9: Glycolysis and Gluconeogenesis

In a well-fed animal, most cells can store a small amount of glucose as glycogen. All cells break glycogen down as needed to retrieve nutrient energy as G-6-P. Glycogen hydrolysis, or ***glycogenolysis***, produces G-1-P that is converted to G-6-P, as we saw at the top of *Stage* 1 of glycolysis. But, glycogen in most cells is quickly used up between meals. Therefore, most cells depend on a different, external source of glucose other than diet. Those sources are liver and to a lesser extent, kidney cells, that can store large amounts of glycogen after meals. In continual feeders (for examples cows and other ruminants), glycogenolysis is ongoing. In *intermittent feeders* (like us), liver glycogenolysis can supply glucose to the blood for 6-8 hours between meals, to be distributed as needed to all cells of the body. Thus, you can expect to use up liver and kidney glycogen reserves after a good night's sleep, a period of intense exercise, or any prolonged period of low carbohydrate intake (fasting or starvation). Under these circumstances, animals use **gluconeogenesis** (literally, *new glucose synthesis*) in liver and kidney cells to provide systemic glucose to nourish other cells. In healthy individuals, the hormones insulin and glucagon regulate blood *glucose homeostasis*, protecting against *hypoglycemia* (low blood sugar) and *hyperglycemia* (high blood sugar) respectively. The gluconeogenic pathway produces glucose from carbohydrate and non-carbohydrate precursor substrates. These precursors include pyruvate, lactate, glycerol and *gluconeogenic amino acids*.

A general summary of the several stages involved is shown in ***Figure 9.1.*** Initially, the storage fuels or foodstuffs (fats, carbohydrates, and proteins) are hydrolyzed into smaller components (fatty acids and glycerol, glucose and other simple sugars, and amino acids). In the next stage, these simple fuels are degraded further to two-carbon fragments that are delivered as the $CH_3C{=}O$ group (ethanoyl, or acetyl) in the form of the thioester of coenzyme A, $CH_3COS\mathbf{CoA}$. This section is concerned mainly with the pathway by which glucose is metabolized by the process known as **glycolysis**.

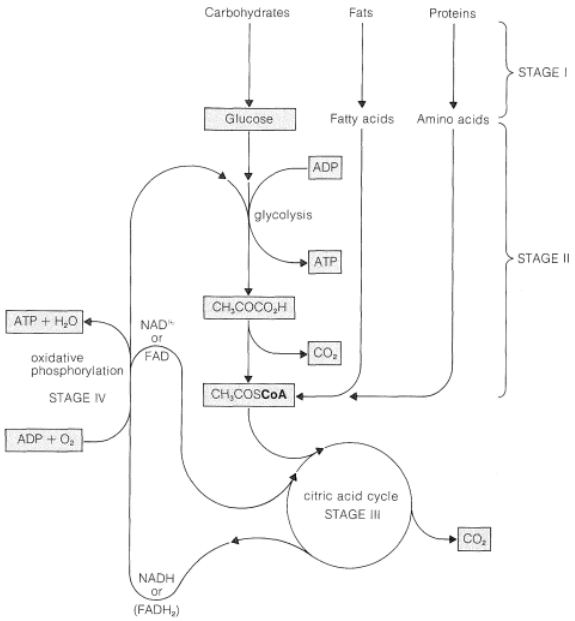

Figure 9.1: *Perspective of the metabolic scheme whereby carbohydrates, fats, and proteins in foodstuffs are oxidized to* CO_2, *showing the link between glycolysis, the citric acid cycle, and oxidative phosphorylation.*

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