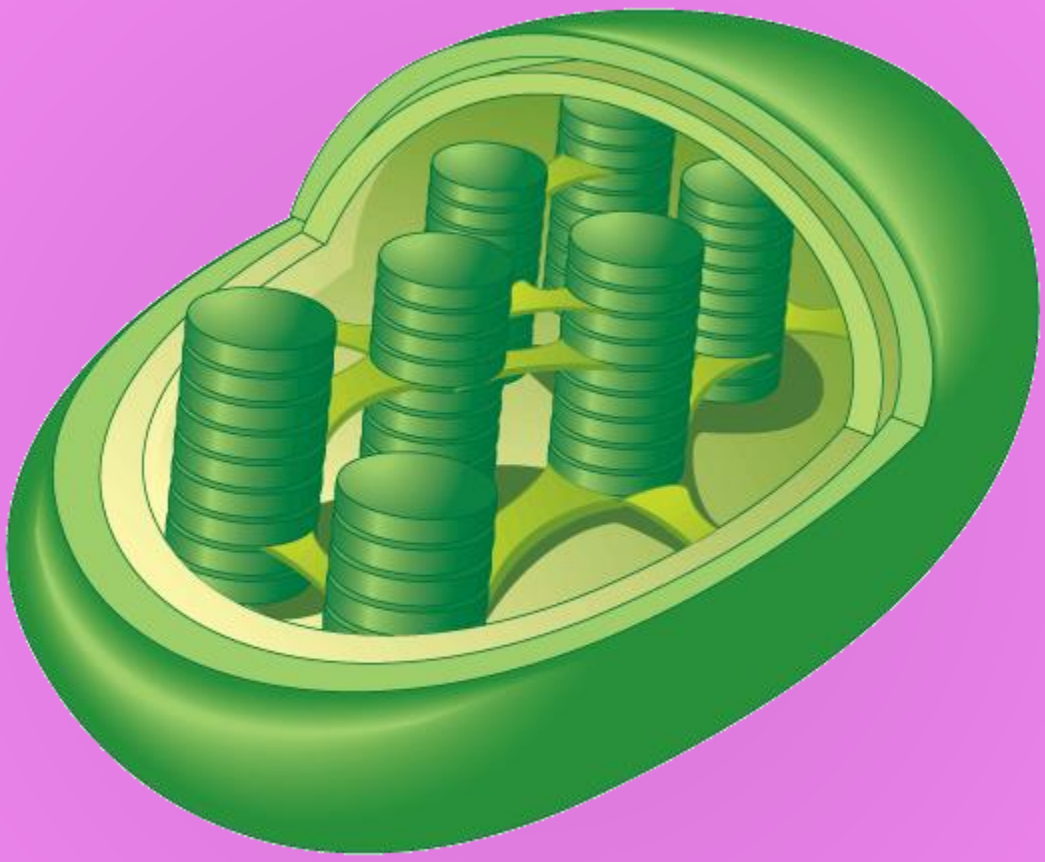
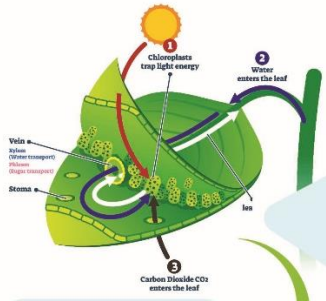
13.PHOTOSYNTHESIS IN HIGHER PLANTS



Biology Smart Booklet

Theory + NCERT MCQs + NEET PYQs

PHOTOSYNTHESIS IN HIGHER PLANTS



EARLY EXPERIMENTS

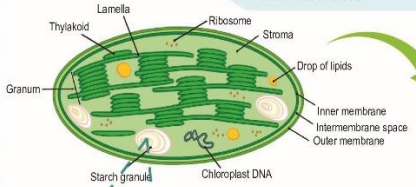
- Joseph Priestley - (1770)- Plants restore air that is removed by breathing animals & burning candles. In 1774, he discovered oxygen.
- Jan Ingenhausz - Green part of the plant is responsible for releasing oxygen. Sunlight is essential for plants.
- Julius von Sachs (1854) – Glucose is produced in green parts. Special bodies of plant & it is stored as starch.
- T.W. Engelmann (1882) – Proved the effects of wavelength the (blue & red light of spectrum on photosynthesis. He used green alga, Cladophora, to do his experiments: Action spectrum of photosynthesis was discovered.
- Cornelius van Niel (1931)– discovered that photosynthesis is a light – dependent redox reaction, worked on purple & green sulphur bacteria. Hydrogen reduces carbon dioxide to carbohydrates.

FACTORS EFFECTING PHOTOSYNTHESIS

- Internal factors - Number, size, age of leaves, amount of chlorophyll
- External favtors – Light – initial increase in rate of photosynthesis with light: later breakdown of chlorophyll.
  - CO_2 Concentration – Major limiting factor: increase upto (0.05%) in CO_2 Concentration increase photosynthesis rate.
  - Temperature – Light reactions not affected by temperature: dark reactions not affected by temperature: dark reaction depends on C_3 or C_4 plant.
  - Water – Stress closes stomata that decreases CO_2 level: decreases metabolic activity.

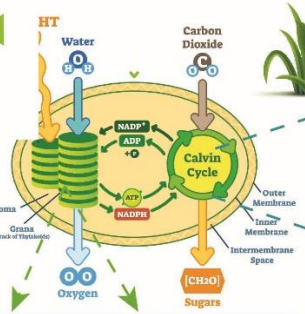
PHOTOSYNTHESIS

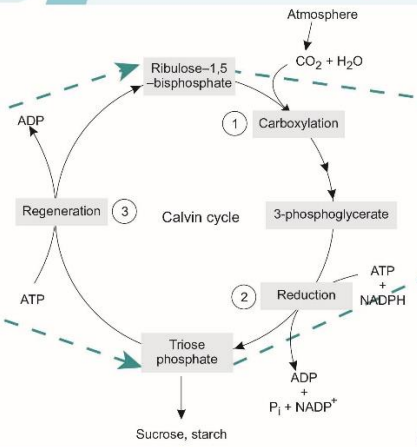
- Process by which plants use light energy to synthesize sugar.
- Chlorophyll a, Chlorophyll b, Carotenoids are involved
- Chlorophyll 'a' absorbs wavelength of 430 & 662 nanometer.
- Wavelengths of 455 & 644 nanometer.



- Thylakoids contain pigment called chlorophyll
- Process of synthesis of ATP by cells (in mitochondria & chloroplasts) is called phosphorylation.
- ATP molecules carry energy in their chemical bonds

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





3 PHASES OF CYCLE

- Carboxylation – First stable product is 3 – PGA
- Primary CO_2 acceptor is RUBP: (RUBISCO enzyme)
- Reduction – Per CO_2 molecule: 2ATP & 2NADPH are reduced.
- Regeneration of RUBP – RUBP regenerates for next cycle.
- One glucose makes by 6 – turns of Calvin cycle

CHEMIOSMOTIC HYPOTHESIS

- Explains how ATP synthesized in chloroplast.
- Synthesis occurs due to development of proton gradient across the membranes of thylakoid.
- Proton accumulation occurs in the lumen (towards the inside of the membrane).
- It results in decrease in protons in stroma & increase in lumen
- It creates proton gradient across thylakoid membrane.
- This gradient is broken down by transfer of protons across the membrane from lumen to stroma.
- It occurs through transmembrane channel of CF_0 of ATP synthase enzyme.
- Change in proton gradient changes conformation of CF_1 (part of ATP synthase) leading to formation of several molecules of ATP

- Light reaction occur in thylakoid (grana)
- Absorbs light, Splits water &forms energy intermediates (ATP & NADPH)
- Light harvesting complexes Photosystem I (PSI P_{700}) & II (PSII / P_{680}) involved.
- Oxygen is liberated

- Dark reaction or light – independent reactions occur in stroma of chloroplast.
- No pigments involved
- CO_2 is fixed
- Glucose is produced by the help of ATP & NADPH

ELECTRON TRANSPORT CHAIN

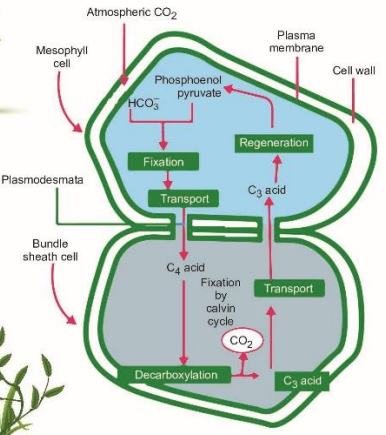
- PSII & PSI connected through ETC
- ETC follows Z- Scheme for transfer of electrons from PS II to PS I
- PS II absorbs 680 nanometer red light
- Electrons pick by acceptors: passed to ETC consisting of cytochromes
- Oxidation – reduction passes electrons to PS I
- After PS I, electrons reduces $NADP^+$ to NADPH.

DARK REACTIONS

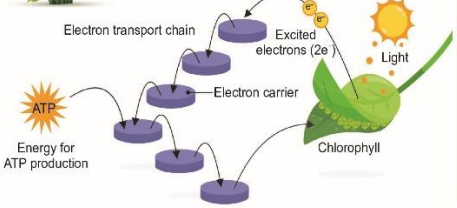
- Use products of light reactions – ATP, NADPH & Oxygen.
- It is Biosynthetic phase of photosynthesis.
- Does not require light
- Oxygen diffuses in air & ATP & NADPH – used for synthesis of food (sugars)
- CO_2 assimilation occurs by two ways – Calvin cycle or C_3 pathway or Hatch & Slack Pathway C_4 pathway.
- Calvin worked on algal photosynthesis (used radioactive ^{14}C) to discover first CO_2 fixation product.
- C_3 cycle - first fixation product is 3- phosphoglyceric acid (3 – C compound)
- C_4 cycle – first fixation product is Oxaloacetic acid (4- C compound)

HATCH & SLACK PATHWAY (C_4 PATHWAY)

- Exhibited by plants of dry tropical region
- C_4 plants have special leaf anatomy "Kranz Anatomy"
- Have large cells around the vascular or bundles called Bundle Sheath Cells.
- Mesophyll cells lack RUBISCO enzyme.
- Primary CO_2 acceptor is Phosphenol Pyruvate (PEP): enzyme is PEP carboxylase.
- Calvin cycle occurs in Bundle Sheath Cells.
- Maize, Sorghum are examples.



C_4 Pathway

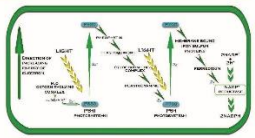


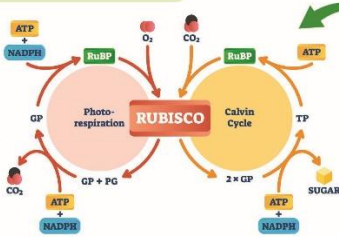
CYCLIC PHOTO-PHOSPHORYLATION

- Sometimes, this electron flow takes an alternative pathway & become cyclic
- This cyclic flow of electrons uses only PS I.
- It is called cyclic photo – phosphorylation. Occurs in stroma lamellae.
- It is like taking a short – route by electrons.
- Produces only ATP

NON-CYCLIC PHOTOPHOSPHORYLATION

- The below Z – Scheme shows linear flow of electrons from PS II to PS I.
- In this, PS II & PS I both are involved
- Plastoquinone (PQ) is primary electron acceptor in PS II
- Produces both ATP & NADPH





PHOTORESPIRATION

- RUBISCO is most abundant enzyme is the world.
- In addition to CO_2 binding affinity, RUBISCO has great affinity to bind with O_2.
- In C_3 Cycle, it Binds with O_2 to form Phosphoglycerate & Phosphoglycolate
- Photorespiration does not produce any sugar or ATP.
- C_4 Plants have special mechanism (Bundel Sheath cells) to avoid Photorespiration.

PHOTOSYNTHESIS IN HIGHER PLANTS

Photosynthesis

Photosynthesis is an enzyme regulated anabolic process of manufacture of organic compounds inside the chlorophyll containing cells from carbon dioxide and water with the help of sunlight as a source of energy.

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

Historical Perspective

Josheph Priestley (1770): Showed that plants have the ability to take up CO_2 from atmosphere and release O_2. (Candle with bell jar and mouse expt.)

Jan Ingenhousz (1779): Release of O_2 by plants was possible only in sunlight and only by the green parts of plants. (Expt. with aquatic plant in light & dark)

Theodore de Saussure (1804): Water is an essential requirement for photosynthesis to occur.

Julius Von Sachs (1854): Green parts in plant produce glucose which is stored as starch.

T.W. Engelmann (1888): The effect of different wavelength of light on photosynthesis and plotted the first action spectrum of photosynthesis.

C.B. Van Niel (1931): Photosynthesis is essentially a light dependent reaction in which hydrogen from an oxidizable compound reduces CO_2 to form sugar. He gave a simplified chemical equation of photosynthesis.

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

Hill (1937): Evolution of oxygen occurs in light reaction.

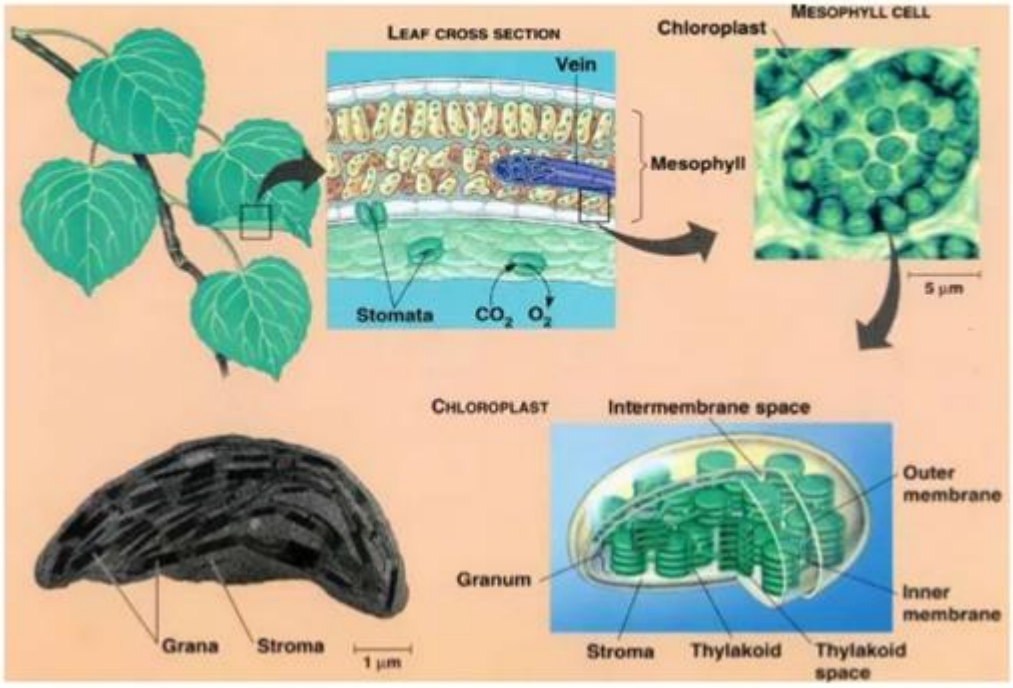
Calvin (1954-55): Traced the pathway of carbon fixation.

Site for photosynthesis

Photosynthesis takes place only in green parts of the plant, mostly in leaves. Within a leaf, photosynthesis occurs in mesophyll cells which contain the chloroplasts. Chloroplasts are the actual sites for photosynthesis. The thylakoids in chloroplast contain most of pigments required for capturing solar.

Energy to initiate photosynthesis: The membrane system (grana) is responsible for trapping the light energy and for the synthesis of ATP and NADPH. Biosynthetic phase (dark reaction) is carried in stroma.

Site of Photosynthesis



Importance of Photosynthesis

- Synthesis of organic compounds.
- Change of radiant energy into chemical energy.
- Useful products are obtained from plants gums, oils timber fire wood, resins rubber, fibers and drugs, etc.
- Balance the percentage of O_2 and CO_2 in atmosphere.
- Fossil fuels like coal, natural gas and petroleum have been formed inside the earth indirectly as a product of photosynthesis.

Pigments involved in photosynthesis

Chlorophyll a: (Bright or blue green in chromatograph). Major pigment, act as reaction center, involved in trapping and converting light into chemical energy. It is called universal photo-synthetic pigment.

Chlorophyll b: (Yellow green)

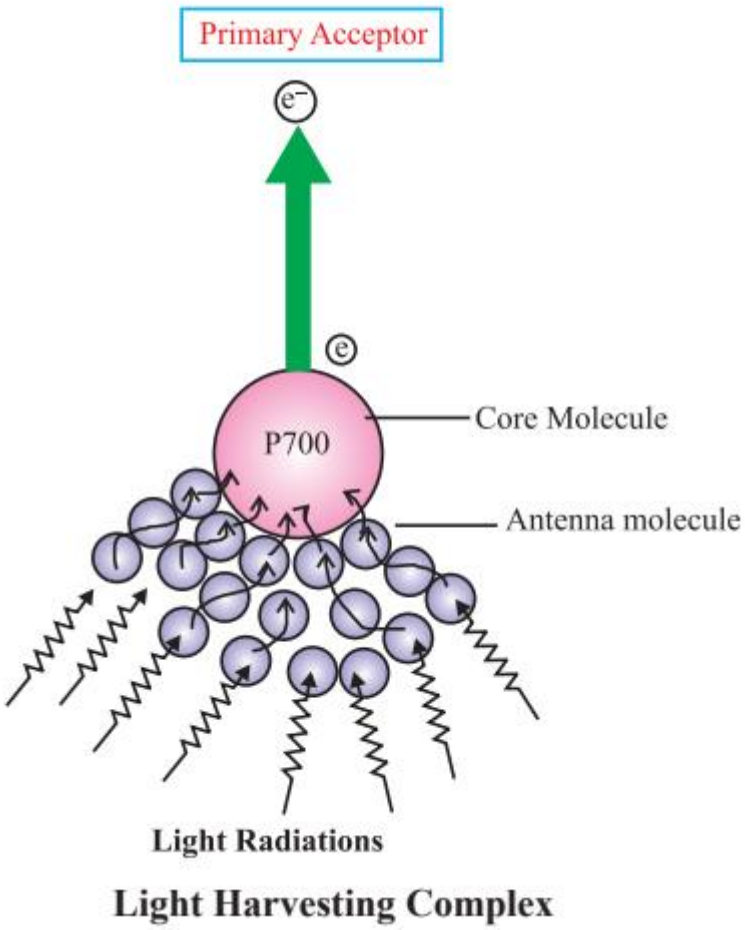
Xanthophyll's: (Yellow)

Carotenoids: (Yellow to yellow-orange)

In the blue and red regions of spectrum shows higher rate of photosynthesis.

Light Harvesting Complexes (LHC)

The light harvesting complexes are made up of hundreds of pigment molecules bound to protein within the photosystem I (PS-I) and photosystem II (PS-II). Each photosystem has all the pigments except one molecule of chlorophyll 'a' forming a light harvesting system (antennae). The reaction center (chlorophyll a) is different in both the photosystems.



Light Harvesting Complex

Photosystem I (PS-I): Chlorophyll 'a' has an absorption peak at 700 nm (P700).

Photosystem II (PS-II): Chlorophyll 'a' has absorption peak at 680 nm (P680),

Process of photosynthesis

It includes two phases-Photochemical phase and biosynthetic phase. (Formerly known as Light reaction and dark reaction)

Photochemical phase (Light reaction): This phase includes-light absorption, splitting of water, oxygen release and formation of ATP and NADPH. It occurs in grana region of chloroplast.

Biosynthetic phase (Dark reaction): It is light independent phase, synthesis of food material (sugars). (Calvin cycle). It occurs in stroma region of chloroplast.

Photophosphorylation

The process of formation of high-energy chemicals (ATP and NADPH) in presence of light.

Non-Cyclic photophosphorylation

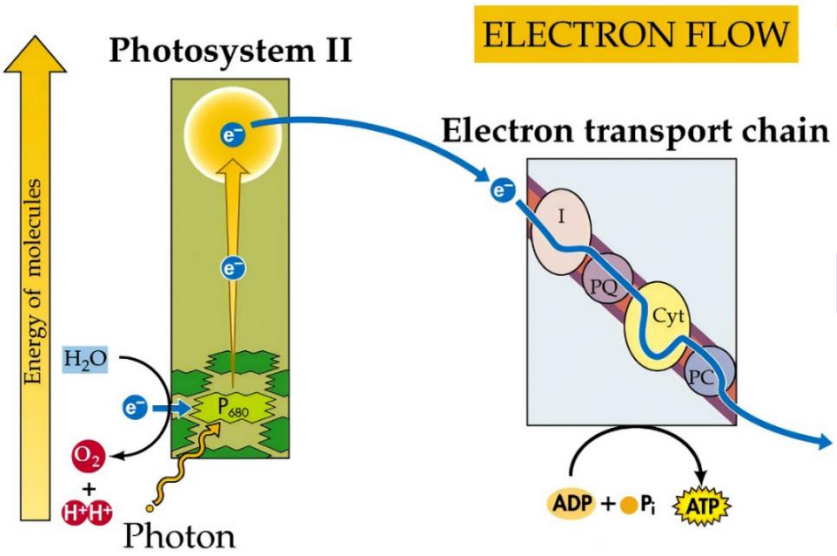
Two photosystems work in series First PSII and then PSI. These two photosystems are connected through an electron transport chain (Z. Scheme). Both ATP and NADPH + H+ are synthesized by this process. PSI and PSII are found in lamellae of grana, hence this process is carried here.

Cyclic photophosphorylation

Only PS-I works, the electron circulates within the photosystem. It happens in the stroma lamellae (possible location) because in this region PSII and NADP reductase enzyme are absent. Hence only ATP molecules are synthesized. It occurs when only light of wavelengths beyond 680 nm are available for excitation.

The Electron Transport System

1. Reaction center of photosystem II absorbs light of 680 nm in red region and causing electron to become excited. These electrons are picked by an electron acceptor which passes to electron transport system consisting of cytochromes.
2. Electrons are passed down the electron transport chain and then to the pigment of PS I.
3. Electron in the PSI also get excited due to light of wavelength 700nm and are transferred to another accepter molecule having a greater redox potential.
4. When electron passes in downhill direction, energy is released. This is used to reduce the ADP to ATP and NADP+ to NADPH. The whole scheme of transfer of electron is called Z-scheme due to its shape.
5. Photolysis of water release electrons that provide electron to PS II. Oxygen is also released during this process.



Calvin Cycle/ C_3 cycle/ Reductive Pentose Sugar Phosphate Pathway

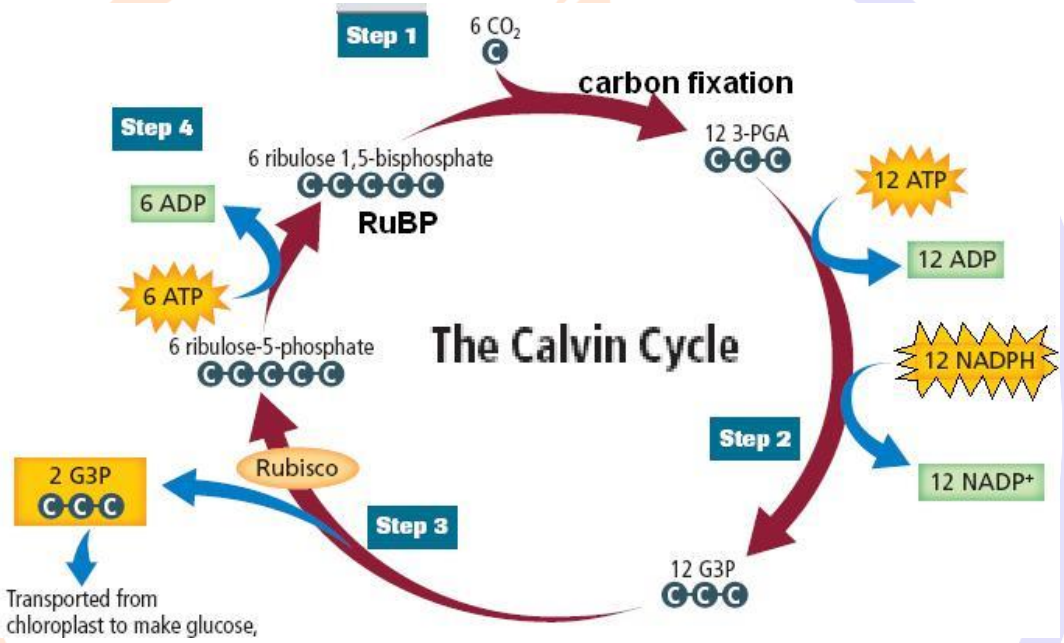
Malvin Calvin, Benson and their colleagues used radioactive 14C and Chlorella and Scenedesmus algae to discover that first CO_2 fixation product is 3-carbon organic compound (3-phosphoglyceric acid) or PGA. Later on a new compound was discovered which contain 4-carbon called Oxaloacetic Acid (AAO). On the basis of number of carbon atoms in first stable product they are named C_3 and C_4 pathway.

Calvin cycle can be described under three stages: carboxylation, reduction and regeneration.

1. Carboxylation is the fixation of into 3-phosphoglyceric acid (3-PGA). Carboxylation of RuBP occurs in presence of enzyme RuBP carboxylase

(RuBisCO) which results in the formation of two molecules of 3-PGA.

2. Reduction is series of reaction that leads to formation of glucose. Two molecules of ATP and two molecules of NADPH are required for reduction of one molecule of. Six turns of this cycle are required for removal of one molecule of Glucose molecules from pathway.
3. Regeneration is the generation of RuBP molecules for the continuation of cycle. This process requires one molecules of ATP.
4. For every molecule of entering the Calvin Cycle, 3 molecules of ATP and 2 molecules of NADPH is required. To make one molecules of glucose 6 turns of cycle is completed so total energy molecule required is.



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

C_4 pathway/ Hatch Slack Pathway

- This pathway was worked out by Hatch and Slack (1965, 1967), mainly operational in plants growing in dry tropical region like Maize, Sugarcane, Sorghum etc.
- In this pathway first stable product is a 4-carbon compound Oxaloacetic acid (AAO) so called as C_4 pathway. C_4 plants have Kranz Anatomy (vascular bundles are surrounded by bundle sheath cells arranged in wreath like manner), characterized by large no of chloroplast, thick wall impervious to gases and absence of intercellular spaces.
- The primary CO_2 acceptor is a 3-carbon molecule Phosphoenol Pyruvate present in mesophyll cells and enzyme involved is PEP carboxylase.
- OAA formed in mesophyll cell forms 4-carbon compound like malic acid or aspartic acid which is transported to bundle sheath cells.
- In bundle sheath cell, it is broken into CO_2 and a 3-carbon molecule. The

3-carbon molecule is returned back to mesophyll cells to form PEP.

- The CO_2 molecules released in bundle sheath cells enters the Calvin cycle, where enzyme RuBisCO is present that forms sugar.

Photorespiration

- It is a the light dependent process of oxygenation of RuBP and release of carbon dioxide by photosynthetic organs of plants.
- Photorespiration decreases the rate of photosynthesis when oxygen concentration is increased from 2-3% to 21%.
- Presence of light and higher concentration of Oxygen results in the binding of RuBisCO enzyme with O_2 to form.
- RuBisCO + O_2 PGA + phosphoglycolate
- This pathway involves Chloroplast, Peroxisome and Mitochondria. Photorespiration do not occurs in C_4 plants.

Difference between C_3 Plants and C_4 Plants

C_3 plants	C_4 plants
The leaves do not have Kranz anatomy.	The leaves show Kranz anatomy in leaves.
Photorespiration occurs.	Photorespiration does not occur.
RuBisCO is the first acceptor of CO_2.	PEP is the first acceptor of CO_2.
PGA is the first stable product.	OAA is the first stable product.
Plants are adapted to all climates.	Plants are adapted to tropical climate.
Mesophyll cells perform complete photosynthesis.	Mesophyll cells perform only initial fixation.

Factors affecting photosynthesis

- **Light:** As light intensity increases, the rate of photosynthesis also increases until light saturation point.
- **Carbon dioxide concentration:** With increase in concentration of CO_2 rate of photosynthesis increase till the compensation point.
- **Temperature:** It does not influence the rate of photosynthesis directly but at higher temperature enzyme activity is inhibited due to denaturation of enzymes which affect the dark reaction.
- **Water:** due to increase in amount of water, rate of photosynthesis does not increase proportionally as after saturation no more water is required during photosynthesis.

Blackman's Law of Limiting Factors states

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 which directly affects the process if its quantity is changed.

NCERT LINE BY LINE QUESTIONS

13.1 What do we know?

1. Chlorophyll is the- **(Pg. 206, E)**
   A) Red pigment of leaf of all plants B) Blue pigment of leaf of all plants
   C) Green pigment of root of all plants D) None of these
2. In an experiment where a part of leaf is enclosed in test tube containing KOH Soaked Cotton & exposed to light will- **(Pg. 207, E)**
   A) Test positive for starch
   B) Test negative for starch due to inability to absorb light inside test tube
   C) Test negative for starch due to inability to absorb CO_2
   D) Test negative for starch due to absence of water

13.2 Early Experiments

3. Match the experiment objective with the scientist who performed it- **(Pg. 207, H)**

i) Priestly	I) Production glucose in photosynthesis
ii) Julius von sachs	II) Role of sunlight in photosynthesis
iii) Jan ingenhousez	III) Role of air in photosynthesis

   (i) (ii) (iii) **(i) (ii) (iii)**
   (A) I III II (B) II I III
   (C) II III I (D) III I II
4. Who performed a series of experiments that revealed the essential role of air on the growth of green plants and when? **(Pg. 207, E)**
   A) Cornelius van Niel (1787) B) Joseph Priestly (1770)
   C) T. Engelmann (1756) D) Both A and B
5. Who discovered oxygen and when? **(Pg. 207, E)**
   A) Joseph Priestly (1770) B) T. Engelmann (1770)
   C) Jan Ingenhousz (1787) D) Joseph Priestly (1774)
6. Who showed that sunlight is essential to the plant? **(Pg. 207, E)**
   A) T. Engelmann B) Joseph Priestly
   C) Jan Ingenhousz D) Cornelius van trial
7. part of the plants that could release oxygen. **(Pg. 207, E)**
   A) Jan Ingenhousz B) T. Engelmann
   C) Joseph priestly D) None of these
8. Match the following **(Pg. 207, H)**
   (A) First action spectrum (1) Cornelius van nel
   (B) Chlorophyll (2) T.W Engelmann
   (C) O_2 evolve from H2O (3) Algae
   (D) *Cladophora* (4) Julius von sachs
   (5) Bacteria
   A) A-1, B-4, C-1, D-3,5 B) A-3, B-2, C-4, D-1
   C) A-1, B-3, C-2, D-5 D) A-2, B-4, C-1, D-3
9. _____ were used to detect the sites of O_2 evolution. **(Pg. 207, E)**
   A) Bacteria B) Daze C) Fungi D) Virus
10. Cornelius van Neil studied on ____ to demonstrate that photosynthesis is essentially a light dependent reaction. **(Pg. 208, E)**
    A) Cladophora B) Purple and green bacteria
    C) Red algae (D) Both A and B
11. _____ from a suitable oxidisable compound reduces CO_2 to Carbohydrates.

(Pg. 208, E)

A) Oxygen B) Hydrogen C) Carbon D) Both A and B

12. *Cladophora* is- **(Pg. 208, E)**
A) Purple and green bacteria B) Green bacteria
C) Red algae D) Green algae

13. (A) – O_2 evolved by the green plant comes from H_2O, not from carbon dioxide.
(B) – This was proved by using Radio isotopic techniques. **(Pg. 208, E)**
A) Statement A is wrong and Statement B is right
B) Both Statement A and B are wrong
C) Statement B is wrong and Statement B is correct
D) Both Statement A and B are correct

13.3 Where does photosynthesis take place?

14. Where does photosynthesis take place? **(Pg. 209, E)**
A) Green part of leaves B) Green part of stem
C) Brown part of stem D) Both A and B

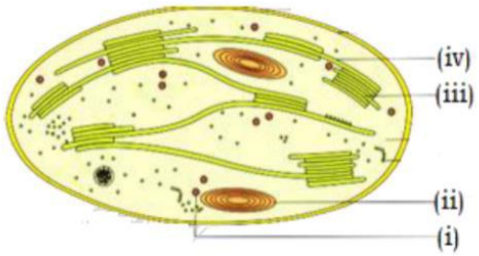
15. Assertion – Chloroplasts usually align themselves along the walls of mesophyll cells.
Reason – They get optimum quantity of incident light by aligning along well.
Choose the correct option. **(Pg. 209, M)**
(A) Assertion and Reason are correct and Reason is correct explanation for Assertion
(B) Assertion and Reason are correct but is not the explanation of Assertion
(C) Assertion and Reason are both incorrect
(D) Assertion is correct but Reason is incorrect

16. Chloroplast is- **(Pg. 209, E)**
A) Single membrane organelle B) Double membrane organelle
C) Triple membrane organelle D) Not an organelle

17. Choose the incorrect statement from the following? **(Pg. 209, E)**
(A) There is no clear division of labour within chloroplast
(B) Chloroplast has membranous system which includes stroma as well
(C) Membrane system is responsible for trapping the light energy
(D) More than one of the above

18. Dark reaction- **(Pg. 209, E)**
A) is not light-dependent B) occurs in darkness
C) is photochemical reaction D) is indirectly light-dependent

19.



Identify correct labelling. **(Pg. 209, E)**

	(i)	(ii)	(iii)	(iv)
A	A Starch granule	Lipid droplet	Stroma lamella	Grana
B	Starch granule	Lipid droplet	Grana	Stroma Lamella
C	Lipid droplet	Starch granule	Grana	Stroma Lamellae
D	Lipid	Starch	Stroma	Grana

	droplet	granule	lamella	

20. Sugar is synthesized- **(Pg. 209, E)**
A) Non-enzymatically in grana B) Non-enzymatically in stroma
C) Enzymatically in grana D) Enzymatically in stroma

21. Which of the following is correct? **(Pg. 209, E)**
A) Light reaction depends on dark reaction
B) Dark reaction depends on light reaction
C) Both of the above D) None of the above

22. If a plant is kept in dark for a long time- **(Pg. 209, E)**
A) Starch will be synthesized in chloroplast
B) ATP will be synthesized in chloroplast but no starch
C) NADPH will be synthesized in chloroplast but no starch
D) None of these

23. Choose the incorrect option- During daytime- **(Pg. 209, E)**
A) ATP will be synthesized in chloroplast by light reaction
B) NADPH will be synthesized in chloroplast by light reaction
C) Starch will not be synthesized by dark reaction
D) None of these

13.4 How many types of pigments are involved in photosynthesis

24. The colour of leaf is due to- **(Pg. 210, E)**
A) Chlorophyll only B) Chlorophyll, carotenoids only
C) Chlorophyll, carotenoids, xanthophyll D) None of these

25. Leaf pigments are separated by- **(Pg. 210, E)**
A) Crystallization B) Gel electrophorese
C) Blotting D) Paper chromatography

26. Match the pigment with its colour – **(Pg. 210, E)**

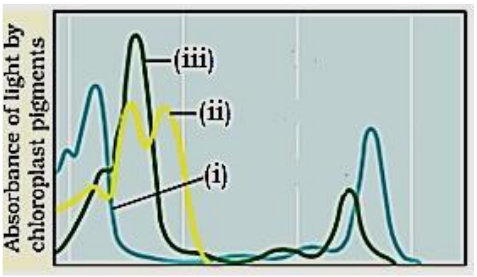
I	II
(i) Chlorophyll a	(A) Blue green
(ii) Chlorophyll b	(B) Yellow
(iii) Carotenoids	(C) Yellow-green
(iv) Xanthophyll	(D) Yelloworange

(i) (ii) (iii) (iv)
A) A C B D
C) A D B C

(i) (ii) (iii) (iv)
B) A C D B
D) A D C B

27. Which is the most abundant plant pigment in the world? **(Pg. 210, E)**
A) Chlorophyll a B) Chlorophyll b
C) Carotenoids D) xanthophylls

28.



Identity correct **(Pg. 210, E)**

	i	ii	iii
A	Chl a	Chl b	Carotenoid
B	Carotenoids	Chl a	Chl b

C	Chl b	Chl a	Carotenoids	
D	Chl b	Carotenoids	Chl a	

29. Maximum absorption by chlorophyll a occors in- **(Pg. 210, E)**
A) blue & green region B) ned & green region
C) blue & red region D) yellow & red region

30. Assertion – Chlorophyll 'a' is the chief pigment associated with photosynthesis Reason – Chlorophyll maximum absorption coincides with maximum photosynthesis.
Choose correct option – **(Pg. 210, M)**
A) Assertion & Reason are correct & Reason is correct explanation of Assertion
B) Assertion & Reason are correct but Reason is not correct explanation of Assertion
C) Assertion is correct & Reason is incorrect.
D) Assertion & Reason are incorrect.

31. Accessory pigments include **(Pg. 210, E)**
A) Chlorophyll a B) Chlorophyll b
C) both of these D) None of these

32. Accessory pigments **(Pg. 210, E)**
A) Pass on the energy to chl 'a'
B) pass on the energy to primary acceptor
C) Use energy for photolysis of water
D) more than one option

33. Advantages of accessory pigments include **(Pg. 210, E)**
A) they help by photolyzing the water
B) they protect chl 'a' from photooxidation
C) they enable narrower range of wavelength of incoming light to be used for photosynthesis
D) both a & b

13.5 What is light Reaction?

34. Light Reaction is also Known as- **(Pg. 211, E)**
A) photochemical phase B) biosynthetic phase
C) both of these D) None of these

35. Choose correct order of events in light reaction- **(Pg. 211, E)**
i) ATP & NADPH formation ii) Water Splitting
iii) Oxygen release iv) Light absorption
A) III IV II I B) IV III I III C) IV II III I D) II III IV I

36. LHC stands for- **(Pg. 211, E)**
A) Late Harvesting Complex B) Light Harvesting Complex
C) Light Hanging Complex D) Late Hanging Complex

37. The naming of PS I & PS II was based on- **(Pg. 211, E)**
A) their discovery order B) their functioning sequence
C) the scientist who named it D) the components of the photosystem.

38. Which of the following is correct? **(Pg. 211, E)**
A) PS I is called P800 B) PS II is called P680
C) Both a & b D) None of these

39. Reaction Centre is formed by- **(Pg. 211, E)**
A) Only one chlorophyll 'a' molecule
B) A few chlorophyll 'a' molecule
C) One chlorophyll 'a' and a few accessory
D) A few chlorophyll 'a' and a few accessory pigments.

40. Choose the incorrect statements- **(Pg. 211, E)**
A) Antennae is a light harvesting system
B) Contains accessory pigments

C) Does not include reaction centre
D) None of these

13.6 The Electron Transport

41. When the light energy is absorbed by PSII, it is- **(Pg. 211, E)**
A) Converted to mechanical energy
B) Used to excite electrons
C) Used to change configuration of RUBisCO
D) Both a & c

42. The movement of excited electrons in Noncyclic Photophosphorylation: **(Pg. 211, E)**
A) uphill in terms of reduction potential scale
B) downhill in terms of reduction potential scale
C) uphill and downhill in terms of oxidation-reduction potential scale
D) both A and C

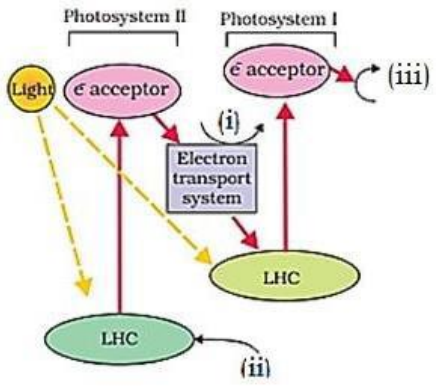
43. The electrons excited form PS II- **(Pg. 211, E)**
A) get used up by the first electron acceptor.
B) get used up in the middle of its ETS pathway to PS I
C) get passed on to pigments of PS I
D) get partially used up in ETS and the rest is passed to PS I.

44. The electrons passed on by PS I to electron acceptor are- **(Pg. 212, E)**
A) the ones that were transferred to PS I from PS II
B) electrons from the water splatted.
C) electrons excited when PS I absorbs light.
D) All of these

45. Electrons from PS-I move downhill to a molecule of energy-rich- **(Pg. 212, E)**
A) NADP+ B) NAD+ C) FAD+ D) GTP

46. The Z scheme is named so because- **(Pg. 212, E)**
A) it was discovered by a scientist with 'Z' as initial letter of name
B) the carriers of ETS present in thylakoid membrane are in 'Z' shape.
C) it forms 'Z' shape when the carriers of ETS are arranged in sequence on redox potential scale.
D) both A & C

47.



Identify the correct site for **(Pg. 212, E)**
I- water splitting, II-NADP+ reduction, IIIATP synthesis

I II III	I II III
A) I II III	B) II I III
C) III II I	D) III I II

13.6.1 Splitting of Water

48. Splitting of water is important- **(Pg. 212, E)**

A) for the O_2 formation
B) for the electrons released
C) for the hydroxide ions released
D) for the H_2 released

49. Water splitting is associated with- **(Pg. 212, E)**
A) PS I located on inner side of thylakoid membrane
B) PS II located on inner side of thylakoid membrane
C) PS I located on Outer stroma lamellae
D) PS II located on outer stroma lamellae membrane

50. The O_2 is released in- **(Pg. 212, E)**
A) Lumen of thylakoid B) Outer side of thylakoid
C) Stroma D) Cytoplasm

51. Protons are released- **(Pg. 212, E)**
A) Lumen of thylakoid B) Outer side of thylakoid
C) Stroma D) Cytoplasm

13.6.2 Cyclic & Non-Cycle Photophosphorylation

52. The process of ATP synthesis in cells is/are- **(Pg. 212, E)**
A) Photo-phosphorylation B) Oxidative phosphorylation
C) Phosphosynthesis D) Both A & B

53. The order of working of the two photosystems is- **(Pg. 213, E)**
A) PS I → PS II B) PS II → PSI
C) Any of these depending upon location
D) None of these

54. Non-cyclic photo-phosphorylation involves- **(Pg. 213, E)**
A) PS I B) PS II
C) Both PS I & PS II D) None of the these, only enzymes in stroma

55. End product of Z-scheme is- **(Pg. 213, E)**
A) ATP B) Glucose C) NADH + H+ D) Both A & C

56. Cyclic photophosphorylation involves- **(Pg. 213, E)**
A) PS I only B) PS II only
C) Both PS I & PS II D) None of these

57. Cyclic phosphorylation ends in formation of- **(Pg. 213, E)**
A) ATP only B) Glucose only
C) NADPH + H+ only D) Both A & C

58. A possible location of cyclic photophosphorylation under full light is condition.
A) Stroma B) Stroma lamellae **(Pg. 213, E)**
C) Cristate D) Outer membrane of chloroplast.

59. Assertion – Cyclic photophosphorylation occurs in stroma
Reason – Stroma membrane lacks PS II and NADP reductase.
Choose correct answer- **(Pg. 213, M)**
A) Both Assertion & Reason are correct and Reason is correct explanation for A
B) Both Assertion & Reason are correct but Reason is not correct explanation for Assertion
C) Assertion is correct but Reason is wrong
D) Both Assertion & Reason are wrong

13.6.3 Chemiosmotic Hypothesis

60. ATP Synthesis is linked to _i_ graduate across a membrane in _ii_ **(Pg. 213, E)**

(i)	(ii)
A) Electron	Photosynthesis & respiration
B) Electron	Photosynthesis only

C) Proton	Photosynthesis and respiration
D) Proton	Photosynthesis but not respiration

61. Which of the following statements is true? **(Pg. 213, E)**
A) the protons accumulate towards outer side of membrane in photosynthesis
B) the protons accumulate to wards inner side (lumen) of thylakoid in respiration.
C) The protons accumulate towards outer side of membrane of respiration thylakoid
D) None of these

62. The proton gradient may be formed in photosynthesis due to- **(Pg. 213, E)**
A) Splitting of water B) Reduction of NAD+
C) Both A and B D) None of these

63. Assertion – Protons move through photosystems, protons are transported across membrane.
Reason – Primary acceptor of electrons is an H carrier **(Pg. 213, M)**
A) Both Assertion & Reason are correct and Reason is explanation of Assertion
B) Both Assertion & Reason are correct and Reason is not the explanation for Assertion
C) Assertion is correct but Reason is not correct
D) Assertion & Reason both are incorrect

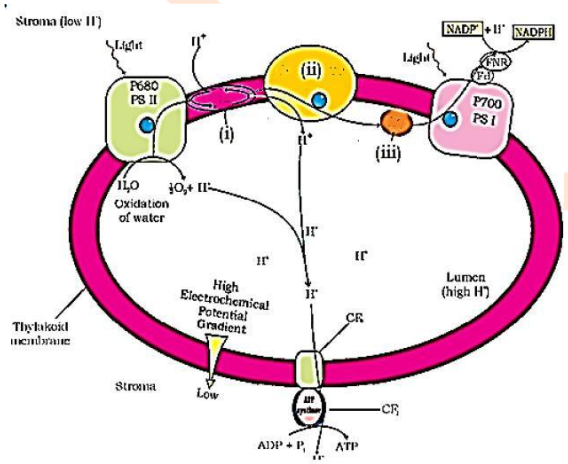
64. Which of these is an H carrier? **(Pg. 213, E)**
A) PS II B) Ferredoxin
C) Plastocyanin D) Plastoquinone

65. NADP reductase enzyme is located on _____ of thylakoid membrane. **(Pg. 214, E)**
A) Stroma side (outer side) B) Lumen side (I,e. outer side)
C) Stroma Side (i.e. inner side) D) Lumen side (i.e. inner side)

66. The proton gradient is also formed due to- **(Pg. 214, E)**
A) reduction of NAD+ B) reduction of NADP+
C) reduction of both NAD+ & NADP+ D) reduction of FAD+

67. Which of the following is true? **(Pg. 214, M)**
A) ATP & NADPH + H+ both are formed towards stroma.
B) ATP & NADPH + H+ both are formed in lumen of thylakoid
C) ATP is formed in lumen while NADPH + H+ is formed towards stroma.
D) NADPH + H+ formed in lumen while ATP is formed in stroma.

68.

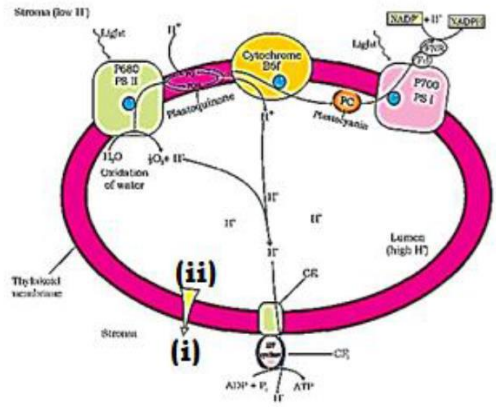


Identify correct labels- **(Pg. 214, E)**

(i)	(ii)	(iii)
A) PQ	PC	Cyt B6f
B) Cyt B6f	PQ	PC
C) PC	Cyt B6f	PC

D) PQ	Cyt B6f	PC

69.



Identify correct - **(Pg. 214, E)**

I	II
A) High electrochemical gradient	Low Gradient
B) Low electrochemical gradient	High Gradient
C) High electrochemical gradient	High Gradient
D) Low electrochemical gradient	Low gradient

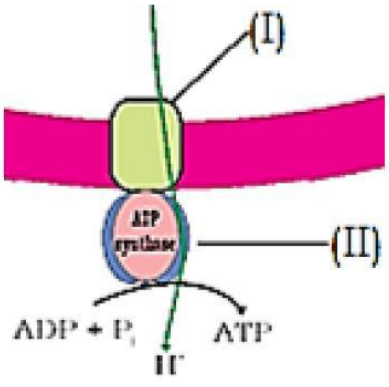
70. Statement A – The accumulation of protons in stroma cause decrease in pH of stroma.
Statement B – The accumulation of proton in lumen cause formation of potential gradient across thylakoid membrane.
Select the correct option- **(Pg. 214, M)**
A) A is correct and B is incorrect B) B is correct and A is incorrect
C) A & B are correct D) A & B are incorrect

71. ATP formation occurs upon- **(Pg. 214, E)**
A) build up of potential gradient B) break down of potential gradient
C) Both of these D) None of these

72. The transmembrane channel in ATP synthase enzyme is formed by- **(Pg. 214, E)**
A) CF_0 B) CF_1 C) CF_2 D) Both A & B

73. The transmembrane channel allows – across membrane for ATP synthesis **(Pg. 214, E)**
A) Osmosis of protons B) Simple diffusion of proton
C) Facilitated diffusion of electron D) Facilitated diffusion of proton

74.



The ATP synthese has two parts I & II
I **II**

(A) CF_0 CF_1
(B) CF_1 CF_0
(C) CF CF_0
(D) None

75. CF_0 is – **(Pg. 214, E)**
A) embedded in chloroplast membrane
B) protruding on outer surface of chloroplast
C) protruding on inner surface of chloroplast membrane
D) None of these

76. CF1 is- **(Pg. 215, E)**
A) embedded in chloroplast membrane
B) protruding on outer surface of chloroplast membrane
C) protruding on inner surface of chloroplast
D) None of these

77. Conformational change in ____ makes ATP. **(Pg. 215, E)**
A) CF_0 B) CF_1 C) Both D) None

78. For creating proton gradient across thylakoid membrane _____ . **(Pg. 215, E)**
A) Energy is used B) No energy is used
C) Energy is released D) None of these

79. The end products of light reaction are- **(Pg. 215, E)**
A) Stored till dark reaction takes place at right
B) immediately used up in next round of light reaction
C) transferred to the stroma from lumen to be used in biosynthetic reaction occurring in stroma
D) None of these

13.7 Where are the ATP and NADPH used?

80. The products of light reaction are- **(Pg. 215, E)**
A) ATP only B) ATP & NADPH
C) ATP, NADPH, O_2 D) NADPH Only

81. O_2 is- **(Pg. 215, E)**
A) used up in dark reaction in stroma
B) used up in dark reaction in lumen thylakoid
C) diffused out of chloroplast
D) more than one option is correct

82. Statement A – Biosynthetic reaction is independent of direct presence of light
Statement B – Biosynthetic process continues for some time after the light becomes unavailable and then stops. **(Pg. 215, E)**
A) Both A & B are correct B) A is correct and B is incorrect
C) A is incorrect and B is correct D) A & B are in correct

83. Calvin discovered that first CO_2 fixation product is- **(Pg. 215, E)**
A) 3-carbon organic acid B) 4-carbon organic acid
C) 5- carbon organic acid D) 6-carbon organic acid

84. To discover the first CO_2 fixation product, Calvin worked on-using- **(Pg. 215, E)**
A) algae, radioactive C_{12} B) fungi, radioactive C_{12}
C) algae, radioactive C_{14} D) fungi, radioactive C_{14}

85. The first product of CO_2 fixation was identified to be in the Calvin cycle. **(Pg. 215, E)**
A) PGA B) RUBP C) Citric acid D) OAA

86. In C_4 pathway, first CO_2 fixation product is same options as **(Pg. 215, E)**
A) PGA B) RUBP C) Citric acid D) OAA

87. OAA and PGA stands for- **(Pg. 216, E)**
A) 3-phophoglyceric acid and oxalis ascetic acid respectively
B) 3-peptido glutaric acid and oxalis ascetic acid respectively
C) 3-phosphas glutamic acid and oxalis ascetic acid respectively
D) None of these

13.7.1 The primary Acceptor of CO_2

88. For a 3 carbon compound to be formed after CO_2 fixation, the acceptor molecule is of- **(Pg. 216, E)**
A) 2-carbon B) 3-carbon C) 4-carbon D) 5-carbon

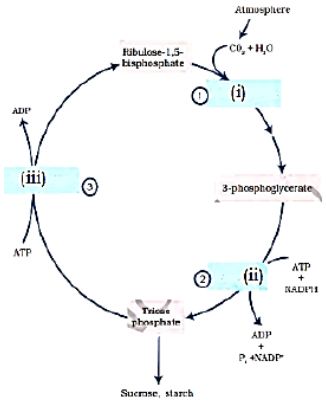
89. RUBP stands for- **(Pg. 216, E)**
A) Ribulose Bisphosphate Carboxylaseoxygenase
B) Ribose Bisphosphate Carboxylaseoxygenase
C) Ribulose Bisphosphate
D) Ribose Bisphosphate Carboxylaseoxygenase

13.7.2 The Calvin Cycle

90. The Calvin cycle starts with _____ ends with **(Pg. 216, E)**
A) RUBisCo, regeneration of RUBisCo
B) RUBP, regeneration of RUBisCo
C) RUBP, regeneration of RUBP
D) PGA, regeneration of PGA

91. Calvin cycle- **(Pg. 216, E)**
A) occurs in C_3 plants only B) occurs in C_4 plants only
C) occurs in both C_3 & C_4 D) None of these

92.



The three steps in Calvin cycle are- **(Pg. 216, E)**

i	ii	iii
A) Carboxylation	Oxidation	Regeneration
B) Reduction	Carboxylation	Regeneration
C) Carboxylation	Reduction	Regeneration
D) Carbonation	Reduction	Regeneration

93. The most crucial step of Calvin cycle is- **(Pg. 216, E)**
A) Carbonation B) Carboxylation
C) Reduction D) Regeneration

94. Carboxylation is catalyzed by the enzyme- **(Pg. 216, E)**
A) RUBP B) PEP C) NADPH D) None of these

95. RUBisCo has the activity of- **(Pg. 217, E)**
A) Carbonation B) Oxygenation

C) Oxidation D) None of these

96. Reduction involves Use of _____ molecules of ATP for fixed CO_2 reduction **(Pg. 217, E)**

A) 1 B) 2 C) 3 D) 4

97. Reduction involves use of – molecules of NADPH to reduce fixed CO_2. **(Pg. 217, E)**

A) 1 B) 2 C) 3 D) 4

98. For formation of 1 glucose molecule, how may turns of Calvin cycle is needed? **(Pg. 217, E)**

A) 3 B) 1 C) 2 D) 6

99. Regeneration of __(i)__ takes place at expense of __(ii)__ ATP & __(iii)__ NADPH. **(Pg. 217, E)**

(i)	(ii)	(iii)
A) RUBP	0	1
B) RUBP	1	0
C) RUBisCo	0	1
D) RUBisCo	1	0

100. Statement A – In CO2 fixation cycle, the molecules of ATP used is more than NADPH used.
Statement B – to meet the difference in number of ATP & NADPH used in dark reaction, cyclic phosphorylation take place.
Choose the correct option- **(Pg. 217, M)**

A) A is correct but B is wrong B) B is correct but A is wrong
C) A & B are correct and A explains B D) A & B are incorrect.

101. For formation of 1 glucose, how many molecules of ATP are required by C3 cycle? **(Pg. 217, E)**

A) 12 B) 16 C) 18 D) 10

102. For one glucose formation, how many NAD molecules are needed by C_3 pathway? **(Pg. 217, E)**

A) 10 B) 12 C) 16 D) 18

13.8 The C4 Pathway

103. C_4 plants are adaptation of plants to- **(Pg. 218, E)**

A) wet regions (heavy rainfall) B) polar regions
C) dry tropics D) moist rainforest

104. (i) – C_4 plants lack Calvin cycle
(ii) – C_4 plants lack photorespiration
(iii) – C_4 plants have more productivity than C3 plants
(iv) – C_4 plants cannot tolerate higher temperature
How many of the above statements are incorrect? **(Pg. 218, M)**

A) 0 B) 1 C) 2 D) 3

105. First CO_2 fixation product in C_4 cycle is- **(Pg. 218, E)**

A) RBP B) PEP C) OAA D) Malate

106. Bundle sheath cells are present in ____ around ____. **(Pg. 218, E)**

A) C_4 plants, vascular bundles B) C_3 plants, vascular bundles
C) Both of these D) None of these

107. Leaves with bundle sheath cells are said to show- **(Pg. 218, E)**

A) Krant anatomy B) Kranz anatomy
C) Kent anatomy D) Krez anatomy

108. Bundle sheath cells- **(Pg. 218, E)**

A) Allow gaseous exchange B) Have intercellular spaces

C) Have large number of chloroplasts D) All of these

109. Example of C4 plants is- **(Pg. 218, E)**
A) Rice B) Maize C) Soyabean D) Both A and C

110. Primary CO_2 acceptor in C_4 plants is- **(Pg. 218, E)**
A) 3-carbon molecule RUBP B) 3-carbon molecule PEP
C) 4-carbon molecule PEP D) 4-carbon molecule OAA

111. Enzyme responsible for primary CO_2 fixation in C_4 plants is- **(Pg. 218, E)**
A) RUBisCO B) PEPCase C) Oxaloacetase D) Phenolase

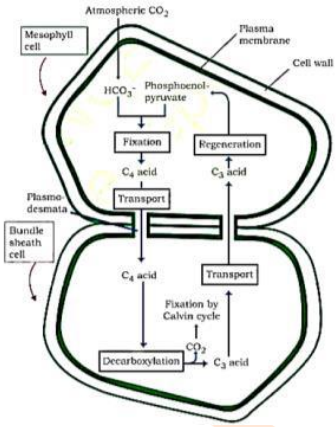
112. Which of the following is true? **(Pg. 218, E)**
A) C_4 plants lack RUBisCO
B) Mesophyll cells of C_4 plants lack RUBisCO
C) Bundle sheath cells of C_4 plants lack RUBisCO
D) C_3 plants lack RUBisCO

113. Primary CO_2 fixation occurs in C_4 plants in **(Pg. 218, E)**
A) Bundle sheath cells B) Mesophyll cells
C) Any of the above D) None of these

114. CO_2 fixation in C_4 plants occurs in- **(Pg. 218, E)**
A) Bundle sheath cells B) Mesophyll cells
C) Both A and B D) None of the above

115. OAA forms other four carbon acids which are transported. They are- **(Pg. 218, E)**
A) Malic acid and oxalic acid B) Malic acid and aspartic acid
C) Succinic acid and aspartic acid D) Succinic acid and glutamic acid

116. The figure shows **(Pg. 219, E)**



A) Krebs cycle B) Calvin cycle
C) Hatch and Slack pathway D) EMP pathway

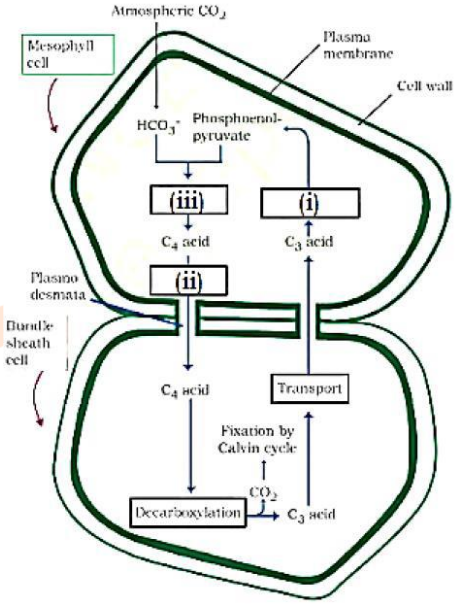
117. In C_4 pathway, RUBisCO is- **(Pg. 219, E)**
A) absent B) present in mesophyll cells
C) present in bundle sheath cell D) none of these

118. PEPcase enzyme is- **(Pg. 219, E)**
A) absent in mesophyll cells B) present in bundle sheath cells
C) both A and B D) None of these

119. Calvin cycle takes place in __(i)__ in all C_3 plants in __(ii)__ in all C_4 plants **(Pg. 219, E)**

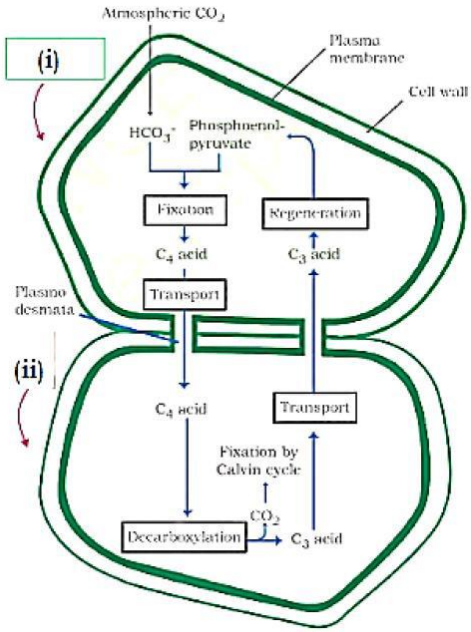
(i)	(ii)
(A) mesophyll cells	Mesophyll cells
(B) bundle sheath cells	Mesophyll cells
(C) mesophyll cells	Bundle sheath cells
(D) bundle sheath cells	Bundle sheath cells

120. Identify correct labels- **(Pg. 219, E)**



(i)	(ii)	(iii)
A) Firation	Decarboxylation	Regeneration
B) Transport	Firation	Regeneration
C) Regeneration	Transport	Fixation
D) Regeneration	Decarboxylation	Fixation

121. Identify the A and B **(Pg. 219, E)**



(i)	**(ii)**
A) mesophyll cells	mesophyll cells
B) bundle sheath cells	mesophyll cells
C) mesophyll cells	Bundle sheath cells
D) bundle sheath cells	Bundle sheath cells

13.9 Photorespiration

122. Read the following statements-
Statement A – Ribulose Bisphosphate is the most abundant enzyme in the world.
Statement B – Photorespiration doesn't occur in C4 plants.
Choose the correct option- **(Pg. 220, E)**
A) A is correct and B is incorrect
B) B is correct and A is incorrect
C) A and B are correct
D) A and B are incorrect

123. RUBisCO has _____ when CO_2 & O_2 is equal. **(Pg. 220, E)**
A) greater affinity for CO_2 than O_2
B) greater affinity for O_2 than CO_2
C) equal affinity for CO_2 & O_2
D) no affinity for O_2

124. In C_3 plants- **(Pg. 220, E)**
A) Some O_2 binds to RUBisCO and CO_2 fixation increases
B) no O_2 binds to RUBisCO
C) Some O_2 binds to RUBisCO and CO_2 fixation decrases
D) only O_2 binds to RUBisCO

125. When O_2 binds to RUBisCO, RUBP is converted to _____ and _____. **(Pg. 220, E)**
A) Phosphoglycerate, phosphoenolpyruvate
B) Phosphoglycerate, phosphoglycerate
C) Phosphoenolpyruvate, phosphoglycerate
D) Phosphoglycolate, phosphoglycerate

126. In photorespiration- **(Pg. 220, E)**
A) Sugar and ATP are formed
B) Sugar is formed but not ATP
C) ATP is formed but not sugar
D) Sugar and ATP are not formed

127. Assertion – Photorespiration doesn't occur in C_4 plants.
Reason – CO_2 concentration at enzyme site is high in C_4 plants.
Chose correct option- **(Pg. 220, E)**
A) Both Assertion and Reason are correct and Reason is correct explanation for Assertion
B) Assertion is correct and Reason is wrong
C) Assertion is wrong and Reason is correct
D) Both Assertion and Reason are wrong

13.10 Factors Affecting Photosynthesis

128. Photosynthesis is dependent on- **(Pg. 222, E)**
A) internal factors of plant
B) external factors of environment
C) both A and B
D) None of these

129. How many of the following are factors affecting photosynthesis? **(Pg. 222, E)**
age of leaves, orientation of leaf, internal CO_2 concentration, amount of chlorophyll, number of leaves
A) 4 B) 2 C) 3 D) 5

130. Blackman's which law comes into effect when several factors affect any biochemical process? **(Pg. 222, E)**
A) Law of Limited Components (1910)
B) Law of Limiting Factors (1910)
C) Law of Limited Components (1905)
D) Law of Limiting Factors (1905)

131. According to Blackmann's Law, the rate of chemical process is determined by the factor which **(Pg. 222, E)**
A) is nearest to its maximum value
B) is nearest to its minimum value
C) both A and B D) none of these

13.10.1 Light

132. The relationship between incident light and CO_2 fixation rate at higher light intensity is- **(Pg. 222, E)**
A) rate is constant with increasing intensity
B) rate increases with increasing intensity
C) rate decreases with increasing intensity
D) none of these

133. At lower Light intensity, the rate of CO_2 fixation- **(Pg. 222, E)**
A) is constant with increasing light intensity
B) increasing with increasing light intensity
C) decreases with increasing light intensity
D) none of these

134. Light saturation occurs at _____ of full sunlight. **(Pg. 222, E)**
A) 5% B) 10% C) 20% D) 40%

135. Very big increase in light intensity causes- **(Pg. 222, E)**
A) increase in photosynthesis
B) decrease in photosynthesis
C) no change in photosynthesis rate
D) none of these

13.10.2 Carbon dioxide concentration

136. Which of the following is true? **(Pg. 223, E)**
A) CO_2 is a major limiting factor for photosynthesis in nature
B) Light is rarely a limiting factor for photosynthesis in nature
C) Both of these D) None of these

137. The concentration of CO_2 beyond which the CO_2 becomes damaging over longer periods is- **(Pg. 223, E)**
A) 0.03% B) 0.04% C) 0.05% D) 0.08%

138. The CO_2 fixation rates increases upto the CO_2 concentration of- **(Pg. 223, E)**
A) 300 ppm B) 400 ppm C) 500 ppm D) 800 ppm

139. At low light conditions, which of the groups respond positively to increase in CO_2- **(Pg. 223, E)**
A) C_3 B) C_4 C) Both D) None

140. At high light conditions, which of the groups respond positively to increase in CO_2. **(Pg. 223, E)**
A) CO_2 B) C_4 C) Both D) None

141. C_4 plants show saturation at CO_2 concentration of- **(Pg. 223, E)**
A) 240 μlL-1 B) 360 μlL-1 C) 450 μlL-1 D) 540 μlL-1

142. C_3 plants show saturation for CO_2 concentration at- **(Pg. 223, E)**
A) 450 μTL-1 B) 360 μlL-1 C) 540 μiL-1 D) 240 μlL-1

143. Assertion – Greenhouse crops like tomatoes and bell pepper are grown in CO_2 enriched atmosphere for higher yields.
Reason – C_4 plants respond to higher CO_2 concentration by showing increased rate of photosynthesis.
Choose the correct option. **(Pg. 223, E)**
A) Both Assertion and Reason are correct and Reason is correct explanation for

Assertion
B) Both Assertion and Reason are correct but Reason is not the explanation for Assertion
C) Assertion is correct but Reason is wrong
D) Assertion and Reason are wrong

13.10.3 Temperature

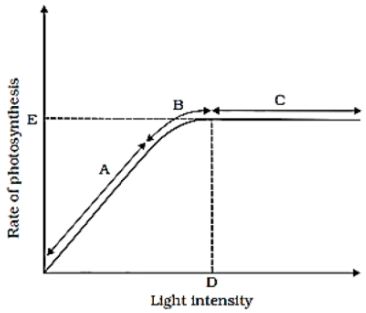
144. Which of the reaction is more sensitive to temperature? **(Pg. 223, E)**
A) Light Reaction B) Dark Reaction
C) Both of then are equal D) None of the above

145. Which group of plants has a higher temperature optimum? **(Pg. 223, E)**
A) C_4 B) C_3 C) Both D) None

146. Which of the following is true? **(Pg. 223, E)**
A) Tropical plants have higher temperature optimum than temperature plants
B) Temperature plants have higher temperature optimum than tropical plants
C) Temperature and Tropical have equal temperature optimum
D) Polar regions plants have highest temperature optimum

147. Water stress causes **(Pg. 223, E)**
A) reduced CO_2 availability B) leaf wilting
C) reduced surface area of leaf D) All of these

148.



In the given graph, in which region will plant not respond to increase in CO_2 concentration? **(Pg. 223, E)**
A) A B) B C) C D) None

NEET PREVIOUS YEARS QUESTIONS

1. Which of the following is not a product of light reaction of photosynthesis? **[2018]**
(a) ATP (b) NADH (c) Oxygen (d) NADPH

2. Oxygen is not produced during photosynthesis by: **[2018]**
(a) Green sulphur bacteria (b) *Nostoc*
(c) *Chara* (d) *Cycas*

3. With reference to factors affecting the rate of photosynthesis, which of the following statements is not correct? **[2017]**
(a) Increasing atmospheric CO2 concentration up to 0.05% can enhance CO2 fixation rate.
(b) C3 plants respond to higher temperatures with enhanced photosynthesis while C4 plants have much lower temperature optimum.

(c) Tomato is a greenhouse crop which can be grown in CO2 - enriched atmosphere for higher yield.
(d) Light saturation for CO2 fixation occurs at 10% of full sunlight.

4. In a chloroplast, the highest number of protons are found in:
[2016]
(a) Stroma (b) Lumen of thylakoids
(c) Inter membrane space (d) Antennae complex

5. Water soluble pigments found in plant cell vacuoles are
[2016]
(a) Xanthophylls (b) Chlorophylls (c) Carotenoids (d) Anthocyanins

6. Emerson's enhancement effect and Red drop have been instrumental in the discovery of
[2016]
(a) photophosphorylation and non-cyclic electron transport.
(b) two photosystems operating simultaneously.
(c) photophosphorylation and cyclic electron transport.
(d) oxidative phosphorylation.

7. A plant in your garden avoids photorespiratory losses, has improved water use efficiency, shows high rates of photosynthesis at high temperatures and has improved efficiency of nitrogen utilisation. In which of the following physiological groups would you assign this plant?
[2016]
(a) C3 (b) C4 (c) CAM (d) Nitrogen fixer

8. Chromatophores take part in:
[2015]
(a) Growth (b) Movement (c) Respiration (d) Photosynthesis

9. The structures that are formed by stacking of organized flattened membranous sacs in the chloroplasts are :
[2015]
(a) Grana (b) Stroma lamellae (c) Stroma (d) Cristae

10. The oxygen evolved during photosynthesis comes from water molecules. Which one of the following pairs of elements is involved in this reaction?
[2015]
(a) Manganese and Potassium (b) Magnesium and Molybdenum
(c) Magnesium and Chlorine (d) Manganese and Chlorine

11. In photosynthesis the light-independent reactions take place at
[2015]
(a) Photosystem-I (b) Photosystem-II (c) Stromal matrix (d) Thylakoid lumen

12. Cytochromes are found in :
[2015]
(a) Outer wall of mitochondria (b) Cristae of mitochondria
(c) Lysosomes (d) Matrix of mitochondria

13. Anoxygenic photosynthesis is characteristic of :
[2014]
(a) *Rhodospirillum* (b) *Spirogyra* (c) *Chlamydomonas* (d) *Ulva*

14. In Hatch and Slack pathway, the primary CO_2 acceptor is - **[NEET-2019 ODISSA]**
(1) Oxaloacetic acid (2) Phosphoglyceric acid (3) Phosphoenol pyruvate (4) RubisCO

15. One scientist cultured Cladophora in a suspension of Azotobacter and illuminated the culture by splitting light through a prism. He observed that bacteria accumulated mainly in the region of:
[NEET-2019 ODISSA]
(1) Violet and green light (2) Indigo and green light
(3) Orange and yellow light (4) Blue and red light

16. During non-cyclic photophosphorylation, when electrons are lost from the reaction centre at PS II, what is the source which replaces these electrons? **[NEET-2020 COVID]**

(1) Oxygen (2) Water (3) Carbon dioxide (4) Light

17. Which of the following statements is incorrect? **[NEET-2020 COVID]**

(1) RuBisCO is a bifunctional enzyme
(2) In C_4 plants, the site of RuBisCO activity is mesophyll cell
(3) The substrate molecule for RuBisCO activity is a 5-carbon compound
(4) RuBisCO action requires ATP and NADPH

18. In light reaction, plastoquinone facilitates the transfer of electrons from **[NEET-2020]**

1) PS-I to ATP synthase 2) PS-II to $Cytb_6f$ complex
3) $Cytb_6f$ complex to PS-I 4) PS-I to NADP

19. The oxygenation activity of RuBisCo enzyme in photorespiration leads to the formation of **[NEET-2020]**

1) 1 molecule of 4-C compound and 1 molecule of 2-C compound 2) 2 molecules of 3-C compound
3) 1 molecules of 3-C compound 4) 1 molecule of 6-C compound

20. The first stable product of CO_2 fixation in sorghum is: **[NEET-2021]**

1) Oxaloacetic acid 2) Succinic acid 3) Phosphoglyceric acid 4) Pyruvic acid

21. Which of the following statements is incorrect? **[NEET-2021]**

1) Stroma lamellae have PS I only and lack NADP reductase.
2) Grana lamellae have both PS I and PS II
3) Cyclic photophosphorylation involves both PS I and PS II
4) Both ATP and NADPH + H^+ are synthesized during non-cyclic photophosphorylation

22. Which one of the following in not true regarding the release of energy during ATP synthesis through chemiosmosis? It involves:

1) Breakdown of proton gradient
2) Breakdown of electron gradient
3) Movement of protons across the membrane to the stroma
4) Reduction of NADP to $NADPH_2$ on the stroma side of the membrane

23. Production of Cucumber has increased manifold in recent years. Application of which of the following phytohormones has resulted in this increased yield as the hormone is known to produce female flowers in the plants:

1) ABA 2) Gibberellin 3) Ethylene 4) Cytokinin

24. Given below are two statements:

Statement I:

The primary CO_2 acceptor in C_4 plants is phosphoenolpyruvate and is found in the mesophyll cells.

Statement II:

Mesophyll cells of C_4 plants lack RuBisCo enzyme

In the light of the above statements, choose the correct answer from the options given below.

1) Bothe statement I and statement II are correct
2) Bothe Statement I and Statement II are incorrect
3) Statement I is correct but Statement II is incorrect
4) Statement I is incorrect but Statement II is correct

25. What is the role of large bundle sheath cells found around the vascular bundles in C_4 plants?

1) To provide the site for photorespiratory pathway
2) To increase the number of chloroplast for the operation of Calvin cycle
3) To enable the plant to tolerate high temperature
4) To protect the vascular tissue from high light intensity

NCERT LINE BY LINE QUESTIONS – ANSWERS

1	2	3	4	5	6	7	8	9	10
D	C	D	B	D	C	A	D	A	B
11	**12**	**13**	**14**	**15**	**16**	**17**	**18**	**19**	**20**
B	D	D	D	A	B	A	D	C	D
21	**22**	**23**	**24**	**25**	**26**	**27**	**28**	**29**	**30**
B	D	C	C	D	B	A	D	C	A
31	**32**	**33**	**34**	**35**	**36**	**37**	**38**	**39**	**40**
B	A	B	A	C	B	A	B	A	D
41	**42**	**43**	**44**	**45**	**46**	**47**	**48**	**49**	**50**
B	C	C	C	A	C	D	B	B	A
D	C	D	B	D	C	A	D	A	B
51	**52**	**53**	**54**	**55**	**56**	**57**	**58**	**59**	**60**
C	D	B	C	D	A	A	B	B	C
61	**62**	**63**	**64**	**65**	**66**	**67**	**68**	**69**	**70**
D	A	C	D	A	B	A	D	B	B
71	**72**	**73**	**74**	**75**	**76**	**77**	**78**	**79**	**80**
B	A	D	A	D	D	B	A	D	C
81	**82**	**83**	**84**	**85**	**86**	**87**	**88**	**89**	**90**
C	A	A	C	A	D	D	D	C	C
91	**92**	**93**	**94**	**95**	**96**	**97**	**98**	**99**	**100**
C	C	B	D	B	B	B	D	B	C
101	**102**	**103**	**104**	**105**	**106**	**107**	**108**	**109**	**110**
C	B	C	C	C	A	B	C	B	B
111	**112**	**113**	**114**	**115**	**116**	**117**	**118**	**119**	**120**
B	B	B	C	B	C	C	D	C	C
121	**122**	**123**	**124**	**125**	**126**	**127**	**128**	**129**	**130**
C	C	A	C	D	D	A	C	D	D
131	**132**	**133**	**134**	**135**	**136**	**137**	**138**	**139**	**140**
B	A	B	B	B	C	C	C	D	C
141	**142**	**143**	**144**	**145**	**146**	**147**	**148**		
B	A	C	B	A	A	D	A		

NEET PREVIOUS YEARS QUESTIONS-ANSWERS

1 (b) **2** (a) **3** (b) **4** (b) **5** (d) **6** (b) **7** (b) **8** (d) **9** (a) **10** (d)
11 (c) **12** (b) **13** (a) **14** (3) **15** (4) **16** (2) **17** (2) **18** (2) **19** (3) **20** (1)
21 (3) **22** (2) **23** (3) **24** (1) **25** (2)

NEET PREVIOUS YEARS QUESTIONS-EXPLANATIONS

1. **(b)** ATP, NADPH and oxygen are products of light reaction, while NADH is a product of respiration process.

2. **(a)** Green sulphur bacteria do not use H2O as source of proton, therefore they do not evolve O2 .

3. **(b)** In C3 plants, photosynthesis decreases at higher temperature due to increased photorespiration. C_4 plants have higher temperature optimum because of the presence of an enzyme called pyruvate phosphate dikinase, which is sensitive to low temperature.

4. **(b)** Proton concentration is higher in the lumen of thylakoid due to photolysis of water, H+ pumping and NADP reductase activity in stroma. During the lightdependent reaction, protons are pumped across the thylakoid membrane into the lumen making it acidic down to pH 4.

5. **(d)** Many leaves produce water-soluble vacuolar pigments, which are stored within cell vacuoles (microscopic water sacs within each cell). Two major classes of leaf vacuolar pigments are anthocyanins and betalains.

6. **(b)** Wavelengths beyond 700nm are apparently of insufficient energy to drive any part of photosynthesis. So in huge drop in efficiency has been noticed at 700nm. This phenomenon is called as "Red drop effect". This effect was first of all noticed by Robert Emerson. Later on Emerson and his group observed that if *Chlorella* plants are given the inefficient far red light and red light of shorter wavelengths in alternate fashion, the quantum yields were greater than could be expected from adding the rates found when either color was provided alone. This synergistic effect or enhancement is known as EEE or "Emerson Enhancement Effect". This was the first good evidence that there are two photosystems; one absorbs far red light and other red light and both of them must operate to drive photosynthesis most effectively.

7. **(b)** C4 plants are adapted to hot and dry climate and lack photorespiration due to Kranz anatomy and have greater productivity of biomass.

8. **(d)** Chromatophores play an important role in the process of photosynthesis. They contain pigments and are found in blue green algae.

9. **(a)** In chloroplasts which are green coloured plastids, thylakoids are arranged in stacks like the pile of coins called grana.

10. **(d)** During photosynthesis photolysis of water is induced by Mn++ and CI– ions.

11. **(c)** Stromal matrix contains a number of flattened membranous sacs called thylakoid or lamellae.

12. **(b)** Cytochromes are found in mitochondria. These are located on the inner membrane of mitochondria and are related with phosphorylation.

13. **(a)**

18. Plastoquinone facilitates the transfer of electrons from PS-II to $Cytb_6f$ complex

19. In the first step of photorespiration 1 molecules of 3-C compound (PGA) and 1 molecule of 2-C compound phosphoglycolate

20. The first stable product of CO_2 fixation in sorghum is – Oxaloacetic acid

21. • Cyclic photophosphorylation involves only PS I. Both PS I and PS II are involved in non-cyclic photophosphorylation where both ATP and NADPH + H^+ are synthesized.
• Both PS I and PS II are found on grana lamellae whereas stroma lamellae have PS I only and lack NADP reductase

22 Breakdown of electron gradient is not found during chemiosmosis which is associated with ATP synthesis

23. Ethylene is known to produce female flowers in cucumber plants

24. Both the statements are correct

25 Bundle sheath cells found around the vascular bundles in C_4 plants helps to increase the number of chloroplasts