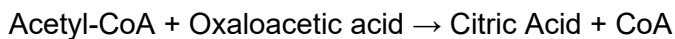


Glyoxylate Cycle: Steps and Significance

It had been observed by many plant physiologists that during the germination of fatty seeds, the fat content decreased with a simultaneous increase in sucrose (i.e., carbohydrates). This apparent conversion of fats into sucrose remained a mystery till 1957 when Kornberg and Krebs discovered that a strain of bacterium *Pseudomonas* could readily convert ^{14}C -labelled acetic acid into labelled malic acid and citric acid (these are intermediates of Krebs' Cycle) which involved the following reactions:

(1) Acetyl-CoA combined with Oxaloacetic acid to form Citric Acid.

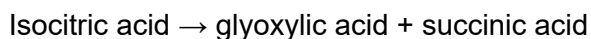


(Acetic acid first reacted with Coenzyme-A to form Acetyl CoA).

(2) Acetyl CoA reacted with glyoxylic acid in the presence of the enzyme malate synthetase to produce Malic acid.



The glyoxylic acid was obtained through the breakdown of Iso-Citric Acid (an intermediate of Krebs' Cycle) by the enzyme Isocitratase



On the bases of the above reactions Kornberg and Krebs (1957) framed a cycle which is called as Glyoxylic acid cycle or Glyoxylate Cycle through which the fats could be converted into sucrose (i.e., carbohydrate) during the germination of fatty seeds in plants.

The glyoxylate cycle (which is intimately associated with Krebs' Cycle) is now known to occur in many other bacteria, yeasts, molds, and higher plants and is completed in glyoxysomes, mitochondria and cytosol.

Steps Involved in Glyoxylate Cycle:

Various steps of this cycle (Fig. 14.3) occurring in higher plants especially during the germination of fatty seeds are as follows:

(a) Reactions in Glyoxysome:

(i) Acetyl-CoA produced after the β -oxidation of fatty acids (in glyoxysomes) condenses with oxaloacetic acid to form Citric Acid.

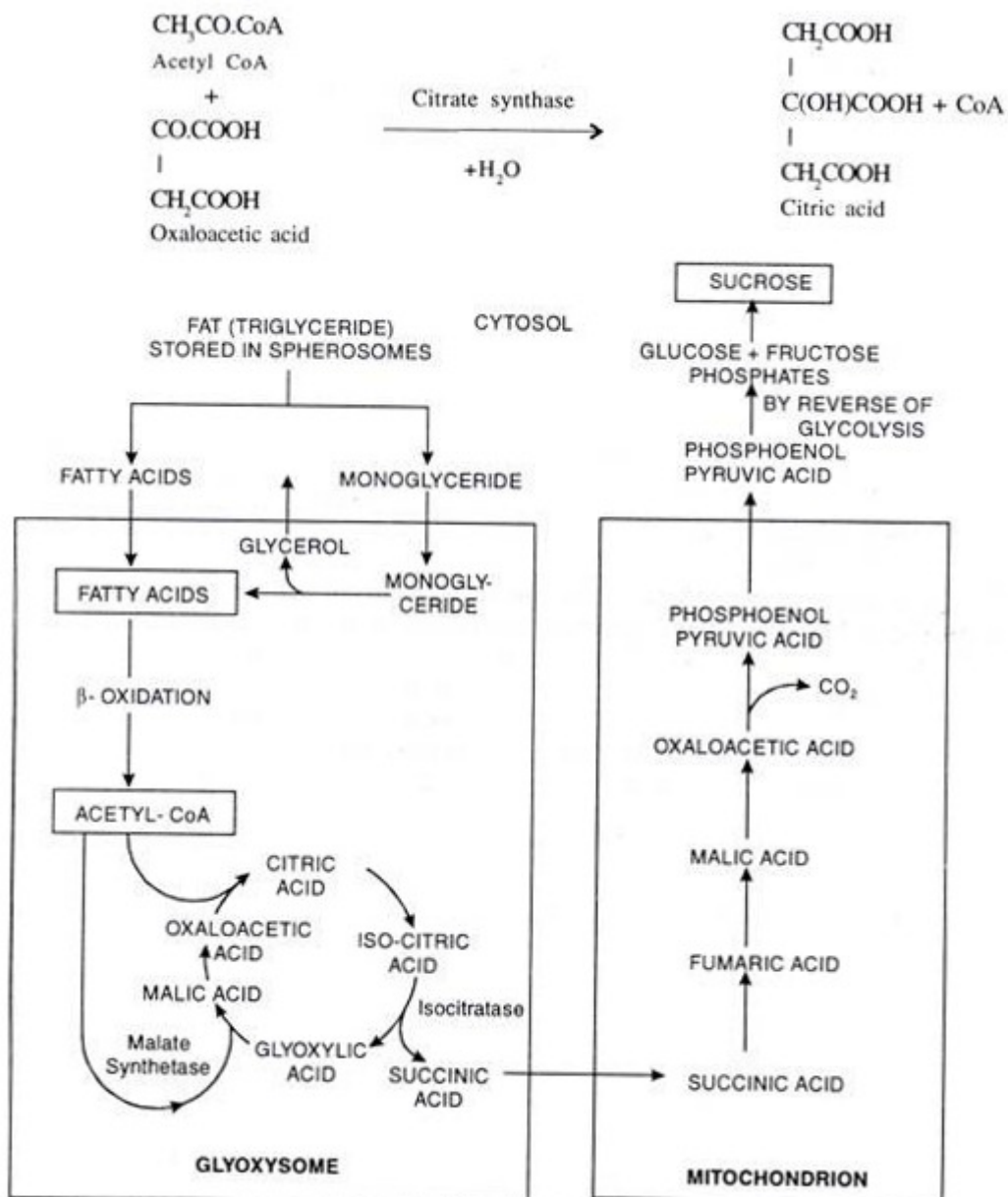
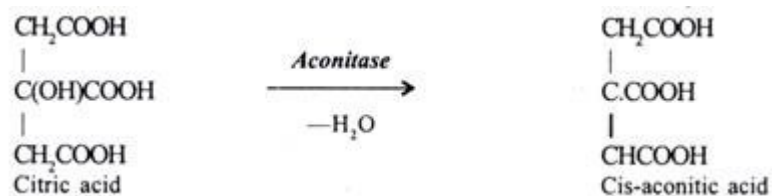


Fig. 14.3. Glyoxylate Cycle.

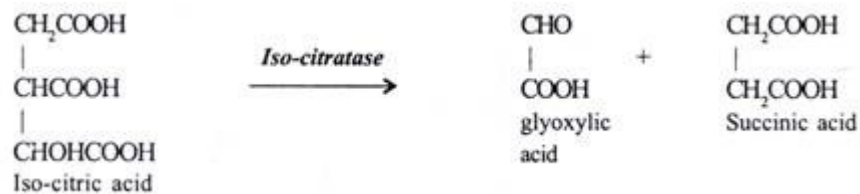
(ii) Citric acid is dehydrated to produce Cis-aconitic Acid in the presence of Aconitase.



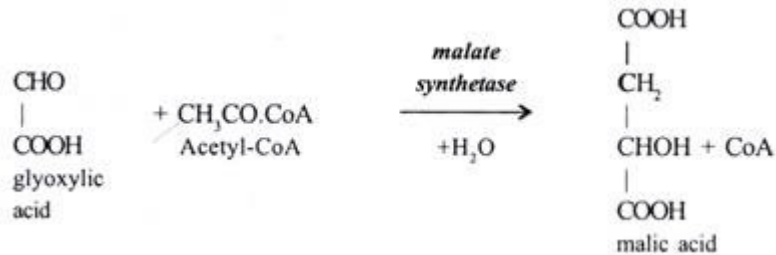
(iii) Cis-aconitic acid reacts with one molecule of H_2O to form Iso-citric acid.



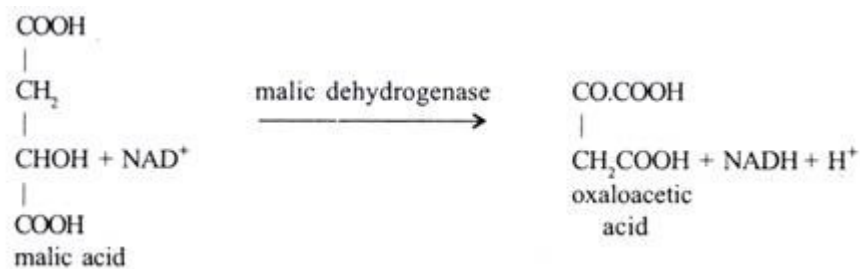
(iv) Iso-citric acid is broken down into glyoxylic acid and succinic acid by the enzyme Isocitratase.



(v) Glyoxylic acid combines with acetyl CoA (produced after the β -oxidation of fatty acids) in the presence of Malate synthetase to produce Malic acid.



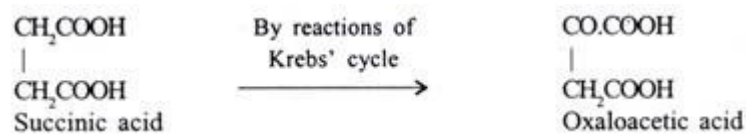
(vi) Malic acid is oxidised into oxaloacetic acid in the presence of Malic dehydrogenase and the coenzyme NAD.



Oxaloacetic acid thus produced combines with acetyl-CoA to regenerate citric acid.

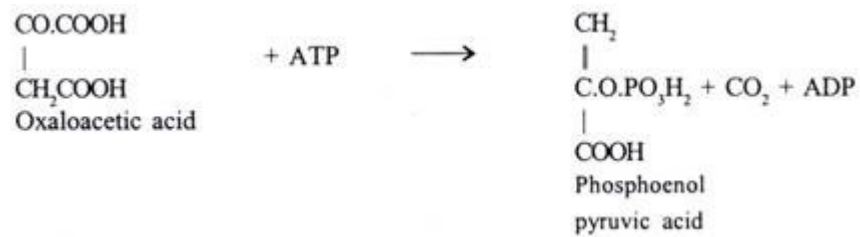
(b) Reactions in Mitochondrion:

(vii) Succinic acid (produced in reaction iv) Moves into mitochondrion and is converted into oxaloacetic acid as in the Krebs' cycle.



The conversion of succinic acid into oxaloacetic acid does not take place in glyoxysomes because of the absence of appropriate enzymes (i.e., succinic dehydrogenase and fumarase) in the latter. It takes place in mitochondria.

(viii) Oxaloacetic acid produced in the above step (vii) is decarboxylated in the presence of ATP to form phosphoenol pyruvic acid. This reaction also takes place in mitochondria)



(c) Reactions in Cytosol:

(ix) Phosphoenol pyruvic acid moves into cytosol and by the reverse reactions of glycolysis and with slight modification is converted into the glucose and fructose phosphates.

(x) Finally, glucose and fructose phosphates are converted into sucrose

After the conversion of fats into carbohydrates is completed, the glyoxysomes disappear from the cells.

Significance of Glyoxylate Cycle:

(1) During the germination of fatty seeds, the fats which are insoluble are hydrolysed into fatty acids and glycerol. Fatty acids after P-oxidation produce acetyl-CoA units which synthesize sucrose (which is soluble) through glyoxylate cycle. Soluble sucrose is then supplied to different growing regions of the young germinating seedling till it develops its own photosynthetic system.

(2) Those micro-organisms which can grow on ethyl alcohol or acetate as a sole source of energy and carbon make use of this cycle in synthesizing longer carbon chains.

(3) The glyoxylate cycle is an example of gluconeogenesis.