

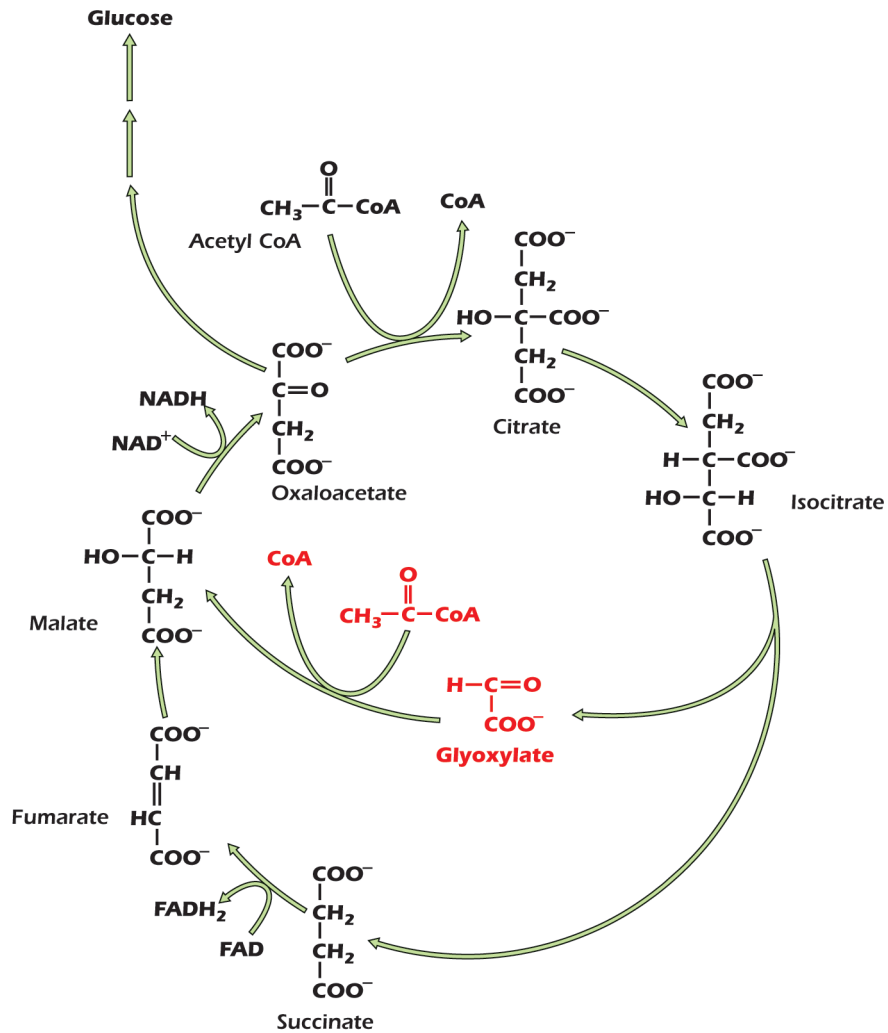
Chapter 13
Web Text Box 1

**Plants can make glucose from fatty acids although mammals cannot:
the glyoxylate shunt**

Gluconeogenesis (book page 216) can make glucose from pyruvate (and lactate) and from glycerol but NOT from acetyl CoA. Recall that pyruvate is carboxylated to oxaloacetate – an intermediate in the Krebs cycle. This is decarboxylated to form phosphoenolpyruvate that is then converted ultimately to glucose 6-phosphate.

The Krebs cycle uses acetyl CoA (made from fatty acids or from pyruvate). It seems simple to take oxaloacetate from it and convert it to glucose skipping the whole business of carboxylation of pyruvate. This doesn't work as for every acetyl CoA that enters the Krebs cycle (carrying in two carbon atoms) two carbon dioxides are lost. If one removes oxaloacetate (or any other intermediate) there will be less oxaloacetate to couple with incoming acetyl CoA. The cycle will slow down and eventually would cease functioning without oxaloacetate.

Carboxylation of pyruvate to make oxaloacetate is therefore essential if oxaloacetate is used for other things. In fact the pyruvate carboxylase reaction is not only essential for gluconeogenesis from pyruvate but is very important in keeping the Krebs cycle "topped up" with oxaloacetate. The cycle is not simply degradative: it provides intermediates for biosynthesis. (succinyl CoA is used in the synthesis of porphyrins, oxaloacetate and 2-oxoglutarate are converted to aspartate and glutamate by transamination). If the cycle is to continue it must be provided with oxaloacetate whenever intermediates are abstracted. The pyruvate carboxylase reaction is very important for this.



Plants and many prokaryotes can make glucose from fatty acids. They do this by “short-circuiting” the Krebs cycle, as shown in the figure. Acetyl CoA is reacted with oxaloacetate to make citrate and that is converted to isocitrate (6 carbons) . Now the isocitrate is converted to succinate (4 carbons) and glyoxylate (2 carbons). An acetyl CoA is then combined with glyoxylate to give malate which is oxidized to oxaloacetate. This can then be converted to glucose. The succinate left is converted to oxaloacetate too . Two acetyl CoAs have been used . There is no loss of carbon dioxide.

These reactions allow, for example, fat-storing seeds to convert their fat stores to glucose for growth. The pathway is called the glyoxylate pathway or sometimes the glyoxylate shunt. In plants it takes place in special organelles called glyoxysomes.