chloroplasts

b. It occurs in day time only

c. It is characteristic of C_4-plants

d. It is characteristic of C_3-plants

D. Non-cyclic from cyclic photophosphorylation in that former phosphorylation differs from cyclic photophosphorylation in that former

a. involves only PS I

b. Include evolution of O_2

c. involves formation of assimilatory y power

d. both 'b' and 'c'

E. For fixation of 6 molecules of CO, and formation of one molecule of glucose in Calvin cycle, requires

a. 3 ATP and 2 $NADPH_2$

b. 18 ATP and 12 $NADPH_2$

c. 30 ATP and 18 $NADPH_2$

d. 6 ATP and 6 $NADPH_2$

F. In maize and wheat the first stable products formed in bundle sheath cells respectively are

a. OAA and PEPA

b. OAA and OAA

c. OAA and 3PGA

d. 3PGA and OAA

G. C_4 pathway called decarboxylation pathway because

a. RuBP+CO_2 in bundle sheath cells

b. PEPA + CO_2 in mesophyll cells

c. both 'a' and 'b'

d. It occurs in presence of intensive light

H. The head and tail of chlorophyll are made up of __

a. porphyrin and phytin respectively

b. pyrrole and tetrapyrrole respectively

c. prophyrin and phytol respectively

d. tetra pyrrole and pyrrole respectively

I. The net result of photo-oxidation of water is release of ___

a. electron and proton

b. proton and oxygen

c. proton, electron and oxygen

d. electron and oxygen

J. For fixing one molecule of CO_2 in Calvin cycle, are required

a. 3 ATP + $NADPH_2$

b. 3 ATP + 2 $NADPH_2$

c. 2 ATP + 3 $NADPH_2$

d. 3 ATP 3 $NADPH_2$

K. In presence of high concentration of oxygen, RuBP carboxylase converts RuBP carboxylase converts RuBP to __

a. Malic acid and PEP

b. PGA and PEP

c. PGA and malic acid

d. PGA and phosphoglycolate

L. The sequential order in electron transport from PSII to PSI of photosynthesis is ___

a. FeS, PQ, PC and Cytochrome

b. FeS, PQ, Cytochrome and PC

c.PQ, Cytochrome, PC and FeS

d. PC, Cytochrome, FeS, PQ

B. Distinguish between : a. Representation and Photorespritionb. absorption spectrum and action spectrum

c. cyclic photophosphorylation and non-cyclic photophosphorylation

a. Respiration and Photorespiration :

Respiration	Photorespiration
1. It occurs in all organisms and under all conditions.	1. It occurs in C, plants under conditions such as
2. It occurs during both day and night.	bright light, high temperature, high oxygen and low CO_2 concentration.
3. It occurs in mitochondria.	2. It takes place only during the day.
4. It is essential for life.	3. It occurs in chloroplasts, peroxisomes and mitochondria.

b. Absorption and Action spectrum :

Absorption spectrum	Action spectrum
1. It is a graphic presentation of absorption of different wavelengths of light by a particular pigment.	1. It is a graphic representation of rates of photosynthesis at different wavelengths of light.
2. It involves direct study of wavelengths of light absorbed by a particular pigment.	2. It is studied in relation to either O, evolved or CO_2 absorbed (photosynthetic activity)

c. Cyclic photophosphorylation and Non-cyclic photophosphorylation

Cyclic photophosphorylation	Non-cyclic photophosphorylation
1. It involves photosystem I and II.	1. It involves both photosystem I and II.
2. Ionized P700 of PS-I receives its own electron back.	2. Ionized P700 of PS-I receives electrons of PS-II. Ionized P680 of PS-II receives electron of OH-formed due to photolysis of water.
3. Movement of electrons is cyclic.	3. Movement of electrons is unidirectional.
4. It involves synthesis of only ATP.	4. It involves synthesis of both ATP and NADPH.
5. It does not involve photolysis of water.	5. It involves photolysis of water.
6. O_2 is not evolved.	6. O_2 is evolved.

C. What are the steps common to C_3 and C_4 photosynthesis?

Ans. All biochemical reactions of Calvin cycle (i.e. carboxylation of RuBP, glycolytic reversal and regeneration of RuBP) occur in both C_3 and C_4 photosynthesis.

D. Are the enzymes that catalyse the dark reactions of carbon fixation located inside the thylakoids or outside the thylakoids?

Ans. The enzymes that catalyse the dark reactions of carbon fixation located outside the thylakoids, in stroma of chloroplast.

E. Calvin cycle consists of three phases, what are they? Explain the significance of each of them.

Ans. (1) Three phases of Calvin cycle are - Carboxylation, Glycolytic reversal and Regeneration
of RuBP.

(2) Significance of carboxylation of RuBP : It results in the synthesis of first stable product of carbon fixation, 3-PGA.

F. Why are the plants that consume more than usual 18 ATPs to produce 1 molecule of glucose favoured in tropical regions?

Ans. (1) Plants which consume more than usual 18 ATPs to produce 1 molecule of glucose are C_4 plants.

(2) In tropical regions, temperature is high and light is bright

(3) At high temperature, stomata close partially to reduce the rate of transpiration and thus the availability of CO_2 decreases.

(4) C_3 plants undergo photorespiration in such conditions due to which their photosynthetic yield decreases.

(5) But in C_4 plants, PEP carboxylase fixes CO_2 even at low concentration in mesophyll cells.

(6) Decarboxylation of malate occurs in bundle sheath cells.

(7) Due to this, CO_2 concentration in bundle sheath cells increases and RuBisCO function as carboxylase.

(8) Thus, photorespiration is avoided in C_4 plants and they become better photosynthesizer than C_3 plants.

(9) Hence, C_4 plants are favoured in tropical regions.

G. What is the advantage of having more than one pigment molecules in a photo centre?

Ans. (1) Light reaction depends upon the amount of solar energy trapped by the pigment molecules.

(2) Having more than one pigment molecules in a photocentre is essential for efficient absorption of solar energy and its conversion into chemical energy.

(3) The reaction centre of a photosystem contains a unique pair of chlorophyll-a and primary electron acceptor.
Chlorophyll dimer gets activated on absorption of photons and expels electrons to higher energy level. Electrons are accepted by primary electron acceptor. It is an essential step for synthesis of ATP during photosynthesis. Solar energy is absorbed more efficiently.

H. Why does chlorophyll appear green in reflected light and red in transmitted light?

Explain the significance of these phenomena in terms of photosynthesis.

Ans. (1) Chlorophyll absorbs red and blue wavelengths of visible light. Green wavelengths of light are reflected by chlorophyll. Hence, chlorophyll appears green in reflected light.

(2) Initially chlorophyll-a is at ground state.

(3) On absorption of photons, it gets activated and expels electrons at higher energy level. This is called excited state.

(4) Expelled energy-rich electrons are accepted by electron carriers.

(5) But in the absence of the electron transport chain, the electrons release their energy in the form of red light as they return to their ground state.

(6) Hence, chlorophyll appears red in transmitted light.

I. Explain why photosynthesis is considered the most important process in the biosphere.

Ans. (1) Photosynthesis produces food for all life forms directly or indirectly.

(2) It maintains balance of O_2 and CO_2 in the atmosphere and helps to purify air.

(3) It provides fossil fuels like coal, petroleum, natural gas which are the main sources of energy.

(4) O_2 evolved during photosynthesis is used in aerobic respiration and in formation of protective ozone.

(5) Hence, photosynthesis is most important process in the biosphere.

J. Why is photolysis of water is accompanied with non-cyclic photophosphorylation?

Ans. (1) During non-cyclic photophos- phorylation, when photosystem II is illuminated by light, P680 gets excited and emits out energy rich electrons.

(2) Due to loss of electrons, Peso becomes positively charged. i.e. ionized.

(3) Ionized P680 acts as a strong oxidizing agent and brings about photolysis of water.

(4) OH- ions generated during photolysis of water, donate their electrons to the reaction centre P680

(5) Hence, photolysis of water is accompanied with non-cyclic photophosphorylation.

K. In C_4 plants, why is C_3 pathway operated in bundle sheath only?

Ans. (1) In C_4 plants, enzymes Rubisco which fixes CO_2 in C_4 pathway occurs in bundle sheath cells.

(2) In these plants, concentration of CO_2 increases only in bundle sheath cells due to decarboxylation of malic acid (4-C).

(3) When CO_2 concentration is high, Rubisco acts as carboxylase and catalyses carboxylation of RuBP.

(4) Hence, Calvin cycle (C_3 pathway) operates in bundle sheath cells only.

(5) C_3 pathway can not operate in mesophyll cells as in mesophyll cells concentration of CO_2 is less and it is fixed by PEP carboxylase.

L. What would have happened if C_4 plants did not have Kranz anatomy?

Ans. If C_4 plants would not have Kranz anatomy, they would undergo photorespiration under the conditions like high temperature, bright light, high oxygen and low CO_2 concentration.

M. Why does RuBisCO carry out preferentially carboxylation than oxygenation in C_4 plants?

Ans. (1) In C_4 plants, RuBisCO occur in bundle sheath cells where concentration of CO_2 is higher due to decarboxylation of malate.

(2) RuBisCO function as oxygenase when CO_2 concentration is low and it acts as

carboxylase when CO_2 concentration is high.

(3) Hence, in C_4 plants RuBisCO carries out of RUBP than preferentially carboxylation oxygenation.

N. What would have happened if plants did not have accessory pigments?

Ans. (1) Accessory pigments (carotenoids and chlorophyll-b) absorb light energy of wavelengths different than reaction centre.

(2) Thus, they broaden the spectrum of light absorbed and help in absorbing light energy more efficiently.

(3) They transmit absorbed energy at a very high rate to the reaction centre where the photochemical act occurs.

(4) Carotenoids also protect chlorophyll from photooxidation.

O. How can you identify whether the plant is C_3 or C_4? Explain or justify.

Ans. We can identify whether the plant is C_3 or C_4 by observing cross section of leaf under microscope. If the leaf shows presence of Kranz anatomy, it is C_4 plant. In these plants mesophyll consists of spongy parenchyma cells and palisade is absent.
There are agranal chloroplasts in bundle sheath cells and granal chloroplasts in mesophyll cells.
Kranz anatomy is absent in C_3 plants.

P. In C_4 plant, bundle sheath cells carrying out Calvin cycle are very few in number. Although C_4 plants are highly productive. Explain.

Ans. (1) In C_4 plants, PEP carboxylase fixes CO_2 at low concentration in mesophyll cells.

(2) Decarboxylation of malic acid takes place in bundle sheath cells.

(3) Due to this, concentration of CO_2 increases in bundle sheath cells and RuBisCO present in bundle sheath cells acts as carboxylase.

(4) This prevents oxygenation of RuBP and thus photorespiration is avoided.

(5) Photorespiration is a wasteful process in which 25% of the photosynthetically fixed CO_2 is lost.

(6) Hence, despite of few bundle sheath cells carrying out Calvin cycle, C_4 plants are highly productive.

Q. What is functional significance of Kranz anatomy?

Ans. (1) In C_4 plants, chloroplasts in mesophyll cells are granal and contain enzyme PEP carboxylase.

(2) PEP carboxylase can fix CO_2 even at low concentration.

(3) Light reaction and first CO_2 fixation occurs in mesophyll chloroplasts.

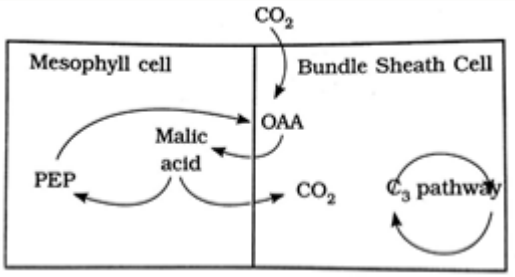
(4) Chloroplasts in bundle sheath cells are agranal and contain enzyme RuBisCO.

(5) In bundle sheath chloroplast, decarboxylation of malate takes place releasing CO_2. This increases the concentration of CO_2 in bundle sheath cells.

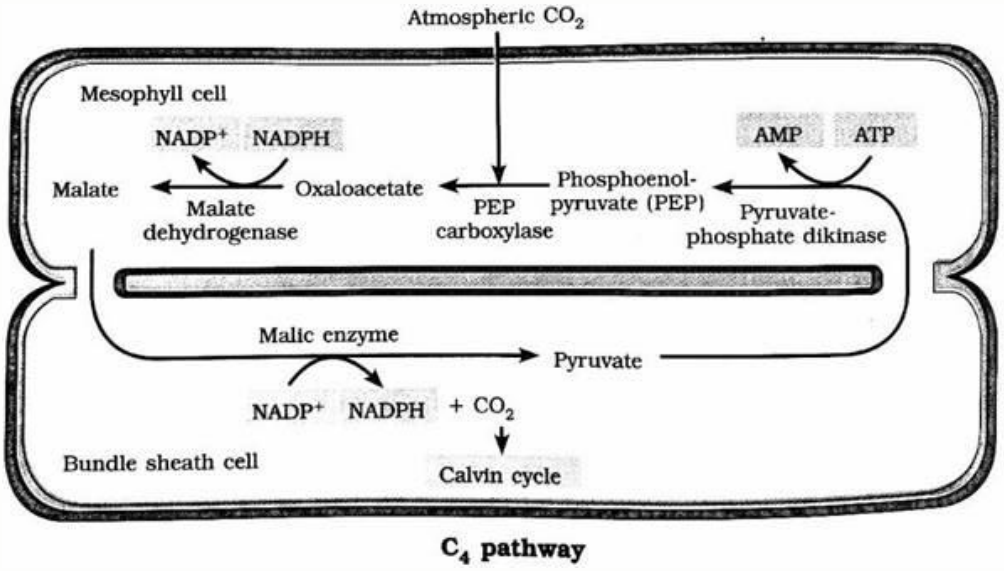
(6) RuBisCO present in bundle sheath cells acts as carboxylase when CO_2 concentration is high.

(7) Thus, C_4 plants can avoid photorespiration because of their leaves showing Kranz anatomy.

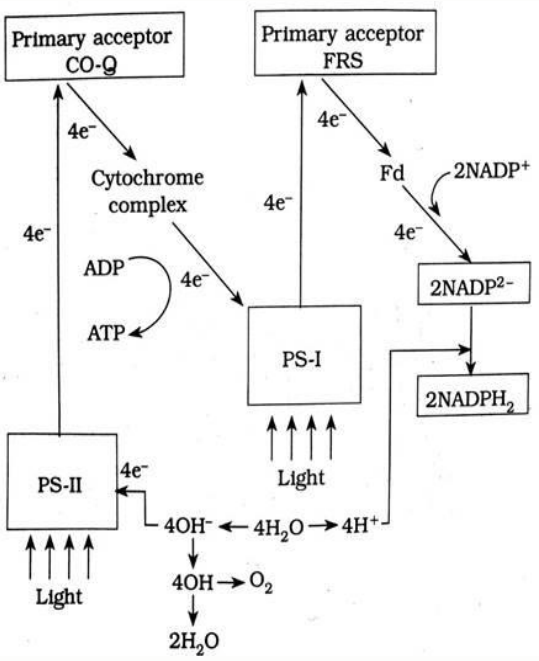
3. Correct the pathway and name it.

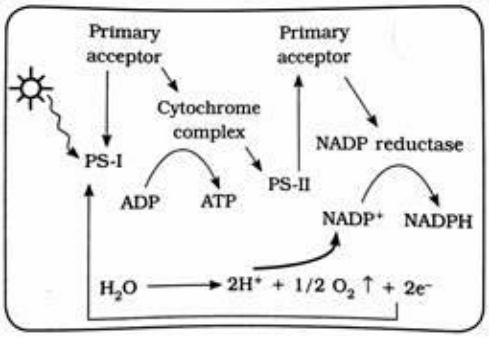


Ans:



C_4 pathway


Primary acceptor CO-Q
Primary acceptor FRS
4e⁻
Cytochrome complex
Fd
2NADP⁺
ADP
ATP
2NADP²⁻
PS-I
2NADPH₂
PS-II
Light
4OH⁻ ← 4H₂O → 4H⁺
4OH → O₂
2H₂O


Primary acceptor
Primary acceptor
Cytochrome complex
NADP reductase
PS-I
PS-II
ADP
ATP
NADP⁺
NADPH
H₂O → 2H⁺ + 1/2 O₂ ↑ + 2e⁻