Short Answer Type Questions – II

Q. 1. Describe briefly the experiment conducted by T.W. Engelmann.

Ans. Engelmann split light into its spectral components by the prism and then illuminated $Cladophora$ (a green alga) placed in a suspension of aerobic bacteria. He found that bacteria accumulated in the region of blue and red light of the split spectrum. He thus discovered the effect of different wavelengths of light on photosynthesis and plotted the first action spectrum of photosynthesis.

Q. 2. Why does chlorophyll appear green in reflected light and red in transmitted light ? Explain the significance of these phenomenon in terms of photosynthesis.

Ans. In reflected light, the chlorophyll appears red because of fluorescence. The light absorbed by chlorophyll molecules loses its energy and emits wavelengths corresponds to red colour. In transmitted light, chlorophyll appears green because it absorbs only light of wavelengths correspond to green colour.

Q. 3. Explain the following: **[V. Imp.]**

(i) There will be no life without photosynthesis.

(ii) There is no oxygen evolution in bacterial photosynthesis.

(iii) Chlorophyll a is an essential photosynthetic pigment.

Ans. (i) For existence of life, food and O_2 are very essential. Photosynthesis is the only process which can trap solar energy and can synthesis food for own and all other organisms. During photosynthesis, O_2 is given out and CO_2 is taken. So, it keeps balance of O_2 and CO_2 in nature. Thus, photosynthesis is essential for existence of life.

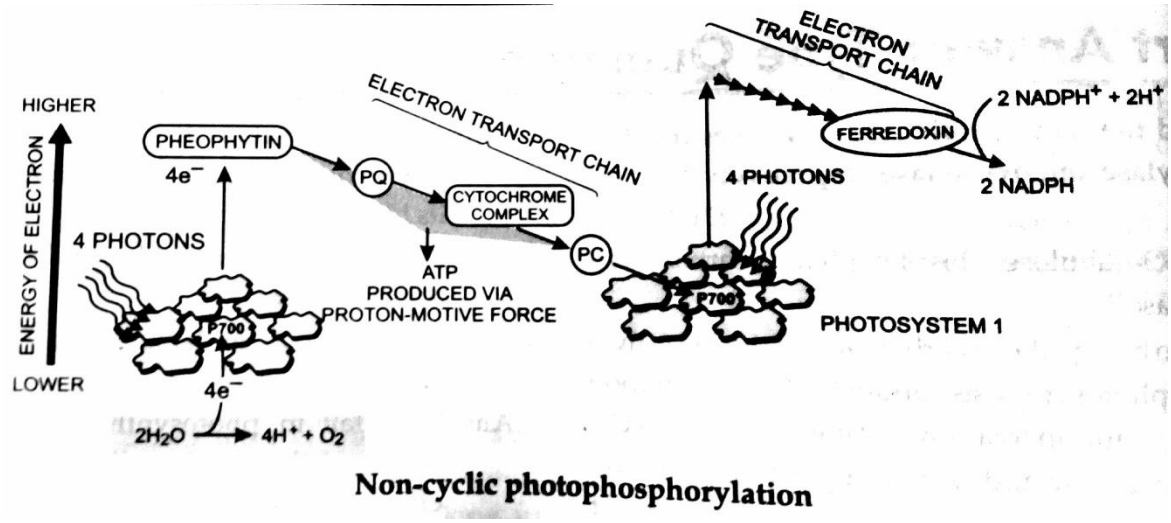
(ii) In bacterial photosynthesis, the raw material of the supply of proton (H^+) is H_2S. than H_2O. Thus, there is production of Sulphur and not oxygen.

(iii) Chlorophyll-b and other pigments of a reaction centre or photosystem absorb solar energy and transfer it to chlorophyll-a. Ultimately it is the chlorophyll-a that initiates the photosynthesis process.

Q. 4. What is difference between cyclic and non-cyclic photophosphorylation ? **[KVS 2015]**

Ans.

	Cyclic photophos-phorylation	Non-cyclic photophos-phorylation
(i)	It is a process of photophosphory- lation in which an electron expelled by the excited photo- centre is returned to it after passing through a series of electron carriers	It is a normal process of photo phosphorylation in which the electron expelled by the excited photocentre does not return to it.
(ii)	It is performed by photosystem I (PSI) only.	It is carried out in collaboration of both photosystem I and II.
(iii)	It synthesises only ATP.	Non-cyclic Photophosphorylation is not only connected with ATP synthesis but also production of NADPH.



Non-cyclic photophosphorylation

Q. 5. What is non-cyclic photophosphorylation ? Describe the process. Why is the process referred to as non-cyclic ? **[KVS Guwahati 2016]**

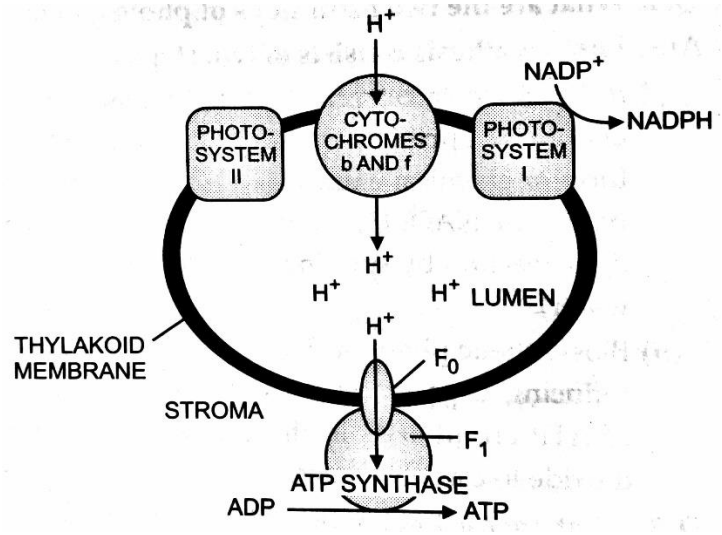
Ans. Non-cyclic photophosphorylation is the process in which electrons emitted from P680 molecule does not return to it but another electron comes from photolysis of water. It involves both PS I and PS II.

Q. 6. Certain plants growing in tropical region suffer from photorespiratory loss. How do they overcome it? Mention the anatomical adaptation. Mention the first stable CO_2 fixation product and the enzyme responsible for it. **[KVS Guwahati 2016]**

Ans. Plants like sugarcane, maize shows C_4 pathway for the CO_2 fixation during the photosynthesis to oercome the problem of photorespiration which is energy consuming process. These plants have kranz anatomy. In kranz anatomy, the mesophyll is undifferentiated and its cells occur in concentric layers around vascular bundles. Vascular bundles are surrounded by large sized bundle sheath cells. The choloroplast of mesophyll cells are smaller and perform light reaction of photosynthesis and also possess PEPcase for the CO_2 fixation. The first stable product of C_4 pathway is oxalo-acetic acid. The enzyme responsible for the fixation of atmospheric CO_2 is PEP Carboxylase (Phosphoenol Pyruvate Carboxylase).

Q. 7. Represent systematically the process of ATP synthesis through chemiosmosis in chloroplast. **[KVS Agra 2017]**

Ans.



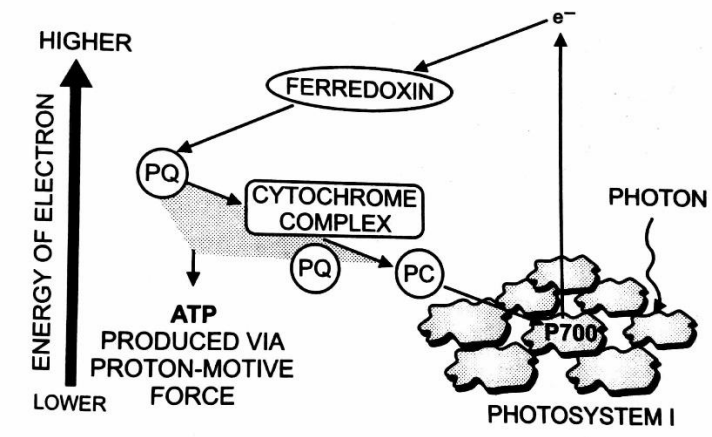
Q. 8. Differentiate between C_3 plants and C_4 plants. **[KVS Silchar2017]**

Ans.

S.No.	C_3 plants	C_4 plants
(i)	Photosynthesis occurs in in mesophyll tissues	Photosynthesis occurs both in mesophyll and undle sheath cells
(ii)	The carbon dioxide acceptor is RuBisCO	The carbon dioxide acceptor is PEP carboxylase
(iii)	Kranz anatomy is absent.	Kranz anatomy is present.
(iv)	The 1st stable compound formed is 3 C compound called 3-Phospho Glyeric acid (PGA).	The 1st stable compound is carbon oxaloacetic. Acud (OAA.)
(v)	The optimum temper ature is 20-25^0 C	The optimum temperature is 35-44^{0}C.
(vi)	Photorespirtory loss is high.	Photresgiration does not take place.

Q. 9. What is cyclic photophosphorylation? Describe the process using a flow diagram. Why is the process referred to as cyclie? [KVS Guwahati 2016]

Ans. **Cyclic photophosphorylation:** It is the process ot emission of electron from P700 molecule after taking energy from sunlight. Electrons passes to a number of reducing agents and return to P700 molecule after giving energy to ADP molecule which form ATP.



Q. 10. Expand the abbreviation RuBP What is its role in photosynthesis?

Ans. Full form of RuBP is Ribulose 1, 5 biphosphate. RuBP is the first acceptor of atmospheric CO_2 during dark reaction of photosynthesis. The reaction is called carboxylation. 6RuBP + $6CO_2$ + $6CH_2O$ → Unstable 6C compound → 3PGA RuBP is regenerated during final formation of sugar molecule.

Q. 11. Distinguish between: Respiration and Photorespiration.

Ans.

S. No.	Respiration	Photorespiration
(i)	It is a bio-chemical process where energy and CO_2 is released during oxidation of food. Glucose is main substance of it.	it is the reversal of photosynthetic reaction where abundant of CO_2 is liberated from the photosynthetic tissues in the presence of light.
(ii)	This process is intitiated in the presence of respiratory enzymen like oxidases and decarbosylases.	Enzyme RuBP carboxylase initiates the photoripiration. Glycolate is the main substrate it.

Q. 12. What is the aignificance of photolysis of water in phulophosphorylation? What happens to each product of this process?

Ans. (i) The photochemical phase is Hill reaction. It oceurs in presence of light. It includes excitation of chlorophyll, photolysis of water molecule, photophosphorylation and reduction of NADP to 15 $NADPH_2$.

(ii) The excited chlorophyll transfers an electron from chlorophyll in many steps. Chlorophyll loses an electron from the water molecule in E.T.S. system. Water splits into H^+ and OH^- ions. O_2 is released in it.

(iii) The fomation of ATP by linking ADP and Pi is called photophosphorylation in photosynthetic ETC.

ADP + Pi → ATP.

It includes two sets of photochemical reactions catalysed in pigment systems PS-I and PS-II. NADP is then reduced is $NADPH_2$.

Q. 13. What are the various events which are responsible for causing proton gradient across the membrane ?

Ans. The various events that cause the proton gradient across the membrane are:

(i) The splitting of water molecule takes place on the inner side of the membrane. The protone (H^+ ions) that are produced by the splitting of water accumulate within the lumen of 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 electron carrier to a proton (H^+) carrier.

(iii) The NADP reductase enzyme is located on the stroma side of the membrane. Along with electrons, protons are necessary for the reduction of $NADP^+$ to NADPH + H^+.

Q. 14. what led to the evolution of C_4 pathway of photosynthesis? Describe in detail.

Ans. (i) The C_4 plants are sugarcane, maize, *Amaranthus*, grases etc. The photorspiration is a wasteful process. It is avoided by these C_4 plants.

(ii) It needs mesophyll cells and bundle sheath cells The bundle sheath show Kranz anatomy. The C_4 plants have dimorphic chloroplasts,. In mesophyll cells, chloroplast are granal (have thylakoids) but in bundle sheath cells, chloroplasts are agranal (grana are absent in thylakoids and are found in stroma lamellae).

(iii) In theseplants, light reaction occurs in the mesophyll cells but CO_2 is foxed in bundle sheath cells.

(iv) RuBisCo is present in bundle sheath cells only. So oxygenation of RuBP is avoided. These plants have CO_2 coneentrating mechanism.

Q 15. How de you prove that the source of oxygen in photosynthesis is the water malecule and not carbon dioxide ?

Ans. Source of O_2 In Photosynthesis is water:

(i) It was previouly assumed that the source of oxygen in photosyntheshn was CO_2 and not H_2O molecules.

(ii) According to recent studies, oxygen is evolved from water and not from CO_2.

(iii) It was proved by the use of radioactive elements For example, the water containing heavy oxygen (H_2O_{18}) was supplied to the leaves in place of natural osygen, (H_2O_{16}).

(iv) On observation it was found that oxygen evolved in photosynthesis was heavy oxygen $^{18}O_2$ and not the natural osygen.

(v) Now, the bheavy isotope of carbon dioxide ($C_{14}O_2$) was supplied to the plant.

(vi) Thus it showed that in photosynthesis, oxygen is evolved from water molecules and not from carbon dicnide.

Q. 16 Why are C_4 plants preferred in the tropical region ? [V.Imp.]

Ans. C_4 plants preferred in tropical region because:

(i) They consume 30 ATPs (12 ATPs more than C_3 plants) to produce one molecule of glucose favoured im tropical region.

(ii) In these plants.photorespiration is the mechanism not to lose the photosynthetic carbon.

(iii) In the process of photorespiration, RuBP is catabolised to a 3-carbon atom compound instead of combining with CO_2.

(iv) More than 50% CO_2 fixed by photosynthesis is lost in photorespiration.

(v) Photorespiration acts to undo the work of photosynthesis as no energy rich compound is produced during this process.

(vi) Thus C_4 plants are better photosynthesizers than C_3 plants and C_4 pathway is of adaptive advantage in tropical region and thus these plants are preferred.

Q. 17. How does carboxylation take place in a sugarcane plant ?

Ans. Sugarcane is a monocotyledonous plant. It has developed an additional C_4 cycle.

Carboxylation in sugarcane: **(i)** Three molecules of RuBP (Ribulose 1-5 biphosphate) reacts with three molecules of carbon dioxide to produce short lived si-carbon intermediates. This process is called carboxylation and involves the enzyme RuBP carboxylase (or RubisCo)

(ii) The bcarbon intermediate are immediately broken down into 6 molecules of 3 phosphoglyceric and (3PGA), a 3 carbon compound. RuBisCO is a large protein molecule.

(iii) It comprises 16% of the chloroplast protein and is the most important protein on earth.

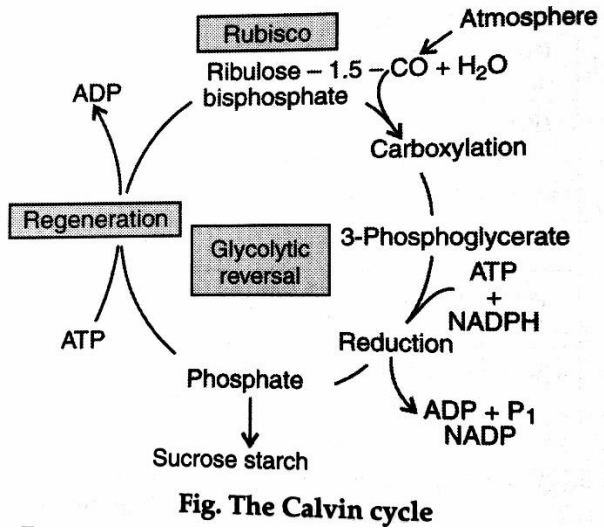


Fig. The Calvin cycle

For every three molecules of CO_2 that entar the cycle, the net output is one molecule d glyceraldehyde phosphate, a three-carbon sugar. To fix the three CO_2 molecules, the cycle spends nine molecules of ATP and six molecules of NADPH.

Q. 18. Distinguish between : Carboxylation and Oxygenation.

Ans.

S. No.	Carboxylation	Oxygenation
(i)	It is the first step of Calvin cycle (C_3in biosynthetic phase).	The oxygenation of RuBP in presence of O_2: is the first reaction of photorespiration.
(ii)	Ribulose 1, 5 bisphosphate is acceptor molecule in it.	The initial acceptor molecule is RuBP.
(iii)	Ribulose 1, 5 biphosphate combines with a molecule of CO_2 in presence of light regulated enzyme RuBP carboxylase	The photorespiration is initiated in the chloroplasts in light only.
(iv)	Fixation of CO_2 is called carboxylation.	The activity of RuBP to catalyse the combination of O_2 with RuBP is oxygenation.

Q. 19. When and why does photorespiration take place in plants ? How does this process result in a loss to the plant ?

Ans. Photorespiration : (i) It is a threat to plants although it occurs in angiosperms because it has some disadvantages.

(ii) No energy rich compound is produced in this process.

(iii) Half of the photosynthetically fixed CO_2 may be lost by photorespiration.

(iv) Moreover it is a ks to the net productivity of green and C_3 plants.

(v) To evercome the photcrespinatory loses in angloxperms like sugareane.they have developed an additiomal cycle called as C_4 pathway or Hatch Sluck pathway.

(vi) C_4 pathway requires 30 ATP molecules (more energy).

Q. 20. who proposed the hypothesis that all photosynthetic organisms require a source of hydregrn and in plants this source wan water and the oxygen is evolved by splitting of water ? What observation led to propose this hypothesis?

Ans. Van Niel in 1931 proposed the hypothesis that all photosynthetic organisms require a source of hydrogen and in plants this source is water and the oxygen is evolved by the splitting of water.

(i) Van Niel observed that green sulphur photosynthetic bacteria fixed carbon dioxide in presence of hydrogen sulphide.

(ii) Okygen was not evolved instead globules of sulphur was formed.

(iii) From this observation he concluded that during bacterial photosynthesis CO_2 does not split, instead hydrogen sulphide splits and acts as a hydrogen donor to CO_2 to form carbohydrates and molecular sulphur is released as one of the products.

$$6CO_2 + 12H_2S \xrightarrow{PEP\ case} C_6H_{12}O_6 + 6H_2O + 12S$$

This observation on photosynthetic bacteria led Van Niel to propose above given hypothesis.

Q. 21. Mention the initial fixation in C_4 pathway.

Ans. (i) Initial fixation of CO_2 occurs in mesophyll cells.

(ii) The primary acceptor of CO_2 is phosphoenol pyruvate or PEP. It combines with CO_2 in the presence of PEP carboxylase to form oxaloacetic acid or oxaloacetate.

PEP + CO_2 + H_2O → Oxalo-acetic acid + H_3PO_4

(iii) Oraloacetic acid is reduced to malic acid or transaminated to form aspartic acid.

$$\text{Oxaloacetic acid} + \text{NADPH} \xrightarrow{\text{Dehydrogenase}} \text{Malic acid} + H_3PO_4$$

$$\text{Oxaloacetic acid} + \text{Alanine} \xrightarrow{\text{Transaminase}} \text{Aspartic acid} + \text{Pyruvic acid.}$$

Q. 22. Differentiate between Photosystem-I and Photosystem-II.

Ans.

S. No.	**Photosystem-I**	Photoystem-II
(i)	The system te lorated in the non-appressed part of grana	Photoystem II is present in the appresaed part present of grana thylakoids

	thylakoids as well as stroma thylakoid"	
(ii)	Its photocentre is $P_{700.}$	Its photocentre is $P_{680.}$
(iii)	It is not connected with photolysin of water.	Photoystem-II is connected with photolytic osidation of waler.

Q. 23. What is the law of limiting factor? Explain.

[NCT-2008] [V. Imp.]

Ans. Law of limiting Factor: (i) It was proposed by F.F. Blackmann (1905).

(ii) It states that "if a chemical process is affected by more than one factor, then its rate will be determined by the factor which is nearest to its minimal value; it is the factor that directly atfects process as its quantity is changed''.

(iii) The rate of photosynthesis is affected mainly by the concentration of CO_2 light intensity and the temperature.

(iv) As the light intensity is increased, the rate of photosynthesis increases proportionately until some other factor like CO_2 or temperature may become limiting.

(v) Similarly, if the concentration of CO_2 is increased, the rate of photosynthesis increases until light may become a limiting factor

Q. 24. (i) Which pathway prevents photorespiration in plants? Explain it.

(ii) What is the role of RuBisCo? [KVS 2012-13]

Ans. (i) C, pathway or Hatch-Slack pathway prevents photorespiration in plants as these plants are adapted to dry tropical regions $E.g.$ of C_4 plants are sugarcane, maize, sorghum, pearl millet etc. in these plants, the vascular bundles are surrounded by large sized bundle sheath cells which are arranged is a wreath-like manner (Kranz - wreath). The anatomy of such leaves are called as Kranz Anatomy.

(ii) RuBisCo catalyses the carboxylation of RuBP to form an unstable 6C compound which breaks up into two 3C compound $i.e.$ PGA Here the enzyme RuBisCo acts an carboxylase. At high temperature RuBP acts as oxygenase to form 4C compound OAA.3