ULTIMATE KCET

CRASH COURSE 2026

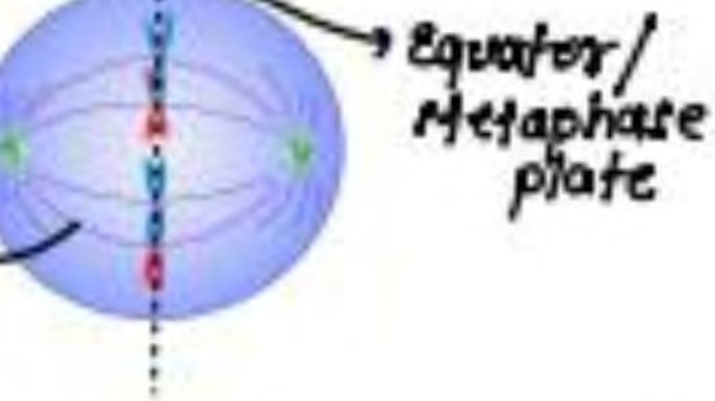
Botany | Lecture - 01

Photosynthesis in higher plants Respiration in plants

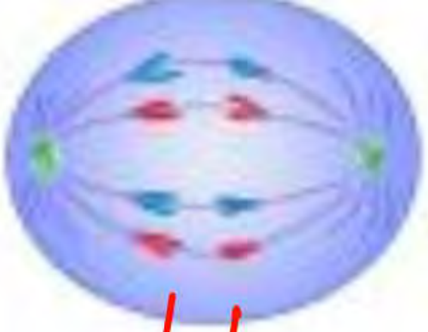
By – Chaitra Ma'am

Topics to be covered

1. Cell cycle
2. Photosynthesis
3.
4.



Equator/ Metaphase plate



matin cond^n complete

mosome clearely visible

plete dit-integration ucleaus membrane gening of metaphase

stage to study Morphology.

hase chromosome p of 2-sister fols which is held by centromere

- Shoutning of spindle fibres
- Chuemosome spliting
- Sister chuomatid separate & move to opp. pole
- Chuomosome move towards poles, with arms trailing behind
- Chuomosome no. Doubled.

- Phase of 2 Nucleus
- Decondensation of Chromosome
- Chromosome lost their identity.
- Reappearance of cell organelle
- Spindle fibre breakdown

initiate after parental chromosome replicate to form sister chromatid at S-phase

• Similar to Mitosis

	G_1	M_I	M_{II}
CN:	46	23	23
DNA:	90	90	45

• Meiosis Have 2 cycle, but Single cycle For DNA Replication.

⑨ MEIOSIS-I

Le. Zy. Pa. Di. Dia

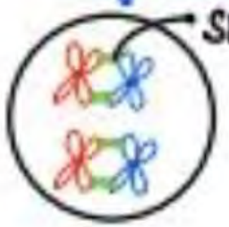
* Prophase-I

Leptotene

• Chromosome Gradually visible under light microscope

• Early prophase

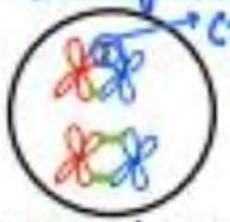
Zygotene



• Synapsis of Homologous chr.
↓
Synaptonemal complex

• Bivalent/tetrad
↓ 2-chromosome
↓ 4-chromatid

Pachytene

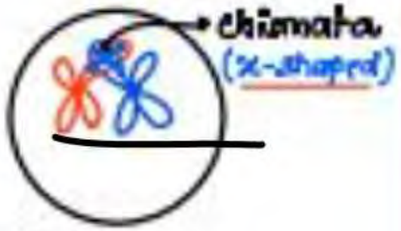


• Bivalent/tetrad clearly visible

• Recombination nodules at crossing over

* Crossing over
→ Site of Recombination nod.
→ b/w non-sister chromatid of Homologous chromosome
→ Enzyme mediated process
→ Recombinase
→ complete at end of pachytene

Diplotene



• Dissolution of SNC
• Homologous chr. seperate except site of crossing over

• X-shaped chiasmata form" at crossing over

* In oocytes of some vertebrates
↓
diplotene last few month/years

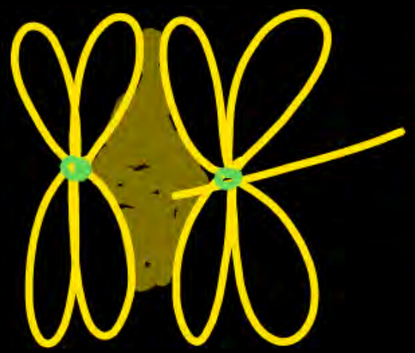
Diakinesis

• Terminalisation of chiasmata

• chromosome fully condensed and Spindle fibre formed

• at end of Diakinesis
→ nucleolus Disappear
→ nuclear envelop break

• Diakinesis repeat transition to metaphase-I.

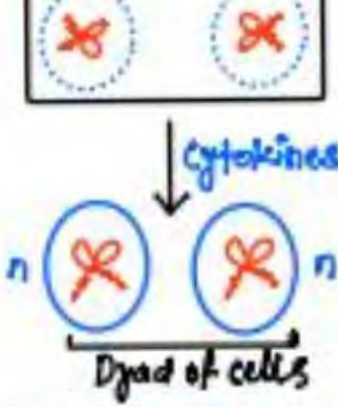


Synaptonemal Complex

Synapsis

Bivalent / Tetrad

recombinase



- Chromosome decondense
- In many cases chromosome undergo some dispersion
- Chromosome do not reach the extreme extended state.

(more complex) **Interkinesis** (less complex)

- stage b/w 2 meiotic division
- short lived
- NO replication of DNA.

(10) Meiosis - II (Similar to mitosis)

Prophase - II ⟶ Metaphase - II ⟶ Anaphase - II ⟶ Telophase - II

Anaphase - II: Splitting of sister chromatids / centromere

Telophase - II: cytokinesis → n n n n — tetrad of cells

* Significance of meiosis

→ Conservation of specific chromosome number ✓
→ Increase Genetic variability (important for evolution) ✓
→ prokaryotic cells lack both mitosis & meiosis

mitosis

4 Mo cell →

1-2
4=?

4x2 = 8 (2n)

meiosis

1 Mo → 4 da. cells

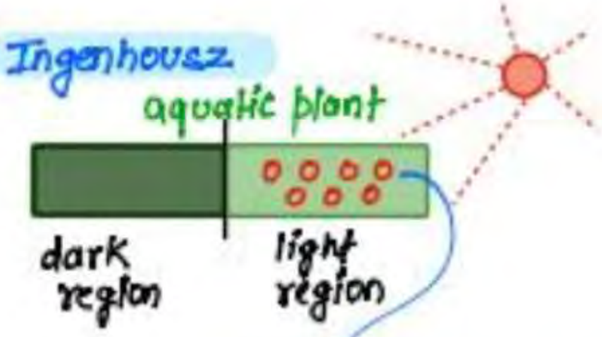
4 Mo → ?

4x4 = 16 (n)

- When plant grow, there is more production of glucose.
- Amount of glucose ∝ growth

(Glucose → made in green part of plant
→ stored as starch)

© Ingenhousz



∴ Sunlight is essential for photosynthesis

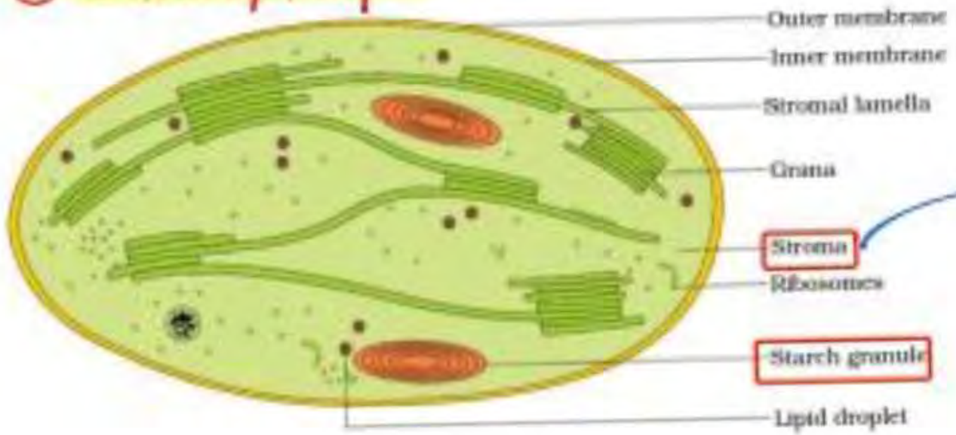
→ expt: bell jar, candle, mouse, leaf

- conclude that plant restores that air, which was removed by breathing animal & burning candle

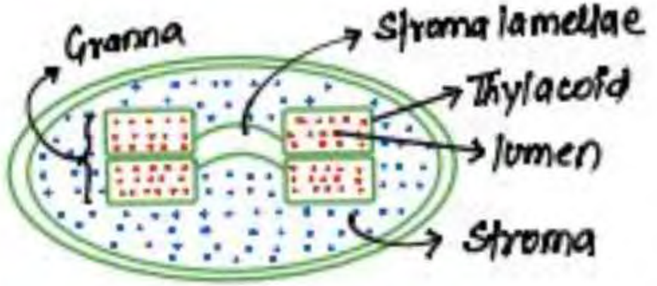
∴ O_2 is essential in growth of green plant

- Ingenhousz: sunlight
- Von sac: Glucose

② Chloroplast



- synthesis of suger → which forms starch (by calvin cycle)



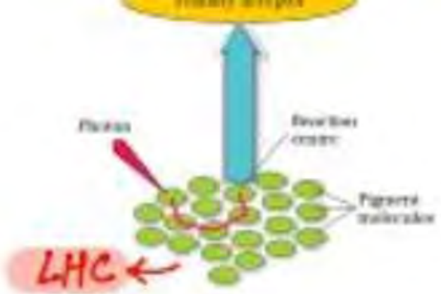
- Membranous system: Grana, Strama lamellae, matrix Stroma
- clear division of labour
- light reaction: directly depend on light → trap light energy & synthesize ATP, NADPH & O_2. (photochemical reaction)
- Dark reaction: not directly depend on light, but depend on product of light reaction (carbon reaction)
  → synthesize suger in Strama by calvin cycle

* Chloroplast align themselves along wall of mesophyll cells soon that they get optimum quantity of light.
  - less light: Chloroplast align parallel
  - High light: Chloroplast align perpendicular

④ Photosystem

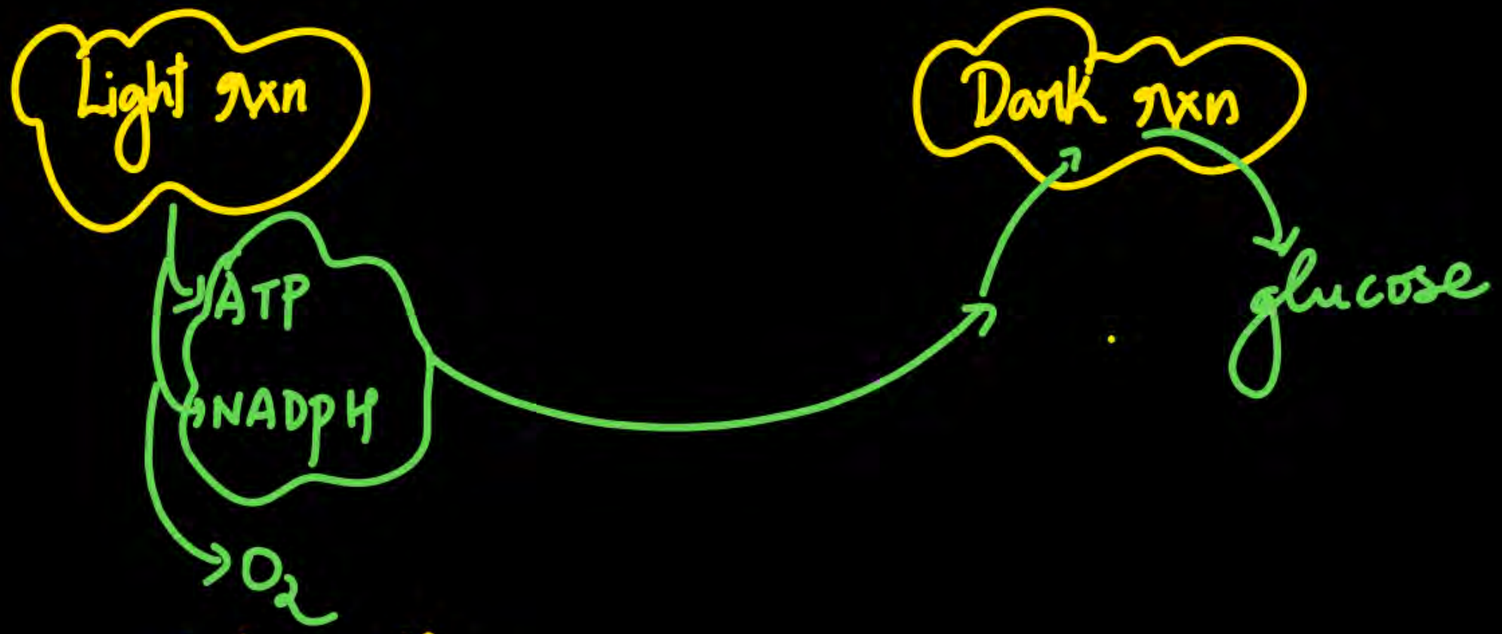
Light harvesting complex (LHC) (Antenae)

Reaction centre



- LHC: · made of Hundreds of pigment bound to protein → Accessory pigment, proteins, ~~chl-a~~
  - ↳ Help to make photosynthesis more efficient by absorbing diff wavelength.
- Photosystem: PS-I: absorb 700 nm (far Red): P700
  - ↳ prf. e⁻ acceptor → Fe-S centre (Fe-S)
- PS-II: absorb 680nm (Red): P680
  - ↳ prf. e⁻ acceptor → pheophytin (PEA)

* PS-I & PS-II name based on their discovery, not on their function.

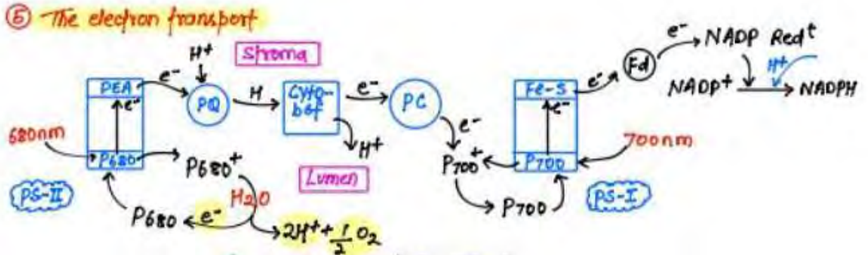


PSI - Stromal lamellae

Grana

PSII - Grana

⑤ The electron transport



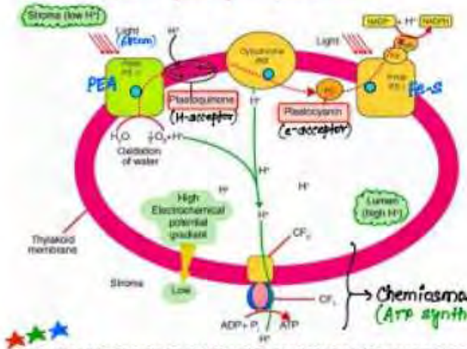
★ Imp points:

- PQ: Plastoquinone: H-acceptor
  (∴ Remove H^+ from stroma)
- PC: Plastocyanin: only e^- acceptor
  (∴ Cyto b6f: H^+ → Lumen)

★ Concentration of H^+

* High H^+ ion in lumen (PH ↓)
  - photolysis of water (lumen)
  - Active dumping of H^+ from stroma to lumen
* low H^+ in stroma (PH ↑)
  - Active dumping of H^+ from stroma to lumen
  - H^+ ion removed by PQ & NADP Red from stroma

⑥ Non-cyclic photophosphorylation



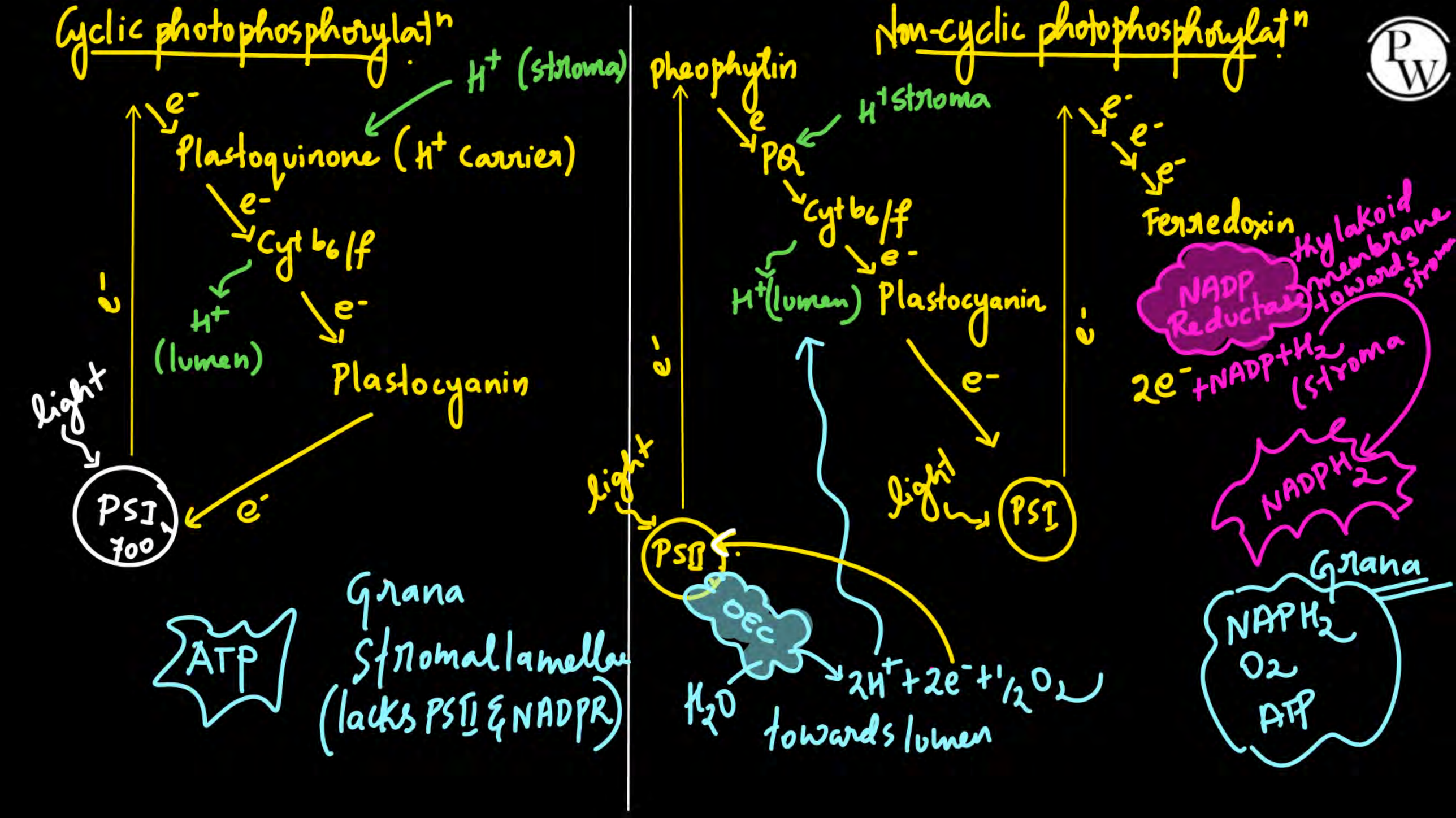
- P700 ✓, P680 ✓ (Both required)
- Fd: Ferridoxin
- FNR: Ferridoxin
  - NADP - oxidoReductase

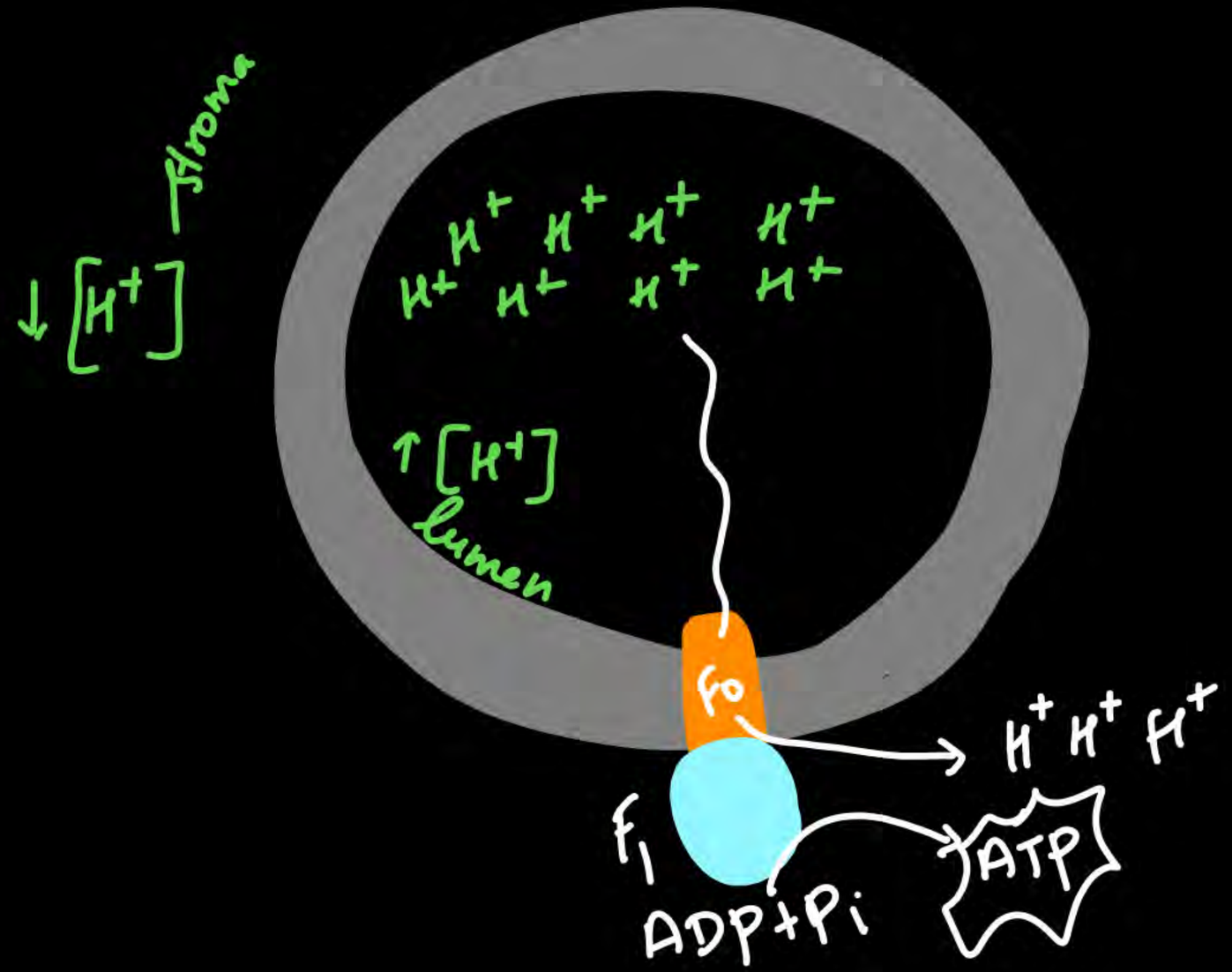
★★★

(a) Since splitting of the water molecule takes place on the inner side of the membrane, the protons or hydrogen ions that are produced by the splitting of water accumulate within the lumen of the thylakoids.

(b) As electrons move through the photosystems, protons are transported across the membrane. This happens because the primary accepter of electron which is located towards the outer side of the membrane transfers its electron not to an electron carrier but to an H carrier. Hence, this molecule removes a proton from the stroma while transporting an electron. When this molecule passes on its electron to the electron carrier on the inner side of the membrane, the proton is released into the inner side or the lumen side of the membrane.

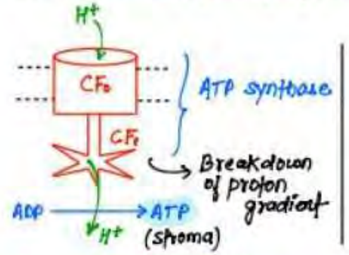
(c) The NADP reductase enzyme is located on the stroma side of the membrane. Along with electrons that come from the acceptor of electrons of PS I, protons are necessary for the reduction of $NADP^+$ to $NADPH + H^+$. These protons are also removed from the stroma. Hence, within the chloroplast, protons in the stroma decrease in number, while in the lumen there is accumulation of protons. This creates a proton gradient across the thylakoid membrane as well as a measurable decrease in pH in the lumen.


Cyclic photophosphorylatn
H+ (stroma)
e-
Plastoquinone (H+ carrier)
e-
Cyt b6/f
H+ (lumen)
e-
Plastocyanin
e-
light
PSI 700
ATP
Grana
Stromal lamellae
(lacks PSII & NADPR)
Non-cyclic photophosphorylatn
Pheophytin
e-
H+ stroma
PQ
Cyt b6/f
H+ (lumen)
e-
Plastocyanin
e-
light
PSI
e-
e-
e-
Ferredoxin
NADP Reductase
thylakoid membrane towards stroma
2e- + NADP + H2
(stroma
NADPH2
light
PSII
OEC
H2O
2H+ + 2e- + 1/2 O2
towards lumen
Grana
NAPH2
O2
ATP


↓ [H+] stroma
H+ H+ H+ H+ H+ H+ H+ H+ H+ H+
↑ [H+] lumen
Fo
H+ H+ H+
F1
ATP
ADP+Pi

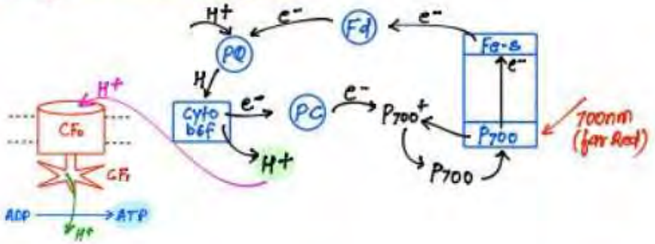
(7) Chemiosmosis:

- Requirement: Membrane, proton pump, proton gradient & ATP synthase (F_0, F_1)



CF_0	v/s	CF_1
• Transmembrane channel		• Conformational change (ADP $\xrightarrow{H^+}$ ATP)
• Integeral		• Periferal
• Embedded in thylakoid membrane		• Outer surface of thylakoid membrane (faces stroma)
• Facilitated diffusion (passive)		

(8) Cyclic photophosphorylation



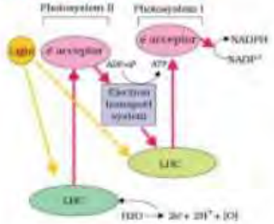
- Only 700nm (far Red) light available.
- P_{680} not working
- NADPH not formed

(9) Non-cyclic photophosphorylation

- 2 light (far Red 700nm & Red 680nm)
  2 photosystem Req (PS-I & PS-II)
  2 product (NADPH & ATP)
- Occur in Granna only

(B/c PS-II present in inner side of Granna only)

- Photolysis of H_2O ✓
- O_2 production ✓
- More energy, more productivity
- Z-Scheme observed

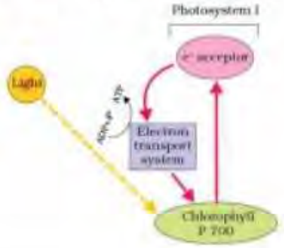


cyclic photophosphorylation

- 1 light (far Red 700nm only) → beyond 680nm
  1 photosystem Req (PS-I only)
  1 product (ATP only)
- Occur in Granna & stroma lamella

(B/c PS-I present in outer side of Granna & stroma lamella)

- Photolysis of H_2O ✗
- O_2 production ✗
- less energy, less productivity



⇒ 1 CO_2 fixation ⟶ 1 turn of calvin cycle ⟶ 1 RUBP ⟶ 3 ATP & 2 NADPH

Product	no. of carbon	CO_2 reqd	RUBP reqd	Turn Reqd	ATP reqd	NADPH reqd
G-3P	3	3	3	3	3x3 = 9	3x2 = 6
Glucose	6	6	6	6	6x3 = 18	6x2 = 12
Sucrose	12	12	12	12	12x3 = 36	12x2 = 24
C_{18}	18	18	18	18	18x3 = 54	18x2 = 36

★ RUBISCO (RUBP carboxylase- oxygenase)

- most abundent enzyme in the world
- main enzyme of calvin cycle
- It can combine with both CO_2 & O_2 (depend on conc^n of gas)

↳ RUBISCO has greater affinity for CO_2

★ RUBP: - Ribulose bi-phosphate
- 5C-Ketose suger
- CO_2 acceptor

- $CO_2 >> O_2$

- Act as carboxylase

- $CO_2 << O_2$

- Act as oxygenase

- $CO_2 \approx O_2$

- Act as both carboxylase & oxygenase (mostly)

(14) C4- plant

Granal chloroplast
- PS-I & PS-II
- Non-cyclic
- * PEP
- * PEPcase

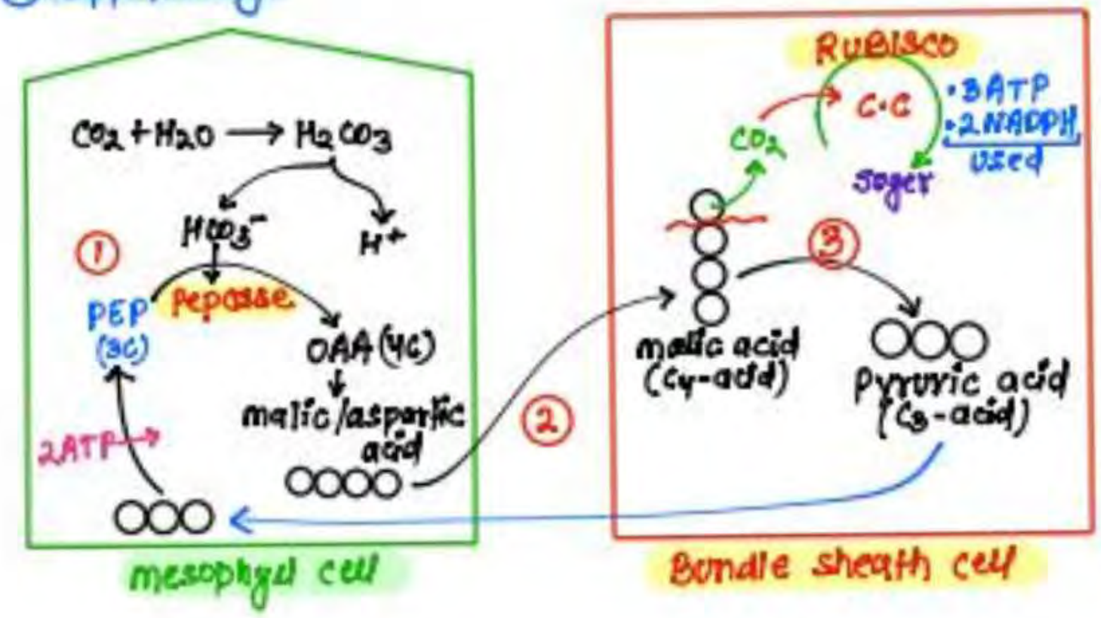
mesophyll cell

- Big cell, thick wall
- large cells around VB
- may have several layer around VB
- Impervious to gaseous exchange
- large no. of chloroplast
- Intercellular space absent

Agranal chloroplast-
- only PS-I ∴ cyclic
- * RUBP & RUBISCO

Bundle sheath cell

(a) C4 pathway

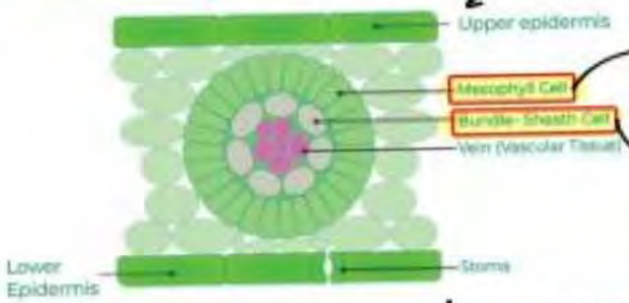


1. CO_2 fixation
2. Transportation
3. decarboxylation

* 1st stable product: OAA (4C)
* pri. CO_2 acceptor: PEP (mesophyll cell)
* For 1 CO_2 fixation ↴

3ATP + 2NADPH + 2ATP
(calvic cycle) (Regeneration of PEP)

* leaf anatomy of C4 → KRNTZ Anatomy



Granal chloroplast
• pepcase

Agranal chloroplast
• RUBISCO

eg: Maize, Sorghum, Sugarcane

(15) Comparision

Cell	C3-plant (•RUBP •RUBISCO — mesophyll)	C4-plant (•PEP •Pepcase — mesophyll; •RUBP •RUBISCO (cc) — Bundle sheath cell)
Calvin cycle	Mesophyll cell	Bundle sheath cell
Chloroplast type	monomorphic	Dimorphic (granal & Agranal)
RUBISCO present in	Mesophyll cell	Bundle sheath cell
How many CO_2 fixⁿ	one (mesophyll)	Two (Mesophyll & Bundle sheath)
Pri. CO_2 fixⁿ cell	mesophyll	Mesophyll
1st stable product	PGA (3C)	OAA (4C)
For 1 CO_2 fixation	3ATP + 2NADPH	3ATP + 2NADPH + 2ATP
CO_2 fixation enzyme	only RUBISCO	Pri: pepcase, Sec: RUBISCO
CO_2 acceptor (CO_2 fixⁿ substrate)	only RUBP (5C)	pri: PEP (3C), Sec: RUBP (5C)
CO_2 fixⁿ product	only PGA (3C)	pri: OAA (4C), sec: PGA (3C)
Optimum Temp^r	20-25°C (low)	30-40°C (High)
Photorespiration	• at High light: ✓ • at High CO_2: ✗ • at low light: ✗ • at low CO_2: ✓	⊗

(16) Factors affecting photosynthesis

- **External factors**
  - CO_2
  - Sunlight
  - Temp
  - water

- **Internal factors** ↓ genetic predisposition & plant growth
  - leaf anatomy, size, age, orientation
  - Internal CO_2 conc^n
  - Mesophyll cell & Chloroplast
  - Chlorophyll

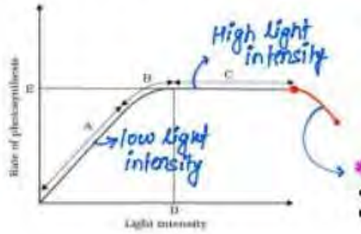
* **Law of limiting factors** : by Blackman in 1905 ↓

When chemical reaction affected by more than one factor, then ROR depend on that factor which nearest to its minimal value (limiting factor)

(a) Light

- Rearly limiting factor, B/C light saturation occur at 10% of sunlight

(exception: Dense forest, deep ocean)



- low light intensity: Rate ∝ incident light (linear)
- High light intensity: Rate = constant (limiting cond^n)

* Further ↑ in light:
- breakdown of chlorophyll
- ↓ Photosynthesis

(b) CO_2

- major limiting factor
- CO_2 conc^n :

present availability CO_2

0.02% (300 µl/L) — 0.04% (400 µl/L) — 0.05% (500 µl/L)

Inc. CO_2 conc^n upto 0.05% cause inc. in photosynthesis

but after 0.05% ↓ damaging effect ⚠

360 µl/L → C_4 plant saturation

beyond 450 µl/L → C_3 plant saturation

current availability of CO_2 limiting for C_3-plant

* At low light intensity → neither group respond to high CO_2. (light become limiting)

* At high light intensity → both C_3 & C_4 show ina. in photosynthesis (but upto their saturation point)

∵ C_3 plant respond to high CO_2 conc^n } AIR
∴ photosynthesis ↑ & productivity ↑ }

* C_3 plant → green house crops (B/C CO_2: green house gas) ↓

eg: Tomatoes, bell pepper.

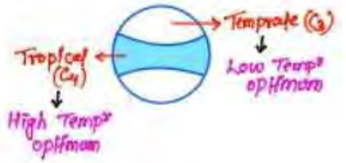
(c) Temperature

- directly affect enzymatic activity
- Dark reaction (calvin cycle) : ∵ Enzymatic
  ∴ Temp^{r} controlled
- light reaction : Temp^{r} sensitive (lesser extent)

* C_3-plant
↓
Respond to low Temp^{r}
∴ low Temp^{r} optimum
≈ 20-25°C

C_4-plant
↓
Respond to High Temp^{r}
∴ High Temp^{r} optimum
≈ 30-40°C

* optimum Temp^{r}
- max^{m} productivity
- different for different plant (C_3, C_4)
- Also depend on plant habitat



(d) Water

- Rearly limiting (B/C plant utilize less than 1% of absorbed water)

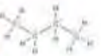
* water stress (deficiency of water)
→ Stomata close → CO_2 conc^{n} ↓ → photosynthesis ↓
→ Leaf wilting → • Surface area of leaf ↓ → photosynthesis ↓
• metabolic activity ↓

RESPIRATION IN FLOWERING PLANTS

① Some imp points

- Green plants & cyanobacteria → photosynthesis (light energy → chemical energy)
- Heterotrophs → Herbivores (directly depend on plants)
  → Carnivores (indirectly depend on plants)
- Saprophytes (Fungi) → depend on dead & decaying matter

* During Respiration → carbon skeleton produced → used as precursors for biosynthesis



- Cellular Respiration → breaking of C-C bond of complex compounds via oxidation & release energy

Respiratory Substrate
- Generally carbs
- protein, fats, organic acids (in certain cond^n)

→ all energy not realeased free to cell or in single step
→ it released in series of slow stepwise reaction
→ it is controlled by enzymes.
* It trapped as chemical energy in the form of ATP → Energy currency of cell

② Do plant breath ?

- plants not have specilised organ but have Stomata & lenticels.

Q: why plants live without respiratory organs ?

⇒ First, each plant part takes care of its own gas-exchange needs. There is very little transport of gases from one plant part to another. Second, plants do not present great demands for gas exchange. Roots, stems and leaves respire at rates far lower than animals do. Only during photosynthesis are large volumes of gases exchanged

Third, the distance that gases must diffuse even in large, bulky plants is not great. Each living cell in a plant is located quite close to the surface of the plant. → leaves

In stems, the 'living' cells are organised in thin layers inside and beneath the bark. They also have openings called lenticels. The cells in the interior are dead and provide only mechanical support. Thus, most cells of a plant have at least a part of their surface in contact with air. This is also facilitated by the loose packing of parenchyma cells in leaves, stems and roots, which provide an interconnected network of air spaces. → thick woody stems

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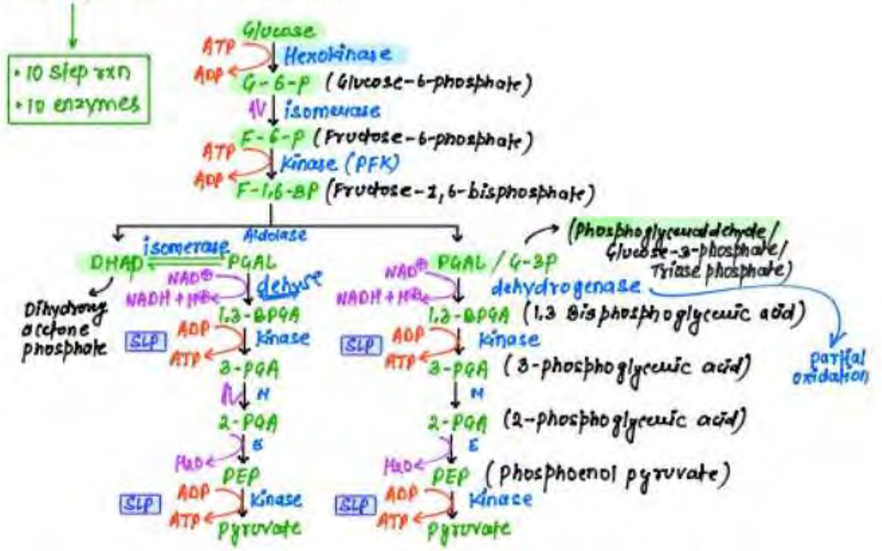
★ The complete combustion of glucose, which produces CO_2 and H_2O as end products, yields energy most of which is given out as heat.

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

not all the liberated energy goes out as heat. The key is to oxidise glucose not in one step but in several small steps enabling some steps to be just large enough such that the energy released can be coupled to ATP

③ Glycolysis (breakdown of Glucose)

- 10 step rxn
- 10 enzymes



④ Imp points of Glycolysis

- In both Aerobic & Anaerobic organism
  { In anaerobs: it is only process Respiration }
- occur in cytoplasm/cytosol
- common respiratory pathway in all organism
- Balance sheet

Input	Output	∴ Net gain
• 1 Glucose	• 2 pyruvate	• 2 pyruvate
• 2 ATP	• 4 ATP (SLP)	• 2 ATP (SLP)
• 2 NAD^+	• 2 $NADH + H^+$	• 2 $NADH + H^+$
	• $2H_2O$	• $2H_2O$

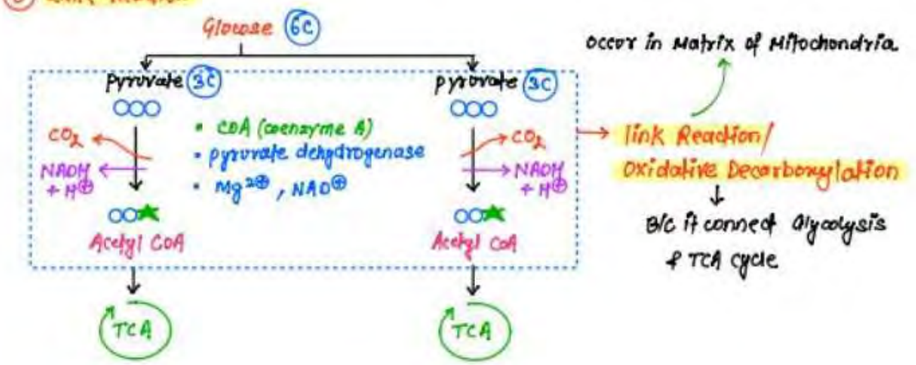
- Discovered by:
  → Embden, Meyerhof & Parnes
  ∴ called ENP pathway
- Sucrose —invertase→ Glucose + Fructose
- Reversible: ⑦ step (eg: DHAP ⟺ PGAL)
- Irreversible: ③ step (HK, PFK, PK)
  PFK → chief regulator/pacemaker
- End product of photosynthesis
  Fructose + Glucose —invertase→ SUCROSE —partial oxidation (Glycolysis)→ pyuvic acid (Key product of Glycolysis)

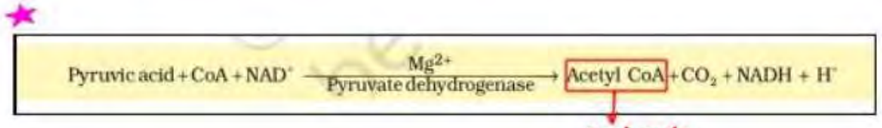
⑤ Fate of pyruvate

1 Glucose → 2 pyruvate

- **Anaerobic Respiration** → Fermentation
  - → lactic Acid Fermentation
  - → Alcoholic Fermentation
- **Aerobic Respiration** → O_2 → Mitochondrial Matrix
  - Link Reaction / Oxd^n Decar^x
  - Kreb cycle

(6) Link Reaction





(7) Aerobic Respiration

For aerobic respiration to take place within the mitochondria, the final product of glycolysis, pyruvate is transported from the cytoplasm into the mitochondria. The crucial events in aerobic respiration are:

- The complete oxidation of pyruvate by the stepwise removal of all the hydrogen atoms, leaving three molecules of CO_2. (one cycle)
- The passing on of the electrons removed as part of the hydrogen atoms to molecular O_2 with simultaneous synthesis of ATP.

• Link Rxn
• Kreb cycle
• ETS
H^+, e^-

What is interesting to note is that the first process takes place in the matrix of the mitochondria while the second process is located on the inner membrane of the mitochondria.

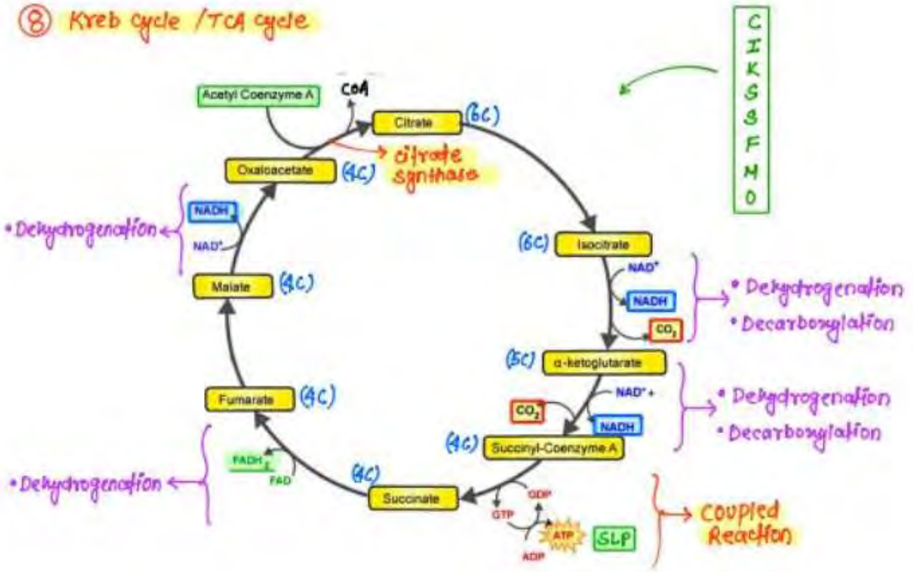
Pyruvate, which is formed by the glycolytic catabolism of carbohydrates in the cytosol, after it enters mitochondrial matrix undergoes oxidative decarboxylation by a complex set of reactions catalysed by pyruvic dehydrogenase. The reactions catalysed by pyruvic dehydrogenase require the participation of several coenzymes, including NAD^+ and Coenzyme A.

$$\text{Pyruvic acid} + \text{CoA} + NAD^+ \xrightarrow[\text{Pyruvate dehydrogenase}]{Mg^{2+}} \text{Acetyl CoA} + CO_2 + \text{NADH} + H^+$$

During this process, two molecules of NADH are produced from the metabolism of two molecules of pyruvic acid (produced from one glucose molecule during glycolysis).

The acetyl CoA then enters a cyclic pathway, tricarboxylic acid cycle, more commonly called as Krebs' cycle after the scientist Hans Krebs who first elucidated it.

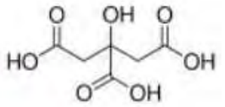
(8) Kreb cycle / TCA cycle



(9) Imp points of Kreb cycle

- Discovered by Hans Kreb
- occur in Matrix of Mitochondria
- Kreb cycle also called ⟶ TCA cycle, citric Acid cycle
- 8th Step Reaction
- Net gain: (each cycle) 3NADH, 1$FADH_2$, 2 CO_2, 1ATP (SLP)

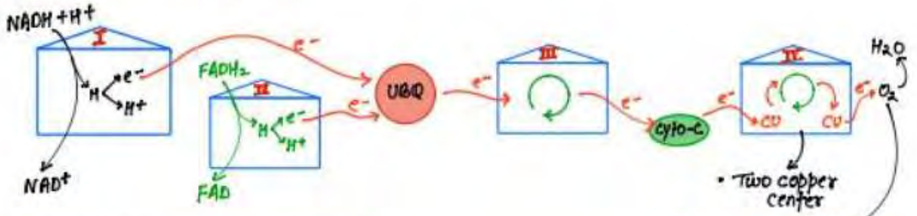
* 1st step: OAA + A-CoA + H_2O $\xrightarrow[\text{synthase}]{\text{citrate}}$ citric Acid (3-carb-acid)



(10) Balance sheet (from 1-Glucose)

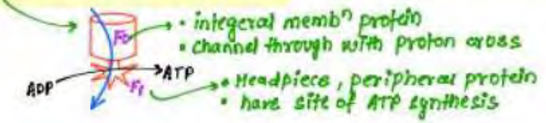
	ATP	NADH	$FADH_2$	CO_2
Glycolysis (cytoplasm)	2	2	0	0
Link Reaction (Matrix)	0	2	0	2
Kreb cycle (Matrix)	2	6	2	4
(SLP)	4ATP	10 NADH	2 $FADH_2$	6 CO_2

(11) Electron transport system

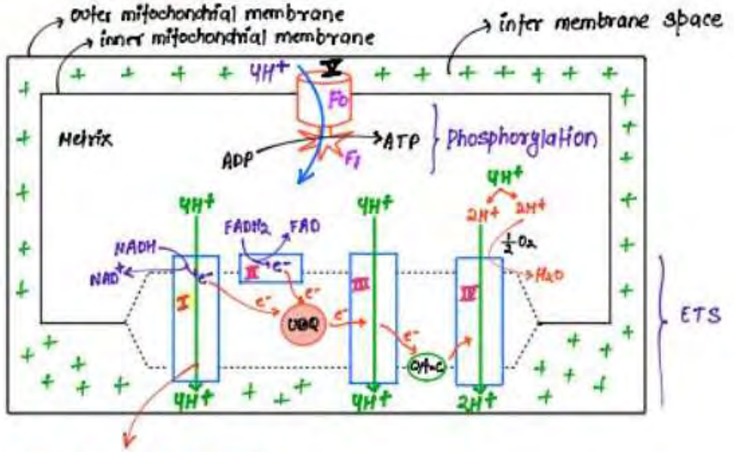


* • Complex-I: NADH Dehydrogenase
  • complex-II: Succinate Dehydrogenase
  • UBQ: UBIQUINONE
  • Complex-III: Cytochrome-bc1
  • Complex-IV: Cytochrome a & a3
  • Cyto-C: Cytochrome-C
  • complex-V: ATP synthase → Fo, F1

* • Intrinsic protein: I/III/IV/Fo
  • extrinsic protein: II/cyto-c/F1
  • mobile carrier: UBQ/cyto-C
  • Non-protein part: UBQ



(12) Oxidative phosphorylation



• Active pumping of H^+ from matrix to inter membrane space
• $4H^+$ required for each ATP production

(18) Mechanism:

- Due to flow of e^- from complex-I to complex-IV
  - These complex will energies & start pumping $H^{\oplus}$ ions from Matrix to inter membrane space of mitochondria
  - ∴ Accumulation of $H^{\oplus}$ ion in inter membrane space
  - $4H^+$ ions moving from 'F_0' of complex-V
  - induce conformational changes in F_1
  - ATP synthesis

★ ATP After ETS

Net gain: 4 ATP + 10 NADH + 2 $FADH_2$ (From Glucose)

30 ATP ← ETS → 4 ATP

∴ Total ATP = 4 ATP (SLP) + 34 ATP (OP) (ETS) = **38 ATP**

★ 1 NADH = 3 ATP
1 $FADH_2$ = 2 ATP

(19) Fermentation

lactic acid ← O_2 ↓ (muscle) pyruvate → (lower organism: yeast, bacteria) Alcohol

lactic acid fermentation

- Glucose → 2 pyruvate (2 ATP, 2 NADH) —LAD→ lactic acid (NAD^+)
- muscles / RBC
- CO_2 Not formed (Decarboxylation ⊗)

Alcoholic fermentation

- Glucose → 2 pyruvate (2 ATP, 2 NADH) —PDC + AD→ 2 Alcohol + CO_2 (NAD^+)
- lower organism (yeast, Bacteria)

* Max^{m} conc^{n} of alcohol reaches to 13%, after that yeast will suicide due to lack of Nutrients & accumulation of toxins

lactic acid fermentation	Alcoholic fermentation
• Cytosol	• Cytosol
• incomplete oxidation	• incomplete oxidation
• Net Gain = 2 ATP	• Net Gain = 2 ATP → • 2 ATP: (from glucose) • 0 ATP: (from pyruvate)
• NADH → slowly break	• NADH → slowly break
• less than (7%) energy released	• less than (7%) energy released
• Lactate dehydrogenase	• Pyruvic acid decarboxylase + Alcoholic dehydrogenase

(15) Aerobic Respiration v/s Fermentation

- complete oxidation
- Net gain = 38 ATP
- NADH Breakdown → vigrously

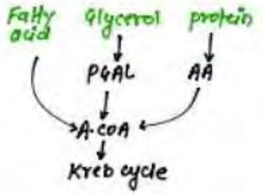
- Incomplete oxidation
- Net gain = 2 ATP (from glucose)
- NADH Breakdown → slowly

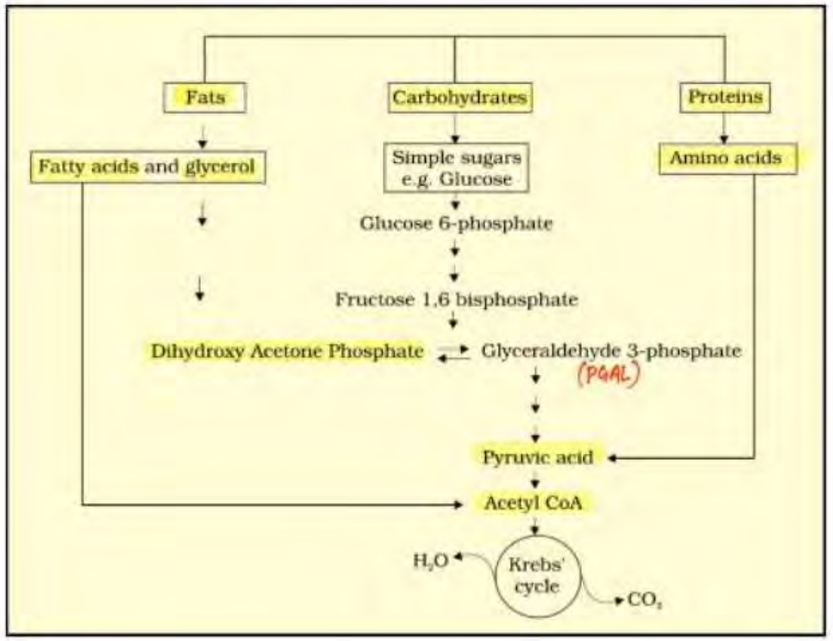
(16) Amphibolic pathway

Breakdown of different organic molecule

Glucose is the favoured substrate for respiration. All carbohydrates are usually first converted into glucose before they are used for respiration. Other substrates can also be respired, as has been mentioned earlier, but then they do not enter the respiratory pathway at the first step.

Fats would need to be broken down into glycerol and fatty acids first. If fatty acids were to be respired they would first be degraded to acetyl CoA and enter the pathway. Glycerol would enter the pathway after being converted to PGAL. The proteins would be degraded by proteases and the individual amino acids (after deamination) depending on their structure would enter the pathway at some stage within the Krebs' cycle or even as pyruvate or acetyl CoA.





(17) Respiratory pathway → Amphibolic pathway → catabolism + Anabolism

Since respiration involves breakdown of substrates, the respiratory process has traditionally been considered a catabolic process and the respiratory pathway as a catabolic pathway. But is this understanding correct? We have discussed above, at which points in the respiratory pathway different substrates would enter if they were to be respired and used to derive energy. What is important to recognise is that it is these very compounds that would be withdrawn from the respiratory pathway for the synthesis of the said substrates. Hence, fatty acids would be broken down to acetyl CoA before entering the respiratory pathway when it is used as a substrate. But when the organism needs to synthesise fatty acids, acetyl CoA would be withdrawn from the respiratory pathway for it. Hence, the respiratory pathway comes into the picture both during breakdown and synthesis of fatty acids. Similarly, during breakdown and synthesis of protein too, respiratory intermediates form the link. Breaking down processes within the living organism is catabolism, and synthesis is anabolism. Because the respiratory pathway is involved in both anabolism and catabolism, it would hence be better to consider the respiratory pathway as an **amphibolic pathway** rather than as a catabolic one.

N/R

(18) Respiratory Quotient (RQ)

$$RQ = \frac{\text{volume of } CO_2 \text{ evolved}}{\text{volume of } O_2 \text{ consumed}}$$ → output gas, → input gas

$$RQ = \frac{CO_2}{O_2}$$

- Carbohydrates: RQ = 1

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

$$RQ = \frac{6CO_2}{6O_2} = 1.0$$

- Proteins: RQ = 0.9
- Fats: RQ = 0.7 (Tripalmitin)

$$2(C_{51}H_{98}O_6) + 145O_2 \longrightarrow 102CO_2 + 98H_2O + \text{energy}$$

Tripalmitin

$$RQ = \frac{102CO_2}{145O_2} = 0.7$$

- Alcoholic fermentation: $RQ = \frac{CO_2}{0} = \infty$

* In living organism Respiratory substrate > 1
* pure protein & pure fats → Never used as respiratory substrate

Question

Among eukaryotes, replication of DNA takes place in (2023)

A G_2 phase

B M phase

C S phase

D G_1 phase

Question

Given below are two statements: (2023)
Statement I: During Go phase of cell cycle the cell is metabolically inactive.
Statement II: The centrosome undergoes duplication during S phase of interphase.
In the light of the above statements, choose the most appropriate answer from the option below:

A. Statement I is incorrect but Statement II is correct

B. Both Statement I and Statement II are correct

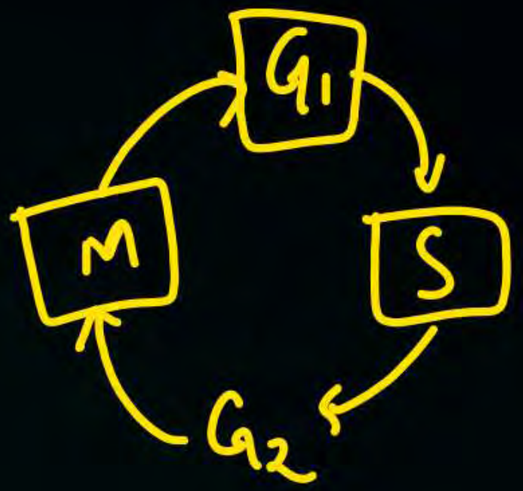
C. Both Statement I and Statement II are incorrect.

D. Statement I is correct but Statement II is incorrect.

Question

Match List-I with List-II (2023)

List-I		List-II	
(A)	M Phase iv	(I)	Proteins are synthesized
(B)	G_2 Phase i	(II)	Inactive phase
(C)	Quiescent stage ii	(III)	Interval between mitosis and initiation of DNA replication
(D)	G_1 Phase iii	(IV)	Equational division



Choose the correct answer from the options given below:

(A) A-II, B-IV, C-I, D-III

(B) A-III, B-II, C-IV, D-I

(C) A-IV, B-II, C-I, D-III

(D) A-IV, B-I, C-II, D-III ✓

Question

Which one of the following is the quiescent stage of cell cycle? [redacted]

A M

B G_2

C G_1

D G_0

Question

The fruit fly has 8 chromosomes (2n) in each cell. During interphase of Mitosis if the number of chromosomes at G_1 phase is 8, what would be the number of chromosomes after S phase? (2021)

A. 16

B. 4

C. 32

D. 8 ✓

2n = 8

Amt of DNA

$G_1 = 8 \rightarrow 10$ pg

$S = 8 \rightarrow 20$ pg

$G_2 = 8$? $\rightarrow 20$ pg

Question

The centriole undergoes duplication during: (2021)

A Prophase

B Metaphase

C G2 phase

D S-phase

Question

Identify the correct statement with regard to G1 phase (Gap 1) of interphase. (2020)

A. Reorganisation of all cell components takes place.

B. Cell is metabolically active, grows but does not replicate its DNA.

C. Nuclear division takes place.

D. DNA synthesis or replication takes place.

Question

Match the following events that occur in their respective phases of cell cycle and

1.	G_1 phase	(i)	Cell grows and organelle duplication
2.	S phase	(ii)	DNA replication and chromosome duplication
3.	G_2 phase	(iii)	Cytoplasmic growth
4.	Metaphase in M-phase	(iv)	Alignment of chromosomes

select the correct option: (2020-Covid)

A 1-(iii) 2-(iv) 3-(i) 4-(ii)

B 1-(iv) 2-(i) 3-(ii) 4-(iii)

C 1-(i) 2-(ii) 3-(iii) 4-(iv)

D 1-(ii) 2-(iii) 3-(iv) 4-(i)

Question

The correct sequence of phases of cell cycle is (2019)

A $M \rightarrow G_1 \rightarrow G_2 \rightarrow S$

B $G_1 \rightarrow G_2 \rightarrow S \rightarrow M$

C $S \rightarrow G_1 \rightarrow G_2 \rightarrow M$

D $G_1 \rightarrow S \rightarrow G_2 \rightarrow M$

Question

Cell in G0 phase

A Exit the cell cycle

B Enter the cell cycle

C Suspend the cell cycle

D Terminate the cell cycle

Question

DNA replication in bacteria occurs: (2017-Delhi)

A. During S-phase - ev'

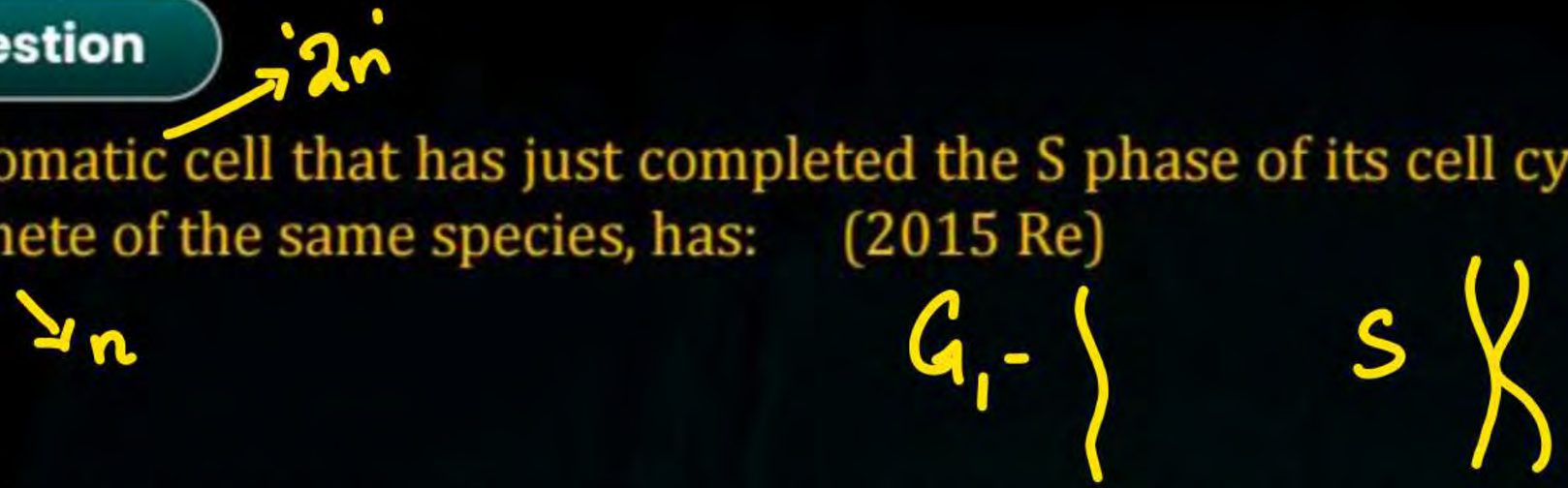
B. Within nucleolus

C. Prior to fission

D. Just before transcription

Question

A somatic cell that has just completed the S phase of its cell cycle, as compared to gamete of the same species, has: (2015 Re)



A. Twice the number of chromosomes and four times the amount of DNA

B. Four times the number of chromosomes and twice the amount of DNA

C. Twice the number of chromosomes and twice the amount of DNA

D. Same number of chromosomes but twice the amount of DNA

Question

During which phase(s) of cell cycle, amount of DNA in a cell remains at 4C level if the initial amount is denoted as 2C? (2014)

A G_2 and M

B G_0 and G_1

C G_1 and S

D Only G_2

Question

In 'S' phase of the cell cycle: (2014)

A Amount of DNA is reduced to half in each cell

B Amount of DNA doubles in each cell

C Amount of DNA remains same in each cell

D Chromosome number is increased

Question

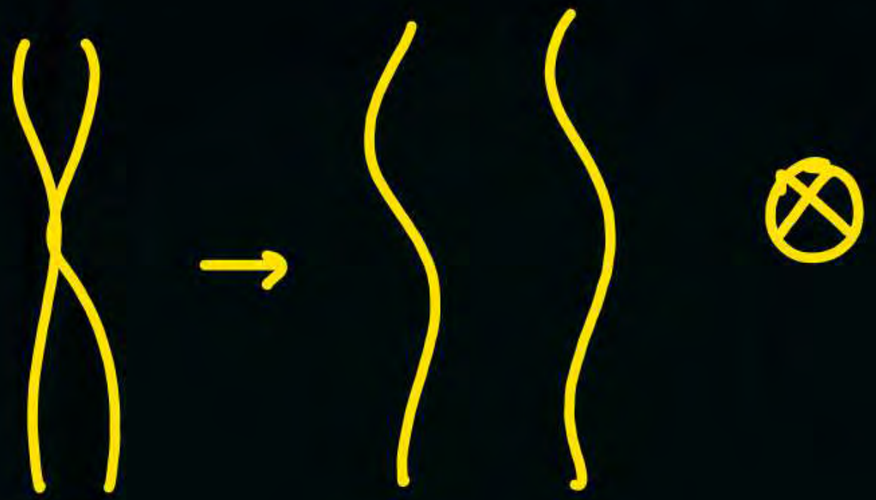
Doubling of the number of chromosomes can be achieved by disrupting mitotic cell division soon after:

A Anaphase

B Telophase

C Prophase

D Metaphase



Question

With respect to metaphase, which of the following statements is incorrect? (2022 Re)

NOT CORRECT

A. Chromosomes lie at the equator of the cell

B. Complete disintegration of nuclear envelope takes place

C. Chromosomes are highly condensed

D. Metaphase chromosomes are made up of four sister chromatids held together by centromere

Question

Which one of the following never occurs during mitotic cell division? (2022)

A Coiling and condensation of the chromatids

B Spindle fibres attach to kinetochores of chromosomes

C Movement of centrioles towards opposite poles

D Pairing of homologous chromosomes

Question

Select the incorrect statement with reference to mitosis: (2022)

A. Splitting of centromere occurs at anaphase.

B. All the chromosomes lie at the equator at metaphase.

C. Spindle fibres attach to centromere of chromosomes.

D. Chromosomes decondense at telophase.

Question

In a mitotic cycle, the correct sequence of phases is (2020-Covid)

A G_1, S, G_2, M

B M, G_1, G_2, S

C G_1, G_2, S, M

D S, G_1, G_2, M

Question

Attachment of spindle fibers to kinetochores of chromosomes becomes evident in: (2020-Covid)

A Telophase

B Prophase

C Metaphase

D Anaphase

Question

Which of the following options gives the correct sequence of events during mitosis?

A. Condensation → Nuclear membrane disassembly →Crossing over → Segregation → Telophase

B. Condensation → Nuclear membrane disassembly →Arrangement at equator → Centromere division →Segregation → Telophase

C. Condensation → Crossing over → Nuclear membrane disassembly → Segregation → Telophase

D. Condensation → Arrangement at equator → Centromere division → Segregation → Telophase

Question

Which of the following is not a characteristic feature during mitosis in somatic cells? (2016 - I)

A Spindle fibres

B Disappearance of nucleolus

C Chromosome movement

D Synapsis

Question

Spindle fibres attach on to: (2016 - I)

A Telomere of the chromosome

B Kinetochore of the chromosome

C Centromere of the chromosome

D Kinetosome of the chromosome

Question

A cell at telophase stage is observed by a student in a plant brought from the field. He tells his teacher that this cell is not like other cells at telophase stage. There is no formation of cell plate and thus the cell is containing more number of chromosomes as compared to other dividing cells. This would result in: (2016 - I)

A Aneuploidy

B Polyploidy

C Somaclonal variation

D Polyteny

Question

A stage in cell division is shown in the figure. Select the answer which gives correct identification of the stage with its characteristics: (2013)

A	Telophase	Endoplasmic reticulum and nucleolus not reformed yet.
B	Telophase	Nuclear envelope reforms, Golgi complex reforms.
C	Late Anaphase	Chromosomes move away from equatorial plate, Golgi complex not present.
D	Cytokinesis	Cell plate formed, mitochondria distributed between two daughter cells.

Question

Which of the following stages of meiosis involves division of centromere? (2023)

A Telophase

B Metaphase I

C Metaphase II

D Anaphase II

Question

The process of appearance of recombination nodules occurs at which sub stage of prophase I in meiosis? (2023)

A Diakinesis

B Pachytene

C Zygotene

D Diplotene

Question

Select the correct statements. (2023)

A. Tetrad formation is seen during leptotene.

B. During Anaphase, the centromere split and chromatids separate.

C. Terminalization takes place during Pachytene.

D. Nucleolus, Golgi complex and ER are reformed during Telophase.

E. Crossing over takes place between sister chromatids of homologous chromosome

Choose the correct answer from the option given below:

(A) B and E only

(B) A and C only

(C) B and D only

(D) A, C and E only

Question

The dissolution of synaptonemal complex occurs during: (2023-Manipur)

A Pachytene

B Diplotene

C Diakinesis

D Leptotene

Question

During which stages of mitosis and meiosis, respectively does the centromere of each chromosome split? (2023-Manipur)

Ana. Ana-II

A. Metaphase, Metaphase II

B. Prophase, Telophase I

C. Telophase, Anaphase I

D. Anaphase, Anaphase II

Question

Select correct sequence of substages of Prophase-I of Meiotic division:
(2023-Manipur)
(A) Zygotene
(B) Pachytene
(C) Diakinesis
(D) Leptotene
(E) Diplotene
Choose the correct answer from the options given below:

A (D), (B), (A), (E), (C)

B (A), (B), (D), (E), (C)

C (D), (A), (B), (E), (C)

D (A), (D), (B), (C), (E)

Question

Which stage of meiosis can last for months or years in the oocytes of some vertebrates? (2022 Re)

A Diakinesis

B Leptotene

C Pachytene

D Diplotene

Question

In meiosis, crossing over and exchange of material between homologous chromosomes catalyzed by the enzyme: (2022 Re)

A Polymerase

B Phosphorylase

C Recombinase

D Transferase

Question

Identify the correct sequence of events during Prophase I of meiosis: (2022 Re)

A. Synapsis of homologous chromosomes - Zy
B. Chromosomes become gradually visible under microscope - Le
C. Crossing over between non-sister chromatids of homologous chromosomes - Pa
D. Terminalisation of chiasmata - Dia
E. Dissolution of synaptonemal complex - Di

Choose the correct answer from the options given below:

A (A), (C), (D), (E), (B)

B (A), (B), (C), (D), (E)

C (B), (C), (D), (E), (A)

D (B), (A), (C), (E), (D) ✓

Question

Bivalent or Tetrad formation is a characteristic feature observed during: (2022 Re)

A Chiasmata in zygotene stage

B Synaptonemal complex in zygotene stage

C Chiasmata in diplotene stage

D Synaptonemal complex in pachytene stage

Question

The appearance of recombination nodules on homologous chromosomes during meiosis characterizes (2022)

A Terminalization

B Synaptonemal complex

C Bivalent

D Sites at which crossing over occurs

Question

Regarding Meiosis, which of the statements is incorrect? (2022)

A. Four haploid cells are formed at the end of Meiosis-II

B. There are two stages in Meiosis, Meiosis-I and II

C. DNA replication occurs in S phase of Meiosis-II

D. Pairing of homologous chromosomes and recombination occurs in Meiosis-I

Question

Which stage of meiotic prophase shows terminalisation of chiasmata as its distinctive feature? (2021)

A Zygotene

B Diakinesis

C Pachytene

D Leptotene

Question

Which of the following stages of meiosis involves division of centromere? (2021)

A Metaphase II

B Anaphase II

C Telophase II

D Metaphase I

Question

Match the following with respect to meiosis: (2020)

	Column-I		Column-II
1.	Zygotene	(i)	Terminalization
2.	Pachytene	(ii)	Chiasmata
3.	Diplotene	(iii)	Crossing over
4.	Diakinesis	(iv)	Synapsis

Select the correct option from the following:

(1) (2) (3) (4)

A (iv) (iii) (ii) (i)

B (i) (ii) (iv) (iii)

C (ii) (iv) (iii) (i)

D (iii) (iv) (i) (ii)

Question

Dissolution of the synaptonemal complex occurs during: (2020)

A Zygotene

B Diplotene

C Leptotene

D Pachytene

Question

During Meiosis I, in which stage synapsis takes place? (2020-Covid)

A Zygotene

B Diplotene

C Leptotene

D Pachytene

Question

The stage during which separation of the paired homologous chromosomes begins is (2018)

A Pachytene

B Diplotene

C Diakinesis

D Zygotene

Question

Match the stages of meiosis in Column–I to their characteristic features in Column–II and select the correct option using the codes given below: (2016 - II)

	Column I		Column II
A.	Pachytene	i.	Pairing of homologous chromosomes
B.	Metaphase-I	ii.	Terminalisation of chiasmata
C.	Diakinesis	iii.	Crossing over takes place
D.	Zygotene	iv.	Chromosomes align at equatorial plate

Codes:

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

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

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

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

Question

In meiosis, crossing over is initiated at: (2016 - I)

A Pachytene

B Leptotene

C Zygotene

D Diplotene

Question

Select the correct option: (2015)

	Column-I		Column-II
A.	Synapsis aligns the homologous chromosomes	i.	Anaphase-II
B.	Synthesis of RNA and protein	ii.	Zygotene
C.	Action of enzyme recombinase	iii.	G_2-phase
D.	Centromeres do not separate but chromatids move towards opposite poles	iv.	Anaphase-I
		v.	Pachytene

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

(B) A-ii B-iii C-iv D-v

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

(D) A-ii B-iii C-v D-iv

Question

Arrange the following events of meiosis in correct sequence: (2015 Re)

A. Crossing over
B. Synapsis
C. Terminalisation of chiasmata
D. Disappearance of nucleolus

A (B), (A), (C), (D)

B (A), (B), (C), (D)

C (B), (C), (D), (A)

D (B), (A), (D), (C)

Question

The enzyme recombinase is required at which stage of meiosis? (2014)

A Diakinesis

B Pachytene

C Zygotene

D Diplotene

Question

The complex formed by a pair of synapsed homologous chromosomes is called: (2013)

A. Axoneme

B. Equatorial plate

C. Kinetochores

D. Bivalent

Question

Spindle fibers attach to kinetochores of chromosomes during (2024)

A Anaphase

B Telophase

C Prophase

D Metaphase

Question

Given below are two statements:

Statement I: Chromosomes become gradually visible under light microscope during leptotene stage.

Statement II: The beginning of diplotene stage is recognized by dissolution of synaptonemal complex.

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

A. Statement I is true but Statement II is false

B. Statement I is false but Statement II is true

C. Both Statement I and Statement II are true

D. Both Statement I and Statement II are false

Question

Anoxygenic photosynthesis is characteristic of: [2014]

A *Ulva*

B *Rhodospirillum*

C *Spirogyra*

D *Chlamydomonas*

Question

Match List-I with List-II.

List-I	List-II
A. Chlorophyll a	I. Yellow to yellow orange
B. Chlorophyll b	II. Yellow green
C. Xanthophyll	III. Blue green
D. Carotenoid	IV. Yellow

Choose the correct answer from the options given below:

(A) A-III, B-II, C-IV, D-I

(B) A-III, B-I, C-IV, D-II

(C) A-II, B-III, C-I, D-IV

(D) A-IV, B-III, C-II, D-I

Question

Which of the following statements is incorrect? [2021]

A. Stroma lamellae have PS I only and lack NADP reductase.

B. Grana lamellae have both PS I and PS II.

C. Cyclic photophosphorylation involves both PS I and PS II.

D. Both ATP and NADPH + H^+ are synthesized during non-cyclic photophosphorylation.

Question

In a chloroplast the highest number of protons are found in:

A. Stroma

B. Lumen of thylakoid

C. Inter membranal space

D. Antennae complex

Question

Water soluble pigments found in plant cell vacuoles are: [2016 – I]

A Xanthophylls

B Chlorophylls

C Carotenoids

D Anthocyanins

Question

In photosynthesis, the light-independent reactions take place at: [2015 Re]

A. Photosystem-I

B. Photosystem-II

C. Stromal matrix

D. Thylakoid lumen

Question

The reaction centre in PS II has an absorption maxima at [2023]

A 780 nm

B 680 nm

C 700 nm

D 660 nm

Question

Which of the following combinations is required for chemiosmosis? [2023]

A. Proton pump, electron gradient, NADP synthase

B. Membrane, proton pump, proton gradient, ATP synthase

C. Membrane, proton pump, proton gradient, NADP synthase

D. Proton pump, electron gradient, ATP synthase

Question

Which out of the following statements is incorrect? [2023-Manipur]

A. Grana lamellae have both PS I and PS II

B. Cyclic photophosphorylation involves both PS I and PS II

C. Both ATP and NADPH + H^+ are synthesised during non-cyclic photophosphorylation

D. Stroma lamellae lack PS II and NADP reductase

Question

Identify the correct statements regarding chemiosmotic hypothesis [2022 Re]

A. Splitting of the water molecule takes place on the inner side of the membrane.
B. Protons accumulate within the lumen of the thylakoids.
C. Primary acceptor of electron transfers the electrons to an electron carrier.
D. NADP reductase enzyme is located on the stroma side of the membrane.
E. Protons increase in number in stroma.

Choose the correct answer from the options given below:

(A) (B), (C) and (E)

(B) (A), (B) and (E)

(C) (A), (B) and (D)

(D) (B), (C) and (D)

Question

Which one of the following is not true regarding the release of energy during ATP synthesis through chemiosmosis? It involves: [2022]

A. Reduction of NADP to $NADPH_2$ on the stroma side of the membrane

B. Breakdown of proton gradient

C. Breakdown of electron gradient

D. Movement of protons across the membrane to the stroma

Question

In light reaction, plastoquinone facilitates the transfer of electrons from: [2020]

A. $Cytb_6f$ complex to PS-I

B. PS-I to $NADP^+$

C. PS-I to ATP synthase

D. PS-II to $Cytb_6f$ complex

Question

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

A Water

B Carbon dioxide

C Light

D Oxygen

Question

How many ATP and NADPH, are required for the synthesis of one molecule of Glucose during Calvin cycle? [2023]

A. 18 ATP and 16 $NADPH_2$

B. 12 ATP and 12 $NADPH_2$

C. 18 ATP and 12 $NADPH_2$

D. 12 ATP and 16 $NADPH_2$

Question

When one CO_2 molecule is fixed as one molecule of triose phosphate, which of the following photochemically made, high energy chemical intermediates are used in the reduction phase? [2022 Re]

ATP . $NADPH_2$

(A) 2 ATP + 2 NADPH

(B) 1 ATP + 1 NADPH

(C) 1 ATP + 2 NADPH

(D) 2 ATP + 1 NADPH

Question

Which of the following is not a product of light reaction of photosynthesis? [2018]

A ATP

B NADH

C NADPH

D Oxygen

Question

Given below are two statements: [2023-Manipur]
Statement I: RuBisCO is the most abundant enzyme in the world.
Statement II: Photorespiration does not occur in C_4 plants.
In the light of the above statements, choose the most appropriate answer from the options given below:

(A) Statement I is correct but Statement II is incorrect

(B) Statement I is incorrect but Statement II is correct

(C) Both Statement I and Statement II are correct

(D) Both Statement I and Statement II are incorrect

Question

What is the role of large bundle sheath cells found around the vascular bundles in C_4 plants? [2022]

A. To protect the vascular tissue from high light intensity

B. To provide the site for photorespiratory pathway

C. To increase the number of chloroplast for the operation of Calvin cycle

D. To enable the plant to tolerate high temperature

Question

Given below are two statements: [2022]

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 C4 plants lack RuBisCO enzyme.

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

A. Statement I is incorrect but Statement II is correct

B. Both Statement I and Statement II are correct

C. Both statement I and statement II are incorrect

D. Statement I is correct but Statement II is incorrect

Question

The first stable product of CO_2 fixation in Sorghum is: [2021]

'C_4'

(A) Oxaloacetic acid ✓

(B) Succinic acid

(C) Phosphoglyceric acid

(D) Pyruvic acid

Question

The oxygenation activity of RuBisCO enzyme in photorespiration leads to the formation of: [2020]

A. 1 molecule of 3-C compound

B. 1 molecule of 6-C compound

C. 1 molecule of 4-C compound and 1 molecule of 2-C compound

D. 2 molecules of 3-C compound

Question

Which of the following statements is incorrect? [2020-Covid]

A. In C_4 plants, the site of RuBisCO activity is mesophyll cell

B. The substrate molecule for RuBisCO activity is a 5-carbon compound

C. RuBisCO action requires ATP and NADPH

D. RuBisCO is a bifunctional enzyme

Question

Phosphoenol pyruvate (PEP) is the primary CO_2 acceptor in:

A. C_3 plants

B. C_4 plants

C. C_2 plants

D. C_3 and C_4 plants

Question

The process which makes major difference between C_3 and C_4 plants is: [2016 – II]

A. Photorespiration

B. Respiration

C. Glycolysis

D. Calvin cycle

Question

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 – I]

A C_3

B C_4

C CAM

D Nitrogen fixer

Question

With reference to factors affecting the rate of photosynthesis, which of the following statements is not correct? [2017-Delhi]

(A) Light saturation for CO_2 fixation occurs at 10% of full sunlight

(B) Increasing atmospheric CO_2 concentration upto 0.05% can enhance CO_2 fixation rate

(C) C_3 plants responds to higher temperatures with enhanced photosynthesis while C_4 plants have much lower temperature optimum

(D) Tomato is a greenhouse crop which can be grown in CO_2 - enriched atmosphere for higher yield

Question

Which of the following are required for the dark reaction of photosynthesis? [2024]

A. Light B. Chlorophyll C. CO_2 D. ATP E. NADPH

Choose the correct answer from the options given below:

(A) C, D and E only

(B) D and E only

(C) A, B and C only

(D) B, C and D only

Question

How many molecules of ATP and NADPH are required for every molecule of CO_2 fixed in the Calvin cycle? [2024]

A. 3 molecules of ATP and 3 molecules of NADPH

B. 3 molecules of ATP and 2 molecules of NADPH

C. 2 molecules of ATP and 3 molecules of NADPH

D. 2 molecules of ATP and 2 molecules of NADPH

Question

Given below are two statements:

Statement I: In C_3 plants, some O_2 binds RuBisCO, hence CO_2 fixation is decreased.

Statement II: In C_4 plants, mesophyll cells shows very little photorespiration while bundle sheath cells do not show photorespiration.

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

(A) Statement I is true but Statement II is false

(B) Statement I is false but Statement II is true

(C) Both Statement I and Statement II are true

(D) Both Statement I and Statement II are false

Thank You