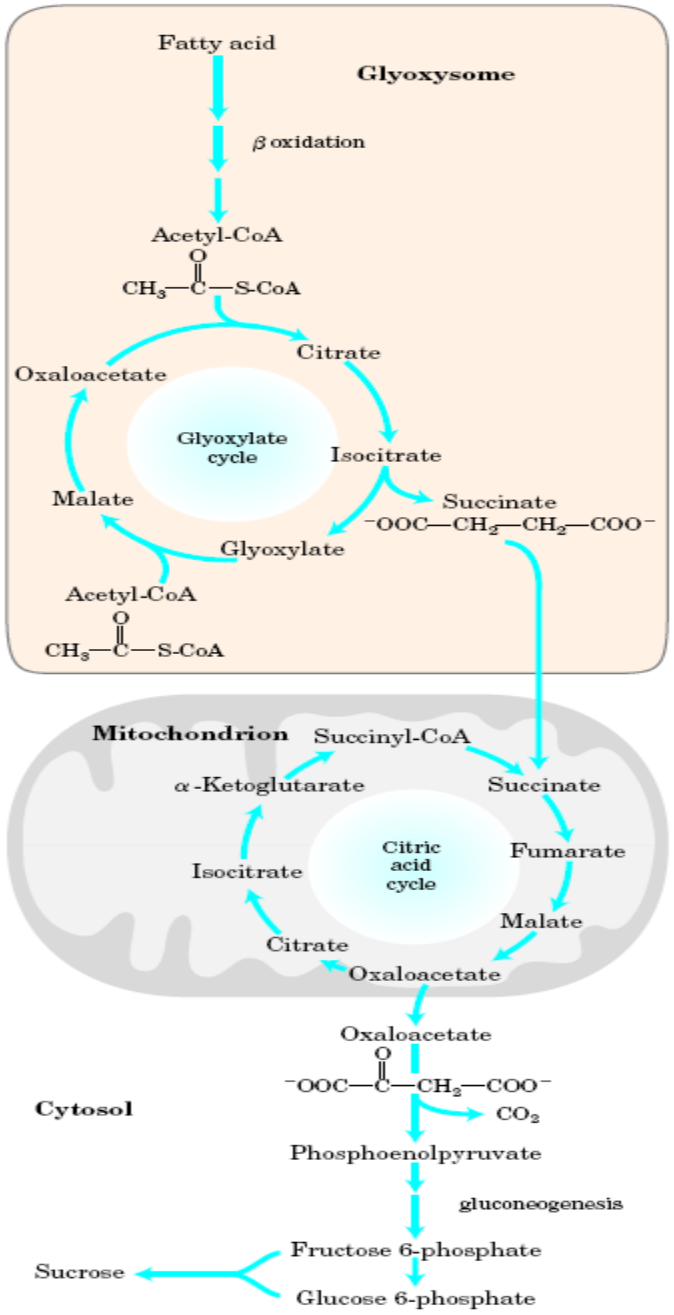
Integration of Carbohydrate Metabolism in the Plant Cell

- Carbohydrate metabolism in a typical plant cell is more complex in several ways than that in a typical animal cell.
- The plant cell carries out the same processes that generate energy in animal cells (glycolysis, citric acid cycle, and oxidative phosphorylation);
  - it can generate hexoses from three- or four-carbon compounds by gluconeogenesis;
  - it can oxidize hexose phosphates to pentose phosphates with the generation of NADPH
  - and it can produce a polymer of (α 1- 4)-linked glucose (starch) and degrade it to generate hexoses.

Gluconeogenesis Converts Fats and Proteins to Glucose in Germinating Seeds

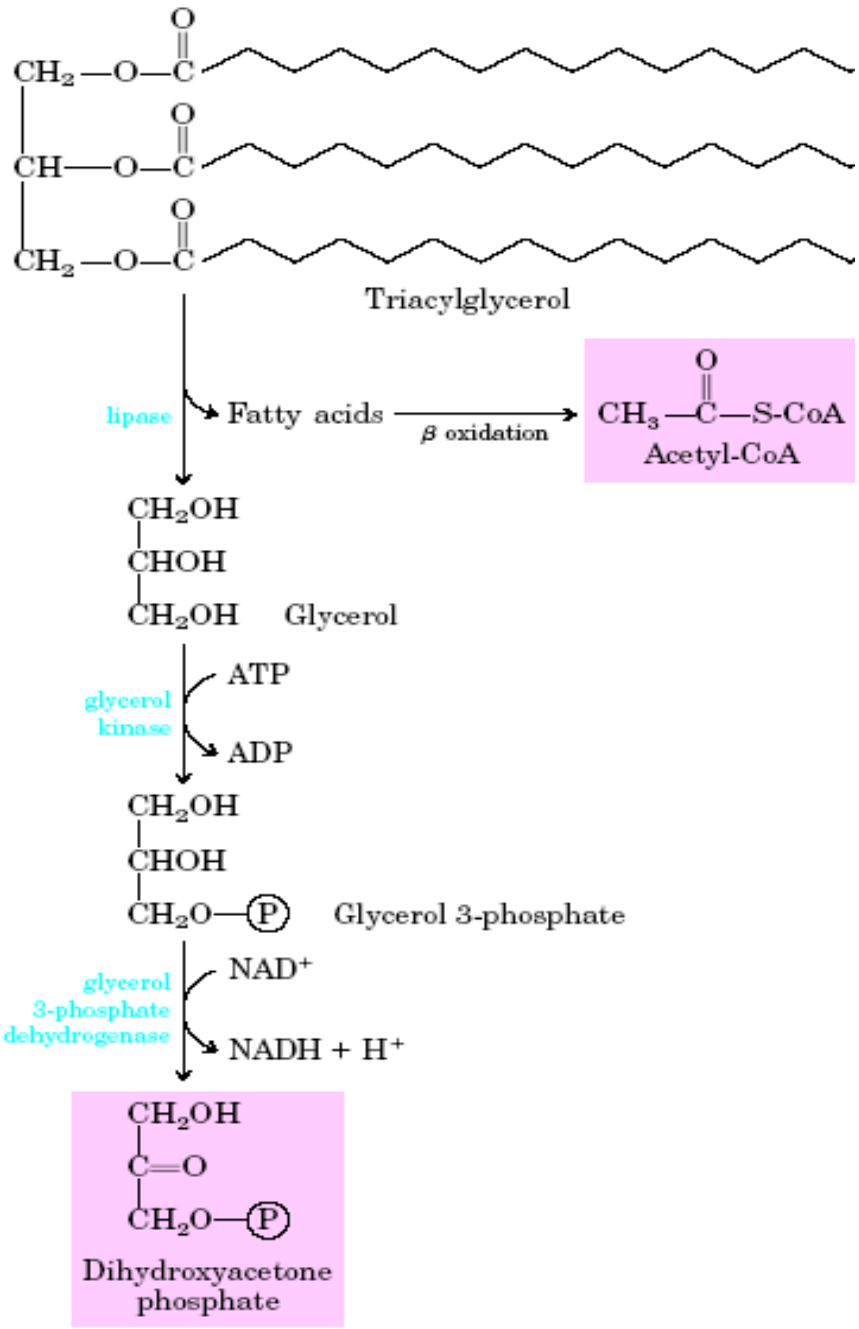
- Many plants store lipids and proteins in their seeds, to be used as sources of energy and as biosynthetic precursors
- during germination, before photosynthetic mechanisms have developed. Active gluconeogenesis in germinating seeds provides glucose for the synthesis of sucrose, polysaccharides, and many metabolites derived from hexoses.
- In plant seedlings, sucrose provides much of the chemical energy needed for initial growth.



•about 75% of the carbon in the fatty acids stored as seed lipids is converted to carbohydrate by the combined pathways.

•The other 25% is lost as CO_2 in the
•conversion of oxaloacetate to phosphoenolpyruvate.

•Hydrolysis of storage triacylglycerols also produces glycerol 3-phosphate, which can enter the gluconeogenic
•pathway after its oxidation to dihydroxyacetone phosphate .


Triacylglycerol
lipase
Fatty acids
β oxidation
Acetyl-CoA
Glycerol
ATP
glycerol kinase
ADP
Glycerol 3-phosphate
NAD+
glycerol 3-phosphate dehydrogenase
NADH + H+
Dihydroxyacetone phosphate

- During daylight hours, triose phosphates produced in leaf tissue by the Calvin cycle move out of the chloroplast and into the cytosolic hexose phosphate pool, where they are converted to sucrose for transport to nonphotosynthetic tissues.
- In these tissues, sucrose is converted to starch for storage or is used as an energy source via glycolysis.
- In growing plants, hexose phosphates are also withdrawn from the pool for the synthesis of cell walls.
- At night, starch is metabolized by glycolysis to provide energy, essentially as in nonphotosynthetic organisms, and NADPH and ribose 5-phosphate are obtained through the oxidative pentose phosphate pathway.