Ch: 4 Bioenergetics

→ Short Answer Questions

Q1- What is electromagnetic spectrum?
The full range of electromagnetic radiation in the universe is called electromagnetic spectrum. Sunlight is an electromagnetic form of energy. It includes different wave lengths and frequencies ranging from radio waves to gama rays.

Q2- Explain "action spectrum" of photosynthesis:
The action spectrum of photosynthesis is a graph that shows ~~that~~ the relative effectiveness of different wavelengths of light in driving the photosynthesis process. It is usually represented by plotting the rate of photosynthesis against the wavelength of light, indicating which wavelength are most effectively absorbed and utilized by chlorophyll pigments.

Q3- What are the types of chlorophyll:?
Chlorophyll a - The primary pigment involved in Photosynthesis absorbing light mostly in the blue-voilet and red regions.

chlorophyll b : An accessory pigment that helps broaden the range of light ~~take~~ that a plant can use for photosynthesis, absorbing mainly blue light.

Chlorophyll c, d, F :

found in various types of algae and cynobacteria.

Q4- What is the importance carotene ?

Carotene is an important accessory pigment in photosynthesis. it helps in capturing light energy in the blue-green and voilet regions of the spectrum and transfers it to chlorophyll a for use in the light-dependent reactions. Carotene also protects the plant cell by quenching excess energy and preventing damage caused by harmful oxygen species.

Q5- Describe "absorption spectrum" in photosynthesis.

The absorption spectrum in photosynthesis is a graph that shows the specific wavelengths of light absorbed by the different pigments involved in photosynthesis, such as chlorophyll a chlorophyll b, and caroteneoids. it highlights the effectiveness of different pigments in absorbing light energy at various wavelength.

Q6- What is photosystem? Explain →

A photosystem is a protein-pigment complex found in the thylakoid membrane of chloroplasts, which plays a crucial role in the light-dependent reactions of photosynthesis. They are two types of photosystems:

Photosystem I: Absorb light best at wavelength of 700 nm.

Photosystem II: Absorb light best at a ~~680~~ wavelenght of 680 nm.

Each photosystem is responsible for capturing light energy and converting it into chemical energy by faciliating the transfer of electron.

Q7- What is the role of carbon-dioxide in photosynthesis?

Carbon-dioxide CO_2 is a key reactent in the photosynthetic process. During the Calvin cycle (light in-d-) CO_2 is fixed into organic molecules to produce glucose and other carbohydrates, which serve as energy storage molecules for the plant.

Q8- How it was confirmed that " plants split water as a source of hydrogen releasing hydrogen as a byproduct ?

This was confirmed through experiments using istopes of oxygen. When plants were supplied with water containing heavy oxygen ($O18$), the oxygen gas released during photosynthesis was found to contain O^{18}, indicating that the oxygen released as a byproduct comes from water molecules rather than carbon dioxide.

Q9- What is the importance of G3P ?

Glyceraldehyde - 3 - phosphate (G3P) is a crucial intermediate in the calvin cycle of photosynthesis. it is the first stable product formed during CO_2 fixation and serves as a building block for the synthesis of gulucose and other carbohydrates. G3P can also be used in other metabolic pathways to produce lipids, amino acids and nucleotids.

Q10- What is the effect of temprature on the activities of RuBisCO ?

The enzyme RuBisCO, which catalyzes the fixation of carbondiocide in the calvin cycle, is sensitive to temprature. At low tenprahres. the enzyme's activity decreases slowing down the photosynthetic process. At higher temperatures, RuBisCO may favour oxygenation over carboxylation, leading to increased photorespiration, which is less efficient for the plant.

Q11- What are the disadvantages of Photorespiration?

The disadvantages of photorespiration include:

Energy Waste: photorespiration consumes energy (ATP) and reducing power (NADPH) without producing glucose or any useful out put.

Carbon loss:

Photorespiration leads to the loss of fixed carbon as CO_2, which reduces the efficiency of photosynthesis.

Reduced Growth:

Due to the loss of energy and carbon, plants may show reduced growth and productivity under conditions favouring

Photorespiration -

Q12- How photorespiration envolved?

Photorespiration is believed to have envolved as a result of high atmospheric oxygen levels and low carbon dioxide concentration during the early evolution of photosynthetic organisms - RuBisCO, which envolved under these conditions, has both carboxylase and oxygenase activity, leading to the ocurence of photorespiration as a side reaction - RubisCO performs oxyganase activity and fix oxygen instead of CO_2 in photo respiration.

DIFFERENCES, Q13, CHAPTER # 4

Q13. a. Chlorophyll a and Chlorophyll b

Chlorophyll a	Chlorophyll b
1. It is a bluish green pigment.	1. It is a yellowish green pigment.
2. It is found in all photosynthetic organisms except photosynthetic bacteria.	2. It is found in all photosynthetic organisms except brown and red algae, dinoflagellates and photosynthetic bacteria
3. It is a primary pigment in photosynthesis involved in converting light energy into chemical energy.	3. It is an accessory pigment that broadens light absorption and transfers light energy to chlorophyll a.
4. It has a methyl group ($-CH_3$) attached to the second pyrrole ring in its structure	4. It has an aldehyde group ($-CHO$) attached to the second pyrrole ring in its structure.
5. Its molecular formula is $C_{55}H_{72}O_5N_4Mg$	5. Its molecular formula is $C_{55}H_{70}O_6N_4Mg$

* Chlorophyll b cannot convert light energy into chemical energy so it broadens the light absorption spectrum of chlorophyll a.

Q13. b. Carotene and Xanthophyll

Carotene	Xanthophyll
1. It is orange red pigments composed of isoprenoid units.	1. It is yellow pigments composed of isoprenoid units
2. It is a hydrocarbon carotenoid consisting of only carbon and hydrogen atoms.	2. It is an oxygenated carotenoid consisting of oxygen, hydrogen, carbon at
3. It captures light energy and protects the plant from excess light in photosynthesis.	3. It also absorps light however it dissipates / releas excess light energy to preven damage to the plant in photosynthesis.
4. It is non polar thus fat soluble.	4. It is polar due to prese of oxygen but still fat so
I.E.	I.E.
Beta-Carotene, Lycopene	Lutein, Zeaxanthin

Q13. c. Action Spectrum and Absorption Spectrum

Action Spectrum	Absorption Spectrum
1. It represents the effectiveness of different wavelengths in driving a biological process	1. It represents the wavelengths of light absorbed by a pigment.
2. It is determined by observing the rate of a specific biological process at various different wavelengths.	2. It is determined by passing light through a pigment and recording transmitted light intensity.
3. It shows peaks that align with the absorption spectrum	3. It shows distinct peaks corresponding to specific wavelengths absorbed by pigment
4. It basically represents the contribution of each wavelength in a biological process	4. It basically represents the amount of light absorbed by a pigment in a biological process.
5. It helps identify which wavelengths are most effective for the specific biological process.	5. It provides insight into the absorption properties and efficiency of pigments in absorbing light energy

*. Action spectrum shows how much the process increases or decreases at specific / different wavelengths. absorption spectrum shows how much light is absorbed by a pigment.

Q13.d. Absorption Spectrum of Chlorophyll a and b.

A.S of Chlorophyll a	A.S of Chlorophyll b
1. The peak absorption of pigment chlorophyll a is at 430 nm (blue-violet) and 668 nm (red) regions.	1. The peak absorption of pigment chlorophyll b is at 455 nm (blue) and 642 nm (red-orange) regions.
2. Chlorophyll a is less efficient at absorbing green region of light thus causing plants to reflect green pigment.	2. Chlorophyll b is less efficient at absorbing green and yellow regions of light thus causing plants to reflect both pigments.
3. Chlorophyll a has a narrower absorption spectrum.	3. Chlorophyll b has a broader absorption spectrum.
4. Chlorophyll a absorbs wavelengths crucial for initiating photosynthesis.	4. Chlorophyll b extends the absorption spectrum for photosynthesis by absorbing wavelengths that chlorophyll a cannot absorb.

Q13.e. Antenna Complex and reaction Centre

Antenna Complex	Reaction Centre
1. It captures and transfers light energy to the reaction centre.	1. It converts the light energy into chemical energy via electron transfer.
2. It contains various pigments I.E. chlorophylls, carotenoids	2. It contains specialized chlorophyll a molecules and proteins for electron transfer.

It enhances light absorption and funnels it to the reaction centre for photosynthesis.	3. It converts light energy into chemical energy which is essential for photosynthesis.
It surrounds the reaction centre in the photosystem	4. It is located at the core of the photosystem
It passes energy to the reaction centre via resonance energy transfer.	5. It uses the transferred energy to excite electrons, leading to ATP and NADPH production.

ergy transfer. | leading to ATP and NADPH production.

Q18. f. Photosystem I and photosystem II

Photosystem I:	Photosystem II
It is a protein pigment complex that produces NADPH used in the calvin cycle.	1. It is a protein pigment complex that produces ATP used in the calvin cycle.
It transfers electrons to NADP$^+$ to form NADPH.	2. It transfers electrons to the cytochrome b6f complex in the electron transport chain.
It receives electrons from the electron transport chain	3. It transfers electrons to electron transport chain

	electron transport chain.
It receives electrons from the electron transport chain.	3. It transfers electrons to electron transport chain.
It absorbs light at 700nm so it is also called as P700.	4. It absorbs light at 680nm so it is called as P680.
It is responsible for reduction of $NADP^+$.	5. It is responsible for photolysis and phosphorylation.

6. It does not directly produce oxygen.	6. It produces oxygen as a byproduct of photolysis of H_2O
7. It is located in the stroma thylakoids and the edges of the grana	7. It is located in the granum thylakoids.

Q13. g. Light dependent and light independent reactions of photosynthesis.

Light dependent reaction	Light independent reaction
1. It is a phase of photosynthesis that occurs in the thylakoid membranes of the chloroplasts.	1. It is a phase of photosynthesis that occurs in the stroma of the chloroplasts.
2. It is also called photochemical reactions or Hill reaction.	2. It is also called dark reaction or Calvin cycle.

3. It needs light to occur.	3. It does not need sunlight to occur.
4. It uses light energy to proceed	4. It uses ATP and NADPH produced from LDR
5. It is driven by processes like photophosphorylation and Electron transport chain and Photolysis of water	5. It is driven by the process of carbon fixation and reduction.
6. It releases oxygen as a byproduct.	6. It does not release oxygen as a byproduct.

The products of light dependent reaction are ; Oxygen, ATP, NADPH	7. The product of Light independent reaction is ; G3P
The input of LDR are ; Sunlight energy, H_2O, $NADP^+$, ADP and Pi (inorganic phosphate)	8. The input of LIR are ; CO_2, NADPH, ATP

Q13. h. Oxidative Phosphorylation and photophosphorylation

Q13. h. Oxidative phosphorylation and photophosphorylation

Oxidative phosphorylation	Photophosphorylation
1. It ... ATP	1. It is the light driven

Q18.h. Oxidative phosphorylation and photophosphorylation

Oxidative phosphorylation	Photophosphorylation
1. It is the production of ATP by the oxidation of NADH and $FADH_2$ during respiration.	1. It is the light driven process producing ATP or ATP and NADPH during light reaction
2. It is a non-cyclic process producing H_2O as a byproduct and ATP.	2. It can be cyclic and non cyclic producing ATP or ATP and NADPH respectively.
3. It occurs in the inner mitochondrial membrane.	3. It occurs in the thylakoid membrane of chloroplast.
4. Electron transport chain generates a proton gradient across the mitochondrial membrane which produces ATP through ATP synthase.	4. Electron transport chain generates a proton gradient across the thylakoid membrane which produces ATP through ATP synthase
5. It is a process of cellular respiration.	5. It is a process of photosynthesis.
6. It uses energy from the oxidation of nutrients.	6. It uses energy from the sunlight.

Q18.i. Cyclic photophosphorylation and non-cylic photophosphorylation

Cyclic Phosphorylation	Non-cyclic phosphorylation
1. It is the production of ATP during light reaction.	1. It is the production of ATP and NADPH during light reaction
2. It occurs when the cell needs ATP and has excess of NADPH	2. It occurs when the cell requires both ATP and NADPH

In this process, electrons cycle back to photosystem I.	3. In this process, electrons donot cycle back.
Photolysis does not occur so oxygen is not released and electrons flow in a cycle thus not reducing $NADP^+$.	4. Photolysis of water occurs so oxygen is released as a byproduct while electrons are used to reduce $NADP^+$.
In this process, Photosystem I is involved.	5. In this process, Photosystem I and photosystem II is involved.

Q13.j. C_4 Carbon Fixation and C_3 Carbon Fixation

C_4 Carbon Fixation	C_3 Carbon Fixation
1. It is the process where carbon dioxide is initially fixed by phosphoenol pyruvate producing a 4-carbon compound (oxaloacetate)	1. It is the process where carbon dioxide is fixed by Ribulose bisphosphate carboxylase/oxygenase producing a 3 carbon compound (3-phosphoglycerate)
2. It takes place in the mesophyll cells and directly occurs in Calvin cycle when 4-carbon compound releases CO_2 in bundle sheath cells during Calvin Cycle.	2. It takes place in the mesophyll cells during Calvin cycle which also happens in mesophyll cells.
3. Oxaloacetate is converted to malate which releases CO_2.	3. 3-phosphoglycerate is used to form various sugars
4. It is more water efficient	4. It is less water efficient.
5. The concentration of CO_2 is	5. The concentration of CO_2

5. The concentration of CO_2 is high around RuBisCO.	5. The concentration of CO_2 is less around RuBisCO.
6. It functions better at higher temperature (above 30°C)	6. It functions better at lower temperature (below 25°C)
7. It requires more ATP for steps outside the Calvin Cycle.	7. It requires ATP only for calvin cycle.
8. Plants using C_4 pathway are called C_4 plants I.E. Wheat, Barley	8. Plants using C_3 pathway are called C_3 plants I.E. Maize, Sugarcane

Q.K. Lactic Acid and Alcoholic Fermentation

Lactic Acid Fermentation	Alcoholic Fermentation
It occurs in animal's muscle cells, anaerobic bacteria and some fungi.	1. It occurs in yeast, some bacteria and plant cells.
It produces lactic acid.	2. It produces ethanol and carbon dioxide.
In this process, 2-pyruvate is reduced to lactic acid and NAD^+ is regenerated.	3. In this process, Acetaldehyde is reduced to ethanol and NAD^+ is regenerated.
In this process, decarboxylation of pyruvate does not take place.	4. In this process, pyruvate is converted into acetaldehyde by decarboxylation.
It does not produce CO_2.	5. It produces CO_2.
Some of its examples are; Yogurt, pickles	6. Some of its examples are; Beer, bread

Q.13. L. Calvin Cycle and Krebs Cycle

Q13. l. Calvin Cycle and Krebs Cycle

Calvin Cycle	Krebs Cycle
1. It is the series of metabolic reactions in which CO_2 is reduced to produce G3P	1. It is a series of metabolic reactions in which acetyl-CoA is oxidized to produce CO_2, ATP and high energy electron carriers.
2. It occurs in the stroma of the chloroplast.	2. It occurs in the mitochondrial matrix.
3. It does not require oxygen.	3. It requires oxygen.
4. It is a stage of photosynthesis.	4. It is a stage of cellular respiration.
5. It includes processes like reduction, phosphorylation, carboxylation.	5. It includes processes like substrate level phosphorylation, oxidative decarboxylation, oxidation, reduction.
6. The energy carriers are ATP, NADPH	6. The energy carriers are NADH, $FADH_2$, ATP
7. CO_2 is fixed to form 4 or 3-carbon compound.	7. Carbon is released as a waste product.
8. The input is ; CO_2 The output is ; G3P	8. The inputs are ; Acetyl-CoA, ADP + Pi, NAD^+, FAD. The outputs are ; CO_2, ATP, NADH, $FADH_2$

Q13. m. Oxidative phosphorylation and substrate level phosphorylation

Oxidative Phosphorylation	Substrate level phosphorylation

Q13. m. Oxidative phosphorylation and substrate level phosphorylation

Oxidative Phosphorylation	Substrate level phosphorylation
1. It is the production of ATP by the oxidation of NADH and $FADH_2$.	1. It is the production of ATP by the transferring of a phosphate group directly from a substrate molecule to ADP through an enzyme
2. It happens in chemiosmosis and Electron transport chain.	2. It happens in glycolysis and kreb cycle.

Biology

It occurs in the mitochondrial membrane.	3. It occurs in the cytoplasm or mitochondrial matrix.
ATP is produced through a proton gradient.	4. ATP is produced directly from a substrate without the involvement of a proton gradient.
It requires oxygen	5. It does not require oxygen.
It produces a large amount of ATP (34 ATP molecules).	6. It produces less amount of ATP (2 ATP molecules).
It is a complex process which involves electron transport, proton gradient, ATP synthase.	7. It is a simpler process which involves enzyme catalyzed transfer.