Course: B.Sc Botany
SEMESTER IV
PAPER CODE: BOT GE 404
PAPER: Plant Physiology and Metabolism
TOPIC: Photorespiration
FACULTY: Isha Gaurav
Department of Botany
Email: ishagaurav86@gmail.com

Photorespiration

- Respiration that is initiated in chloroplasts and occurs in light only is called photorespiration.
- It is interesting to know that in the plants possessing Calvin cycle, the enzyme RuBP carboxylase can initiate the reversal of photosynthetic reactions. This process occurs when there is low CO_2, concentration but high O_2, concentration.

- At mid-day, when temperature and CO_2 content are high, the affinity of RuBP carboxylase increases for O_2 but decreases for CO_2. Thus, it converts RuBP to 3-carbon compound (PGA) and a 2-carbon compound (phosphoglycolate). The phosphoglycolate is converted rapidly to glycolate in the peroxisomes.
- Glycolate is further converted to glycine, serine, CO_2 and NH_3 without the generation of ATP or NADPH. Thus net result is oxidation of organic food synthesized during photosynthesis. This process is called photorespiration or glycolate pathway as it occurs at high rate in the presence of light. As already mentioned that photorespiration is a loss to the net productivity of green plants having Calvin cycle.
- The green plants having Calvin cycle are C_3 plants. Overcoming photo-respiratory loss poses a challenge to plants growing in the tropics. Photorespiration occurs due to fact that the active site of enzyme Rubisco (ribulose bisphosphate carboxylase oxygenase) is same for both carboxylation and oxygenation.

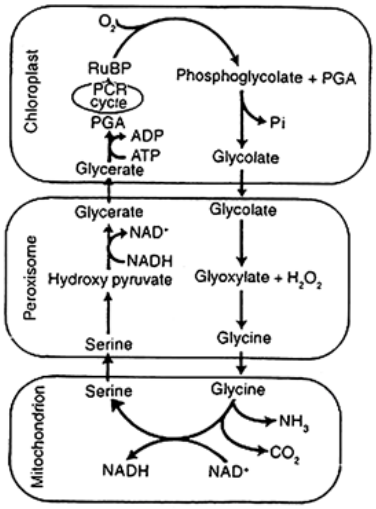

Fig: Photorespiration

- The oxygenation of RuBP (ribulose bisphosphate) in the presence of O_2 is first reaction of photorespiration that leads to the formation of one molecule of phosphoglycolate, a two-carbon compound and one molecule of PGA.

- Where PGA is used in Calvin cycle, and phosphoglycolate is dephosphorylated to form glycolate in the chloroplast.

- From chloroplast, glycolate is diffused to peroxisome where it is oxidised to in glyoxylate. Here glyoxylate is used to form amino acid, glycine. Now, glycine enters mitochondria where two glycine molecules (4 carbons) give rise to one molecule of serine (3 carbons) and one molecule of CO_2 (one carbon).
- Now, serene is taken up by peroxisome, and through a series of reactions is being converted into glycerate. This glycerate leaves the peroxisome and enters the chloroplast, where it is phosphorylated to form PGA.

- Now PGA molecule enters the Calvin cycle to make carbohydrates, but one CO_2 molecule released in mitochondria during photorespiration has to be re-fixed. This means, 75 per cent of the carbon lost by the oxygenation of RuBP is recovered and 25 per cent is lost as release of one molecule of CO_2.

Photorespiration is also known as photosynthetic carbon oxidation cycle.

This process involves an interaction of three organelles, i.e.,

(i) Chloroplast

(ii) Peroxisome, and

(iii) Mitochondria.

- Under conditions of high light and limited CO_2 supply, photorespiration plays an important role for protection of plants from photo-oxidative damage. This shows that if enough CO_2 is not available to utilise light energy for carboxylation, and excess energy inflicts damage to plants.

- However, photorespiration being oxygenation of RuBP, utilises part of light energy and saves the plant from photo-oxidative damage.

- The relative levels of O_2 and CO_2 are responsible for determination of the occurrence of photorespiration as both of these gases (O_2 and CO_2) compete for the same active site of enzyme Rubisco.
- Increased O_2 level increases photorespiration; while increased CO_2 level decreases photorespiration, and increases C_3 photosynthesis.