Subject — Botany
Semester — B.Sc. II
Topic — C_4 Cycle (Plant physiology)
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Lecture No.

CO_2 fixation in C_4 Plants / C_4 plants / Hatch & Slack Cycle

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The existence of C_4 pathway was for the first time reported by Kortschak et al in 1965 while studying the process of photosynthesis in sugarcane leaves. They studied the process of photosynthesis with the help of labelled carbon $C^{14}O_2$ and found that the labelled carbon was first incorporated with a four carbon compound i.e. oxalo acetic acid.

Later on Hatch and Slack made extensive study (1966-67 & 71) regarding the photosynthesis and they became successful in establishing the fact that the C_4 pathway was common in a good no. of plants. The example of C_4 plants are Maize, Sugarcane, Sorghum, Panicum (a type of Bajra) etc of family Graminaceae, Cyperaceae, Portulacaceae, Nyctaginaceae, Amaranthaceae, Chenopodiaceae.

The C_4 plants differ in their internal structure of leaves from that of C_3 plants. In C_4 plants vascular bundle remains covered with bundle sheath and the bundle sheath in its turn covered with — Concentric layer of mesophyll cells. These mesophyll cells and the cells of bundle sheath remain — connected with Plasmodesmata. In the Concentric layer of mesophyll cells considerable amount of grana remains present.

Not only that but also these mesophyll cells have peripheral reticulum.

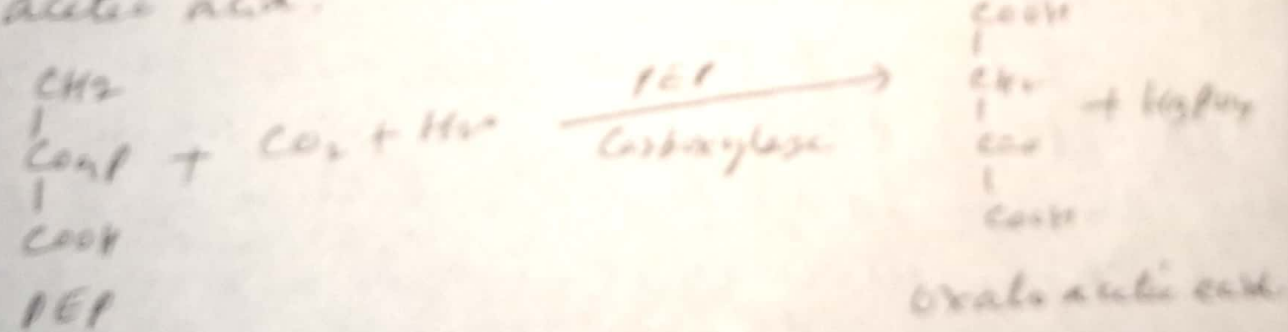
Mechanism of CO_2 fixation in C_4 plants

In all C_4 plants there are two CO_2 reduction cycle.

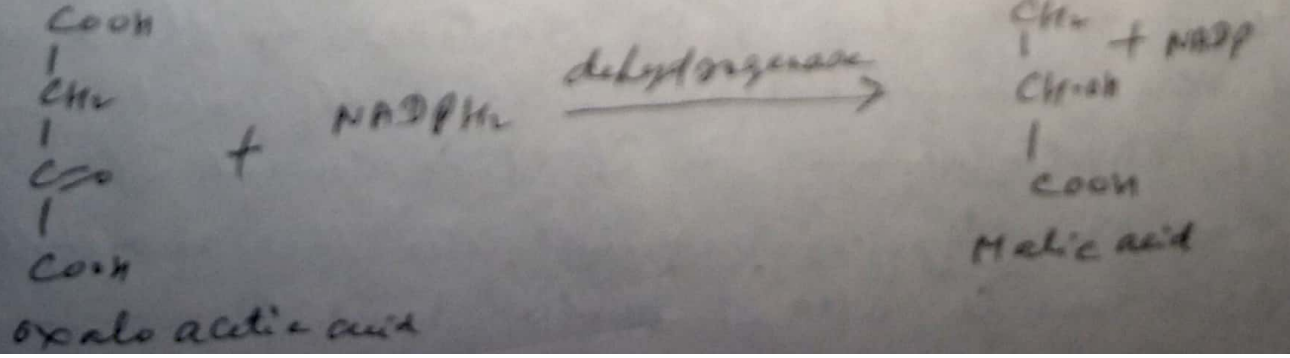
(a) Hatch and Slack cycle

(b) Calvin cycle

The initial CO_2 acceptor in C_4 plants is phosphoenol pyruvic acid PEP. The initial fixation of CO_2 occurs in mesophyll cells. This phosphoenol pyruvic acid reacts with a molecule of CO_2 in the presence of enzyme PEP-carboxylase. A molecule of water is also consumed in this reaction. The result of the reaction is the formation of oxalo acetic acid.

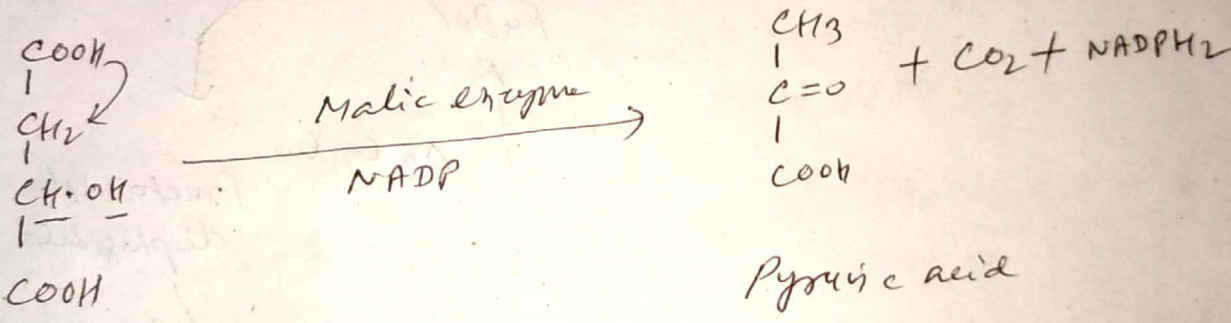


Thereafter this oxalo acetic acid is reduced into malic acid by the influence of enzyme "Malic dehydrogenase". Here NADPH functions as hydrogen donor.



This malic acid is then transferred from mesophyll cells to the cells of bundle sheath. There inside the bundle sheath malic acid undergoes — oxidative decarboxylation reaction. This reaction is catalysed by Malic enzyme and the end — product is the Pyruvic acid. This pyruvic acid is then transported back into the mesophyll cells where it is again converted into phospho enol Pyruvic acid.

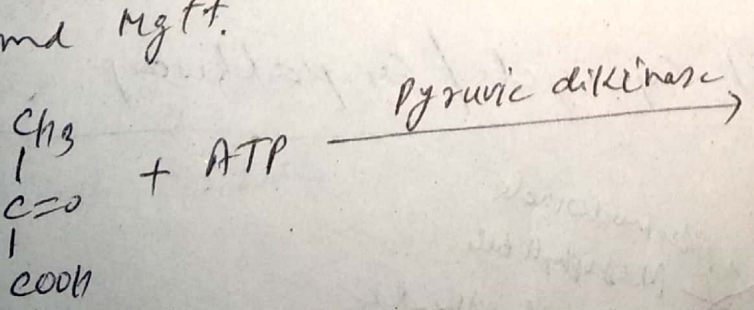
The CO_2 liberated during this reaction enters into the Calvin cycle i.e Pentose phosphate cycle.



Malic acid

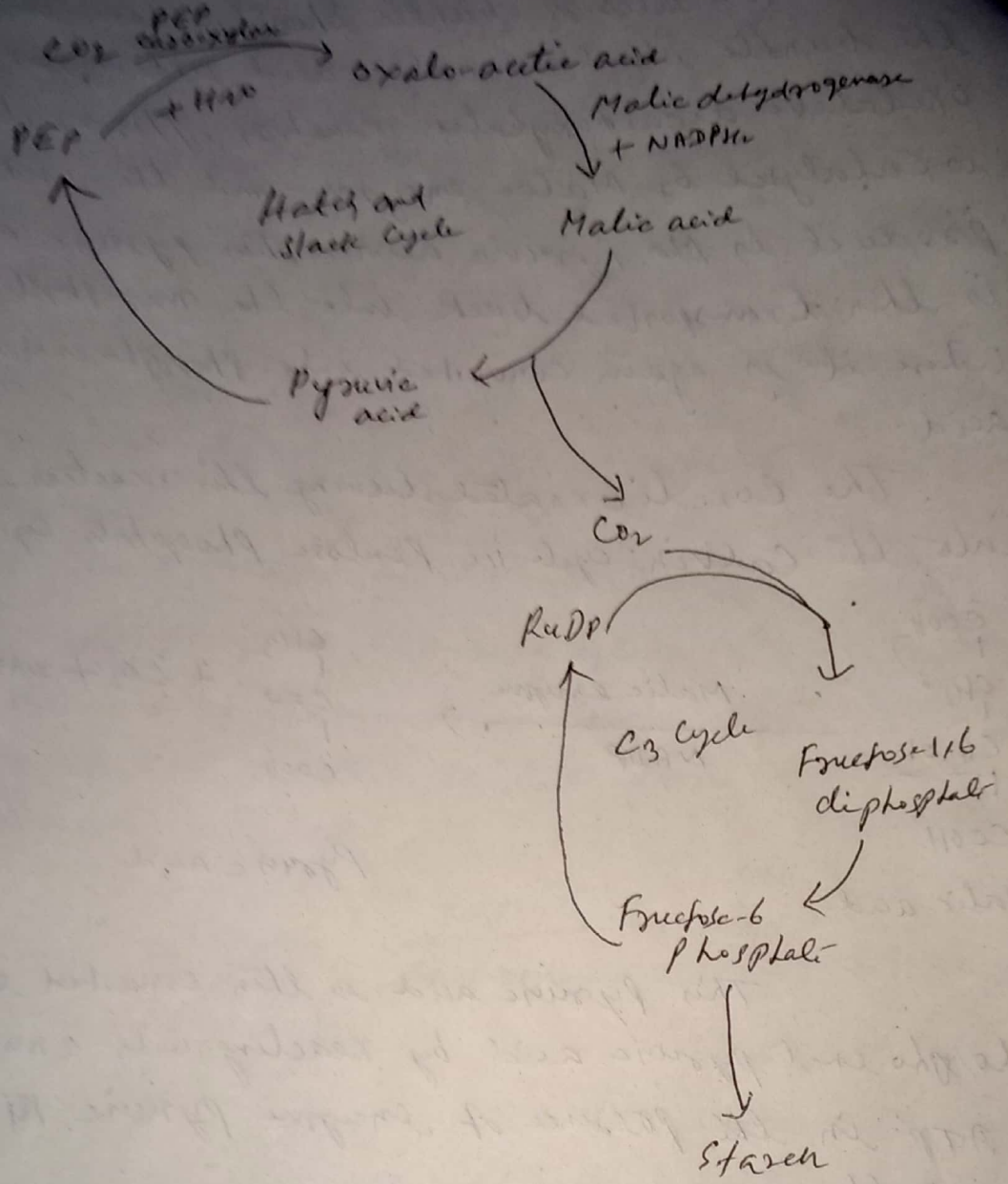
Pyruvic acid

This Pyruvic acid is then converted into phospho enol pyruvic acid by reacting with a molecule of ATP in the presence of enzyme Pyruvic Kinase and Mg^{++}.



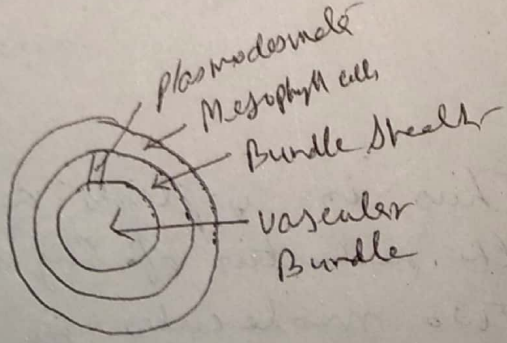
PEP.

Thus in C_4 plants a molecule of CO_2 requires for the reduction of Sugar, 5 molecules



Sketch diagram of C_4 cycle / C_4 pathway

C_4 plants



Kranz anatomy