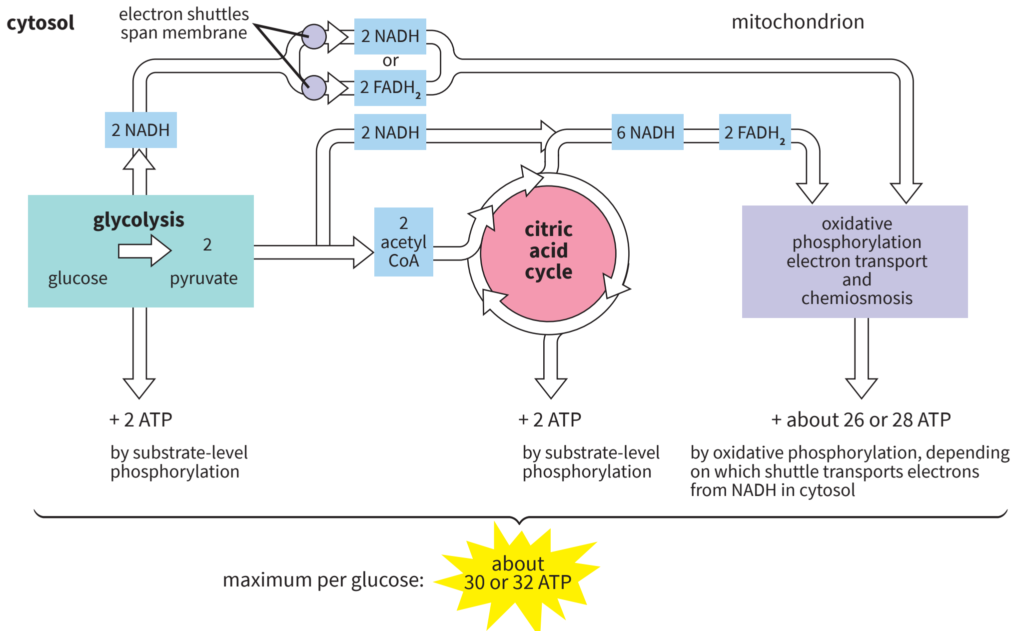

How much ATP can the eukaryotic cell produce for every molecule of glucose via aerobic cellular respiration? The theoretical net yield is 30–32 ATP molecules. The actual yield, however, is lower than that because of two reasons. The first is that the protons can leak across the inner mitochondrial membrane without passing through the channel of the ATP synthase complex. This causes a decrease in the stored energy of the proton motive force. Secondly, the proton motive force generated in the mitochondrion is used by the mitochondrion for other metabolic processes apart from ATP synthesis.

ATP YIELD FROM SUBSTRATE LEVEL PHOSPHORYLATION

You have learned that glycolysis produces 4 ATP molecules via substrate-level phosphorylation. However, glycolysis requires an investment of 2 ATP molecules. Therefore, you need to deduct 2 ATP molecules to get a net ATP yield of 2.

The next substrate level phosphorylation is during the citric acid cycle. Two rounds of this cycle are needed to fully oxidize a glucose molecule. These yield 2 ATP molecules. At this point, you have a total of 4 ATP molecules from substrate-level phosphorylation.

ATP Yield from Oxidative Phosphorylation

How do you account for the number of ATP molecules produced from oxidative phosphorylation? You have to determine how many ATP molecules are produced as a result of the proton motive force created by the transfer of electrons from NADH and $FADH_2$. Most scientists estimate that the electrons from 1 NADH create a proton gradient that can be used to make 2.5 ATP; while the electrons from $FADH_2$ are equivalent to 1.5 ATP.

[redacted]

or FAD^{2+}. In skeletal muscle and brain cells, the electrons from cytosolic NADH are transferred to FAD^{2+}, producing $FADH_2$. Two $FADH_2$ is equivalent to 3 ATP molecules. On the other hand, in liver, heart, and kidney cells, the electrons from cytosolic NADH are transferred to mitochondrial NAD^+, so the resulting 2 NADH are equivalent to 5 ATP molecules.

Hence, depending on the shuttle system used for cytosolic NADH, oxidative phosphorylation can produce 26–28 ATP molecules. This shows that between substrate-level and oxidative phosphorylation, the latter produces most of the ATP from glucose.

If you add all the ATP molecules derived from both substrate-level and oxidative phosphorylation, you get a total of 30–32 ATP molecules for a molecule of glucose. This represents about 32 percent of the energy stored in glucose.