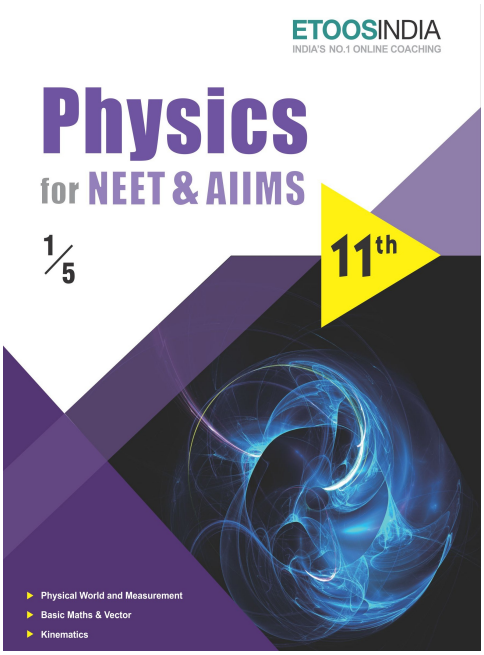
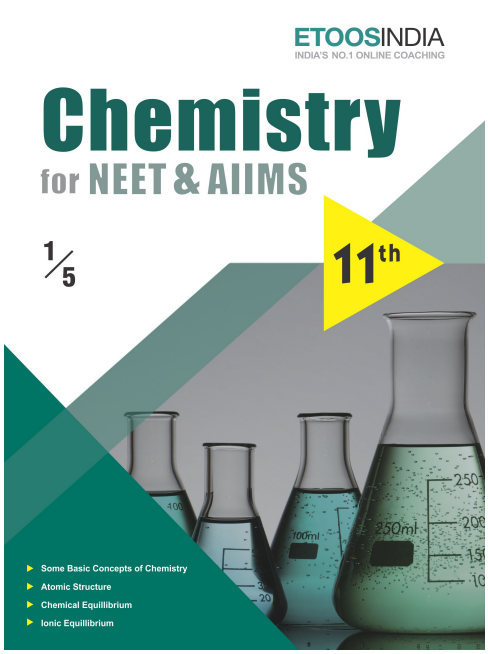
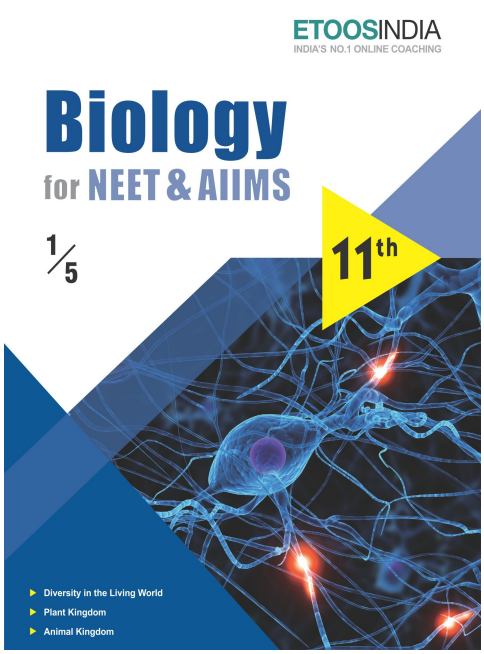
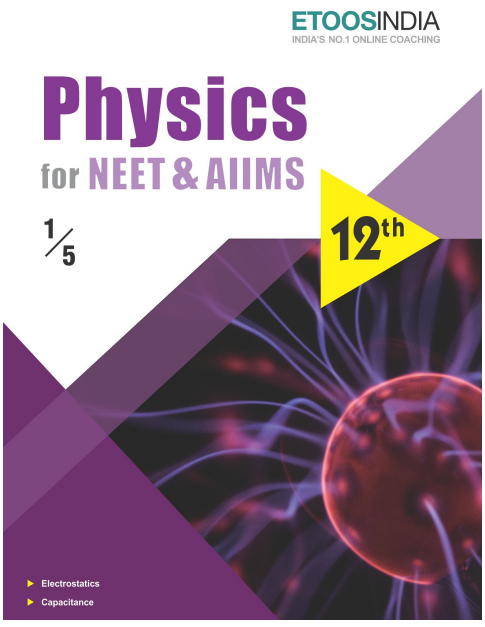
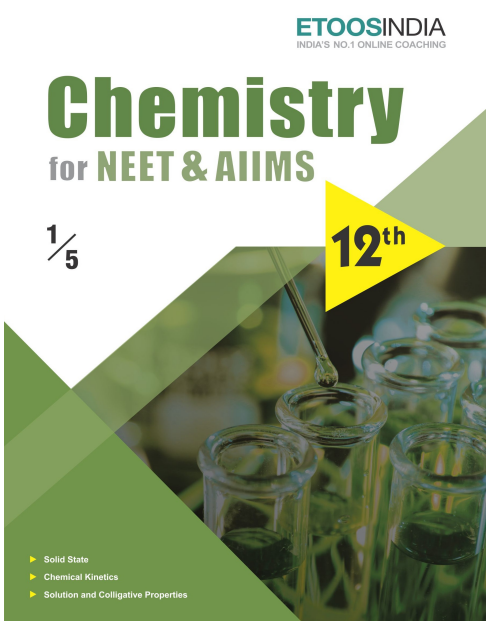
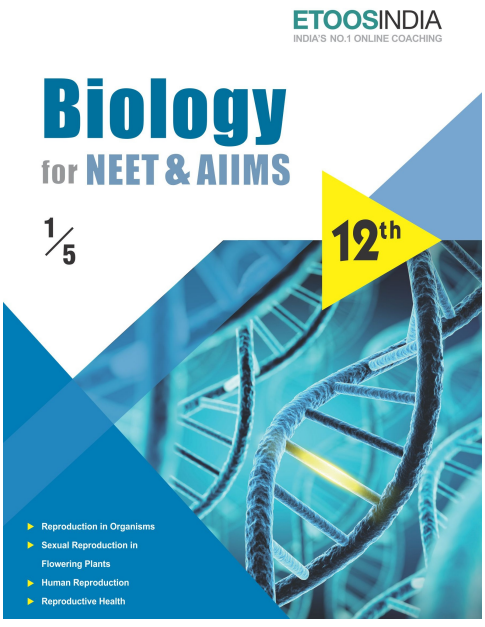












CHAPTER 12

PHOTOSYNTHESIS IN HIGHER PLANTS

"Will is nothing more than a particular case of the general doctrine of association of ideas, and therefore a perfectly mechanical thing".

"JOSEPH PRIESTLEY (1733-1804)"

INTRODUCTION

The process in which green parts of the manufacture or synthesize complex organic food substances using carbon dioxide and water in the presence of sunlight and release oxygen as a by-product. In this process, energy from the sun is converted into chemical energy. It is endergonic, anabolic and oxido-reduction process. Photosynthesis is important due to two reasons: it is the primary source of all food on earth . It is also responsible for the release of oxygen into the atmosphere by green plants.

A simple equation reperesening the process is:

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

PHOTOSYNTHESIS IN HIGHER PLANTS

History of Photosynthesis

- **Aristotle and Theophrastus (320 BC) :–** Stated that plants absorb all food matter from **soil** (Humus theory).
- **Van Helmont (1648) :–** By weighing the Willow plant, concluded that plant take up their food mostly from soil **water**.
- **J. Woodbard (1699) :–** Besides water, soil also increases the weight of plants.
- **Stephen Hales (1727) :–** Recognised the importance of air (CO_2) and **light** for photosynthesis (nourishment) in plants. He is considered as discoverer of photosynthesis and **"Father of plant physiology"**.
- **J. Priestley (1772) :–** He carried out very interesting **experiment on Bell jar**, Rat, Pudina & Candle. He came to conclude that plants purify air (burning of candles) and gaseous exchange occurs during photosynthesis.
- **Jan Ingenhousz (1779) :–** He explained the importance of **light and green colour** and also suggested the O_2 releases in the presence of light by green parts.
- **Senebier (1782) :–** Green plants absorb CO_2 from atmosphere and when the concentration of CO_2 increases the rate of O_2 evolution also increases.
- **N. De–Saussure (1804) :–** Clarified that released O_2 is equal to the absorbed CO_2. He realised the **significance of H_2O in this process**. De–Saussure stated that O_2 comes from CO_2 during photosynthesis. (Later on it was disproved by Van Niel)
- **Pallatier & Caventou (1818) :–** They named green pigment as '**Chlorophyll**' and isolated the chlorphyll with the help of alcohol.
- **Englemann (1888) :–** Described **action spectrum** of photosynthesis with the help of **Spirogyra/Cladophora** and **aerobic bacteria** experiment.
- **Mayer (1845) :–** Green plants convert **solar energy into chemical (potential) energy** in the form of organic substance. He gave law of conservation of energy. Formation of organic matter recognised by Mayer.
- **Liebig (1845) :–** Organic matter are derived from CO_2 and H_2O, during the process of photosynthesis.
- **J. V. Sachs (1862) :–** Recognised the relation among photosynthesis, chloroplast and starch. First visible product of photosynthesis is starch. Founder of modern concept of photosynthesis. Some people consider Sachs as father of plant physiology. Three cardinal point concept wal also given by him.
- **Willstater, Stall Fisher :–** Chemistry, structure and properties of Chl–a, and nobel prize winner.
- **F. F. Blackman (1905) :– Dark reaction** associated with **light reaction** in photosynthesis and **law of limiting factors.**
- **Warburg (1920) :– Intermittent** or **flash light experiment** on **Chlorella** and proved that dark reaction exists in photosynthesis.
- **Emerson and Arnold (1932) :–** Concept of **two pigment system** (photosystem) in light reaction. **Red drop & Emerson enhancement effect.**
- **Van Niel :– O_2 releases from water** and O_2 of glucose comes from CO_2.

$$6CO_2 + 12H_2S \xrightarrow{\text{Bacteria}} C_6H_{12}O_6 + 12S + 6H_2O$$

- **Robert Hill & Bendal (1937) :–** Detailed study of light reaction in isolated chloroplast of **stellaria.**
  Photolysis of H_2O is the chief role of chloroplast and evolution of O_2 only in the presence of suitable e^- acceptor, from water in photosynthesis. **(Hill–reaction)**
- **Ruben, Hassid & Kamen (1941) :–** Used **O_{18}** to experimentally show that O_2 in photosynthesis released from water.

ETOOS KEY POINTS

"Photosynthesis is a photo–biochemical process, in which organic compounds are synthesized from the inorganic raw materials (H_2O & CO_2) in presence of light energy and pigments (chl.) gas–oxygen evolved as byproduct."

First true & oxygenic photosynthesis started in **cyanobacteria (BGA).**

Roots of **Tinospora** and **Trapa** are photosynthetic.

Modern view about photosynthesis is conversion of **light/radiant energy into biochemical or potential energy.**

Absorption spectrum for photosynthesis in visible light is **blue** & **red** wavelength.

Action spectrum is **red** & **blue** light in which rate of photosynthesis is higher.
(But rate of photosynthesis is highest in white light than monochromatic light).

Function of accessory pigment carotene is –

1. Converts elementary or nasent oxygen to molecular/gaseous O_2.

   $O + O$ (elementary oxygen) + Carotene $\rightarrow$ Epoxide complex $\xrightarrow{\text{Deepoxidase}}$ O_2 + Carotene.
2. Protects photooxidation (photodamaging) of pigment system.
3. Precursor of vit.–A.
4. Oxidation to form ABA hormone in guard cells.

Chlorophyll pigment soluble in organic solvents like acetone, ether etc. (anthocyanin is non photosynthetic water soluble pigment, which present in vacuole).

Chloroplast in bundle sheath of **Burmuda** grass is also granal type.

Photolysis of water occurs at +0.8 E°

In cyanobacteria (BGA), photosynthesis occurs on **chlorosomes** or **lamellisome** or **carboxysome.**

PS–I is strong reductant as PS–I has good ability to reduce $NADP^+$, while PS-II is a strong oxidant, because it has extreme power of oxidation & photolysis of water molecule.

264 gm. CO_2 and 216 gm. water produced, 108 gm. water, 192 gm. O_2 and 180 gm. glucose.

Annual production of photosynthesis is 170 billion tones of carbohydrate.

Wilmott's bubbler apparatus proves that oxygen is evolved during photosynthesis.

Cytochromes are Iron – porphyrin protein discoverd by MacMunn (termed by Keilin).

Pigments except chlorophyll, presents in Quantasomes are called as **accessory** or **antenna pigment** of light harvesting complex (LHC).

Electroosmotic theory - By **Spanner** and **Jones** for translocation of sugars.

Chollet and Ogren (1975) - Recognised 3 categories of C_4 plants.

(i) **Maize and Sugarcane type** : **In this category malate** transported to bundle sheath cells and its decarboxylation gives CO_2 for C_3 cycle.

(ii) **Panicum and Chloris type** :- In this category malate transported into bundle sheath cells, but this changes into **oxaloacetate**, which gives CO_2 for C_3 cycle.

(iii) **Atriplex type** :- In this category the aspartate transported into bundle sheath cells, where it changes into malate, which provides CO_2 for C_3 cycle.

Mg^{++} required for Rubisco & PEPcase

I^{st} formed unstable 6-C compound during Calvin cycle is **carboxy ketoribitol biphosphate.**

Significance of photosynthesis –

Photosynthesis is vital process for life on planet earth as it is the only process, that links the physical and biological world by conversation of solar energy into organic matter, which make bulk of the dry matter of any organism.

Presence of O_2 in the atmosphere is also an outcome of photosynthesis. This oxygen is helpful to living organisms in two ways :

1. Oxidative break down of organic food matter (respiration)
2. Making ozone (O_3), in outer layer of atmosphere, which helps in stopping the highly destructive U.V. rays.

Efficiency of photosynthesis –

One quantum of red light = 47.6 Kcal (One red photon or quantum = 47.6 Kcal)

One glucose = 686 Kcal. (1 CH_2O = 114.3 Kcal)

8 Quantum × 47.6 Kcal = 381 Kcal energy require for fixation of one CO_2

Etoos Tips & Formulas

→ It is an physicochemical process .

→ Half leaf experiment showed that CO_2 is required for photosynthesis .

→ Joseph Priestley -Proposed the Concept of gaseous exchange by plants with the help of bell jar experiment.

→ Jan Ingenhousz -Showed the importance of Sunlight and Green colour in photosynthesis by using a similar setup as the one used by Priestley.

→ Julius von Sachs -Provided evidence for production of glucose and its storage as starch.

→ T.W. Engelmann -Proposed action spectrum of photosynthesis i.e. Red -blue. Experiment on green filamentous alga Cladophora.

→ Cornelius Van Niel -Suggested that O_2 evolved during photosynthesis comes from H_2O, not from CO_2 . Experiments on purple and green sulphur bacteria.

→ There is a clear division of labour (distribution of work) within the chloroplast i.e. membrane system (grana thylakoids and stroma lamellae) is responsible for light reaction and stroma for dark reaction.

→ In the chromatogram, chlorophyll 'a' shows bright or blue green colour, chloropyll 'b' shows yellow green colour, xanthophyll - yellow & carotenes - yellow - orange.

→ Absorption spectrum of photosynthesis - blue red.

→ Action spectrum of photosynthesis - red blue.

→ Accessory pigments (chlorophylls other than reaction centre, xanthophylls and carotenoids) absorb light and transfer the energy to chlorophyll a (reaction centre) thus enhance the efficiency and range of absorption for photosynthesis. →These pigments also protect chlorophyll a from photo-oxiation.

→ One molecule of chlorophyll a (reaction centre) + Antennae molecules (LHC = Light Harvesting Complex) = Photosystem.

PS-I - Reaction centre (Chi 'a' 700 or P700)

PS-II - Reaction centre (Chi 'a' 680 or P 680)

P = Peak of absorption

→ Noncyclic photophosphorylation is called the Z scheme (due to characteristic shape on a redox potential scale) Water splitting (Photolysis of water) occurs on the inner side (lumen side) of the thylakoid membrane . Products of noncyclic photophosphorylation - ATP, NADPH + H^+ and O_2 .

→ Product of cyclic photophosphorylation - ATP .

→ Products of light reaction which are utilised in dark reaction - ATP & NADPH + H^+ .

→ In grana thylakoid - both noncyclic & cyclic process occurs .

→ In stroma thylakoid - only cyclic process occurs because stroma thylakoid / lamellae lack PS-II as well as NADP reductase enzyme.

→ Primary electron acceptor from PS-I : - Fe-S protein (FRS)

→ Primary electron acceptor from PS-II : - Pheophytin .

→ The chemiosmotic hypothesis has been put forward by Peter Mitchell to explain the mechanism of ATP synthesis in chloroplast (Photophosphorylation) and Mitochondria (oxidative phosphorylation). According to this hypothesis, ATP synthesis is linked to development of a proton gradient across a membrane (Thylakoid membrane in chloroplast and Inner membrane in mitochondria).

SOLVED EXAMPLE

Ex.1 The law of limiting factor for photosynthesis was enunciated by

(A) Blackman **(B)** Hill

(C) Ruben **(D)** Kalmen

Sol. **(A)** : Blackman propounded the law of limiting factors. He also proposed the occurrence of the dark phase in photosynthesis.

Ex.2 Emerson's enhancement effect and Red drop have been instrumental in the discovery of

(A) Photophosphorylation and non-cyclic electron transport

(B) Two photosystems operating simultaneously

(C) Photophosphorylation and cyclic electron transport

(D) Oxidative phosphorylation

Sol. **(B)**

Ex.3 Isotopes popularly known to have been used in the study of photosynthesis are

Or

Which of the following isotope of carbon was used by Calvin to trace the path of carbon in photosynthesis

(A) C^{14} and O^{18} **(B)** C^{11} and C^{32}

(C) C^{16} and N^{15} **(D)** P^{32} and C^{15}

Sol. **(A)** : C^{14} isotope used for knowing carbon path and O^{18} used for verified that source of O_2 in photosynthesis is H_2O, not CO_2

Ex.4 The first event in photosynthesis is

(A) Synthesis of ATP

(B) Photoexcitation of chlorophyll and ejection of electron

(C) Photolysis of water

(D) Release of oxygen

Sol. **(B)** : When photon of light energy falls on chlorophyll molecule, one of the electrons pair from ground or single state passes into higher energy level called excited single state.

Ex.5 The synthesis of ATP in photosynthesis and respiration is essentially an oxidation-reduction process involving removal of energy from

Or

Which one is always transferred in redox reaction

(A) Oxygen **(B)** Phytochrome

(C) Cytochrome **(D)** Electrons

Sol. **(D)**

Ex.6 Manganese and Chlorine is required in

(A) Nucleic acid synthesis

(B) Plant cell wall formation

(C) Photolysis of water during photosynthesis

(D) Chlorophyll synthesis

Sol. **(C)** : The splitting of water during photosynthesis is called photolysis. Mn and Cl plays important role in photosynthesis specially light reaction of photosynthesis in splitting of water.

Ex.7 Stroma in the chloroplasts of higher plant contains

(A) Light-independent reaction enzymes

(B) Light-dependent reaction enzymes

(C) Ribosomes

(D) Chlorophyll

Sol. **(A)**

Ex.8 Consider the following statements with respect to photosynthesis

A. The first carbon dioxide acceptor in C_4 cycle is PGA

B. In C_3 plants, the first stable product of photosynthesis during dark reaction is RuBP

C. Cyclic photophosphorylation results in the formation of ATP

D. Oxygen which is liberated during photosynthesis comes from water

Of the above statements

(A) A and B alone are correct

(B) A and C alone are correct

(C) C and D alone are correct

(D) B and C alone are correct

(E) B and D alone are correct

Sol. **(C)**

Ex.9 Excitation of chlorophyll due to light is a

(A) Photooxidation reaction

(B) Endergonic reaction

(C) Thermochemical reaction

(D) Photochemical reaction

Sol. **(A)**

Exercise # 1 SINGLE OBJECTIVE NEET LEVEL

1. Oxygen which is liberated during photosynthesis comes from -
(A) Carbon di oxide
(B) Water
(C) Chlorophyll
(D) Phosphoglyceric acid

2. The process of taking in CO_2 by plants and releasing O_2 is termed as
(A) Transpiration (B) Respiration
(C) Photosynthesis (D) Endosmosis

3. In plants during the process of photosynthesis
(A) CO_2 is taken in
(B) O_2 is taken in
(C) CO_2 is taken out
(D) O_2 is taken in and CO_2 is given out

4. In which of the following process, the light energy is converted into chemical energy
(A) Digestive action (B) Respiration
(C) Photosynthesis (D) Fermentation

5. The dark reaction in photosynthesis is called so because
(A) It can only occur in dark
(B) It does not require light
(C) None of these
(D) Both (A) & (B)

6. The law of limiting factor for photosynthesis was given by :–
(A) R. Hill (B) Krebs
(C) Calvin (D) Blackman

7. Beside water and light which is more essential as a raw material for food formation
(A) CO_2 (B) O_2
(C) NADP (D) Mineral salts

8. If the CO_2 content of the atmosphere is as high as 300 parts per million -
(A) All plants would be killed
(B) The plants would not grow properly
(C) Plants would grow for some time and then die.
(D) The plants would thrive well

9. The isotope of carbon used extensively for studies in photosynthesis :–
(A) C^{13} (B) C^{14}
(C) C^{15} (D) C^{16}

10. Which is the evidence to show that oxygen released in photosynthesis comes from water :–
(A) Isotopic oxygen (O^{18}) supplied as H_2O appears in the O_2 released in photosynthesis.
(B) Activated chloroplast in water released O_2 if supplied potassium ferrocyanide or some other reducing agent in the absence of CO_2.
(C) Photosynthetic bacteria use H_2S and CO_2 to make carbohydrates, H_2O and sulphur.
(D) All of the above.

11. The path of CO_2 in the dark reactions of photosynthesis was sucessfully traced by the use of the following :–
(A) O_2^{18} (B) $C^{14}O_2$
(C) P^{32} (D) X - rays

12. Discovery of Emerson effect has already shown the existence of :–
(A) Two distinct photosystems
(B) Light and dark reactions of photosynthesis
(C) Photophosphorylation
(D) Photorespiration

13. During the process of photosynthesis the raw materials used are :–
(A) Glucose (B) Chlorophyll
(C) Starch (D) CO_2 and H_2O

14. Products of photosynthesis are :–
(A) Carbon dioxide and food material
(B) Carbohydrates and oxygen
(C) Carbon dioxide and oxygen
(D) Formaldehyde and nitrogen

15. Name the scientist, who first pointed out that plants purify foul air by bell jar experiment.
(A) Willstatter (B) Robert Hooke
(C) Priestley (D) Iean Senebier

Exercise # 2 SINGLE OBJECTIVE AIIMS LEVEL

1. Photosynthesis is
(A) Oxidative, exergonic, catabolic
(B) Redox-reaction, endergonic, anabolic
(C) Reductive, exergonic, anabolic
(D) Reductive, endergonic, catabolic

2. What is photosynthetic quotient?
(A) O_2/CO_2 (B) CO_2/O_2
(C) O_2 / Starch (D) Water / starch

3. Which of the following carries out non-oxygenic photosynthesis?
(A) Cyanobacteria (B) Crab grass
(C) Bacteria (D) Wheat plant

4. Wavelength of light responsible for Emerson's enhancement effect :–
(A) only 680 nm
(B) only 680 nm
(C) infra red wavelength
(D) Both 680 nm- and 680 nm

5. The "red - drop" phenomenon is due to the disruption of the photo chemical activity of
(A) PS - I (B) PS-I & PS-II both
(C) PS - II (D) Carotenoids

6. True for photosynthesis :-
(A) Oxidation of CO_2 and reduction of H_2O
(B) process which connects the biotic and abiotic world
(C) Exergonic process
(D) Oxidation of Glucose

7. Which of the following order is correct about the rate of photosynthesis?
(A) Blue > yellow > orange > red
(B) Blue > red > yellow > orange
(C) Red > blue > yellow > orange
(D) Yellow > orange > blue > red

8. The product of hill reaction are :–
(A) ATP and $NADPH_2$ in chloroplast
(B) ATP and $NADPH_2$ in mitochondria
(C) Only oxygen
(D) A reduced substance $NADPH_2$, ATP and O_2 in chloroplast

9. Which of the following is excited molecule during photosynthesis :–
(A) Chlorophyll (B) Oxygen
(C) Carbondioxide (D) Water

10. During ionisation of H_2O, H^+ is captured by
(A) Chlorophyll (B) NADP
(C) O_2 (D) Cytochrome

11. At the time of ionization of H_2O, which initially captures the electron
(A) Chlorophyll (B) NADP
(C) OH^- (D) Cytochrome

12. Fixation of 1 CO_2 requires :–
(A) $6NADPH_2$ & 3ATP (B) $2NADP.H_2$ & 3ATP
(C) 4 $NADP.H_2$ & 3ATP (D) 5 $NADP.H_2$ & 3ATP

13. During ATP synthesis electron pass through
(A) Water (B) Cytochromes
(C) O_2 (D) CO_2

14. Which pigment system ultimately donates e^- for the reduction of NADP.
(A) PS II (B) PS I
(C) CO_2 (D) Plastoquinone

15. Respiration and photosynthesis both require
(A) Green cells (B) Sunlights
(C) Cytochromes (D) Organic fuel

16. Photosynthesis is an oxidation reduction process, the materials that is oxidised is
(A) CO_2 (B) NADP
(C) H_2O (D) PGA

17. Element which helps in electron transport in the process of photosynthesis is
(A) Zinc (B) Molybdenum
(C) Boron (D) Mangnese

18. Photo - oxidation of chlorophyll is called
(A) Intensification (B) Chlorosis
(C) Solarization (D) Defoliation

Exercise # 3 PART - 1 MATRIX MATCH COLUMN

1. Match Column-I with Column-II and select the correct option from the codes given below.

Column - I	Column - II
A. C_4 plants	**i.** Succulents
B. Chlorophyll *b*	**ii.** Accessory photosynthetic pigment
C. PS II	**iii.** Photo-oxidation of H_2O
D. CAM	**iv.** Kranz anatomy

(A) A-iv, B-ii, C-iii, D-i **(B)** A-iii, B-ii, C-iv, D-i **(C)** A-i, B-iii, C-ii, D-iv **(D)** A-i, B-ii, C-iii, D-iv

2. Match Column - I with Column - II and select the correct option from the codes given below.

A. C_3 plants	**i.** *Kalanchoe, Opuntia*
B. C_4 plants	**ii.** Maize, sugarcane
C. CAM plants	**iii.** Helianthus

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

3. Which of the following with respect to early experiments of photosynthesis is wrongly matched

(A) Joseph Priestley – Showed that plants release O_2
(B) Jan Ingenhousz – Showed that sunlight is essential for photosynthesis
(C) Julius von Sachs – Proved that plants produce glucose when they grow
(D) T.W. Engelmann – Showed that the green substance is located within special bodies in plant
(E) Cornelius van Net – Showed that hydrogen reduces CO_2 to carbohydrates

4. Match the following and choose the correct combination from the options given

Column - I	Column - II
A. Visible light	**i.** 0.1 to 1 nm
B. Ultraviolet	**ii.** 400 to 700 nm
C. X-Rays	**iii.** Longer than 740 nm
D. Infrared	**iv.** 100 to iv00 nm
	v. 0.1 nm

(A) A-i, B-iii, C-iv, D-v **(B)** A-iii, B-ii, C-i, D-v **(C)** A-iv, B-iii, C-ii, D-i **(D)** A-ii, B-iv, C-i, D-iii
(E) A-v, B-iv, C-iii, D-ii

5. Match the sites in column I with the processes in column II and choose the correct combination from the options

Column I	Column II
A. Grana of chloroplast	**i.** Kreb's cycle
B. Stroma of chloroplast	**ii.** Light reaction
C. Cytoplasm	**iii.** Dark reaction
D. Mitochondrial matrix	**iv.** Glycolysis

(A) A-iv, B-iii, C-ii, D-i **(B)** A-i, B-ii, C-iv, D-iii **(C)** A-ii, B-i, C-iii, D-iv **(D)** A-iii, B-iv, C-i, D-ii
(E) A-ii, B-iii, C-iv, D-i

6. Select the incorrect matched pair with regard to C_4 cycle

(A) Primary CO_2 fixation product – PGA
(B) Site of initial carboxylation – Mesophyll cells
(C) Primary CO_2 acceptor – PEP
(D) C_4 plant – Maize
(E) Location of enzyme RuBisCO – Bundle sheath cells

Exercise # 4 PART - 1 PREVIOUS YEAR (NEET/AIPMT)

1. Photochemical reactions in the chloroplast are directly involved in : [CBSE AIPMT 2000]
(A) Formation of phosphoglyceric acid
(B) Fixation of carbon dioxide
(C) Synthesis of glucose and starch
(D) Photolysis of water and phosphorylation of ADP to ATP

2. Fixation of one CO_2 molecule through Calvin cycle requires [CBSE AIPMT 2000]
(A) 1 ATP and 2NADPH$_2$
(B) 2 ATP and 2NADPH$_2$
(C) 3 ATP and 2NADPH$_2$
(D) 2 ATP and 1NADPH$_2$

3. The first step of photosynthesis is [CBSE AIPMT 2000]
(A) Excitation of electron of chlorophyll by a photon of light
(B) Formation of ATP
(C) Attachment of CO_2 to 5 carbon sugar
(D) Ionisation of water

4. How many turns of Calvin cycil yield one molecule of glucose ? [CBSE AIPMT 2000]
(A) 8 (B) 2
(C) 6 (D) 4

5. Which pair is wrong : - [CBSE AIPMT 2001]
(A) C_3 – Maize
(B) C_4 – Kranz anatomy
(C) Calvin cycle - PGA
(D) Hatch and Slake cycle ? O.A.A.

6. Which pigment system inactivated in red drop : - [CBSE AIPMT 2001]
(A) PS-I and P.S-II (B) PS – I
(C) PS – II (D) None

7. In Photosynthesis energy from light reaction to dark reaction is transferred in the form of : - [CBSE AIPMT 2002]
(A) ADP (B) ATP
(C) RUDP (D) Chlorophyll

8. Which of the following absorb light energy for photosynthesis : - [CBSE AIPMT 2002]
(A) Chlorophyll (B) Water molecule
(C) O_2 (D) RUBP

9. Which element is located at the centre of the porphyrin ring in chlorophyll : -[CBSE AIPMT 2003]
(A) Manganese (B) Calcium
(C) Magnesium (D) Potassium

10. Which one of the following is wrong in relation to photorespiration : - [CBSE AIPMT 2003]
(A) It is a characteristic of C_3 - plants
(B) It occurs in chloroplasts
(C) It occurs in daytime only
(D) It is a characteristic of C_4 -plants

11. In sugarcane plant 14CO_2 is fixed in malic acid, in which the enzyme that fixes CO_2 is :- [CBSE AIPMT 2003]
(A) Fructose phosphatase
(B) Ribulose biphosphate carboxylase
(C) Phosphoenol pyruvic acid carboxylase
(D) Ribulose phosphate kinase

12. Which fractions of the visible spectrum of solar radiations are primarily absorbed by carotenoids of the higher plants : - [CBSE AIPMT 2003]
(A) Violet and blue (B) Blue and green
(C) Green and red (D) Red and violet

13. Chlorophyll in chloroplasts is located in :- [CBSE AIPMT 2004]
(A) Outer membrane (B) Inner membrane
(C) Thylakoids (D) Stroma

14. Plants adapted to low light intensity have :- [CBSE AIPMT 2004]
(A) Larger photosynthetic unit size than the sun plants
(B) Higher rate of CO_2 fixation than the sun plants
(C) More extended root system
(D) Leaves modified to spines

15. In C_3 -plants, the first stable product of photosynthesis during the dark reaction is :- [CBSE AIPMT 2004]
(A) Malic acid
(B) Oxaloacetic acid
(C) 3-phosphoglyceric acid
(D) Phosphoglyceraldehyde

MOCK TEST

1. A plant is provided with ideal conditions for photosynthesis and supplied with isotope $^{14}CO_2$. When the products of the process are analysed carefully, what would be the nature of products?
   (A) Both glucose and oxygen are normal. **(B)** Both glucose and oxygen are labelled.
   (C) Only glucose is labelled and oxygen is normal **(D)** Only oxygen is labelled but glucsoe is normal.

2. Chromatophores take part in
   (A) movement **(B)** respiration **(C)** photosynthesis **(D)** growth

3. Carbon dioxide is necessary for photosynthesis. The chemical used to remove this gas most effectively from entering a control apparatus is
   (A) calcium oxide **(B)** distilled water
   (C) potassium hydroxide solution **(D)** sodium carbonate.

4. Anoxygenic photosynthesis is characteristic of
   (A) *Rhodospirillum* **(B)** *Spirogyra* **(C)** *Chlamydomonas* **(D)** *Ulva*

5. Which of the following statements is correct?
   (A) The core of cilium or flagellum is the basal body
   (B) Elaioplasts store starch whereas aleuroplasts store proteins.
   (C) Membranous extensions into the cytoplasm in cyanobacteria which contain pigments are called chromatophores.
   (D) Acrocentric chromosomes have only one arm.

6. Which of the following with respect to early experiments of photosynthesis is wrongly matched?
   (A) Joseph Priestley – Showed that plants relase O_2
   (B) Jan Ingenhousz – Showed that sunlight is essential for photosynthesis
   (C) Julius von Sachs – Proved that plants produce glucose when they grow.
   (D) T.W. Engelmann – Showed that the green substance is located within special bodies in plants
   (E) Cornelius van Niel – Showed that hydrogen reduces CO_2 to carbohydrates

7. In photosynthesis, the light-independent reactions take place at
   (A) photosystem II **(B)** stromal matrix **(C)** thylakoid lumen **(D)** photosystem I

8. Chlorophyll molecules are located in the
   (A) thylakoid membrane **(B)** thylakoid lumen
   (C) stroma **(D)** inner chloroplast membrane

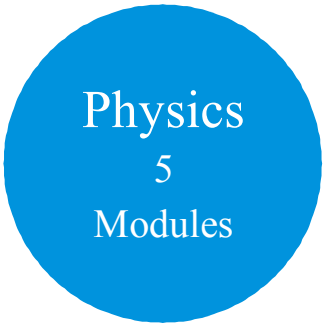
9. Emerson's enhancement effect and Red drop have been instrumental in the discovery of
   (A) photophosphorylation and cyclic electron transport
   (B) oxidative phosphorylation
   (C) photophosphorylation and non-cyclic electron transport
   (D) two photosystems operating simultaneously

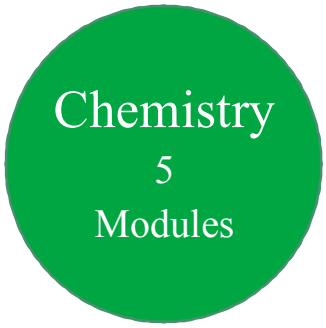
10. Match the following.

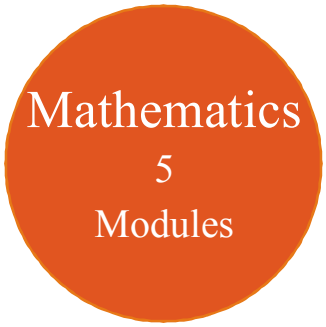
A. Chlorophyll *a*	(i) yellow
B. Chlorophyll *b*	(ii) bright or blue green
C. Xanthophyll	(iii) yellow - yellow orange
D. Carotenoids	(iv) yellow green

(A) A-(ii), B-(iv), C-(i), D-(iii) **(B)** A-(iii), B-(iv), C-(ii), D-(i)
(C) A-(iv), B-(iii), C-(ii), D-(i) **(D)** A-(iv), B-(ii), C-(i), D-(iii)
(E) A-(iv), B-(i), C-(iii), D-(ii)

11th Class Modules Chapter Details

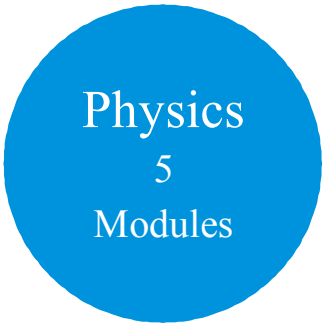


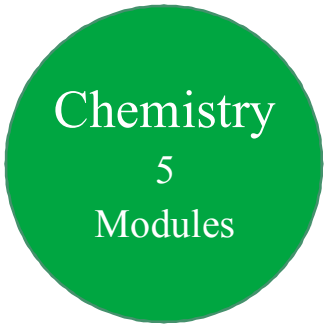


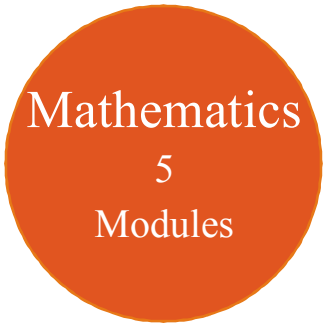


PHYSICS	CHEMISTRY	BIOLOGY
Module-1 1. Physical World & Measurements 2. Basic Maths & Vector 3. Kinematics **Module-2** 1. Law of Motion & Friction 2. Work, Energy & Power **Module-3** 1. Motion of system of particles & Rigid Body 2. Gravitation **Module-4** 1. Mechanical Properties of Matter 2. Thermal Properties of Matter **Module-5** 1. Oscillations 2. Waves	**Module-1(PC)** 1. Some Basic Conceps of Chemistry 2. Atomic Structure 3. Chemical Equilibrium 4. Ionic Equilibrium **Module-2(PC)** 1. Thermodynamics & Thermochemistry 2. Redox Reaction 3. States Of Matter (Gaseous & Liquid) **Module-3(IC)** 1. Periodic Table 2. Chemical Bonding 3. Hydrogen & Its Compounds 4. S-Block **Module-4(OC)** 1. Nomenclature of Organic Compounds 2. Isomerism 3. General Organic Chemistry **Module-5(OC)** 1. Reaction Mechanism 2. Hydrocarbon 3. Aromatic Hydrocarbon 4. Environmental Chemistry & Analysis Of Organic Compounds	**Module-1** 1. Diversity in the Living World 2. Plant Kingdom 3. Animal Kingdom **Module-2** 1. Morphology in Flowering Plants 2. Anatomy of Flowering Plants 3. Structural Organization in Animals **Module-3** 1. Cell: The Unit of Life 2. Biomolecules 3. Cell Cycle & Cell Division 4. Transport in Plants 5. Mineral Nutrition **Module-4** 1. Photosynthesis in Higher Plants 2. Respiration in Plants 3. Plant Growth and Development 4. Digestion & Absorption 5. Breathing & Exchange of Gases **Module-5** 1. Body Fluids & Its Circulation 2. Excretory Products & Their Elimination 3. Locomotion & Its Movement 4. Neural Control & Coordination 5. Chemical Coordination and Integration

12th Class Modules Chapter Details







PHYSICS

Module-1

1. Electrostatics
2. Capacitance

Module-2

1. Current Electricity
2. Magnetic Effect of Current and Magnetism

Module-3

1. Electromagnetic Induction
2. Alternating Current

Module-4

1. Geometrical Optics
2. Wave Optics

Module-5

1. Modern Physics
2. Nuclear Physics
3. Solids & Semiconductor Devices
4. Electromagnetic Waves

CHEMISTRY

Module-1(PC)

1. Solid State
2. Chemical Kinetics
3. Solutions and Colligative Properties

Module-2(PC)

1. Electrochemistry
2. Surface Chemistry

Module-3(IC)

1. P-Block Elements
2. Transition Elements (d & f block)
3. Co-ordination Compound
4. Metallurgy

Module-4(OC)

1. HaloAlkanes & HaloArenes
2. Alcohol, Phenol & Ether
3. Aldehyde, Ketone & Carboxylic Acid

Module-5(OC)

1. Nitrogen & Its Derivatives
2. Biomolecules & Polymers
3. Chemistry in Everyday Life

BIOLOGY

Module-1

1. Reproduction in Organisms
2. Sexual Reproduction in Flowering Plants
3. Human Reproduction
4. Reproductive Health

Module-2

1. Principles of Inheritance and Variation
2. Molecular Basis of Inheritance
3. Evolution

Module-3

1. Human Health and Disease
2. Strategies for Enhancement in Food Production
3. Microbes in Human Welfare

Module-4

1. Biotechnology: Principles and Processes
2. Biotechnology and Its Applications
3. Organisms and Populations

Module-5

1. Ecosystem
2. Biodiversity and Conservation
3. Environmental Issues