B.Sc.(RT) III Semester

AU – 7020

RTB: 306 Plant Physiology and Biochemistry

Model Answer

Section - A

(i) (d) Transpiration

(ii) (d) All of the above

(iii) (b) PS – II

(iv) (b) PGA

(v) (b) Lenticles

(vi) (a) 686 Kcal

(vii) (b) Ethylene

(viii) (c) Shoot apex

(ix) (d) Amino acid

(x) (b) Apoenzyme

Section - B

2. Factors affecting Transpiration:

Transpiration process may be affected by both internal as well as external factors:

Internal factors:

(i) Stomatal apparatus (ii) Stomatal frequency

External factors:

(i) Humidity of air (ii) Temperature (iii) Wind velocity (iv) Light (v) Atmospheric pressure (vi) Water supply

Internal factors:

(i) Stomatal apparatus: Certain plants are adapted to reduce the rate of transpiration. e.g. reduced size of leaves, needle-like or spine like leaves. The rate of transpiration is further checked by the deposition of cutin or wax like substances of leaves. In several plants, stomata are found in cavities or sunken stomata surrounded by hairs.

(ii) Stomatal frequency: It varies from plant to plant and also depends upon the effect of environment. If the stomata are open, with increased stomatal frequency the rate of transpiration increases. It also depends upon the degree of opening of stomata.

External factors:

(i) Humidity of the air: The higher the relative humidity of the atmosphere lower will be the rate of transpiration. The rate of transpiration increases with the decrease in the humidity of the external environment.

(ii) Temperature: The increase in temperature increases the rate of transpiration by increasing the rate of evaporation of water from cell surface and decreases the humidity of the external environment.

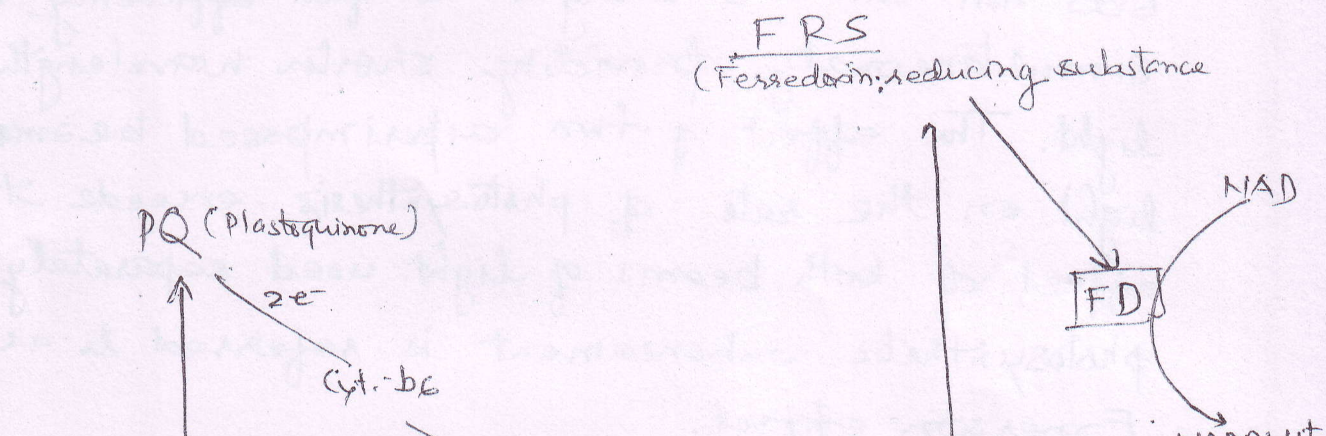
(iii) Wind velocity: The increase in the wind increases the rate of transpiration by removing the water vapour of the atmosphere and lowering the relative humidity. The Transpiration is faster in mild wind. The wind of much higher velocity, however, retards the rate of transpiration probably due to closer of stomata.

(iv) Light: Light has got no direct effect on the rate of transpiration, but indirectly it affects the rate in two ways by controlling the stomatal opening and by affecting the temperature.

(v) Atmospheric pressure: The reduction of atmospheric pressure reduces the density of the external atmosphere thus permitting more rapid diffusion of water. The plant growing on hill show higher rates of transpiration because of low atmospheric pressure and they develop xerophytic characters.

(vi) Water Supply: Deficiency of water in the soil decreases the rate of transpiration indirectly by decreasing the rate of absorption.

Ans. 3.



Schematic representation of non-cyclic photophosphorylation

Ans 4. Red drop: Quantum yield is defined as the number of O_2 molecules released per light quanta absorbed in the process. Emerson and Lewis (1943) observed that quantum yield declined sharply at the wavelength greater than 680 nm in the red zone, this decline is called red drop.

Emerson effect: Emerson and Chalmers (1952) found that in the quantum yield of photosynthesis beyond 680 nm can be brought to full efficiency by simultaneously providing shorter wavelength of light. The effect of two superimposed beams of light on the rate of photosynthesis exceeds the sum effect of both beams of light used separately. This photosynthetic enhancement is referred to as Emerson effect.

Ans. 5. Difference between aerobic and anaerobic respiration.

Aerobic respiration	Anaerobic respiration
1. It is common to all plants	1. It is of rare occurrence in plants.
2. Energy is liberated in larger quantity. In total, 38 ATP molecule are formed.	2. Energy is liberated in lesser quantity. Only 2 ATP molecules are formed.
3. Oxygen is ~~liberated~~ utilized during the process	3. It occurs in the absence of Oxygen.
4. The carbohydrates are oxidised completely and are broken down into CO_2 and H_2O.	4. the carbohydrates are oxidised incompletely and ethyl alcohol and CO_2 are formed.

Contd....

5. The end products are CO_2 and water.	5. The end products are ethyl alcohol and CO_2.
6. The process takes place partly (glycolysis) in the cytosol and partly (Kreb cycle) inside the mitochondria.	6. The process occurs only in the cytosol.

Ans 6. Physiological role of Cytokinins.

1. Cell division: The most important function of cytokinins is the promotion of cell division. It is now well established that these are true cell division factors. The varying amounts of cytokinins, along with sufficient auxin is required for the growth of callus in tissue culture experiments.

2. Cell enlargment: The cytokinins can also cause the enlargement of cells in leaf discs and Cotyledons. This effect of kinetin can occur in the absence of auxin.

3. Initiation of interfascicular cambium: The cytokinins can induce the formation of interfascicular cambium in plants.

4. Morphogenesis: Cytokinins play a vital role in the morphogenesis in plants. It is now well documented that kinetin - auxin interaction controls the morphogenetic differentiation of shoot and root meristems. In plant tissue culture callus tissue grown in high auxin and low cytokinin produced only roots whereas high kinetin and low auxin could promote the formation of shoot buds.

5. Breaking of dormancy: Cytokinins can break the dormancy ... seeds and also promote their germination.

6. <u>Delay of senescence</u>: Senescence is the phenomenon in which the leaves los their pigment chlorophyll, turn yellow, proteins are degraded and ultimately they shed from the plants. Application of cytokinins delay the phenomenon of senescence. It helps the leaves to remain gree ~~much~~ much longer by reducing the break down of chlorophyll, protein and nucleic acid.

7. <u>Accumulation and translocation of solutes</u>: A high production of cytokinins in some plants helps them to grow stunted. Cytokinins also help solute translocation in phloem.

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Ans. 7. Enzymes were discovered by a German Scientist <u>Buchner</u> (1897). This Term was coined by W. Kuhne (1898) while working on Fermentation.

According to Mayback (1952) "Enzymes are simple or compound proteins acting as ~~spec~~ specific catalysts."

Enzymes are proteinaceous in nature. Enzymes may entirely consist of protein (simple protein enzyme) or may contain a non-protein part (conjugated protein enzyme).

<u>Characteristic features of Enzyme</u>:

1. Enzymes are colloidal in nature. Being colloidal, enzymes are hydrophilic in nature and form hydrosols in the free state.
2. Enzymes lowe dow the energy of activation.
3. Enzymes can react with both acidic and alkaline substances.
4. Enzymes are thermolabile. They are heat sensitive.
5. Enzyme activity can be inhibited or accelerated.
6. Enzyme are required in a very small quantity yet they are capable of bringing about a change in a large amount of substrate.
7. Enzymes are specific in their ~~spec~~ action.

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Section – C

Ans. 8 C4 Cycle:

C_4 cycle is also known as dicarboxylic acid cycle or Hatch and Slack cycle. This mechanism has been reported not only in the members of Graminae but also among certain members of Cyperaceae, Portulacaceae etc.

- C_4 cycle mainly occurs in chloroplast of mesophyll cell and chloroplast of bundle sheath.
- The Phosphoenolpyruvic acid (PEP) was found to be the CO_2 acceptor molecule.
- The first stable product is formed after the carboxylation of PEP is Oxalo ~~acetic~~ acetic a which is 4C compound, hence this cycle is known as C4 cycle.

The main features of C_4 cycle is as follows:

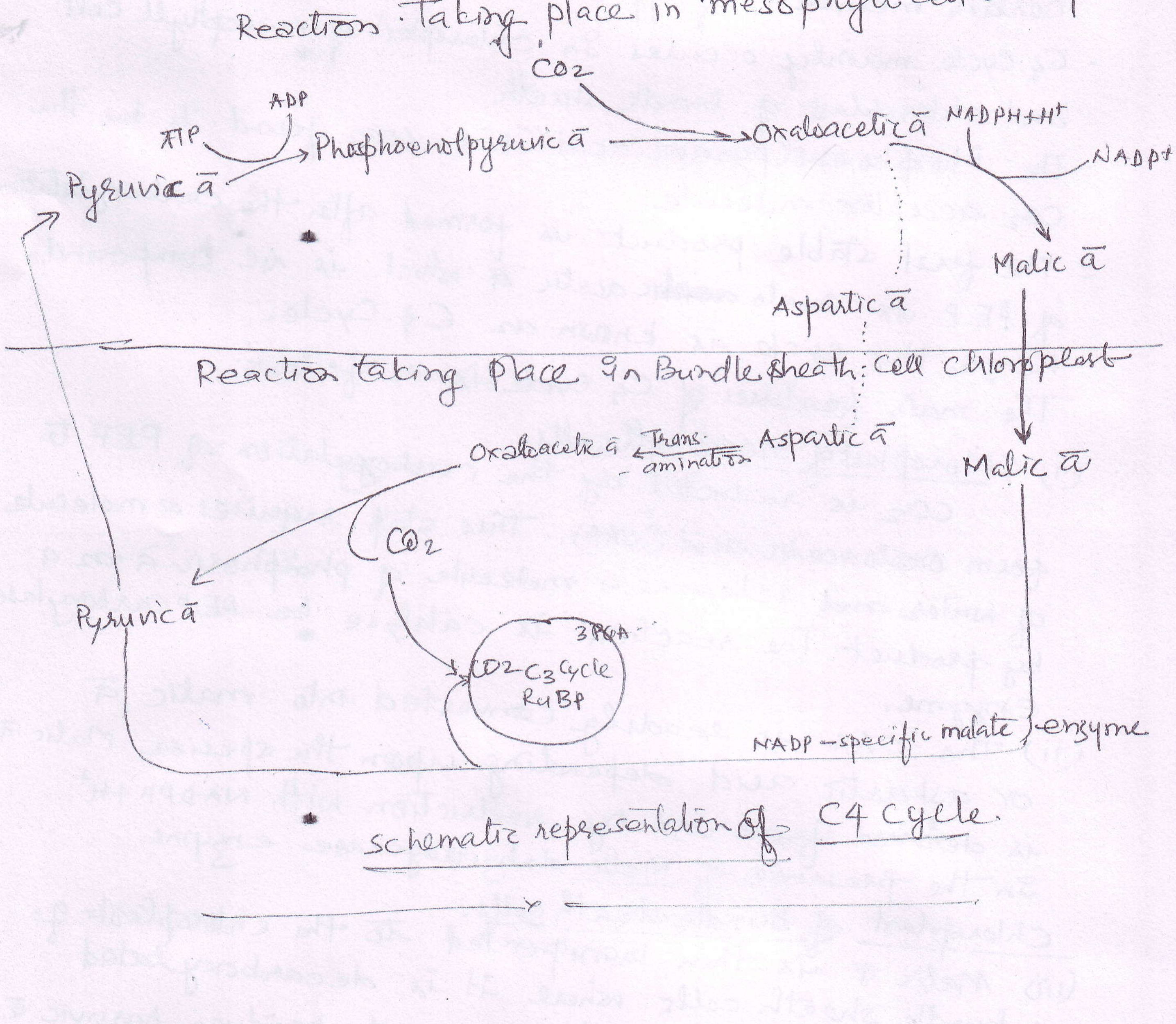
(i) Chloroplast of mesophyll cells
CO_2 is reduced by the carboxylation of PEP to form oxaloacetic acid (OAA). This step requires a molecule of water and releases a molecule of phosphoric a as a by product. The reaction is catalyse be PEP carboxylase enzyme.

(ii) The OAA is readily converted into malic a or aspartic acid depending upon the species. Malic a is derived from OAA by reduction with $NADPH + H^+$ in the presence of Malic dehydrogenase enzyme.

Chloroplast of bundle sheath cells:

(iii) Malic a is then transported to the chloroplasts of bundle sheath cells where it is decarboxylated by NADP specific malate enzyme to produce pyruvic a and CO_2. The released CO_2 is used in the carboxylation of Ribulose 1-5, diphosphate in the presence of enzyme carboxydismutase to produce, 3 phosphoglyceric acid, the first product of Calvin cycle of photosynthesis.

Simultaneously, the pyruvic ā is transported back to the chloroplast of mesophyll cell where it is reconverted into the phosphoenolpyruvic ā by utilizing ATP in the presence of the enzyme pyruvate phosphate dikinase.



Schematic representation of C4 cycle.

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Ans. 9 Photorespiration: Krotkov (1963) introduced the term photorespiration to refer to the release of CO_2 in respiration in presence of light. The process is carried out only in presence of light.

Essential condition for photorespiration:

(i) Rise in Temperature

(ii) High O_2/CO_2 ratio

Under these conditions RuBP carboxylase is unable to catalyse CO_2 fixation and the RuBP carboxylase switches to oxygenase activity. As a result a 2-carbon phosphoglycolic acid and a 3 carbon phosphoglyceric acid are formed.

Three organelles - chloroplast, peroxisome and mitochondria participate in the photorespiration process.

In Chloroplast:

Under these two above mentioned conditions the RuDP carboxylase switches to oxygenase activity and result in the formation of a 2-C phospho-glycolic acid and a 3-carbon phosphoglyceric ā are formed. The phosphoglycolic ā is easily converted into glycolic acid.

RuDP + O_2 ⟶ Phosphoglycolic ā + Phosphoglyceric ā

Phosphoglycolic ā + H_2O ⟶ Glycolic ā + Phosphoric ā

Glycolic ā is transported to peroxisomes.

In Peroxisome:

Glycolic ā is converted into glyoxylic ā in presence of the enzyme glycolate oxidase. In the reaction H_2O_2 is also formed which is destroyed by the enzyme catalase into oxygen and water.

Glycolic ā + O_2 $\xrightarrow[\text{light}]{\text{Glycolate oxidase}}$ Glyoxylic acid + H_2O_2

$2H_2O_2$ $\xrightarrow{\text{catalase}}$ $2H_2O$ + O_2

In the next step, glyoxylic acid is converted into glycine in the presence of the enzyme glutamate glyoxylate aminotransferase.

Glyoxylic acid + Glutamic acid $\xrightarrow[\text{glyoxylate aminotransferase}]{\text{Glutamate}}$ Glycine + α-ketoglutaric acid

Glycine is transported to mitochondria via cytoplasm.

In mitochondria:

In mitochondria the two glycine molecules react to produce one molecule each of serine, CO_2 and NH_3. Serine is then transported out of mitochondria and into the peroxisomes where it is converted to hydroxy-pyruvic a and glyceric acid. Glyceric ā is transported out of peroxisome into chloroplast where it is phosphorylated by ATP to 3-phosphoglyceric acid which is ultimately used in photosynthetic carbon reduction cycle.

2 Glycine + H_2O + NAD^+ ⟶ Serine + CO_2 + NH_3 + NADH

In peroxisome: Serine ⟶ Hydroxypyruvic ā + glyceric acid.

In Chloroplast: glyceric ā $\xrightarrow{\text{ATP} \to \text{ADP}}$ 3-phosphoglyceric acid → (Photosynthetic carbon reduction cycle)

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Ans 10. Physiological role of Gibberellins (GA3)

1. Stem elongation: The most important effect of GA is stem elongation. GA3 induces internodal elongation. It has been confirmed in several plants such as pea, Tomato, cabbage etc. A rosette habit showing cabbage grows 2 m tall and produces flowers after treated with GA3.

2. Apical bud dormancy: The activity of apical meristem is almost independent of GA3. But under certain environmental condition when the apical bud become dormant and meristic activity ceases, Gibberellin can reverse this dormancy.

3. Role in sub apical meristem: GAs role in sub-apical meristem is direct. It regulates the mitotic processes in this region. Growth retardants resulted in cessation of cell division in this region and dwarfing of stem. The normal activity could be restored by subsequent addition of gibberellin.

4. Flowering: GAs also play an important role in the initiation of flowering. GAs induces flowering ~~in~~ in reenalised and long day plants. The synthesis of florigen is mediated through GA.

5. <u>Seed Germination</u>: During seed germination, the role of GA in the induction of synthesis of α-amylase and other hydrolytic enzymes amongs monocots and certain dicots is well documented. GA_3 appears mainly to induce the activity of the gluconeogenic enzyme during early stages of seed germination.

6. <u>Mobilization of foods in seed storage cell.</u>: Akazawa and Miyata (1982) working on cereal grains suggested that GA stimulates conversion of storage food materials into sucrose or mobile amino a or amides to facilitate their translocation via phloem into and throughout the young root and shoots.

Ans. 11

Lipids: Lipids are widely distributed important groups of organic substances found in plants and animals. Lipids consist of fats and their derivatives.

According to Bloor (1943) " Lipids are naturally occurring compounds, which are insoluble in water and soluble in one or more organic solvents and on hydrolysis yield fatty acids which are utilized by the living organisms.

Common properties of lipids.

(i) They are sparingly soluble in water.
(ii) They are appreciably soluble in one or more organic solvents.
(iii) They all exist as actual or potential esters of fatty acids.
(iv) They can be utilized by the living organisms.

Classification of lipids

Lipids are classified as simple lipids, compound or conjugated lipid, sterols and Prostaglandins.

A. **Simple lipids:** These are esters of fatty acids with alcohols.
(i) Fats are esters of fatty acids with glycerol.
(ii) Waxes are esters of high molecular weight fatty acids with alcohols other than glycerol.

Ex. Triglycerides.

B. **Compound lipids or conjugated lipids:** These lipids ~~yields~~ on hydrolysis yield in addition to alcohol and fatty acids, other group. They includes:
(i) Glycerophospholipids: Phosphoric ā and usually two fatty acids esterified to glycerol. e.g. phosphatidic ā
(ii) **Sphingophospholipids**; They contain the amine alcohol 4-spingenine instead of glycerol, in addition to a fatty acid, phosphoric ā and cholines.

(iii) Glycolipids: On hydrolysis they yield sphingenine, a fatty acid and a monosaccharide sugar.

C. Steroids: They included among lipids because of similar physical properties, although they have a different chemical structure based on their structure.

D. Prostaglandins: are derivatives of fatty acids and contain 20 carbon atoms.

Functions of lipids:

(i) Lipids are the most concentrated source of energy and provide double the amount of energy per gram material than carbohydrates and protein.

(ii) They participate in the structural framework of living tissues. Phospholipids are the principal constituent of membrane binding cytoplasm, vacuole, chloroplast etc.

(iii) Lipids are the components of the ETS in mitochondria and chloroplast.

(iv) Some lipids like waxes give a protective covering to the surface of leaves, stems and fruits.

(v) Some lipid derivatives such as chlorophylls and carotenoids are essential for photosynthesis in plants.

(vi) Some lipids are important as vitamins.

(vii) Lipids also occur as components of some enzyme systems.