

MULTIPLE CHOICE QUESTIONS

1. Which metal ion is a constituent of chlorophyll?

- a. Iron
- b. Copper
- c. Magnesium
- d. Zinc

Solution:

Option (c) is the answer.

2. Which pigment acts directly to convert light energy to chemical energy?

- a. Chlorophyll a
- b. Chlorophyll b
- c. Xanthophyll
- d. Carotenoid

Solution:

Option (a) is the answer.

3. Which range of wavelength (in nm) is called photosynthetically active radiation (PAR)?

- a. 100 - 390
- b. 390 - 430
- c. 400 - 700
- d. 760 - 100,00

Solution:

Option (c) is the answer.

4. Which light range is least effective in photosynthesis?

- a. Blue
- b. Green
- c. Red
- d. Violet

Solution:

Option (b) is the answer.

5. Chemosynthetic bacteria obtain energy from

- a. Sun
- b. Infrared rays
- c. Organic substances
- d. Inorganic chemicals

Solution:

Option (d) is the answer.

6. The energy required for ATP synthesis in PSII comes from

- a. Proton gradient
- b. Electron gradient

- c. Reduction of glucose
- d. Oxidation of glucose

Solution:

Option (a) is the answer.

7. During light reaction in photosynthesis, the following are formed:

- a. ATP and sugar
- b. Hydrogen, O₂ and sugar
- c. ATP, hydrogen and O₂
- d. ATP, hydrogen and O₂ donor

Solution:

Option (c) is the answer.

8. The dark reaction in photosynthesis is called so because of

- a. It can occur in dark also
- b. It does not depend on light energy
- c. It cannot occur during daylight
- d. It occurs more rapidly at night

Solution:

Option (b) is the answer.

9. PEP is the primary CO₂ acceptor in

- a. C₄ plants
- b. C₃ plants
- c. C₂ plants
- d. Both C₃ and C₄ plants

Solution:

Option (a) is the answer.

10. Splitting of water is associated with

- a. Photosystem I
- b. The lumen of thylakoid
- c. Both Photosystem I and II
- d. The inner surface of the thylakoid membrane

Solution:

Option (d) is the answer.

11. The correct sequence of flow of electrons in the light reaction is

- a. PSII, plastoquinone, cytochromes, PSI, ferredoxin
- b. PSI, plastoquinone, cytochromes, PSII, ferredoxin
- c. PSI, ferredoxin, PSII,
- d. PSI, plastoquinone, cytochromes, PSII, ferredoxin

Solution:

Option (a) is the answer.

12. The enzyme that is not found in a C₃ plant is

- a. RuBP Carboxylase
- b. PEP Carboxylase
- c. NADP reductase
- d. ATP synthase

Solution:

Option (b) is the answer

13. The reaction that is responsible for the primary fixation of CO₂ is catalysed by

- a. RuBP carboxylase
- b. PEP carboxylase
- c. RuBP carboxylase and PEP carboxylase
- d. PGA synthase

Solution:

Option (c) is the answer.

14. When CO₂ is added to PEP, the first stable product synthesised is:

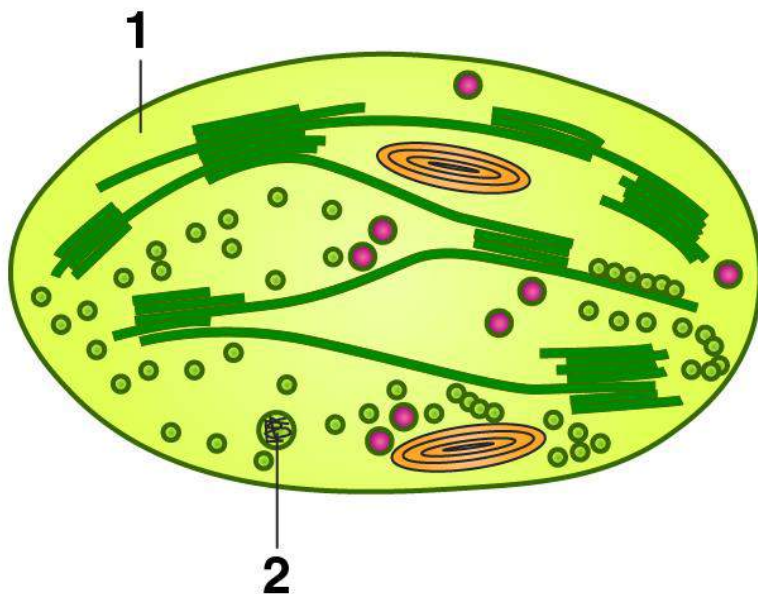
- a. Pyruvate
- b. Glyceraldehyde-3-phosphate
- c. Phosphoglycerate
- d. Oxaloacetate

Solution:

Option (d) is the answer.

VERY SHORT ANSWER TYPE QUESTIONS

1. Examine the figure



- a. Is this structure present in an animal cell or plant cell?
- b. Can these be passed on to the progeny? How?
- c. Name the metabolic processes taking place in the places marked (1) and (2)

Solution:

- (a) This structure is present in the plant cell.
- (b) Chloroplast can self-replicate and hence it can be passed on to the progeny.
- (c) (1) shows dark reaction and (2) shows the site of replication of chloroplast.

2. $2\text{H}_2\text{O} \rightarrow 4\text{H}^+ + \text{O}_2 + 4\text{e}^-$

Based on the above equation, answer the following questions:

- a. Where does this reaction take place in plants?
- b. What is the significance of this reaction?

Solution:

- a. It takes place in PS II which is a decomposition reaction of the water molecule.
- b. Splitting of water continuously provides electrons to the electron transport chain; further steps of photosynthesis.

3. Cyanobacteria and some other photosynthetic bacteria don't have chloroplasts. How do they conduct photosynthesis?

Solution:

In the inner membrane of cyanobacteria, they have folds to take place the photosynthesis. Bluish pigment phycocyanin is there to take photo-synthesis with solar energy.

4. a. NADP reductase enzyme is located on _____.

b. Breakdown of proton gradient leads to release of _____.

Solution:

- a) Outer side of thylakoid membrane (Grana-lamella)
- (b) ATP molecules

5. Can girdling experiments be done in monocots? If yes, how? If no, why not?

Solution:

No. The monocot stem is scattered over all of the widths of the trunk by vascular bundles. So, we can't reach a particular band of girdling phloem.

6. $3\text{CO}_2 + 9\text{ATP} + 6\text{NADPH} + \text{Water} \rightarrow \text{glyceraldehyde 3-phosphate} + 9\text{ADP} + 6\text{NADP}^+ + 8\text{Pi}$

Analyse the above reaction and answer the following questions:

- a. How many molecules of ATP & NADPH are required to fix one molecule of CO_2 ?
- b. Where in the chloroplast does this process occur?

Solution:

- (a) 3 molecules of ATP are required for phosphorylation and 2 molecules of NADPH are required for reduction of carbon dioxide.
- (b) This reaction occurs in the stroma of the chloroplast.

7. Does moonlight support photosynthesis?

Solution:

It does not support photosynthesis because they don't have enough energy to excite chlorophyll molecules.

8. Some of these terms/chemicals are associated with the C₄ cycle. Explain.

a. Hatch slack pathway

b. Calvin cycle

c. PEP carboxylase

d. Bundle sheath cells

Solution:

(a) In C₄ plants the process is called the Hatch & Slack Pathway, the glucose synthesis process.

(b) Steps leading to the formation of carbohydrate following the division of the water molecule. This happens cyclically and is called the Calvin Cycle.

(c) PEP carboxylase is an enzyme. It is present in mesophyll cells of C₄ plants.

(d) The specialized sclerenchyma cells present around vascular bundles in the veins of C₄ plants are called bundle sheath cells.

9. Where is NADP reductase enzyme located in the chloroplast? What is the role of this enzyme in proton gradient development?

Solution:

NADP reductase enzyme is located on the outer side of the thylakoid membrane. It facilitates the breakdown of the proton gradient to release energy, i.e. NADPH.

10. ATPase enzyme consists of two parts. What are those parts? How are they arranged in the thylakoid membrane? Conformational change occurs in which part of the enzyme?

Solution:

Two parts of the enzyme are ATPase: the head of F₀ and the head of F₁. The F₀ head is towards the thylakoid's inner side while F₁ is towards the thylakoid's outer side. In F₁ part of the enzyme, the conformation changes.

11. Which products formed during the light reaction of photosynthesis are used to drive the dark reaction?

Solution:

ATP & NADPH are formed during the light reaction of photosynthesis.

12. What is the basis for designating C₃ and C₄ pathways of photosynthesis?

Solution:

The number of carbon atoms in the end product is the basis for designating C₃ and C₄ pathways of photosynthesis.

SHORT ANSWER TYPE QUESTIONS

1. Succulents are known to keep their stomata closed during the day to check transpiration. How do they meet their photosynthetic CO₂ requirements?

Solution:

These plants have designed a special approach for ensuring the daily supply of carbon dioxide. These plants fix carbon dioxide at night in the form of malic acid.

2. Chlorophyll 'a' is the primary pigment for a light reaction. What are accessory pigments? What is their role in photosynthesis?**Solution:**

Accessory pigments are known to support chlorophyll in the trapping of solar radiation. The accessory pigments are chlorophyll b, xanthophylls and carotenoids. They help collect and transfer solar radiation to chlorophyll a.

3. Do reactions of photosynthesis called, as 'Dark Reaction' needs light? Explain.**Solution:**

The dark reaction occurs in full darkness but continues even during the day. Dark reaction, therefore, requires indirectly light but is not dependent on light.

4. How are photosynthesis and respiration related to each other?**Solution:**

Carbon dioxide is an important raw material for photosynthesis and much of the carbon dioxide comes as a by-product of respiration. Respiration does not take place without photosynthesis.

5. If a green plant is kept in dark with proper ventilation, can this plant carry out photosynthesis? Can anything be given as a supplement to maintain its growth or survival?**Solution:**

When a plant is kept in the dark and ventilated correctly, carbon dioxide is still present. The plant can be supplied with an adequate amount of water to maintain its survival. However, due to lack of nutrients, the seed would eventually die.

6. Photosynthetic organisms occur at different depths in the ocean. Do they receive qualitatively and quantitatively the same light? How do they adapt to carry out photosynthesis under these conditions?**Solution:**

They do not receive qualitatively and the quantitatively same light. Solar radiation is important in life. The photosynthetic pigments of these organisms show considerable variations. These pigments help these organisms even in low light conditions to perform photosynthesis.

7. In tropical rain forests, the canopy is thick and plants growing below receive filtered light. How are they able to carry out photosynthesis?**Solution:**

In tropical rain forests, the canopy is thick and plants growing below receive it called sciophytes. In very low condition also they can undergo photosynthesis and have larger units.

8. What conditions enable Rubisco to function as an oxygenase? Explain the ensuing process.**Solution:**

Rubisco is competitive to bind one of them. This means that the enzyme would be used as carboxylase in the event of a higher CO₂ concentration. However, the enzyme would act as oxygenase in cases of

higher concentration of O₂.

9. Why does the rate of photosynthesis decrease at higher temperatures?

Solution:

Rate of photosynthesis decreases as the temperature increases, because the enzymes will function at an optimum temperature. If it exceeds they could not function.

10. Explain how during light reaction of photosynthesis, ATP synthesis is a chemiosmotic phenomenon.

Solution:

Proton pumps pump ions with a proton gradient, which is finally synthesized in ATP. Because of these factors, ATP synthesis is called a chemiosmotic phenomenon during light reaction.

11. Find out how Melvin Calvin worked out the complete biosynthetic pathway for synthesis of sugar.

Solution:

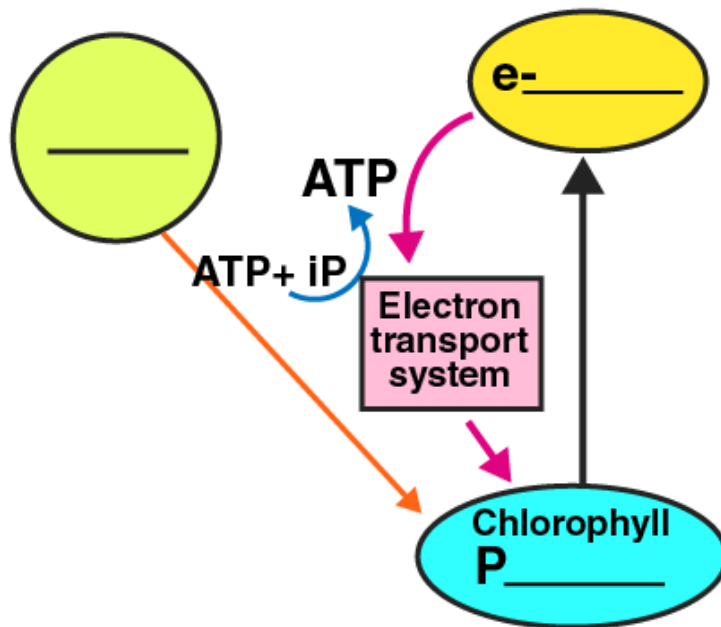
The following measures were used: carbon dioxide, a radioactive isotope of carbon, was labelled C¹⁴ and was supplied to the plants for this experiment. The path C¹⁴ was then monitored and analysed. After the experiment on live plant got over, the plant was killed and the labelled compound was extracted from the dead plant and based on the observation in both live and dead Calvin and his colleagues found the pathway.

12. Six turns of the Calvin cycle are required to generate one mole of glucose. Explain.

Solution:

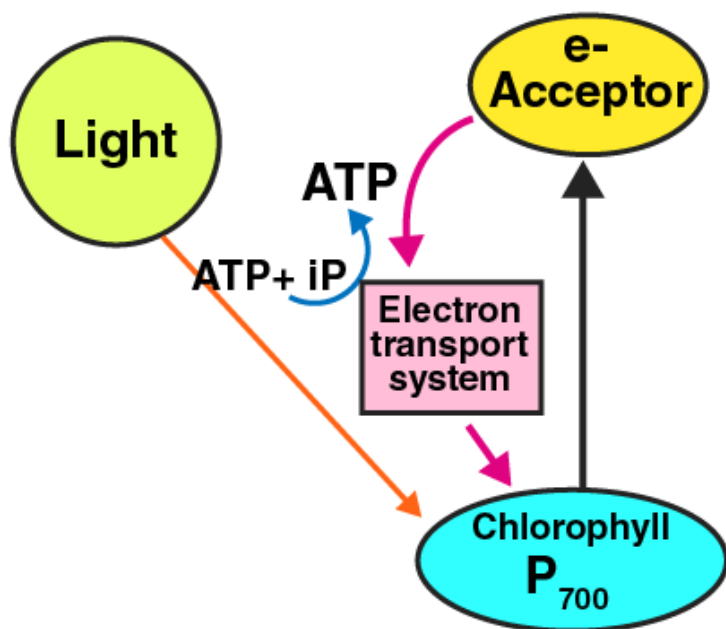
Glucose is a 6-carbon compound, so six carbon dioxide molecules are required to produce a single glucose molecule. Hence, six turns of the Calvin Cycle are required to generate one mole of glucose.

13. Complete the flow chart for cyclic photophosphorylation of the photosystem-I



Solution:





14. In what kind of plants do you come across ‘Kranz’ anatomy? To which conditions are those plants better adapted? How are these plants better adapted than the plants which lack this anatomy?

Solution:

C₄-plants, such as maize, sugar cane etc. are found in Kranz anatomy. These plants are also suitable for a limited nitrogen and carbon dioxide supply.

15. In a way, green plants and cyanobacteria have synthesized all the food on the earth. Comment.

Solution:

Cyanobacteria are unicellular prokaryotic organisms. They have photosynthetic pigments like chlorophyll ac, phycocyanin and phycoerythrin. These enable them to produce food by themselves. Green plants are multicellular organisms capable of making food by using carbon dioxide, water and light energy. Therefore the bacteria and green plants make food for living organisms on earth.

16. Tomatoes, carrots and chillies are red due to the presence of one pigment. Name the pigment. Is it a photosynthetic pigment?

Solution:

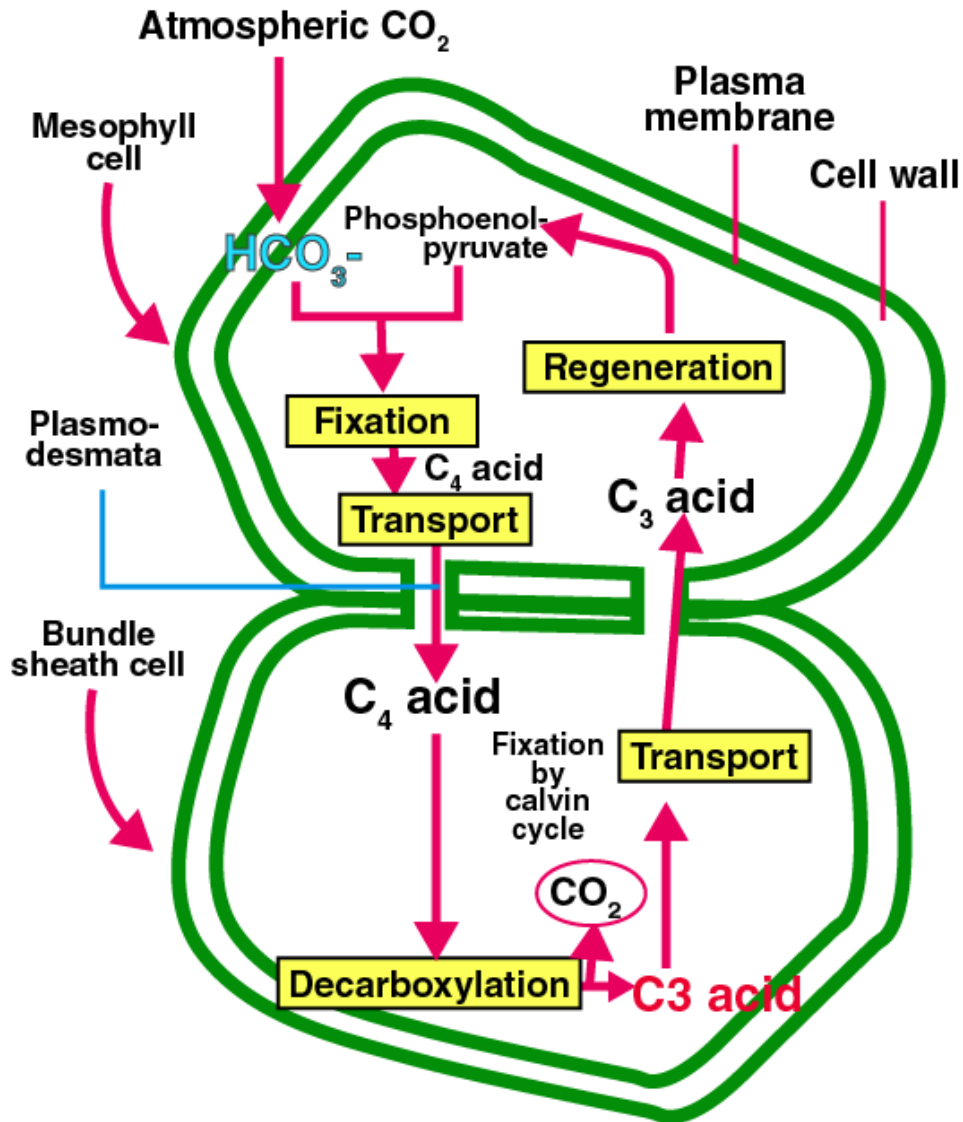
Tomatoes, carrots and chillies are red due to the presence of carotene pigment. It is an accessory photosynthetic pigment.

17. Why do we believe chloroplast and mitochondria to be semi-autonomous organelle?

Solution:

Extra genomic DNA is present in the chloroplast and mitochondria. This enhances the replication of these organelles. Thus believed that chloroplast and mitochondria as semi-autonomous.

18. Observe the diagram and answer the following.



- Which group of plants exhibits these two types of cells?
- What is the first product of the C₄ cycle?
- Which enzyme is there in bundle sheath cells and mesophyll cells?

Solution:

- Monocot plants show bundle sheath cells and mesophyll cells.
- Oxaloacetic acid
- PEP carboxylase or PEP case.

19. A cyclic process is occurring in a C₃ plant, which is light-dependent and needs O₂. This process doesn't produce energy rather it consumes energy.

- Can you name the given process?
- Is it essential for survival?
- What are the end products of this process?
- Where does it occur?

Solution:

- Photorespiration
- It is not essential for survival.
- Hydrogen peroxide
- It occurs in chloroplast, mitochondria and peroxisome.

20. Suppose Euphorbia and Maize are grown in the tropical area.

- Which one of them do you think will be able to survive under such conditions?
- Which one of them is more efficient in terms of photosynthetic activity?
- What difference do you think are there in their leaf anatomy?

Solution:

- Euphorbia is a CAM plant and maize is a C₄ plant. Both can survive in tropical areas.
- Maize due to the C₄ plant
- Leaves of maize plant show Kranz anatomy which is absent in Euphorbia plant.

LONG ANSWER TYPE QUESTIONS

1. Is it correct to say that photosynthesis occurs only in leaves of a plant? Besides leaves, what are the other parts that may be capable of carrying out photosynthesis? Justify.

Solution:

Any part of the plant which has green in colour can photosynthesize. So the statement is wrong. Examples include Chlorophyll roots of Trap and Timisoara and photosynthesis. The stem is changed into a fleshy green structure in Opuntia and the leaves are altered in spines to reduce transpiration. Photosynthesis occurs in the stem of these plants. Opuntia's modified stem is named phylloclade. In most of the plants, sepals are green and they do perform photosynthesis.

2. The entire process of photosynthesis consists of a number of reactions. Where in the cell does each of these take place?

- Synthesis of ATP & NADPH _____
- Photolysis of water _____
- Fixation of CO₂ _____
- Synthesis of sugar molecule _____
- Synthesis of starch _____

Solution:

- Outer side of thylakoid membrane
- Inner side of thylakoid membrane
- Stroma of chloroplast
- Chloroplast

(e) Chloroplast

3. Which property of the pigment is responsible for its ability to initiate the process of photosynthesis? Why is the rate of photosynthesis higher in the red and blue regions of the spectrum of light?

Solution:

The most abundant pigment in plants is chlorophyll a. This pigment demonstrates the optimal efficiency between blue and red-light wavelengths. Pigments are capable of absorbing light with a certain wavelength so they absorb various colours of light. Pigments show optimal efficiency between the blue and red light. This is due to the chlorophyll and also can be due to the accessory pigments. This means that in the range of red and blue light the rate of photosynthesis is higher.

4. What can we conclude from the statement that the action and absorption spectrum of photosynthesis overlap? At which wavelength do they show peaks?

Solution:

In the blue and region there is maximum absorption by the chlorophyll and also shows a higher rate of photosynthesis. Thus we can say that the chief pigment associated with photosynthesis is chlorophyll a. The diagram peak is of 400nm wavelength which is equal to blue and peaks again between 600 and 700nm which is of red. Therefore shows that the spectrum of action and absorption overlaps. The black line shows the photosynthesis action spectrum, while the blue line displays the spectrum of absorption.

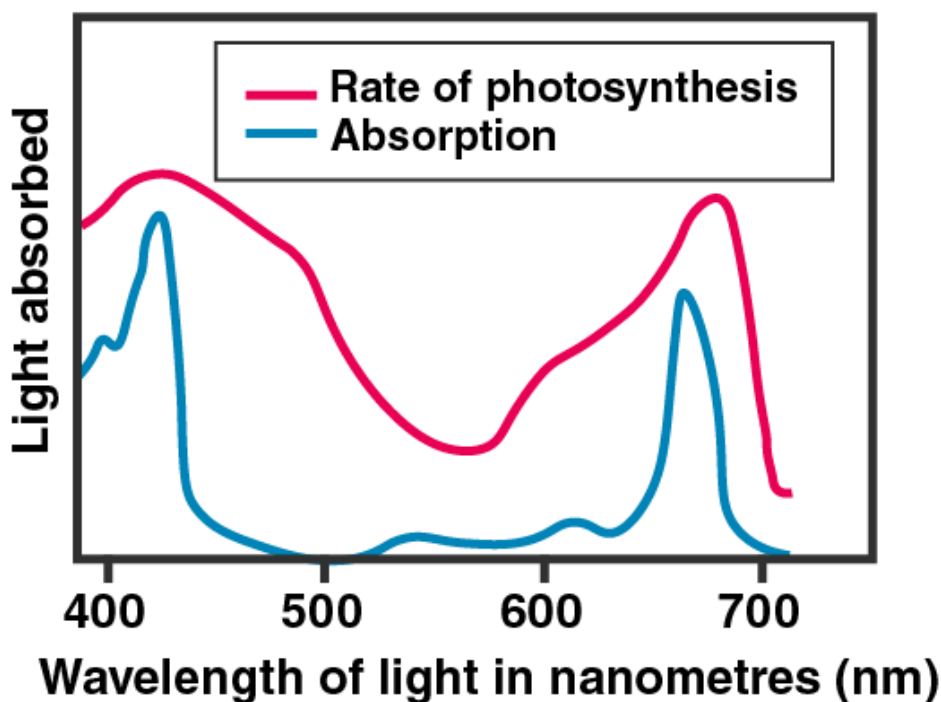
5. Under what conditions are C4 plants superior to C3?

Solution:

C4 plants are superior to C3 due to the following conditions

- They have a characteristic leaf anatomy
- They withstand higher temperatures.
- They show response to high light intensities
- They have greater productivity of biomass

6. In the figure given below, the black line (upper) indicates the action spectrum for photosynthesis and the lighter line (lower) indicates the absorption spectrum of chlorophyll a. Answer the following



- a. What does the action spectrum indicate? How can we plot an action spectrum?
b. How can we derive an absorption spectrum for any substance?

Solution:

- a. The action spectrum indicates the rate of photosynthesis. The measurement is oxygen release the oxygen releases on the y-axis and the wavelength on the x-axis can be compared to the action spectrum.
b) The absorption of various wavelengths for a particular pigment can be done by the processing, such as chlorophyll-a, or chlorophyll b, or any other pigment.

7. List the important events and end products of the light reaction?

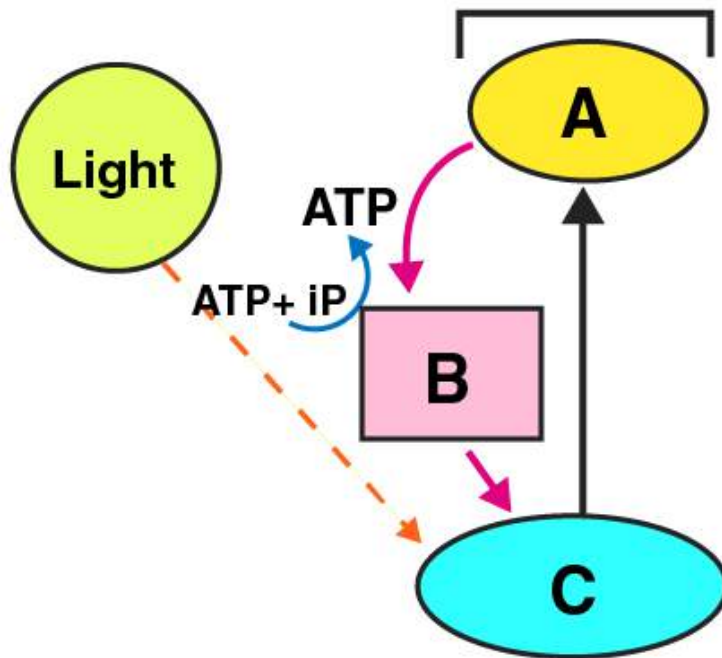
Solution:

Water division: sunlight energy is used to divide the water molecule into hydrogen ion and NADP^+ to NADPH is used for the extra electron released after the split.

Oxygen release: after the division of the water molecule oxygen discharges into the stomach.

High-energy intermediate formation (ATP and NADPH): two energy-rich combinations ATP and NADPH are formed at the end of an electricity reaction.

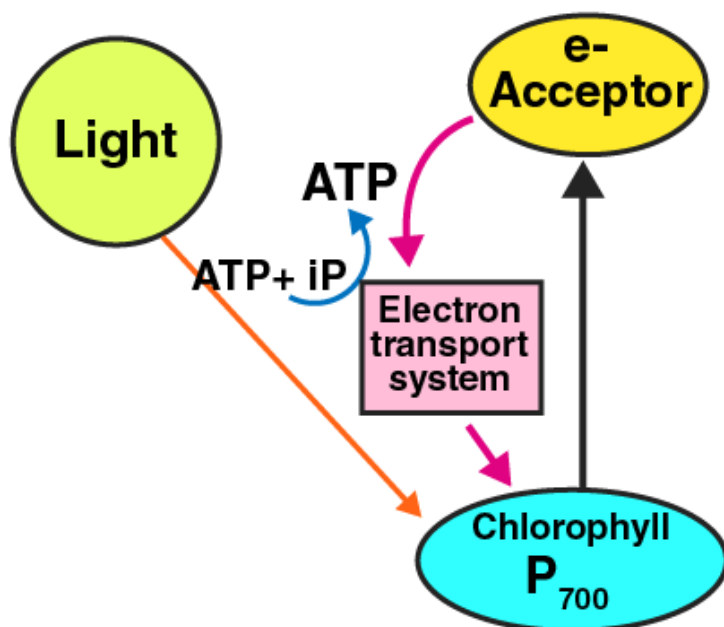
8. In the diagram given below what is label A, B and C. What type of phosphorylation is possible in this?



Solution:



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cyclic photophosphorylation is possible here. Photophosphorylation is the synthesis of ATP from ADP and inorganic phosphate in the presence of light.

9. Why is the Rubisco enzyme more appropriately called RUBP Carboxylase-Oxygenase and what important role does it play in photosynthesis?

Solution:

It acts as both carboxylase and oxygenase, so it is referred to as RUBP carboxylase–Oxygenase. Rubisco binds CO₂ to 3PGA in C₃ plants. In C₃ plants, Rubisco is binding with O₂ in a process known photorespiration to generate phosphoglycerate and phosphoglycerate. Photo vacuum reduces carbon attachment in C₃ plants.

10. What special anatomical features are displayed by leaves of C₄ plants? How do they provide an advantage over the structure of C₃ plants?

Solution:

The vascular bundles in leaves contain a sheath of large cells. In particular, chloroplast impregnates several layers of cells around the bundle cell. These cell thick walls cannot be exchanged for gasses. The sheath is without intercellular space. C₄ plants over C₄ plants are securely fastened with the bundle sheath. It helps to increase the level of carbon dioxide in the leaves. We know that it is competitive to bind Rubisco to CO₂ and oxygen. C₄ plants lack photorespiration. C₄ plants are superior to C₃ due to the following conditions

- a) They have a characteristic leaf anatomy
- b) They withstand high temperatures.
- c) They show response to high light intensities

11. Name the two important enzymes of the C₄ pathway, and explain their role in fixing CO₂?**Solution:**

Rubisco and PEP case are the two important enzymes of C₃ and C₄ pathways. Rubisco is the primary CO₂ receiver in C₃ facilities while PEP case is the main CO₂ receiver for C₄ facilities. The important enzyme of the C₃ pathway is RUBisCO and C₄ is PEPcase. In the Calvin cycle, carboxylation is the most crucial step. Carbon dioxide is utilized for the carboxylation of RuBP. This is catalyzed by RuBP carboxylase which results in the formation of two molecules of 3-PGA. The primary carbon dioxide acceptor in the C₄ pathway is 3 carbon molecule phosphoenolpyruvate.

12. Why is Rubisco enzyme the most abundant enzyme in the world?**Solution:**

The enzyme catalyzes during the Calvin cycle to transform carbon dioxide into sugar. From cyanobacteria to the floors of large trees; literally, Rubisco is present all over the place. All carbon in the biosphere can be said to be derived from Rubisco carbon fixation. Therefore it is considered as the world's largest enzyme.

13. Why photorespiration does not take place in C₄ plants?**Solution:**

Photorespiration does not occur in C₄ plants because they increase the concentration of carbon dioxide at the enzyme site by a mechanism. This happens when the C₄ acid from the mesophyll is broken down in the bundle sheath cells to release Carbon dioxide which further results in the increasing the intracellular of carbon dioxide. The high carbon dioxide concentration in the plants makes all Rubisco bind to carbon dioxide and no oxygen-binding exists.