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BIO · BIOLOGY

04. Bioenergetics

Official PMDC Solved Past Paper Topical Booklet · High-Yield Examination Series

67 Solved Questions

2022 to 2024 Archive

Boards: BUMHS, DUHS, KMU, NUMS, SZABMU, UHS

Weightage: 34% of MDCAT (68 MCQs)

Curated by Ibrahim for fellow bees. Every question in this chapter has been verified against official UHS, NUMS, SZABMU, DUHS, and KMU answer keys. Propolis cognitive autopsies are provided at the end of this booklet to explain core concepts and break down common distractor traps.

OFFICIAL SOLVED EDITION**Q1.**

KMU 2024

The process of ATP synthesis through a combination of electrochemical and osmotic events is known as: **[KMU-2024]**

- (A) Fermentation
- (B) Glycolysis
- (C) Oxidative phosphorylation
- (D) Oxidation of pyruvate to acetyl CoA

Q2.

SZABMU 2024

Which of the following receives electrons from $FADH_2$ during oxidative phosphorylation in cristae of mitochondria? **[SZABMU-2024]**

- (A) Cytochrome a
- (B) Coenzyme Q
- (C) Cytochrome c
- (D) Cytochrome b

Q3.

SZABMU 2024

What is the product formed at the end of the respiratory chain in inner membrane of mitochondria? **[SZABMU-2024]**

- (A) NADH
- (B) Oxygen
- (C) Water
- (D) Carbon dioxide

Q4.

SZABMU 2024

The type of phosphorylation which involves the transfer of electrons from NADH to Coenzyme Q in the inner mitochondrial membrane is called: **[SZABMU-2024]**

- (A) Cyclic Phosphorylation
- (B) Non-cyclic Phosphorylation
- (C) Oxidative Phosphorylation
- (D) Substrate level Phosphorylation

Q5.

NUMS 2024

Which mechanism would be compromised in the absence of cytochrome complex during light reactions of photosynthesis? **[NUMS-2024]**

- (A) Reduction of reaction center chlorophyll
- (B) Photolysis of water
- (C) Oxidation of primary electron receptor
- (D) Establishment of proton gradient across thylakoid membrane

Q6.

SZABMU 2024

Which of the following steps of glycolysis does **not** involve ATP directly? **[SZABMU-2024]**

- (A) Conversion of Glucose to Glucose 6-phosphate
- (B) Conversion of Fructose 6-phosphate to Fructose 1,6-bisphosphate
- (C) Conversion of Glyceraldehyde 3-phosphate to 1,3-bisphosphoglycerate
- (D) Conversion of 1,3-bisphosphoglycerate to 3-phosphoglycerate

Q7.

NUMS 2024

During glycolysis, isomerization takes place in the form of: [NUMS-2024]

- (A) Dihydroxyacetone phosphate and 2-phosphoglycerate
- (B) G3P and fructose 6-phosphates
- (C) PEP and pyruvate
- (D) Fructose 6-phosphate and 3-phosphoglycerate

Q8.

KMU 2024

The production of energy is _____. [KMU-2024]

- (A) Faster in anaerobic respiration
- (B) Faster in aerobic respiration
- (C) Same in both types of respiration
- (D) Not associated with respiration

Q9.

KMU 2024

The pathway to the breakdown of glucose, carried out by micro-organisms, is called: [KMU-2024]

- (A) Lactic acid fermentation
- (B) Alcoholic fermentation
- (C) Cellular respiration
- (D) None of the above

Q10.

SZABMU 2024

The amount of energy present in bonds of glucose which is converted into ATP during anaerobic respiration is: [SZABMU-2024]

- (A) 2%
- (B) 4%
- (C) 10%
- (D) 36%

Q11.

UHS 2024

Which option is correct about a chlorophyll molecule? [UHS-2024]

- (A) Chemical formula $C_{55}H_{70}O_6N_4Mg$
- (B) Porphyrin ring with nitrogen in centre
- (C) Methyl group on second pyrrole ring
- (D) Aldehyde group on second pyrrole ring

Q12.

UHS 2024

In the journey of electrons from photosystem II to photosystem I plastocyanin is reduced by: [UHS-2024]

- (A) Plastoquinone
- (B) Cytochrome complex
- (C) P700
- (D) Primary electron acceptor of PSI

Q13.

UHS 2024

Enzyme NADP reductase is responsible for: [UHS-2024]

- (A) Reducing $NADP^+$
- (B) Oxidizing $NADP^+$
- (C) Reducing Ferredoxin
- (D) Reducing P700

Q14.

UHS 2024

The PS II during light reactions receives electrons from splitting: [UHS-2024]

- (A) Water
- (B) Plastoquinone
- (C) Plastocyanin
- (D) Ferredoxin

Q15.

UHS 2024

In Calvin cycle CO_2 reacts with RuBP to produce _____. [UHS-2024]

- (A) 3-PGA
- (B) G3P
- (C) 6-Carbon unstable intermediate
- (D) 1,3 bisphosphoglycerate

Q16.

SZABMU 2024

The step of Calvin Cycle during which five molecules of Glyceraldehyde 3-phosphate (G3P) are converted in Ribulose 1,5-Phosphate by utilizing 3 molecules of ATP is: [SZABMU-2024]

- (A) Fixation
- (B) Reduction
- (C) Regeneration
- (D) Phosphorylation

Q17.

SZABMU 2024

Which of the following does **not** take place during cyclic phosphorylation of the light dependent reaction of photosynthesis? [SZABMU-2024]

- (A) ATP synthesis
- (B) Light Absorption
- (C) Photoexcitation of electrons
- (D) Photolysis of water

Q18.

SZABMU 2024

Ubiquinone contains: [SZABMU-2024-Reconduct]

- (A) Iron chloride
- (B) Iron sulphate
- (C) Iron
- (D) Iron Phosphate

Q19.

SZABMU 2024

Chlorophyll and accessory pigments absorb light and transfer the energy, that initiates the light reactions.

What is the order of energy transfer? [SZABMU-2024-Reconduct]

- (A) Chlorophyll b → Carotenoids → Chlorophyll a
- (B) Chlorophyll b → Carotenoids → Chlorophyll b
- (C) Chlorophyll a → Chlorophyll b → Carotenoids
- (D) Carotenoids → Chlorophyll b → Chlorophyll a

Q20.

SZABMU 2024

What is the concentration of CO_2 in air? [SZABMU-2024]

- (A) 0.003–0.004%
- (B) 0.03–0.04%
- (C) 0.0003–0.0004%
- (D) 3–4%

Q21.

SZABMU 2024

What is the efficiency of CO_2 fixation in plants with photorespiration? [SZABMU-2024]

- (A) 20%
- (B) 25%
- (C) 45%
- (D) 75%

Q22.

NUMS 2024

Presence of PEP carboxylase in C_4 plants enable them to avoid photorespiration due to: [NUMS-2024]

- (A) Presence of enzyme in high concentration
- (B) Absence of RuBisCO
- (C) PEP carboxylase being strictly carboxylase
- (D) High yield of enzyme

Q23.

NUMS 2024

Fats and proteins can be used as respiratory fuel.

Which of the following serves as common molecule produced through their catabolism? [NUMS-2024]

- (A) Acetyl CoA
- (B) Pyruvate
- (C) G3P
- (D) Lactate

Q24.

UHS 2023

Which is the main event in electron transport chain? [UHS-2023]

- (A) ATP synthesis
- (B) Decarboxylation
- (C) Substitution
- (D) Isomerisation

Q25.

UHS 2023

Out of 36 ATPs, how many are produced in electron transport chain? [UHS-2023]

- (A) 28
- (B) 30
- (C) 32
- (D) 34

Q26.

UHS 2023

The major enzymes involved in transfer of phosphate group from ATP to Glucose is: [UHS-2023]

- (A) Isomerase
- (B) Dehydrogenase
- (C) Kinase
- (D) Decarboxylase

Q27.

SZABMU 2023

The end product of glycolysis in anaerobic respiration is: [SZABMU-2023]

- (A) Ethanol and Carbon dioxide
- (B) Lactate
- (C) Pyruvate
- (D) Acetyl CoA

Q28.

KMU 2023

The ATP formed in the preparatory phase of glycolysis is (are): [ETEA-2023]

- (A) 1
- (B) 2
- (C) 4
- (D) 0

Q29.

UHS 2023

Which of the following is used in baking? [UHS–2023]

- (A) Aerobic respiration
- (B) Anaerobic respiration
- (C) External respiration
- (D) Internal respiration

Q30.

KMU 2023

In alcoholic fermentation _ ATP molecules are produced from 1 glucose molecule. [ETEA–2023]

- (A) 2
- (B) 18
- (C) 32
- (D) 36

Q31.

KMU 2023

What is the number of carbon atoms in pyruvic acid? [ETEA–2023 Retake]

- (A) 2
- (B) 3
- (C) 4
- (D) 5

Q32.

SZABMU 2023

The final acceptor of both electrons and protons during light reactions of photosynthesis is: [SZABMU–2023]

- (A) PQ
- (B) PC
- (C) Fd
- (D) $NADP^+$

Q33.

NUMS 2023

When light falls on P700, which event is likely to occur? [NUMS–2023]

- (A) It induces photolysis
- (B) Gains hydrogen
- (C) Accept electrons
- (D) It is oxidized

Q34.

SZABMU 2023

The only copper containing protein involved during light reactions of photosynthesis is: [SZABMU–2023]

- (A) Plastoquinone
- (B) Cytochrome
- (C) Ferredoxin
- (D) Plastocyanin

Q35.

SZABMU 2023

End product of Calvin cycle is: [SZABMU–2023]

- (A) 3 phosphoglycerate
- (B) 1–3 bisphosphoglycerate
- (C) Glyceraldehyde 3 phosphate
- (D) Glucose

Q36.

NUMS 2023

Which are the end products of light reactions of photosynthesis? [NUMS–2023]

- (A) ATP and NADPH
- (B) ATP and glucose
- (C) Glucose and NADP
- (D) ATP and water

Q37.

NUMS 2023

Synthesis of ATP during photosynthesis takes place at the region: [NUMS–2023]

- (A) Stroma
- (B) Thylakoid
- (C) Matrix
- (D) Cisternae

Q38.

NUMS 2023

Which of the following molecules are released after completion of light reaction and the utilized in the dark reaction of photosynthesis? [NUMS–2023]

- (A) ATP and $NADP^+$
- (B) ADP and $NADP^+$
- (C) ADP and NADPM
- (D) ATP and NADPH

Q39.

KMU 2023

Light reaction occurs in the _ of chloroplast: [ETEA–2023]

- (A) Outer membrane
- (B) Inner membrane
- (C) Granum
- (D) Stroma

Q40.

KMU 2023

The carotenoids absorb light in the visible spectrum between _ and wavelengths. [ETEA–2023 Retake]

- (A) 400–600nm
- (B) 630–700nm
- (C) 500–600nm
- (D) 400–500nm

Q41.

KMU 2023

In the non-cyclic electron transport of light reaction, the deficit of _ electrons occur in the chlorophyll, as it absorbs energy. [ETEA-2023 Retake]

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

Q42.

NUMS 2022

During photosynthesis, CO_2 works as: [NUMS-2022]

- (A) Proton donor
- (B) Electron donor
- (C) Proton acceptor
- (D) Source of O_2

Q43.

NUMS 2022

In the process of photosynthesis, water acts as: [NUMS-2022]

- (A) Proton acceptor
- (B) Electron donor
- (C) CO_2 reducer
- (D) CO_2 acceptor

Q44.

KMU 2022

The range of visible light is from: [ETEA-2022]

- (A) 300–650 nm
- (B) 350–700 nm
- (C) 380–750 nm
- (D) 430–790 nm

Q45.

KMU 2022

Which scientist among the following hypothesized that plant splits water to release oxygen as by-product? [ETEA-2022]

- (A) Van Neil
- (B) Lysenko
- (C) Calvin
- (D) Krebs

Q46.

BUMHS 2022

Maximum photosynthesis occurs when: [BUMHS-2022]

- (A) Blue light is given to the plant
- (B) Red light is given to the plant
- (C) Green light is given to the plant
- (D) Yellow light is given to the plant

Q47.

UHS 2022

What is the colour of chlorophyll 'b' molecule? [UHS-2022]

- (A) Bluish green
- (B) Yellowish green
- (C) Dark green
- (D) Reddish green

Q48.

NUMS 2022

Magnesium is an important nutrient in plant for the formation of: [NUMS-2022]

- (A) Proteins
- (B) Lipids
- (C) Chlorophyll
- (D) Enzymes

Q49.

NUMS 2022

If oxygen is available, complete breakdown of glucose produces _ ATP molecules in prokaryotes. [NUMS-2022]

- (A) 20
- (B) 36
- (C) 38
- (D) 40

Q50.

BUMHS 2022

What is the number of hydrogen atoms in the molecular formula of chlorophyll 'a'? [BUMHS-2022]

- (A) Six
- (B) Fifty five
- (C) Seventy
- (D) Seventy two

Q51.

UHS 2022

Each carrier in electron transport chain is first and then . [UHS-2022]

- (A) Broken-down, regenerate
- (B) Generated, broken down
- (C) Oxidized, reduced
- (D) Reduced, oxidized

Q52.

UHS 2022

Electron transport chain explains: [UHS-2022]

- (A) Photophosphorylation
- (B) Z-scheme
- (C) Photolysis
- (D) Mechanism of ATP synthesis

Q53.

NUMS 2022

What are the products of light dependent reactions of photosynthesis? [NUMS–2022]

- (A) ATP, RuBP and reduced NAD
- (B) ATP, oxygen and reduced NADP
- (C) GP, oxygen and reduced NAD
- (D) GP, reduced NADP and RuBP

Q54.

SZABMU 2022

Each granum consists of _ thylakoids. [SZABMU–2022]

- (A) 40–60
- (B) 25–50
- (C) 50–70
- (D) 100–200

Q55.

SZABMU 2022

The element whose electrons are excited during light reactions of photosynthesis is: [SZABMU–2022]

- (A) Carbon
- (B) Hydrogen
- (C) Magnesium
- (D) Nitrogen

Q56.

DUHS 2022

Light reaction of photosynthesis takes place in: [DUHS–2022]

- (A) Cristae
- (B) Stroma
- (C) Cisternae
- (D) Thylakoid

Q57.

NUMS 2022

End product of Calvin cycle is: [NUMS–2022]

- (A) 3-phosphoglycerate
- (B) 1-3 bisphosphoglycerate
- (C) Glyceraldehyde 3-phosphate
- (D) Glucose

Q58.

SZABMU 2022

Light independent phase of photosynthesis involves: [SZABMU–2022]

- (A) Formation of energy rich carbohydrates
- (B) Hydrolysis of water
- (C) ATP generation
- (D) Production of reducing molecules

Q59.

KMU 2022

In which part of chloroplast the fixation of carbon dioxide results in the formation of sugars? [ETEA–2022]

- (A) Grana
- (B) Stroma
- (C) Intergranum
- (D) Outer membrane of chloroplast

Q60.

KMU 2022

The Calvin cycle is completed in _ stages. [ETEA–2022]

- (A) Two
- (B) Three
- (C) Four
- (D) Five

Q61.

DUHS 2022

The enzyme which is used in Calvin cycle is: [DUHS–2022]

- (A) Oxidase
- (B) Reductase
- (C) Isomerase
- (D) Rubisco

Q62.

UHS 2022

What is the end product of glucose by yeast in anaerobic respiration? [UHS–2022]

- (A) Ethanol and oxygen
- (B) Ethanol and water
- (C) Ethanol and CO_2
- (D) Lactic acid and CO_2

Q63.

UHS 2022

Which of the following is **not** a consequence of anaerobic respiration in human muscles cells? [UHS–2022]

- (A) Cramps
- (B) High consumption of energy
- (C) Pain
- (D) Tiredness

Q64.

BUMHS 2022

Which of the following is used in baking? [BUMHS-2022]

- (A) Aerobic respiration
- (B) External respiration
- (C) Internal respiration
- (D) Anaerobic respiration

Q65.

DUHS 2022

Net ATP produced at the end of glycolysis: [DUHS-2022]

- (A) 2 ATP
- (B) 4 ATP
- (C) 6 ATP
- (D) 3 ATP

Q66.

DUHS 2022

Pyruvic acid is acid of: [DUHS-2022]

- (A) 4 carbon compound
- (B) 5 carbon compound
- (C) 6 carbon compound
- (D) 3 carbon compound

Q67.

KMU 2022

In aerobic respiration, glucose molecule is completely broken down into CO_2 , H_2O and $_$. [ETEA-2022]

- (A) 2 ATP
- (B) 4 ATP
- (C) 34 ATP
- (D) 36 ATP

RAPID 5–COLUMN ANSWER KEY

Official PMDC verified answer keys for 04. Bioenergetics.

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Q#	KEY	BOARD	Q#	KEY	BOARD	Q#	KEY	BOARD	Q#	KEY	BOARD	Q#	KEY	BOARD
1	C	KMU 2024	15	C	UHS 2024	29	B	UHS 2023	43	B	NUMS 2022	57	C	NUMS 2022
2	B	SZABMU 2024	16	C	SZABMU 2024	30	A	KMU 2023	44	C	KMU 2022	58	A	SZABMU 2022
3	C	SZABMU 2024	17	D	SZABMU 2024	31	B	KMU 2023	45	A	KMU 2022	59	B	KMU 2022
4	C	SZABMU 2024	18	C	SZABMU 2024	32	D	SZABMU 2023	46	A	BUMHS 2022	60	B	KMU 2022
5	D	NUMS 2024	19	D	SZABMU 2024	33	D	NUMS 2023	47	B	UHS 2022	61	D	DUHS 2022
6	C	SZABMU 2024	20	B	SZABMU 2024	34	D	SZABMU 2023	48	C	NUMS 2022	62	C	UHS 2022
7	B	NUMS 2024	21	D	SZABMU 2024	35	C	SZABMU 2023	49	D	NUMS 2022	63	B	UHS 2022
8	B	KMU 2024	22	C	NUMS 2024	36	A	NUMS 2023	50	D	BUMHS 2022	64	D	BUMHS 2022
9	B	KMU 2024	23	A	NUMS 2024	37	B	NUMS 2023	51	D	UHS 2022	65	A	DUHS 2022
10	A	SZABMU 2024	24	A	UHS 2023	38	D	NUMS 2023	52	D	UHS 2022	66	D	DUHS 2022
11	A	UHS 2024	25	C	UHS 2023	39	C	KMU 2023	53	B	NUMS 2022	67	D	KMU 2022
12	B	UHS 2024	26	C	UHS 2023	40	C	KMU 2023	54	B	SZABMU 2022			
13	A	UHS 2024	27	C	SZABMU 2023	41	B	KMU 2023	55	C	SZABMU 2022			
14	A	UHS 2024	28	D	KMU 2023	42	C	NUMS 2022	56	D	DUHS 2022			

TOTAL
MCQS

67

CORRECT

INCORRECT

BLANK

ACCURACY

%

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autopsies.

PROPOLIS COGNITIVE ERROR AUTOPSIES

Step-by-step conceptual derivations, formula working, and distractor autopsies for every question.

Question #1 Key: (C)

KMU 2024

The process of ATP synthesis through a combination of electrochemical and osmotic events is known as: [KMU-202...

CORE CONCEPT AND DERIVATION

The synthesis of ATP driven by a proton gradient across a membrane is formally known as chemiosmosis.

Solution:

- During cellular respiration, this chemiosmotic generation of ATP is coupled to the transfer of electrons from NADH/FADH₂ to oxygen.
- Because it relies on oxygen as the final electron acceptor and involves a proton (osmotic) gradient, the entire combined process is called **Oxidative phosphorylation**.

Why other options are incorrect:

- Glycolysis and fermentation generate ATP via *substrate-level* phosphorylation, which involves direct enzymatic transfer of a phosphate group, not an electrochemical gradient.

Question #2 Key: (B)

SZABMU 2024

Which of the following receives electrons from [Formula] during oxidative phosphorylation in cristae of mitocho...

CORE CONCEPT AND DERIVATION

Electrons from different carriers enter the electron transport chain at different points based on their energy levels.

Solution:

- While NADH delivers electrons to Complex I, *FADH₂* possesses slightly less energy and bypasses Complex I entirely.
- FADH₂* donates its electrons directly to Complex II.
- From Complex II, the electrons are immediately passed to the mobile lipid carrier **Coenzyme Q (Ubiquinone)**.

Why other options are incorrect:

- Cytochromes a, b, and c are located further downstream in the electron transport chain and receive electrons only after they have passed through Coenzyme Q.

Question #3 Key: (C)

SZABMU 2024

What is the product formed at the end of the respiratory chain in inner membrane of mitochondria? [SZABMU-2024...

CORE CONCEPT AND DERIVATION

The electron transport chain ends when the depleted electrons are finally accepted by a terminal molecule.

Solution:

- At the very end of the respiratory chain (Complex IV), electrons are passed to molecular Oxygen (O₂).
- The oxygen atoms accept these electrons and combine with protons (H⁺) from the surrounding matrix.
- This chemical combination yields **Water (H₂O)** as the final metabolic product of the chain.

Why other options are incorrect:

- Oxygen is the reactant (acceptor), not the product.
- CO₂ is produced earlier during the Krebs cycle and link reaction, not the ETC.

Question #4 Key: (C)

SZABMU 2024

The type of phosphorylation which involves the transfer of electrons from NADH to Coenzyme Q in the inner mito...

CORE CONCEPT AND DERIVATION

Phosphorylation (the addition of a phosphate to ADP) is classified by the energy source driving the reaction.

Solution:

- The transfer of electrons from NADH to Coenzyme Q is the first step of the mitochondrial electron transport chain.
- The energy released from this redox transfer pumps protons, creating a gradient that drives ATP synthase.
- Because this entire process is dependent on redox reactions ending with oxygen, it is termed **Oxidative Phosphorylation**.

Why other options are incorrect:

- Cyclic and Non-cyclic phosphorylation are light-driven processes occurring in chloroplasts (photosynthesis).
- Substrate-level phosphorylation relies on direct enzyme transfer without an ETC.

Question #5 Key: (D)

NUMS 2024

Which mechanism would be compromised in the absence of cytochrome complex during light reactions of photosynth...

CORE CONCEPT AND DERIVATION

The cytochrome complex sits between Photosystem II and Photosystem I and acts as a proton pump.

Solution:

- As electrons move from PSII to PSI, they pass through the cytochrome b_6f complex.
- This complex uses the energy of the electrons to actively pump protons (H^+) from the stroma into the thylakoid lumen.
- Without this complex, protons would not be pumped, heavily compromising the **establishment of the proton gradient** necessary for ATP synthesis.

Why other options are incorrect:

- Photolysis of water is driven by PSII, upstream of the cytochrome complex.

Question #6 Key: (C)

SZABMU 2024

Which of the following steps of glycolysis does not involve ATP directly? [SZABMU-2024]

CORE CONCEPT AND DERIVATION

Glycolysis features specific steps that either consume ATP (kinases) or produce ATP via substrate-level phosphorylation.

Solution:

- Step A consumes 1 ATP (Hexokinase).
- Step B consumes 1 ATP (Phosphofructokinase).
- Step D produces 1 ATP (Phosphoglycerate kinase).
- **Step C** is an oxidation reaction catalyzed by GAPDH. It utilizes inorganic phosphate (P_i) from the cytosol and reduces NAD^+ to NADH. It **does not directly involve ATP**.

Why other options are incorrect:

- Options A, B, and D all feature a direct physical interaction with ATP molecules.

Question #7 Key: (B)

NUMS 2024

During glycolysis, isomerization takes place in the form of: [NUMS-2024]

CORE CONCEPT AND DERIVATION

Isomerases are enzymes that rearrange the atomic structure of a molecule without adding or removing atoms, converting it into its isomer.

Solution:

- During glycolysis, two major classical isomerization reactions occur:
- 1. Glucose 6-phosphate is isomerized into **Fructose 6-phosphate** by phosphoglucose isomerase.
- 2. Dihydroxyacetone phosphate (DHAP) is isomerized into **Glyceraldehyde 3-phosphate (G3P)** by triose phosphate isomerase.
- Option B correctly pairs molecules that are products of these specific isomerization steps in the glycolytic pathway.

Why other options are incorrect:

- PEP and pyruvate involve a kinase (phosphate transfer), not an isomerase.
- 3-phosphoglycerate and 2-phosphoglycerate involve a mutase, which is a subtype of isomerase, but the pairings in the other options incorrectly mix non-isomeric steps.

Question #8 Key: (B)

KMU 2024

The production of energy is _____. [KMU-2024]

CORE CONCEPT AND DERIVATION

Cellular respiration is responsible for the production of ATP, but the efficiency and overall rate of productive yield depend heavily on the presence of oxygen.

Solution:

- Aerobic respiration fully oxidizes a glucose molecule, generating **36 to 38 ATP** per molecule.
- Anaerobic respiration only yields **2 ATP** per molecule.
- Because aerobic respiration rapidly generates such a massive, sustained yield of ATP through the electron transport chain, its overall functional "production of energy" is considered significantly higher and effectively faster at meeting large metabolic demands.

Why other options are incorrect:

- While anaerobic glycolysis can rapidly produce ATP in short bursts (like in sprinting muscles), it cannot sustain high-volume energy production, leading to rapid energy depletion compared to aerobic pathways.

Question #9 Key: (B)

KMU 2024

The pathway to the breakdown of glucose, carried out by microorganisms, is called: [KMU-2024]

CORE CONCEPT AND DERIVATION

Microorganisms utilize specific anaerobic pathways to extract energy from glucose when oxygen is scarce.

Solution:

- In specific microorganisms, most notably **yeast**, the anaerobic breakdown of glucose follows a specific pathway.
- After glycolysis, pyruvate is decarboxylated and reduced to form ethanol and CO_2 .
- This entire process is classified as **Alcoholic fermentation**.

Why other options are incorrect:

- Lactic acid fermentation primarily occurs in animal muscle cells and certain bacteria (like *Lactobacilli*), but standard microbiology/botany contexts highlight yeast's alcoholic fermentation as the classic micro-organism pathway for industrial/baking applications.

Question #10 Key: (A)

SZABMU 2024

The amount of energy present in bonds of glucose which is converted into ATP during anaerobic respiration is: ...

CORE CONCEPT AND DERIVATION

Anaerobic respiration is an incredibly inefficient method of extracting the total potential chemical energy locked within the bonds of a glucose molecule.

Solution:

- The complete aerobic oxidation of glucose captures a large percentage of its energy (around 36–40%).
- However, during anaerobic respiration (fermentation), the glucose molecule is only partially broken down.
- As a result, only a net of 2 ATP is produced, meaning only about **2%** of the total potential energy in glucose is actually converted into usable ATP. The rest remains locked in the toxic byproducts (ethanol or lactic acid).

Why other options are incorrect:

- 4%, 10%, and 36% grossly overestimate the thermodynamic efficiency of fermentation.

Question #11 Key: (A)

UHS 2024

Which option is correct about a chlorophyll molecule? [UHS-2024]

CORE CONCEPT AND DERIVATION

There are different forms of chlorophyll (primarily *a* and *b*), each with a highly specific molecular formula and functional group.

Solution:

- The chemical formula $C_{55}H_{70}O_6N_4Mg$ is the exact molecular formula for **Chlorophyll *b***.
- Since Chlorophyll *b* is definitively "a chlorophyll molecule," this statement is completely accurate.

Why other options are incorrect:

- **Option B:** The center of the porphyrin ring contains Magnesium (*Mg*), not Nitrogen. The nitrogen atoms strictly coordinate the central Magnesium.
- **Option C & D:** These are specific differentiators. Chlorophyll *a* has a methyl group, and Chlorophyll *b* has an aldehyde group, but a general formula is universally true for its specific type.

Question #12 Key: (B)

UHS 2024

In the journey of electrons from photosystem II to photosystem I plastocyanin is reduced by: [UHS-2024]

CORE CONCEPT AND DERIVATION

The thylakoid electron transport chain follows a strict, sequential order of electron carriers between the two photosystems.

Solution:

- Electrons leave Photosystem II and are passed to Plastoquinone (PQ).
- Plastoquinone passes them to the **Cytochrome *b₆f* complex**.
- The Cytochrome complex then passes the electrons to **Plastocyanin (PC)**.
- Because Plastocyanin receives (gains) these electrons from the Cytochrome complex, it is technically *reduced* by the Cytochrome complex.

Why other options are incorrect:

- Plastoquinone passes electrons to cytochrome, not directly to plastocyanin.
- P700 and the primary acceptor of PSI are located *after* plastocyanin in the chain.

Question #13 Key: (A)

UHS 2024

Enzyme NADP reductase is responsible for: [UHS-2024]

CORE CONCEPT AND DERIVATION

Enzymes are generally named after the substrate they act upon and the specific type of chemical reaction they catalyze.

Solution:

- NADP reductase is located at the very end of the non-cyclic electron transport chain.
- It takes two high-energy electrons from Ferredoxin and a proton (H^+) from the stroma.
- It adds these to $NADP^+$. The addition of electrons is called reduction.
- Therefore, it is responsible for **reducing** $NADP^+$ to form NADPH.

Why other options are incorrect:

- It does not oxidize $NADP^+$.
- Ferredoxin is what reduces the enzyme, not the other way around.
- P700 is reduced by plastocyanin.

Question #14 Key: (A)

UHS 2024

The PS II during light reactions receives electrons from splitting: [UHS-2024]

CORE CONCEPT AND DERIVATION

When Photosystem II (P680) absorbs light and ejects electrons, it becomes a powerful oxidizing agent that must replace its lost electrons to continue functioning.

Solution:

- To fill the "electron hole" created in the P680 reaction center, an associated enzyme complex carries out photolysis.
- Photolysis is the physical splitting of **Water** (H_2O) into protons, oxygen, and electrons.
- These extracted electrons are immediately fed into Photosystem II.

Why other options are incorrect:

- Plastoquinone, Plastocyanin, and Ferredoxin are all downstream carriers in the electron transport chain; they receive electrons *from* the photosystems, rather than supplying them to PS II.

Question #15 Key: (C)

UHS 2024

In Calvin cycle [Formula] reacts with RuBP to produce _ . [UHS-2024]

CORE CONCEPT AND DERIVATION

The very first step of the Calvin cycle is carbon fixation, catalyzed by the enzyme RuBisCO.

Solution:

- A single molecule of CO_2 (1 carbon) is covalently attached to Ribulose-1,5-bisphosphate (RuBP) (5 carbons).
- This immediately produces a **6-carbon unstable intermediate** compound.
- Because it is so highly unstable, this 6-carbon molecule instantly breaks in half to form two molecules of 3-phosphoglycerate (3-PGA).

Why other options are incorrect:

- While 3-PGA is the first *stable* product, the direct initial reaction produces the transient 6-carbon intermediate.

Question #16 Key: (C)

SZABMU 2024

The step of Calvin Cycle during which five molecules of Glyceraldehyde 3-phosphate (G3P) are converted in Ribu...

CORE CONCEPT AND DERIVATION

For a biochemical cycle to continuously run, its starting material must be remade at the end of every turn.

Solution:

- The starting molecule of the Calvin cycle is RuBP.
- After the reduction phase, some G3P exits the cycle, but the majority (5 out of 6 molecules) remain.
- Through a complex series of ATP-dependent reactions, these five 3-carbon G3P molecules are rearranged to **regenerate** three 5-carbon RuBP molecules.
- This specific final phase is fundamentally called the **Regeneration** step.

Why other options are incorrect:

- **Fixation** is the attachment of CO_2 .
- **Reduction** uses ATP and NADPH to convert 3-PGA to G3P.

Question #17 Key: (D)

SZABMU 2024

Which of the following does not take place during cyclic phosphorylation of the light dependent reaction of ph...

CORE CONCEPT AND DERIVATION

Cyclic photophosphorylation is an alternate pathway that only involves Photosystem I to generate extra ATP.

Solution:

- In cyclic flow, electrons are excited in PSI, travel down the cytochrome complex (generating ATP), and return directly back to PSI.
- Because the electrons cycle in a closed loop, there is no electron deficit in PSI.
- Therefore, there is no need to split water to replace electrons. **Photolysis of water** absolutely does NOT occur in this pathway.

Why other options are incorrect:

- Light absorption, photoexcitation of electrons, and ATP synthesis are the fundamental driving events of the cyclic pathway.

Question #18 Key: (C)

SZABMU 2024

Ubiquinone contains: [SZAMBU-2024-Reconduct]

CORE CONCEPT AND DERIVATION

Electron transport chain prosthetic groups and carriers.

Solution: Ubiquinone (Coenzyme Q) works closely with iron-sulfur clusters in mitochondrial Complex I and Complex II to transfer electrons down the respiratory chain.

Question #19 Key: (D)

SZABMU 2024

Chlorophyll and accessory pigments absorb light and transfer the energy, that initiates the light reactions. W...

CORE CONCEPT AND DERIVATION

The photosystem acts like a funnel, gathering light energy from a wide antenna complex and directing it inward to a central reaction center.

Solution:

- Light is initially absorbed by the outermost accessory pigments (**Carotenoids**), which absorb broader wavelengths.
- They pass this excitation energy via resonance to **Chlorophyll b**.
- Chlorophyll b funnels the energy inward directly to the reaction center, which is exclusively composed of **Chlorophyll a**.
- Therefore, the correct inward vector is: Carotenoids → Chlorophyll b → Chlorophyll a.

Why other options are incorrect:

- Energy always flows from accessory pigments towards the primary pigment (Chlorophyll a), never outward or in reverse.

Question #20 Key: (B)

SZABMU 2024

What is the concentration of [Formula] in air? [SZAMBU-2024]

CORE CONCEPT AND DERIVATION

Carbon dioxide is a crucial trace gas in the Earth's atmosphere, acting as the primary carbon source for global photosynthesis.

Solution:

- Despite its massive biological importance, CO_2 makes up a tiny fraction of the standard atmospheric volume.
- The universally taught biological baseline for atmospheric CO_2 concentration is approximately **0.03% to 0.04%** (which equates to 300–400 parts per million).

Why other options are incorrect:

- Options A and C represent concentrations that are far too low (plants would suffocate and die).
- Option D (3–4%) is far too high and would be toxic to much of aerobic life while causing catastrophic global warming.

Question #21 Key: (D)

SZABMU 2024

What is the efficiency of [Formula] fixation in plants with photorespiration? [SZABMU-2024]

CORE CONCEPT AND DERIVATION

Photorespiration is a wasteful process where RuBisCO accidentally binds to Oxygen instead of Carbon Dioxide, draining the plant's resources.

Solution:

- In standard C_3 plants, when stomata close on hot days, O_2 builds up and outcompetes CO_2 .
- This oxygenase activity can undercut the plant's photosynthetic output by roughly 25%.
- Consequently, the remaining operational efficiency of actual CO_2 fixation drops down to about **75%**.

Why other options are incorrect:

- 25% represents the amount of efficiency lost, not the amount retained.
- 20% and 45% do not align with standard physiological metrics for photorespiratory drag.

Question #22 Key: (C)

NUMS 2024

Presence of PEP carboxylase in [Formula] plants enable them to avoid photorespiration due to: [NUMS-2024]

CORE CONCEPT AND DERIVATION

C_4 plants have evolved a unique biochemical pump to ensure RuBisCO only ever interacts with CO_2 , completely bypassing photorespiration.

Solution:

- In mesophyll cells of C_4 plants, the initial carbon fixation is performed by PEP carboxylase, not RuBisCO.
- The key evolutionary advantage is that PEP carboxylase has **absolutely no affinity for oxygen**. It is **strictly a carboxylase**.
- It locks CO_2 into malate, safely shuttles it to the bundle-sheath cells, and floods RuBisCO with CO_2 so photorespiration cannot happen.

Why other options are incorrect:

- C_4 plants definitely still possess RuBisCO (it operates in the bundle-sheath cells to run the Calvin cycle).
- Concentration and yield of the enzyme are irrelevant; its structural specificity (zero oxygenase activity) is the mechanism.

Question #23 Key: (A)

NUMS 2024

Fats and proteins can be used as respiratory fuel. Which of the following serves as common molecule produced t...

CORE CONCEPT AND DERIVATION

Metabolic pathways are interconnected. Carbohydrates, lipids, and proteins can all feed into cellular respiration at various intersection points.

Solution:

- When fats are broken down (beta-oxidation of fatty acids) and proteins are deaminated, they must enter the central respiratory pathway to generate ATP.
- The universal "crossroads" molecule that links the catabolism of carbohydrates, fats, and most amino acids directly into the Krebs cycle is **Acetyl CoA**.

Why other options are incorrect:

- While some amino acids can form pyruvate, fatty acids cannot. Acetyl CoA is the exclusively common denominator.
- G3P is specific to glycolysis.
- Lactate is an end-product of anaerobic fermentation.

Question #24 Key: (A)

UHS 2023

Which is the main event in electron transport chain? [UHS-2023]

CORE CONCEPT AND DERIVATION

The electron transport chain (ETC) is the final and most productive phase of cellular respiration.

Solution:

- The primary purpose and main functional event of the ETC is to generate a proton gradient that drives the enzyme ATP synthase.
- This results in massive **ATP synthesis** via oxidative phosphorylation.

Why other options are incorrect:

- Decarboxylation (removal of CO_2) happens during the link reaction and Krebs cycle.
- Isomerisation and substitution are chemical reactions that occur heavily in glycolysis and the Krebs cycle, not the main event of the ETC.

Question #25 Key: (C)

UHS 2023

Out of 36 ATPs, how many are produced in electron transport chain? [UHS-2023]

CORE CONCEPT AND DERIVATION

ATP accounting in cellular respiration.

Solution: Out of 36 net ATP generated per glucose molecule, 4 ATP are produced via substrate-level phosphorylation (2 in glycolysis, 2 in Krebs cycle). The remaining **32 ATP** are derived via oxidative phosphorylation in the electron transport chain.

Question #26 Key: (C)

UHS 2023

The major enzymes involved in transfer of phosphate group from ATP to Glucose is: [UHS-2023]

CORE CONCEPT AND DERIVATION

Enzymes are strictly categorized based on the specific type of chemical reaction they catalyze.

Solution:

- Enzymes that transfer a phosphate group from a high-energy molecule (like ATP) to a substrate are universally called **Kinases** (e.g., Hexokinase or Phosphofructokinase in glycolysis).

Why other options are incorrect:

- Isomerases:** rearrange atoms within a single molecule.
- Dehydrogenases:** remove hydrogen atoms (involved in redox reactions).
- Decarboxylases:** remove carboxyl groups, releasing CO_2 .

Question #27 Key: (C)

SZABMU 2023

The end product of glycolysis in anaerobic respiration is: [SZABMU-2023]

CORE CONCEPT AND DERIVATION

Glycolysis is a universal pathway that is identical regardless of whether oxygen is present or absent.

Solution:

- The pathway of **glycolysis** specifically ends with the formation of two molecules of **Pyruvate (pyruvic acid)**.
- What happens to the pyruvate afterward (e.g., turning into lactate or ethanol) is defined as the fermentation phase, which occurs *after* glycolysis.

Why other options are incorrect:

- Ethanol and Lactate are end products of fermentation, not glycolysis itself.
- Acetyl CoA is formed during the transition reaction in aerobic environments.

Question #28 Key: (D)

KMU 2023

The ATP formed in the preparatory phase of glycolysis is (are): [ETEA-2023]

CORE CONCEPT AND DERIVATION

Glycolysis is divided into an energy-investment (preparatory) phase and an energy-payoff phase.

Solution:

- During the preparatory phase, the cell must spend energy to phosphorylate the glucose molecule, consuming 2 ATP.
- Because ATP is **consumed** and not generated during this phase, the number of ATP *formed* is exactly **0**.

Why other options are incorrect:

- 4 ATP are formed later in the *payoff* phase.
- 2 ATP represents the amount consumed, not formed.

Question #29 Key: (B)

UHS 2023

Which of the following is used in baking? [UHS-2023]

CORE CONCEPT AND DERIVATION

The baking industry relies heavily on the metabolic byproducts of *Saccharomyces cerevisiae* (baker's yeast).

Solution:

- When mixed into dough, the environment rapidly becomes devoid of oxygen.
- The yeast shifts to **anaerobic respiration (alcoholic fermentation)** to survive.
- This process converts sugars into ethanol and CO_2 . The trapped CO_2 bubbles cause the bread dough to rise.

Why other options are incorrect:

- Aerobic respiration requires oxygen and does not produce the intense, rapid gas accumulation necessary for rising dough.

Question #30 Key: (A)

KMU 2023

In alcoholic fermentation _ ATP molecules are produced from 1 glucose molecule. [ETEA-2023]

CORE CONCEPT AND DERIVATION

Fermentation pathways allow glycolysis to continue in the absence of oxygen but do not produce additional ATP themselves.

Solution:

- During alcoholic fermentation, the entire energy yield comes solely from the preceding glycolysis step.
- Glycolysis yields a net of **2 ATP** per glucose molecule.
- The subsequent steps (converting pyruvate to ethanol) consume NADH but produce no further ATP.

Why other options are incorrect:

- 32 and 36 ATP represent the massive energy yields of aerobic respiration, which utilizes the electron transport chain.

Question #31 Key: (B)

KMU 2023

What is the number of carbon atoms in pyruvic acid? [ETEA-2023 Retake]

CORE CONCEPT AND DERIVATION

Glycolysis physically cleaves the carbon skeleton of glucose into two smaller, equal-sized molecules.

Solution:

- Glucose starts as a 6-carbon molecule ($C_6H_{12}O_6$).
- It is split directly in half during glycolysis.
- Therefore, each resulting molecule of pyruvic acid contains exactly **3** carbon atoms.

Why other options are incorrect:

- 2-carbon compounds form after pyruvate is decarboxylated into Acetyl CoA.
- 4-carbon and 5-carbon compounds are intermediates in the Krebs cycle.

Question #32 Key: (D)

SZABMU 2023

The final acceptor of both electrons and protons during light reactions of photosynthesis is: [SZABMU-2023]

CORE CONCEPT AND DERIVATION

Non-cyclic electron flow (the Z-scheme) in photosynthesis moves electrons from water ultimately to a carrier molecule that will be used in the dark reactions.

Solution:

- Electrons travel from PSII, through the ETC, to PSI, and finally to the enzyme NADP reductase.
- Here, $NADP^+$ serves as the terminal electron acceptor.
- It simultaneously picks up protons (H^+) from the stroma to form NADPH, taking both to the Calvin cycle.

Why other options are incorrect:

- Plastoquinone (PQ), Plastocyanin (PC), and Ferredoxin (Fd) are intermediate carriers that simply pass electrons along, rather than holding them at the end of the chain.

Question #33 Key: (D)

NUMS 2023

When light falls on P700, which event is likely to occur? [NUMS-2023]

CORE CONCEPT AND DERIVATION

P700 is the specialized pair of chlorophyll a molecules at the reaction center of Photosystem I.

Solution:

- When P700 absorbs photon energy (either directly or via antenna pigments), its electrons become highly excited.
- These excited electrons are physically ejected out of the molecule and transferred to a primary electron acceptor.
- Losing electrons chemically means that P700 becomes **oxidized**.

Why other options are incorrect:

- **Photolysis** (splitting of water) is induced by P680 (Photosystem II), not P700.
- It loses electrons rather than accepting them initially (it accepts them later from the ETC to regenerate).

Question #34 Key: (D)

SZABMU 2023

The only copper containing protein involved during light reactions of photosynthesis is: [SZABMU-2023]

CORE CONCEPT AND DERIVATION

The electron transport chain connecting Photosystem II to Photosystem I relies on specific metalloproteins to pass electrons.

Solution:

- **Plastocyanin** is a small, water-soluble, blue-colored protein found in the thylakoid lumen.
- Its ability to carry electrons is strictly dependent on a single **copper** atom at its active site, which cycles between Cu^{2+} and Cu^{+} .

Why other options are incorrect:

- **Plastoquinone**: is a lipid-soluble quinone, not a metalloprotein.
- **Cytochrome**: contains iron (heme).
- **Ferredoxin**: contains iron-sulfur clusters.

Question #35 Key: (C)

SZABMU 2023

End product of Calvin cycle is: [SZABMU-2023]

CORE CONCEPT AND DERIVATION

The Calvin cycle builds sugar one carbon at a time and releases a specific 3-carbon intermediate.

Solution:

- The direct, final carbohydrate product that exits the Calvin cycle is **Glyceraldehyde 3-phosphate (G3P)**.
- For every 3 turns of the cycle, one G3P molecule leaves to be used by the plant to build glucose and other organic compounds.

Why other options are incorrect:

- 3-phosphoglycerate and 1,3-bisphosphoglycerate are intermediates within the cycle.
- Glucose is assembled later outside the cycle in the cytoplasm using two G3P molecules.

Question #36 Key: (A)

NUMS 2023

Which are the end products of light reactions of photosynthesis? [NUMS-2023]

CORE CONCEPT AND DERIVATION

The sole purpose of the light-dependent reactions is to trap solar energy into usable chemical forms for the dark reactions.

Solution:

- Light energy drives the phosphorylation of ADP to create **ATP**.
- Electrons from water are used to reduce $NADP^{+}$ to create **NADPH**.
- These two molecules (collectively called assimilatory power) are the crucial end products sent to the stroma.

Why other options are incorrect:

- Glucose is produced in the light-independent reactions (Calvin cycle).
- Water is consumed (split via photolysis), not produced, during the light reactions.

Question #37 Key: (B)

NUMS 2023

Synthesis of ATP during photosynthesis takes place at the region: [NUMS-2023]

CORE CONCEPT AND DERIVATION

ATP synthesis requires an intact membrane to hold a proton gradient (chemiosmosis).

Solution:

- In chloroplasts, protons are pumped into the lumen of the **thylakoid**.
- ATP synthase enzymes are physically embedded in the **thylakoid membrane**.
- As protons flow back out into the stroma, ATP is synthesized right at the membrane surface.

Why other options are incorrect:

- **Stroma**: where ATP is consumed during the Calvin cycle, not where it is synthesized.
- **Matrix**: found in mitochondria, not chloroplasts.

Question #38 Key: (D)

NUMS 2023

Which of the following molecules are released after completion of light reaction and the utilized in the dark ...

CORE CONCEPT AND DERIVATION

There is a strict biochemical link between the light-dependent thylakoid reactions and the light-independent stroma reactions.

Solution:

- The light reactions generate energy-rich molecules.
- Specifically, **ATP** provides the chemical energy, and **NADPH** provides the reducing power (high-energy electrons).
- Both of these are released into the stroma where they are immediately utilized by the Calvin cycle (dark reaction) to fix CO_2 into sugars.

Why other options are incorrect:

- ADP and $NADP^+$ are the depleted, low-energy forms that return to the light reactions to be recharged.

Question #39 Key: (C)

KMU 2023

Light reaction occurs in the _ of chloroplast: [ETEA-2023]

CORE CONCEPT AND DERIVATION

The light reactions heavily depend on photosystems, which are large protein-pigment complexes requiring a specific membrane structure.

Solution:

- These photosystems are densely packed into the thylakoid membranes.
- A stack of thylakoid membranes is called a **granum**.
- Therefore, the grana are the precise structural locations where light energy is absorbed and converted into chemical energy.

Why other options are incorrect:

- The outer and inner membranes of the chloroplast simply serve as protective and selective boundaries.
- The stroma is the fluid site of the dark reactions.

Question #40 Key: (C)

KMU 2023

The carotenoids absorb light in the visible spectrum between _ and wavelengths. [ETEA-2023 Retake]

CORE CONCEPT AND DERIVATION

Accessory pigments like carotenoids absorb wavelengths of light that chlorophyll cannot efficiently capture, broadening the plant's action spectrum.

Solution:

- Carotenoids are yellow, orange, and red pigments.
- They primarily absorb light in the blue-green range of the spectrum.
- Based on the specific data from the curriculum notes, this blue-green absorption strongly occurs in the **500–600 nm** range.

Why other options are incorrect:

- 630–700 nm is the red range, which is strongly absorbed by chlorophyll, not carotenoids. (Note: The source document provides options C and D as identical 500–600nm, which corresponds to the correct range).

Question #41 Key: (B)

KMU 2023

In the non-cyclic electron transport of light reaction, the deficit of _ electrons occur in the chlorophyll, a...

CORE CONCEPT AND DERIVATION

Non-cyclic photophosphorylation (Z-scheme) relies on a continuous flow of electrons from water, through the photosystems, to $NADP^+$.

Solution:

- When light strikes Photosystem II (P680), an excited pair of electrons is ejected.
- This creates a deficit of exactly **2 electrons** in the chlorophyll a reaction center.
- To fill this hole, one molecule of water is split (photolysis) to provide exactly 2 replacement electrons.

Why other options are incorrect:

- The biological mechanism of photolysis specifically yields 2 electrons per water molecule split, perfectly matching the 2-electron deficit in the activated photosystem.

Question #42 Key: (C)

NUMS 2022

During photosynthesis, [Formula] works as: [NUMS-2022]

CORE CONCEPT AND DERIVATION

During the Calvin cycle (light-independent reactions), carbon dioxide is reduced to form glyceraldehyde 3-phosphate (G3P).

Solution:

- In the reduction phase of the Calvin cycle, CO_2 receives protons and electrons from $NADPH$ (which is oxidized to $NADP^+$).
- Because it accepts protons during this reduction, CO_2 acts as a proton acceptor.

Why other options are incorrect:

- CO_2 does not donate protons or electrons.
- Water (H_2O), not CO_2 , is the source of oxygen evolved during photosynthesis.

Question #43 Key: (B)

NUMS 2022

In the process of photosynthesis, water acts as: [NUMS-2022]

CORE CONCEPT AND DERIVATION

In the light-dependent reactions of photosynthesis, water undergoes photolysis to replace the electrons lost by Photosystem II.

Solution:

- Light energy splits water into $2H^+$, $\frac{1}{2}O_2$, and releases electrons.
- These electrons are donated to the oxidized chlorophyll molecules of the reaction center, making water the ultimate electron donor in non-cyclic photophosphorylation.

Why other options are incorrect:

- Water donates protons (H^+) to the thylakoid lumen rather than accepting them.
- $NADPH$ acts as the direct reducer of CO_2 , not water.

Question #44 Key: (C)

KMU 2022

The range of visible light is from: [ETEA-2022]

CORE CONCEPT AND DERIVATION

The visible light spectrum is the segment of the electromagnetic spectrum that the human eye can view, and which drives photosynthesis.

Solution:

- The accepted standard range of visible light is approximately **380 nm to 750 nm**.
- Photosynthetic pigments specifically absorb various wavelengths within this exact spectrum to capture energy.

Why other options are incorrect:

- Other ranges are either too narrow, omitting key red or violet wavelengths, or shift too far into the infrared or ultraviolet regions.

Question #45 Key: (A)

KMU 2022

Which scientist among the following hypothesized that plant splits water to release oxygen as by-product? [ETE...]

CORE CONCEPT AND DERIVATION

The origin of oxygen evolved during photosynthesis was a major historical question in biology, eventually traced back to water rather than carbon dioxide.

Solution:

- In the 1930s, **Cornelis van Niel** hypothesized that plants split water (H_2O) as a source of hydrogen, releasing oxygen as a byproduct.
- He based this on his studies of photosynthetic bacteria that utilize hydrogen sulfide (H_2S) and release sulfur.

Why other options are incorrect:

- **Melvin Calvin** discovered the light-independent carbon fixation pathway.
- **Hans Krebs** discovered the citric acid cycle in cellular respiration.

Question #46 Key: (A)

BUMHS 2022

*Maximum photosynthesis occurs when: [BUMHS-2022]***CORE CONCEPT AND DERIVATION**

Photosynthetic pigments, particularly chlorophyll a and b, have specific absorption peaks that determine the rate of photosynthesis across different wavelengths.

Solution:

- Chlorophyll absorbs blue and red light most effectively.
- While both drive high rates of photosynthesis, **blue light** is absorbed at a slightly higher maximum capacity by the combined action of chlorophylls and accessory pigments (carotenoids).

Why other options are incorrect:

- Green and yellow light are mostly reflected or transmitted, leading to minimal photosynthetic activity.

Question #47 Key: (B)

UHS 2022

*What is the colour of chlorophyll 'b' molecule? [UHS-2022]***CORE CONCEPT AND DERIVATION**

Different types of chlorophyll have slight structural differences that shift their absorption spectra, resulting in different visible colors.

Solution:

- **Chlorophyll a** appears blue-green.
- **Chlorophyll b** appears **yellow-green**.
- This difference allows plants to broaden the spectrum of light they can effectively absorb.

Why other options are incorrect:

- Bluish-green is the characteristic color of chlorophyll a.

Question #48 Key: (C)

NUMS 2022

*Magnesium is an important nutrient in plant for the formation of: [NUMS-2022]***CORE CONCEPT AND DERIVATION**

Chlorophyll is a complex organic molecule built around a central metallic ion.

Solution:

- The core of the chlorophyll molecule consists of a porphyrin ring.
- **Magnesium (Mg^{2+})** is located exactly in the center of this porphyrin ring.
- Without magnesium, the plant cannot synthesize chlorophyll, leading to chlorosis (yellowing of leaves).

Why other options are incorrect:

- Proteins and enzymes primarily rely on nitrogen and sulfur.
- Lipids are primarily composed of carbon, hydrogen, and oxygen.

Question #49 Key: (D)

NUMS 2022

*If oxygen is available, complete breakdown of glucose produces _ ATP molecules in prokaryotes. [NUMS-2022]***CORE CONCEPT AND DERIVATION**

Cellular respiration yields ATP through substrate-level phosphorylation and oxidative phosphorylation.

Solution:

- In prokaryotes, the complete breakdown of glucose yields a net of 38 ATP.
- However, during the preparatory phase of glycolysis, 2 ATP are consumed.
- Therefore, the **total (gross) production** of ATP molecules during the complete breakdown is 38 (net) + 2 (consumed) = **40 ATP**.

Why other options are incorrect:

- **38** is the net ATP yield in prokaryotes.
- **36** is the standard net ATP yield in eukaryotes (due to the cost of transporting NADH into the mitochondria).

Question #50 Key: (D)

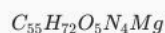
BUMHS 2022

What is the number of hydrogen atoms in the molecular formula of chlorophyll 'a'? [BUMHS-2022]

CORE CONCEPT AND DERIVATION

Chlorophyll a is the primary photosynthetic pigment with a specific complex chemical formula.

Formula:



Solution:

- Based on the molecular formula, chlorophyll a contains exactly **72** hydrogen atoms.

Why other options are incorrect:

- 55 is the number of Carbon atoms.
- 70 is the number of hydrogen atoms in chlorophyll b ($C_{55}H_{70}O_6N_4Mg$).

Question #51 Key: (D)

UHS 2022

Each carrier in electron transport chain is first and then . [UHS-2022]

CORE CONCEPT AND DERIVATION

The electron transport chain (ETC) is a series of consecutive redox (reduction-oxidation) reactions.

Solution:

- When an electron carrier accepts an electron from the previous molecule, it gains a negative charge and becomes **reduced**.
- When it passes that electron to the next carrier in the chain, it loses the electron and becomes **oxidized** again.
- Thus, the sequence is always **reduced**, then **oxidized**.

Why other options are incorrect:

- Starting with oxidized would mean it loses an electron before gaining one, which contradicts the chain flow. Carriers must first receive (reduce) before they can give (oxidize).

Question #52 Key: (D)

UHS 2022

Electron transport chain explains: [UHS-2022]

CORE CONCEPT AND DERIVATION

The ETC is fundamentally coupled to chemiosmosis, providing the energy required to synthesize ATP.

Solution:

- As electrons move energetically downhill along the ETC, they release energy.
- This energy is used to pump protons across a membrane, creating an electrochemical gradient.
- The flow of protons back across the membrane through ATP synthase explains the primary **mechanism of ATP synthesis**.

Why other options are incorrect:

- While the ETC is involved in photophosphorylation and the Z-scheme, its universal biological role (in both mitochondria and chloroplasts) is explaining the mechanism behind bulk ATP synthesis.

Question #53 Key: (B)

NUMS 2022

What are the products of light dependent reactions of photosynthesis? [NUMS-2022]

CORE CONCEPT AND DERIVATION

The light-dependent reactions convert solar energy into chemical energy, providing the necessary assimilatory power for the dark reactions.

Solution:

- ATP** is generated via photophosphorylation.
- Reduced NADP (NADPH)** is generated when electrons from PSI reduce $NADP^+$.
- Oxygen (O_2)** is released as a byproduct from the photolysis of water.

Why other options are incorrect:

- RuBP and GP (glycerate 3-phosphate) are components/products of the light-independent reactions (Calvin cycle).
- Reduced NAD (NADH) is produced in cellular respiration, not photosynthesis.

Question #54 Key: (B)

SZABMU 2022

Each granum consists of _ thylakoids. [SZABMU-2022]

CORE CONCEPT AND DERIVATION

Thylakoids are flattened membrane sacs inside the chloroplast that stack on top of each other to maximize light absorption.

Solution:

- A stack of thylakoids is called a granum (plural: grana).
- A typical granum consists of a stack of **25 to 50** thylakoid sacs.

Why other options are incorrect:

- The other numerical ranges over-estimate or under-estimate the standard biological average taught for granum structure.

Question #55 Key: (C)

SZABMU 2022

The element whose electrons are excited during light reactions of photosynthesis is: [SZABMU-2022]

CORE CONCEPT AND DERIVATION

Photosynthetic pigments must be able to absorb light energy and readily release high-energy electrons.

Solution:

- The core of the chlorophyll molecule is a porphyrin ring containing a central **Magnesium (Mg)** atom.
- When sunlight hits chlorophyll, it is the electrons associated with this central magnesium atom and the alternating double bonds of the porphyrin ring that become highly excited and are expelled to a primary electron acceptor.

Why other options are incorrect:

- Carbon, hydrogen, and nitrogen form the structural backbone of the ring, but magnesium plays the central role in electron excitation and release.

Question #56 Key: (D)

DUHS 2022

Light reaction of photosynthesis takes place in: [DUHS-2022]

CORE CONCEPT AND DERIVATION

The light-dependent reactions require a membrane to embed photosystems and establish a proton gradient.

Solution:

- Photosystems (groups of pigment molecules) and the electron transport chain are physically embedded in the **thylakoid membrane**.
- Consequently, all light-driven reactions, including photolysis of water and ATP synthesis, take place on or across the thylakoid.

Why other options are incorrect:

- **Stroma:** The fluid where light-independent reactions (Calvin cycle) occur.
- **Cristae:** The folds of the inner mitochondrial membrane (cellular respiration).
- **Cisternae:** Flattened sacs in the Golgi apparatus or ER.

Question #57 Key: (C)

NUMS 2022

End product of Calvin cycle is: [NUMS-2022]

CORE CONCEPT AND DERIVATION

The Calvin cycle synthesizes a 3-carbon sugar directly, which the plant then uses to synthesize larger carbohydrates.

Solution:

- The actual carbohydrate product expelled by the Calvin cycle is **Glyceraldehyde 3-phosphate (G3P)**.
- For every three molecules of C_3O_2 that enter the cycle, one molecule of G3P is released as a net product.

Why other options are incorrect:

- **Glucose:** is synthesized later in the cytoplasm by combining two molecules of G3P. It is not the direct end product of the cycle itself.
- **3-phosphoglycerate & 1,3-bisphosphoglycerate:** are intermediate compounds formed prior to the reduction phase of the cycle.

Question #58 Key: (A)

SZABMU 2022

Light independent phase of photosynthesis involves: [SZABMU-2022]

CORE CONCEPT AND DERIVATION

The light-independent phase (Calvin cycle) uses the assimilatory power generated by the light reactions to fix carbon.

Solution:

- In this phase, CO_2 is incorporated into organic molecules.
- ATP and NADPH are consumed to reduce this carbon, leading to the **formation of energy-rich carbohydrates** (such as G3P).

Why other options are incorrect:

- Hydrolysis of water, ATP generation, and production of reducing molecules (NADPH) strictly occur during the light-dependent reactions.

Question #59 Key: (B)

KMU 2022

In which part of chloroplast the fixation of carbon dioxide results in the formation of sugars? [ETEA-2022]

CORE CONCEPT AND DERIVATION

Carbon fixation via the Calvin cycle requires a specific biochemical environment rich in specific enzymes (like RuBisCO).

Solution:

- The Calvin cycle takes place in the **stroma**, which is the dense aqueous fluid surrounding the thylakoids inside the chloroplast.
- The stroma contains all the necessary soluble enzymes to catalyze the formation of sugars from CO_2 .

Why other options are incorrect:

- Grana and intergrana (thylakoid structures) are dedicated solely to capturing light and carrying out the light-dependent reactions.

Question #60 Key: (B)

KMU 2022

The Calvin cycle is completed in _ stages. [ETEA-2022]

CORE CONCEPT AND DERIVATION

The Calvin cycle is conventionally divided into distinct functional phases.

Solution:

- The cycle occurs in **three** primary stages:
- **Stage 1: Carbon Fixation** (attaching CO_2 to RuBP).
- **Stage 2: Reduction** (using ATP and NADPH to convert 3-PGA to G3P).
- **Stage 3: Regeneration** (re-arranging G3P to regenerate the starting RuBP molecule).

Why other options are incorrect:

- Dividing the cycle into any other number of core phases does not align with standard biochemical consensus.

Question #61 Key: (D)

DUHS 2022

The enzyme which is used in Calvin cycle is: [DUHS-2022]

CORE CONCEPT AND DERIVATION

Carbon fixation requires an incredibly specific enzyme to attach inorganic CO_2 to an organic 5-carbon molecule.

Solution:

- The critical enzyme that performs this initial carbon fixation is **Ribulose-1,5-bisphosphate carboxylase/oxygenase (RuBisCO)**.
- It is considered the most abundant protein on the planet.

Why other options are incorrect:

- While reductases and isomerases are general classes of enzymes used throughout metabolism, RuBisCO is the defining, specific enzyme of the Calvin cycle.

Question #62 Key: (C)

UHS 2022

What is the end product of glucose by yeast in anaerobic respiration? [UHS-2022]

CORE CONCEPT AND DERIVATION

When oxygen is absent, yeast cells undergo alcoholic fermentation to regenerate NAD^+ so glycolysis can continue.

Solution:

- In yeast, the pyruvic acid from glycolysis is first decarboxylated to form acetaldehyde, releasing **Carbon Dioxide (CO_2)**.
- The acetaldehyde is then reduced by NADH to form **Ethanol**.

Why other options are incorrect:

- Oxygen is never a product of anaerobic respiration.
- Lactic acid is the end product of anaerobic respiration in animal muscle cells and certain bacteria, not yeast.

Question #63 Key: (B)

UHS 2022

Which of the following is not a consequence of anaerobic respiration in human muscles cells? [UHS-2022]

CORE CONCEPT AND DERIVATION

Anaerobic respiration (lactic acid fermentation) in human muscle cells is a temporary emergency measure that yields very little energy compared to aerobic respiration.

Solution:

- Anaerobic respiration provides a very low energy yield (only 2 net ATP per glucose molecule), meaning it is highly inefficient.
- Therefore, "**High consumption of energy**" (implying a high energy output or high-efficiency state) is NOT a consequence of anaerobic pathways; rather, it is characterized by an energy deficit.
- The accumulation of lactic acid leads to tiredness, pain, and cramps.

Why other options are incorrect:

- Cramps, pain, and tiredness are all direct physiological consequences of the lactic acid buildup during anaerobic exertion.

Question #64 Key: (D)

BUMHS 2022

Which of the following is used in baking? [BUMHS-2022]

CORE CONCEPT AND DERIVATION

The baking of bread relies on the metabolic byproducts of yeast.

Solution:

- In baking, yeast cells are trapped inside the dough where oxygen is rapidly depleted.
- The yeast undergoes **anaerobic respiration (alcoholic fermentation)**, converting sugars into ethanol and CO_2 gas.
- The trapped CO_2 bubbles cause the dough to rise, giving bread its fluffy texture.

Why other options are incorrect:

- Aerobic respiration does not produce the rapid burst of CO_2 gas in a trapped, oxygen-deprived dough environment necessary for rising.

Question #65 Key: (A)

DUHS 2022

Net ATP produced at the end of glycolysis: [DUHS-2022]

CORE CONCEPT AND DERIVATION

Glycolysis includes an investment (preparatory) phase and a payoff phase.

Solution:

- During the preparatory phase, the cell consumes **2 ATP** to phosphorylate glucose.
- During the payoff phase, substrate-level phosphorylation produces a total of **4 ATP**.
- The net gain is calculated as: 4 (produced) - 2 (invested) = **2 ATP**.

Why other options are incorrect:

- 4 ATP is the gross production, not the net.
- 6 and 3 ATP do not reflect the stoichiometry of glycolysis.

Question #66 Key: (D)

DUHS 2022

*Pyruvic acid is acid of: [DUHS-2022]***CORE CONCEPT AND DERIVATION**

Glycolysis is the splitting of a single sugar molecule into two smaller molecules.

Solution:

- Glucose is a 6-carbon sugar.
- During glycolysis, it is ultimately split into two molecules of pyruvic acid.
- Therefore, each pyruvic acid molecule is a **3-carbon compound**.

Why other options are incorrect:

- 4-carbon compounds are typical in the Krebs cycle (e.g., oxaloacetate).
- 5-carbon compounds include RuBP (Calvin cycle) or alpha-ketoglutarate (Krebs cycle).
- 6-carbon compounds include glucose and citrate.

Question #67 Key: (D)

KMU 2022

*In aerobic respiration, glucose molecule is completely broken down into [Formula], [Formula] and _ . [ETEA-20...]***CORE CONCEPT AND DERIVATION**

Aerobic cellular respiration maximizes the extraction of energy from a single glucose molecule.

Solution:

- In eukaryotic cells, the complete oxidation of one glucose molecule yields a net total of roughly **36 ATP**.
- This includes 2 net ATP from glycolysis, 2 from the Krebs cycle, and 32 from the electron transport chain.

Why other options are incorrect:

- 2 ATP is the yield from anaerobic respiration (glycolysis only).
- 34 ATP represents just the typical output of the electron transport chain (or an intermediate estimate), not the complete net yield.