NEET Important Questions with Solutions from Photosynthesis in Higher Plants

Q.1. First visible product of photosynthesis is:

A) Glucose

B) Sucrose

C) Cellulose

D) Starch

Answer: Starch

Solution: Julius von Sachs was a German botanist and physiologist whose experimental study of plant nutrition, transpiration, hydroponics, etc, greatly advanced the knowledge of plant physiology. Therefore, he is regarded as the founder of experimental plant physiology.

Sachs's most important experiments revolve around developing the concept of photosynthesis. In 1865, Sachs proved that chlorophyll was not diffused in the plant but instead, confined to special bodies within the cell, later named as chloroplasts. He also proved that the starch present in the chloroplasts results from the absorption of carbon dioxide, and he established that starch is the first visible product of photosynthesis.
He found out that the formation of starch-grains in leaf chloroplasts depend on sunlight. A leaf that has been in sunlight on staining with iodine turns black, proving its starch content, whereas a leaf from the same plant that has been out of the sun will remain white.

Q.2. Maximum absorption of light occurs in the region (PAR) of

A) $400-700 \mathrm{~nm}$

B) $700-900 \mathrm{~nm}$

C) $1000-1200 \mathrm{~nm}$

D) $1500-2000 \mathrm{~nm}$

Answer: $400-700 \mathrm{~nm}$

Solution: The portion of the light spectrum utilized by plants for photosynthesis is better known as Photosynthetically active radiation (PAR). Plants utilize 400-700 nm wavelength of light in photosynthesis; hence, it constitutes photosynthetically active radiation (PAR).

The green plants have photosynthetic pigments chlorophyll a and b which show maximum absorption of light in red(620nm — 750nm) and blue(450nm) regions of the absorption spectrum. Hence, the maximum absorption of light by green plants occurs in 400nm — 700nm wavelength of light.

Q.3. In the 1930s, C.B. Van Niel correctly hypothesized that oxygen atoms in the oxygen gas released by plants come from

A) H_2O

B) CO_2

C) $C_6H_{12}O_6$

D) O_3

Answer: H_2O

Solution: Cornelis Bernardus Van Niel was a Dutch-born American microbiologist who studied photosynthesis in purple sulphur bacteria that synthesises glucose from CO_2 in the presence of light as green plants do. However, purple sulphur bacteria do not use water as the raw material. Instead, they use hydrogen sulphide (H_2S). Furthermore, oxygen is not liberated during the bacterial photosynthesis rather elemental sulphur is formed. Van Niel concluded that the action of light caused the breaking of H_2S into hydrogen and sulphur atoms. Then, in a series of dark reactions, the hydrogen atoms were used to reduce CO_2 to carbohydrate:

$$CO_2 + 2H_2S \rightarrow (CH_2O) + H_2O + 2S$$

By comparing the bacterial photosynthesis with that of photosynthesis in green plants, Van Niel emphasised that the energy of light causes' water to break up into hydrogen and oxygen.

Hence, Van Niel pointed out that the oxygen released during photosynthesis comes from the water just as all the sulphur produced by the purple sulphur bacteria comes from H_2S. Therefore, the equation for photosynthesis had to be rewritten as:

$$6\,CO_2 + 12H_2O \rightarrow C_6H_{12}O_6 + 6H_2O + 6O_2$$

Q.4. Which is the most effective wavelength of light for photosynthesis?

A) Green

B) UV light

C) Red

D) Yellow

Answer: Red

Solution: In 1881, a German plant physiologist T. W. Engelmann studied the effect of the different wavelengths of light on the rate of photosynthesis and plotted the first action spectrum of photosynthesis. A graph of the rate of photosynthesis as a function of the wavelength of light is called an action spectrum.

The first action spectrum was made by German plant physiologist T. W. Engelmann in 1881, using a filamentous green alga, *Cladophora* placed in a suspension of aerobic bacteria, and illuminating the alga with a tiny spectrum of light. After a few minutes, the aerobic bacteria are found to be aggregated around the portions of the algal filament illuminated by red and blue light.
Engelmann, thus discovered that the rate of oxygen evolution or rate of photosynthesis is maximum in red and blue light.

Q.5. Who was first to explain the evolution of oxygen during photosynthesis?

A) Dutrochet

B) Joseph Priestley

C) V. Helmont

D) Wilstatter

Answer: Joseph Priestley

Solution: In 1770, an English preacher Joseph Priestly performed a series of experiments, popularly known as bell jar experiments thereby he showed the role of air in the growth of plants.
Priestly observed that in a closed bell jar, a burning candle soon gets extinguished and a mouse soon suffocates and dies. Hence, he concluded that a burning candle or an animal, both somehow, damage air.

Next, he placed a mint plant in the same bell jars and found that the mouse stayed alive and the candle continued burning in the presence of the mint plant.
Therefore, Priestly made the assumption that plants restore to the air whatever breathing animals and burning candles remove, and so he made the conclusion that animals and humans 'consume air' and that the 'plants give the air back its freshness'.

Q.6. Which is the first stable intermediate of photosynthesis?

A) glucose

B) formaldehyde

C) phosphoglyceric acid

D) phosphoglyceraldehyde

Answer: phosphoglyceric acid

Solution: **Carbon dioxide** unites with ribulose-1, 5-biphosphate (**RuBP**) to produce a temporary intermediate compound. The intermediate compound breaks up immediately in the presence of water to produce the two molecules of 3-phosphoglycerate or 3-PGA. It is the first stable product of photosynthesis. It is also known as 3-Phosphoglyeceric acid.

Q.7. ATP in non-cyclic photophosphorlyation is formed when electron passes from

A) plastocyanin to P_{700}

B) plastoquinone to ferrodoxin

C) cytochrome f to plastcquinone

D) cytochrome b to cytochrome f

Answer: cytochrome b to cytochrome f

Solution: ATP in non-cyclic photophosphorylation is obtained when an electron passes from cytochrome b_6 to cytochrome f down the redox potential. The route of electrons follows **Z scheme** of non-cyclic phosphorylation, in which the electron traverse from PS II to PS I through a Redox potential gradient and the Cytochromes, constituting it.

Q.8. How many full turns of the Calvin cycle are required to make one molecule of glucose?

A) One

B) Two

C) Four

D) Six

Answer: Six

Solution: During the Calvin cycle, Carbon dioxide fixation occurs in three stages as carboxylation, reduction, and regeneration. One turn of the cycle fixes one molecule of carbon dioxide. Because the glucose molecule has six carbon atoms, it takes six turns of the Calvin cycle to make one glucose molecule (one for each carbon dioxide molecule fixed). The remaining G3P molecules regenerate RuBP, which enables the system to prepare for the carbon-fixation step.

Q.9. Which organelle out of these does not participate in photorespiration?

A) Peroxisomes

B) Mitochondria

C) Chloroplasts

D) Golgi bodies

Answer: Golgi bodies

Solution: The process that makes an important difference between C3 and C4 plants is photorespiration. The method of photorespiration interferes with the functioning of the Calvin cycle, and it is quite different from respiration as no ATP or NADH is produced.

Photorespiration takes place in the 3 cell organelles chloroplasts, mitochondria and peroxisomes.

Reactions in the chloroplasts: In the chloroplasts, atmospheric O_2 combines with RuBP (5C) to form one molecule of 3-PGA (3C) and one molecule of phosphoglycolate (3C). 3-PGA enters the Calvin cycle. Phosphoglycolate gets dephosphorylated to form glycolate (2C) which is transported to the peroxisomes.

Reactions in the peroxisomes:

- In the peroxisomes, glycolate (2C) gets oxidised to form glyoxylate(2C) and hydrogen peroxide (H_2O_2).
- Glyoxylate then gets converted to amino acid glycine (2C) which is transported to mitochondria.

Reactions in the mitochondria:

- In the mitochondria, two molecules of amino acid glycine (2C) combine to form one molecule of amino acid serine (3C) and release one molecule of CO_2.
- Amino acid serine is then transported to peroxisomes.

Q.10. Read the below statements and choose the right option.
Statement I: Photorespiration interferes with the successful functioning of Calvin cycle.
Statement II: Photorespiration oxidises ribulose- $1,5$ biphosphate which is an acceptor of CO_2 in Calvin cycle.

A) Both statements I and II are correct

B) Statement I is correct but statement II is incorrect

C) Statement I is incorrect but statement II is correct

D) Both statements I and II are incorrect

Answer: Both statements I and II are correct

Solution: Photorespiration (Photosynthetic carbon oxidative or PCO cycle) is the light-dependent process of oxygenation of ribulose-1,5 biphosphate (RuBP) and release of CO_2 by the photosynthetic organs of a plant. Normally, during the Calvin cycle, carboxylation of RuBP takes place whereas, during photorespiration, oxygenation of RuBP takes place. This is due to the abnormal behaviour of the enzyme RuBisCO, which at a high temperature (more than $35^{o}C$), functions as oxygenase (instead of carboxylase). Instead of fixing CO_2, it performs oxygenation of RuBP to produce a 3-carbon phosphoglyceric acid (PGA) and a 2-carbon phosphoglycolate.

$$\mathrm{RuBP} + \mathrm{O_2} \xrightarrow[\text{oxygenase}]{\text{RuBP}} \mathrm{PGA} + \mathrm{Phosphoglycolate}$$

Q.11. Read the following statements and state them as true (T) or false (F).

A. If the CO_2 concentration increases up to 0.05%, the rate of photosynthesis increases for short terms.

B. C_3 and C_4 plants respond similarly to the CO_2 concentration.

C. C_3 plants respond to high temperature and show higher photosynthetic rate.

D. The light reaction is less temperature sensitive than dark reaction.

A) (A – T), (B – F), (C – F), (D – T)

B) (A – T), (B – F), (C – F), (D – F)

C) (A – F), (B – T), (C – T), (D – F)

D) (A – F), (B – F), (C – T), (D – T)

Answer: (A – T), (B – F), (C – F), (D – T)

Solution: Carbon dioxide is the major limiting factor for photosynthesis. The CO_2 concentration is very low in the atmosphere, between 0.03 and 0.04% $(300 - 400$ ppm). This concentration of CO_2 is far below the optimum requirement of photosynthesis.
The minimum CO_2 concentration below which there is no net absorption of CO_2 and the rate of photosynthesis is equal to the rate of respiration is called compensation point.
The maximum CO_2 concentration at which photosynthesis occurs but beyond which photosynthesis takes place is called saturation point.
A very high concentration of carbon dioxide causes the closure of stomata. As a result rate of photosynthesis decreases.
The compensation point for the C_3 plant is $25 - 100$ ppm and for the C_4 plant is $0 - 10$ ppm. Whereas the saturation point for the C_3 plant is 450 ppm, and that of the C_4 plant is 360 ppm. The dark reactions, i.e. light-independent reactions, are controlled by enzymes which are more sensitive to temperature than light reaction. The optimum temperature for photosynthesis depends on the habitat the plants are adapted to.

The optimum temperature for C_3 plants is $20 - 25^0$ C. The optimum temperature for C_4 plants is $30 - 45^0$ C.
Minimum temperature of photosynthesis:

(a) For most plants is $0 - 5^0$ C

(b) For some gymnosperms is -35^0 C

Maximum temperature of photosynthesis:

(a) For desert plants, is $50 - 55^0$ C

(b) For hot spring algae is $70 - 75^0$ C

The Q10 value of photosynthesis is 2

This means that within the optimum temperature range, the rate of photosynthesis almost doubles with a 10^0C increase in temperature.

Q.12. Substrate for photorespiration is

A) Glyoxylate

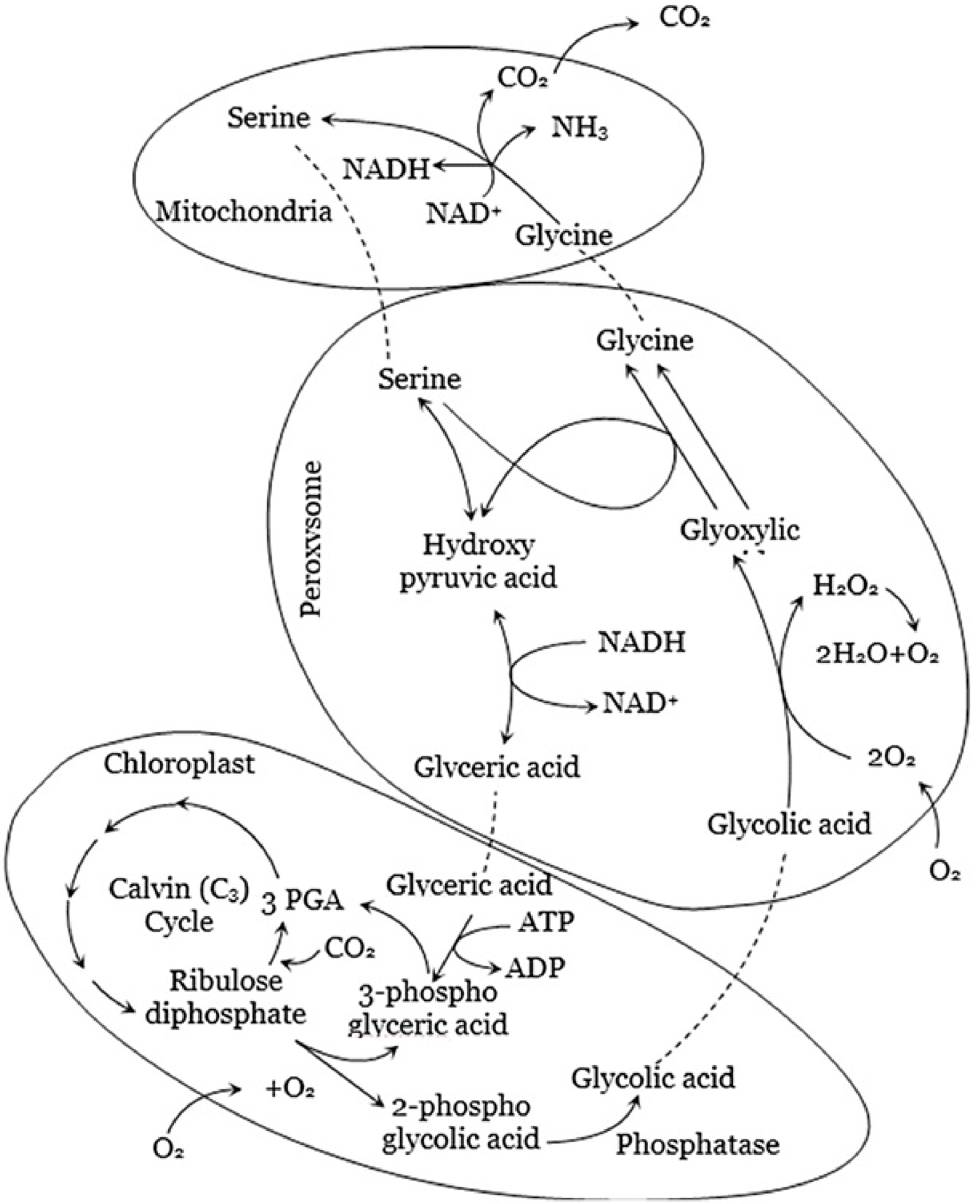
B) Glycolate

C) Glycine

D) RuBR

Answer: Glycolate

Solution: Photorespiration is the uptake of O2 and release of CO2 in light and results from the biosynthesis of glycolate in chloroplasts and subsequent metabolism of glycolate acid in the same leaf cell. The biochemical mechanism for photorespiration is also called glycolate metabolism. Loss of energy occurs during this process. The process of photorespiration occurs through three different organelles, chloroplasts, peroxisomes, and mitochondria, respectively. RuBP carboxylase also catalyzes another reaction that interferes with the successful functioning of the Calvin cycle. MECHANISM OF PHOTORESPIRATION: (1) Ribulose bisphosphate carboxylase (RUBISCO), the main enzyme of the Calvin cycle that fixes CO2, acts as ribulose bisphosphate oxygenase under the low atmospheric concentration of CO2 (i.e., below 1%) and increased concentration of O2. In the presence of a high concentration of O2, the enzyme RuBPoxygenase splits a molecule of Ribulose-1, 5-bisphosphate into one molecule each of 3-phosphoglycerate and 2-phosphoglycolate. Ribulose-1, 5- bisphosphate 2 Phosphoglycolate +3 Phosphoglyceric acid (2) The 2-phosphoglycolic acid loses its phosphate group in the presence of enzyme phosphatase and gets converted into glycolic acid – 2 Phosphoglycolic acid + H2O Glycolic acid + Phosphoric acid. (3) The glycolic acid, synthesized in the chloroplast acts as the first product of photosynthesis, is then transported to the peroxisome. The glycolic acid reacts with O2 and oxidizes to glyoxylic acid and hydrogen peroxide with the help of enzyme glycolic acid oxidase. Glycolic acid + O2 Glyoxylic acid + H2O2 The hydrogen peroxide is destroyed by enzyme catalase as follows: 2H2O2 2H2O + O2



(4) The glyoxylic acid is then converted to an amino acid-glycine by transamination reaction catalyzed by enzyme glutamate-glyoxylate transaminase. Glyoxylic acid + Glutamic acid Glycine + -ketoglutaric acid (5) The glycine is transported out of peroxisomes into mitochondria, where two molecules of glycine interact to form one molecule each of serine, CO_2, and NH_3 – 2 Glycine + H_2O + NAD^+ Serine + CO_2 + NH_3 + NADH The CO_2 is then released in photorespiration from mitochondria. The NH_3 released during glycine decarboxylation is transported to the cytoplasm or chloroplast, where it is incorporated into the synthesis of glutamic acid. (6) The amino acid serine returns to peroxisome where it is deaminated and reduced to hydroxypyruvic acid and finally to glyceric acid – Serine + Glyoxylic acid Hydroxypyruvic acid + Glycine Hydroxypyruvic acid Glyceric acid (7) The glyceric acid finally enters the chloroplast where it is phosphorylated to 3-phosphoglyceric acid, which enters into C3 cycle – Glyceric acid + ATP 3-Phosphoglyceric acid + ADP + Phosphate.

Q.13. If green plant cells are incubated with O^{18-} labelled CO_2, which of the following molecules will become radioactive when the cells are exposed to light?

A) ATP

B) Water

C) Sugar

D) O_2

Answer: Sugar

Solution: Ruben and Kamen (1941), while working on *Chlorella* (unicellular green alga) found that oxygen liberated during photosynthesis comes from water and not from CO_2. This even explain the process of production of carbohydrates or sugar when labelled oxygen and carbon dioxide is used.

(i) When normal H_2O and radioactive CO_2 ($CO^{18}{}_2$) were used, normal O_2 is evolved in presence of chlorophyll and light.

$nCO^{18}{}_2 + nH_2O^{-} \rightarrow (CH_2O^{18})n + nO_2\uparrow$ (normal) + H_2O

(ii) When normal CO_2 and radioactive H_2O (H_2O^{18}) were used, radioactive O_2 ($O^{18}{}_2$) is evolved.

$nCO_2 + nH_2O^{18} \rightarrow (CH_2O)n + nO^{18}{}_2\uparrow$ (radioactive oxygen) + H_2O

Q.14. Refer to the given reaction.

$\mathrm{RuBP} + \mathrm{O_2} \xrightarrow[\text{oxygenase}]{\text{RuBP}} \text{Phosphoglyceric acid} + \text{Phosphoglycolic acid}$

It is the first reaction of

A) C_3 pathway

B) C_4 pathway

C) C_2 pathway

D) glycolysis

Answer: C_2 pathway

Solution: Photorespiration (C_2 pathway) is a biochemical process in C_3 plants in which some O_2 does bind to RuBisCO as it has both a carboxylase and the oxygenase activity. It converts Ribulose diphosphate (RuBP) to one molecule of phosphoglycerate and phosphoglycolate instead of being converted to 2 molecules of PGA and hence CO_2 fixation is decreased. In this pathway of photorespiration, there is neither synthesis of sugars, nor ATP. Instead, it results in the release of CO_2.

Q.15. In an experiment in which photosynthesis is performed during the day, you provide a plant with radioactive carbon dioxide $(^{14}CO_2)$ as a metabolic tracer. The ^{14}C is incorporated first into oxaloacetic acid. The plant is best characterised as a

A) C_4 plant

B) C_3 plant

C) CAM plant

D) insectivorous plant

Answer: C_4 plant

Solution: In C_4 plants, the first stable photosynthetic product is a 4 -carbon compound, i.e., oxaloacetic acid (OAA), which is formed by initial fixation of CO_2 by the carboxylation of phosphoenolpyruvate in the mesophyll cells. So, when radioactive $^{14}CO_2$ is introduced into the reaction, it is first incorporated into the OAA.

$\mathrm{PEP} + {}^{14}\mathrm{CO_2} + \mathrm{H_2O} \xrightarrow{\text{PEP carboxylase}} \mathrm{OAA} + \mathrm{H_3PO_4}$

In a CAM plant, although the first product formed is OAA, but here the initial CO_2 fixation occurs at night.

Q.16. Consider following statements with respect to the C_4 pathway and select the correct ones.
(i) Mesophyll cells possess both RuBisCO and PEPcase enzymes.
(ii) Initial CO_2 fixation occurs in mesophyll cells.
(iii) Final CO_2 fixation occurs in bundle sheath cells.

A) (i) and (ii)

B) (ii) and (iii)

C) (i) and (iii)

D) (i), (ii) and (iii)

Answer: (ii) and (iii)

Solution: The C_4 plants are better photosynthesizers than C_3 plants. CO_2 taken from the atmosphere is accepted by phosphoenolpyruvic acid (PEP) present in the chloroplasts of mesophyll cells of these leaves, leading to the formation of a 4-C compound, oxaloacetic acid (OAA), which in turn, is converted to another 4-C acid, the malic acid which enters into the chloroplasts of bundle sheath cells, and there undergoes oxidative decarboxylation yielding pyruvic acid (a 3-C compound) and CO_2. CO_2 released in bundle sheath cells reacts with ribulose-1,5-biphosphate (RuBP) already present in the chloroplasts of bundle sheath cells and thus Calvin cycle starts. Pyruvic acid then re-enters mesophyll cells and regenerates PEP (phosphoenol pyruvic acid). CO_2 after reacting with RuBP gives rise to sugars and other carbohydrates. Mesophyll cells have PEP carboxylase and pyruvate orthophosphate dikinase enzyme while the bundle sheath cells have decarboxylase and complete enzymes of the Calvin cycle.

Here we can clearly see that in the C4 pathway the mesophyll cells have PEPcase, and the bundle sheath cells have RUBISCO.

Q.17. Chlorophyll a and b shows maximum absorption in

A) Blue region

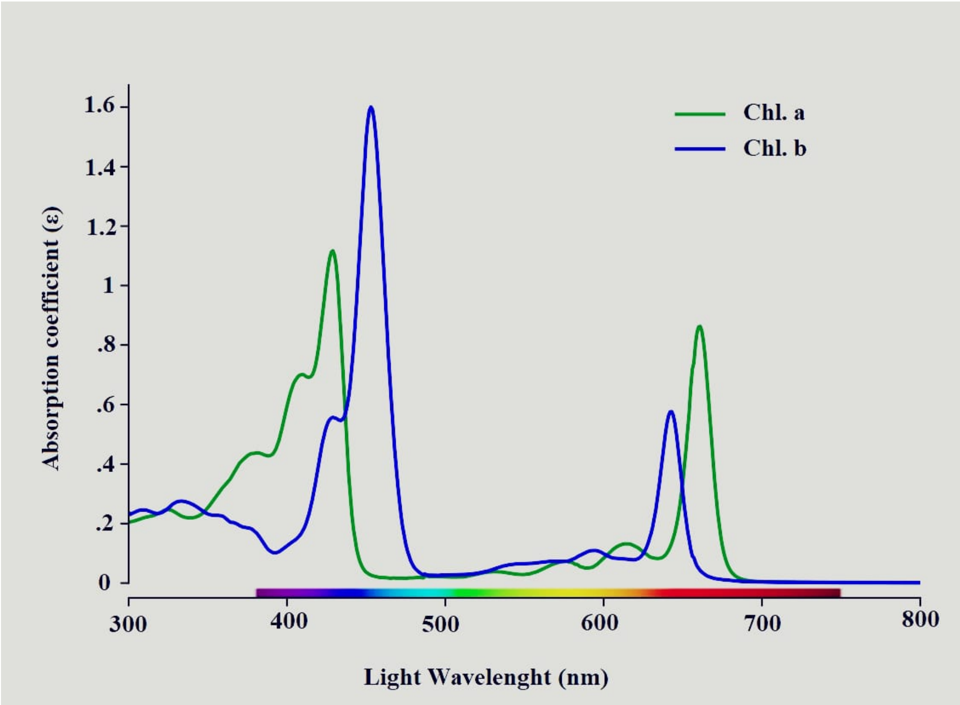
B) Red region

C) Blue and red regions

D) Yellow and violet regions

Answer: Blue and red regions

Solution: Solar energy is also called radiant energy or electromagnetic energy. This energy, according to electromagnetic wave theory (Proposed by James Clark Maxwell, 1960), travel in space as waves, and the distance between the crest of two adjacent waves is called a wavelength. Shorter the wavelength greater the energy. Solar Radiation ranges between 300nm (ultraviolet) to 2600nm (infra-red). Photosynthetically active radiation (PAR) is 400–700nm. Leaves appear green because chlorophylls do not absorb green light and the same is reflected and transmitted through leaves.



The curve representing the light absorbed at each wavelength by pigment is called the absorption spectrum. The absorption spectrum can be studied with the help of a spectrophotometer. **The absorption spectrum of chlorophyll a and chlorophyll b (given in the graph) indicate that these pigments mainly absorb blue and red lights and hence we can say that the maximum photosynthesis occurs in the blue and red light.**

Q.18. During non-cyclic photophosphorylation, electrons are continuously lost from the reaction centre of PS II . Which source is used to replace these electrons?

A) Sunlight

B) O_2

C) H_2O

D) CO_2

Answer: H_2O

Solution: In plants, non-cyclic photophosphorylation is the normal process of photophosphorylation. In this process, the electron that is expelled by the excited reaction centre does not return to it as observed in the cyclic photophosphorylation. Non-cyclic photophosphorylation is carried out in collaboration with both photosystems I and II. The electron gets released during the photolysis of water is picked up by the reaction centre of PS II called P_{680nm}.

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

The electron is extruded out from the reaction centre after absorbing the light energy and is accepted by the electron acceptors like pheophytin with the continuation of an oxidation-reduction reaction releasing ATP and $NADPH_2$.

Q.19. The given table shows the CO_2 compensation point and optimum CO_2 concentration for photosynthesis for C_3 and C_4 plants.

	C_3 **Plants**	C_4 **Plants**
CO_2 compensation point	$25 - 100$ ppm	A
Optimum CO_2 concentration	B	360 ppm

Select the correct values for A *and* B.

	A	B
(i)	$0 - 50$ ppm	300 ppm
(ii)	$0 - 10$ ppm	450 ppm
(iii)	$100 - 150$ ppm	250 ppm
(iv)	$100 - 110$ ppm	290 ppm

A) (i)

B) (ii)

C) (iii)

D) (iv)

Answer: (ii)

Solution: CO_2 compensation point or threshold value is that concentration of CO_2 at which illuminated plant parts stop absorbing carbon dioxide from their environment. At this value, CO_2 fixed in photosynthesis is equal to CO_2 evolved in respiration and photorespiration. The value is 25-100 ppm in C_3 plants and 0-10 ppm in C_4 plants. The reason for low compensation value for C_4 plants is the greater efficiency of CO_2 -fixation through PEP-carboxylase. The optimum CO_2 concentration for C_4 plants is 360 ppm and for C_3 plants, it is 450 ppm.

Q.20. PEP is primary CO_2 acceptor in

A) C_4 plants

B) C_3 plants

C) C_2 plants

D) Both C_3 and C_4 plants

Answer: C_4 plants

Solution: In C_4 plants, the CO_2 taken from the atmosphere is accepted by phosphoenolpyruvic acid (PEP) present in the chloroplasts of mesophyll cells of these leaves, leading to the formation of a 4-C compound, oxaloacetic acid (OAA), which in turn, is converted to another 4-C acid, the malic acid which enters into the chloroplasts of bundle sheath cells, and there undergoes oxidative decarboxylation yielding pyruvic acid (a 3-C compound) and CO_2. CO_2 released in bundle sheath cells reacts with ribulose-1,5-biphosphate (RuBP) already present in the chloroplasts of bundle sheath cells and thus Calvin cycle starts. Pyruvic acid then re-enters mesophyll cells and regenerates PEP (phosphoenol pyruvic acid). CO_2 after reacting with RuBP gives rise to sugars and other carbohydrates.

Q.21. Read the given statements and select the correct option.
Statement I: In photosynthesis, during ATP synthesis, protons accumulate in the lumen of thylakoid.
Statement II: In respiration, during ATP synthesis, protons accumulate in the intermembranal space of mitochondria.

A) Both statements I and II are correct

B) Statement I is correct but statement II is incorrect

C) Statement I is incorrect but statement II is correct

D) Both statements I and II are incorrect

Answer: Both statements I and II are correct

Solution: During photosynthesis in the chloroplast, proton accumulates in the lumen of thylakoid, whereas during respiration in mitochondria, protons accumulate in the peri-mitochondrial space of the mitochondria when electrons move through the ETS. This creates a proton gradient across the thylakoid membrane in the chloroplast and inner membrane of mitochondria. This gradient is broken down due to the movement of protons from the lumen of thylakoid to the stroma of the chloroplast and from the inter-membrane space of mitochondria to the matrix through the transmembrane channel of the F_o of the ATPase.

The ATPase enzyme consists of two parts- the F_o and F_1 particles. The F_o is embedded in the membrane and forms a transmembrane channel that carries out facilitated diffusion of protons across the membrane while the F_1 particle protrudes on the surface of the membrane. The break down of the proton gradient provides enough energy to cause a conformational change in the F_1 particle of the ATPase, which enables the ATPase enzyme to synthesize ATP.

Q.22. The first step of Z scheme is

A) splitting of water.

B) photoexcitation of chlorophyll molecule.

C) release of oxygen.

D) synthesis of reducing power.

Answer: photoexcitation of chlorophyll molecule.

Solution: **Non-cyclic photophosphorylation or the Z-scheme of photophosphorylation was proposed by Hill and Bendall**. It involves both PS I and PS II. When light falls on P680 of PSII and P700 of PSI, they get excited and release electrons. The flow of the electrons is unidirectional. Electrons are not cycled back and are used in the reduction of NADP to $NADPH_2$. Here, H_2O is utilised and O_2 evolution occurs. In this chain, high energy electrons released from 'P680' do not return to 'P680' but pass through pheophytin, plastoquinone (PQ), cytochrome b_6f complex, plastocyanin and then enter P700 (The pheophytin is the primary electron acceptor here). In this transfer of electrons from PQ to cytochrome b_6f complex, ATP is synthesised. Because high energy electrons released from 'P680' do not return to 'P680' and ATP (one molecule) is formed, this process is called non-cyclic photophosphorylation. ATP is synthesised at only one step.

Q.23. Accessory photosynthetic pigments in most green plants are

A) chlorophyll a

B) chlorophyll b

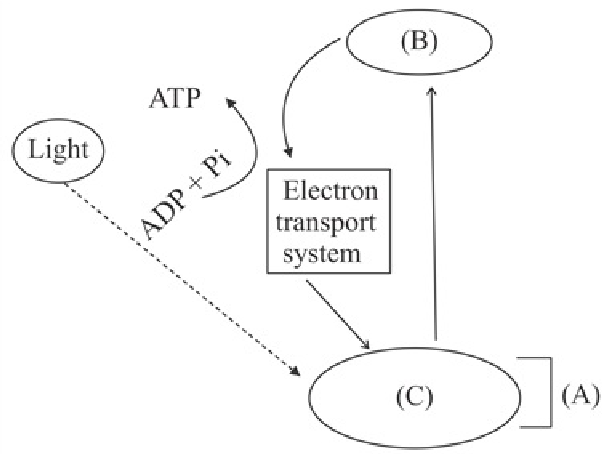
C) carotenoids and xanthophylls

D) both (B) and (C)

Answer: both (B) and (C)

Solution: Chlorophyll a is found in almost all photosynthetic plants except bacteria and is called primary photosynthetic pigment. Carotenoids are a group of chemicals that are called accessory pigments for the photosynthesis process. They are groups of yellow-orange to reddish pigments. They are associated with the chlorophyll molecules. Chlorophyll-b and carotenoids together are called accessory pigments. Carotenoids (made up of carotenes and xanthophylls) are with conjugated double bonds. Carotenes are hydrocarbons and xanthophylls (yellow colored pigments) are oxygen-derivatives of carotenes. Besides being accessory pigments, with an absorption spectrum of yellow-orange range, these pigments also perform some other function. They protect the chloroplast contents from the attack of nascent oxygen released during the photolysis of water. Carotenes can pick up the nascent oxygen by virtue of their double bonds and change them into a stable molecular form. Thus, carotenes can protect the chlorophylls from the photo-oxidation process.

Q.24. Read the given flow chart of cyclic photophosphorylation and select the correct answer for A, B and C.



A)

A	B	C
PS I	e^- acceptor	P_{680}

B)

A	B	C
PS I	e^- acceptor	P_{700}

C)

A	B	C
PS I	Cytochrome	P_{700}

D)

A	B	C
PS II	Cytochrome	P_{680}

Answer:

A	B	C
PS I	e^- acceptor	P_{700}

Solution: In the light reaction, the two photosystems, viz. PS I and PS II participate in two schemes- cyclic and non-cyclic photophosphorylation.

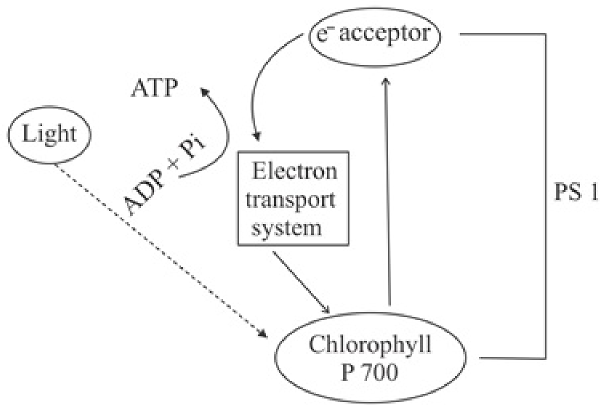
In the primitive environment, free oxygen was not available and when the photosynthetic forms began to get evolve, the primitive bacteria (Eubacteria) derived their ATP through cyclic photophosphorylation. This is an anoxygenic photosynthetic process with common features like:

1. There is only one reaction center (P_{700}) of only one photosystem (PS-I).

2. There is no splitting of the water molecules and hence, no evolution of oxygen.

3. The electron comes back, after getting de-energized completely, to the same reaction centre.

4. This cyclic event occurs when there is a low intensity of light (of wavelength more than 680 nm) is available, or there is an improper CO_2 fixation rate.



Q.25. PS II is located on

A) inner side of thylakoid membrane

B) outer side of thylakoid membrane

C) lumen of thylakoid membrane

D) stroma lamellae

Answer: inner side of thylakoid membrane

Solution: The water-splitting complex is associated with PS II, which is physically located on the inner side of the thylakoid membrane with the liberation of oxygen. This splitting of water to release molecular O_2 and H^+ during photosynthesis is called photolysis. Photolysis is catalysed by the protein-bound inorganic complex containing manganese ions (oxygen-evolving complex) of photosystem II.

Practice more on Photosynthesis in Higher Plants