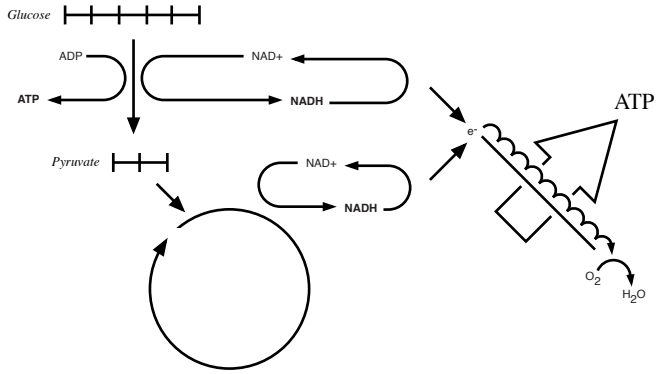
Glycolysis and Cellular Respiration

A quick review on

Cellular Energetics

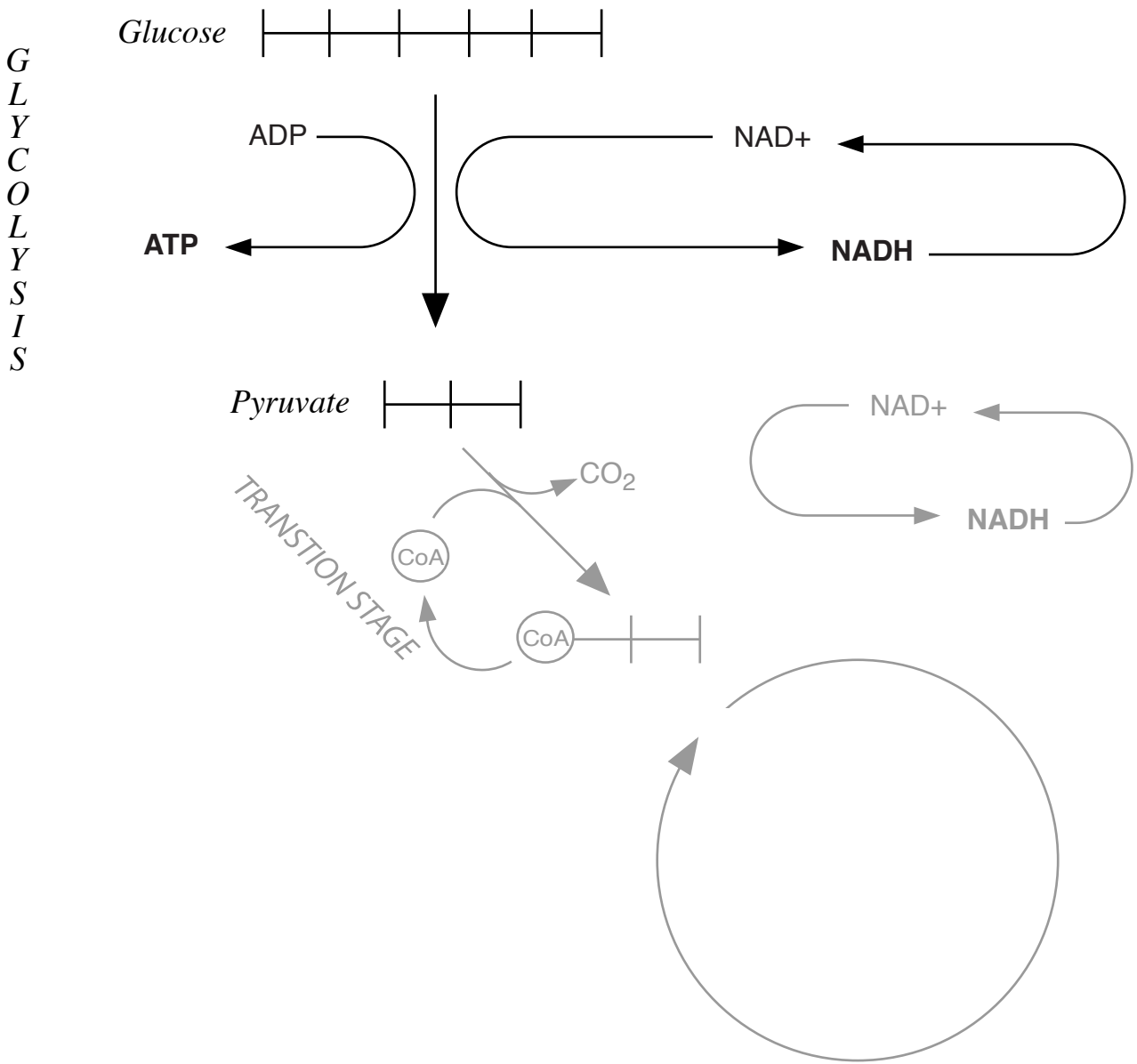
in preparation for

Microbial Metabolic Issues



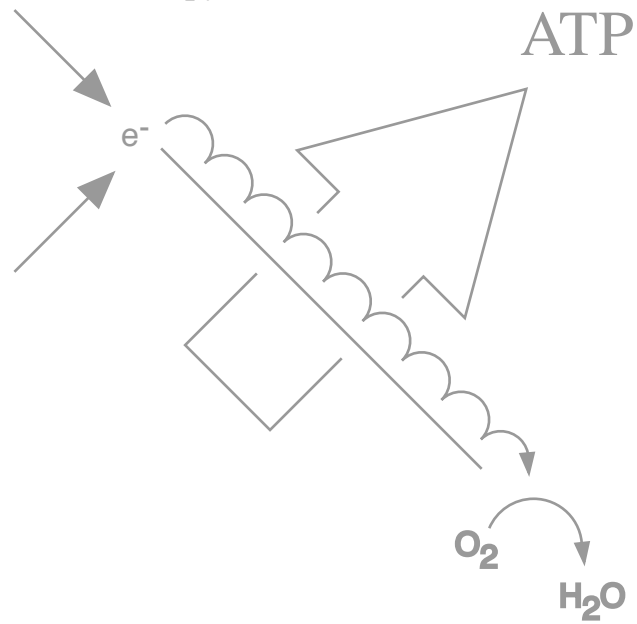
By Noel Ways

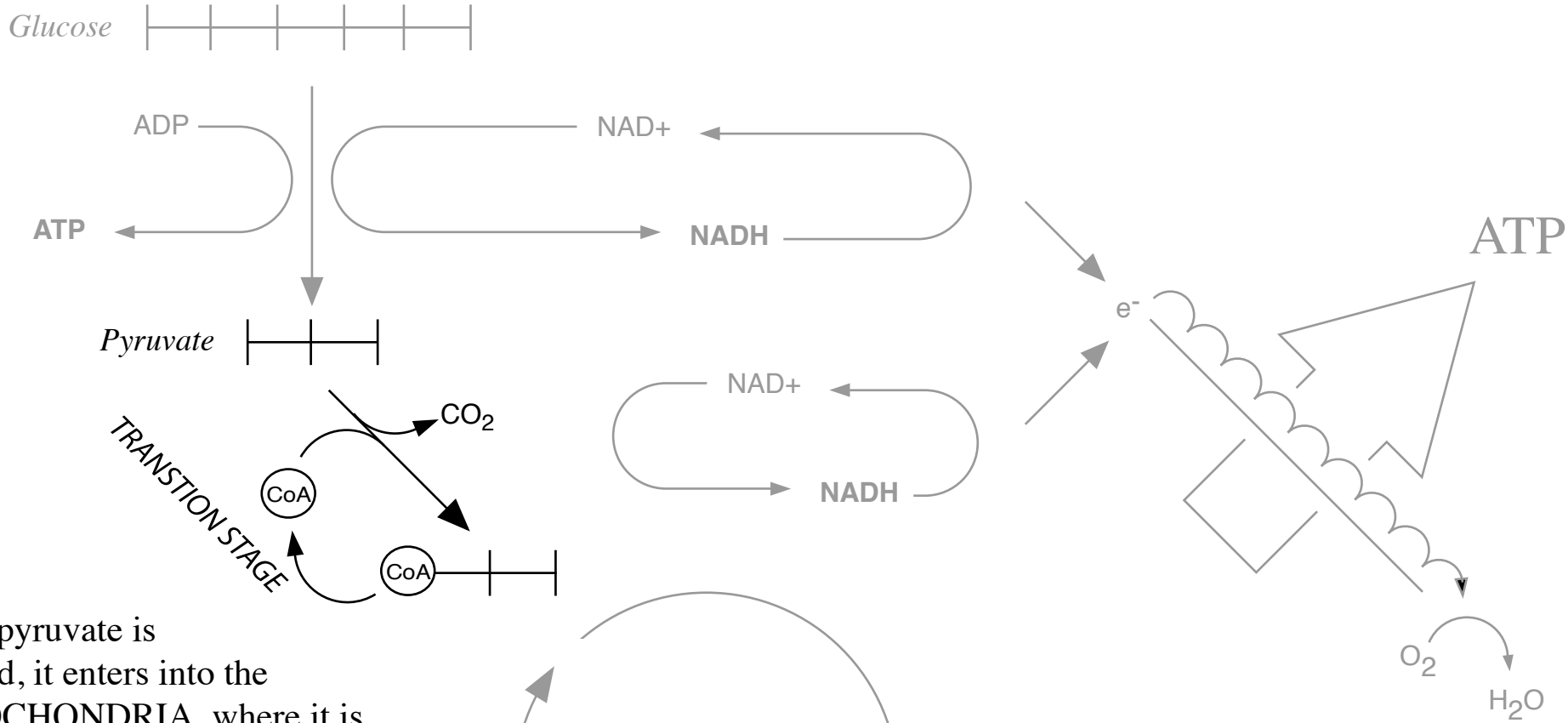
Glycolysis and Cellular Respiration function to convert glucose (useless for cellular work) into ATP, the only useful energy form for living things. Boradly, this energy transformation process can be broken down into four essential steps.



Glucolysis is the first step. This step occurs in the cytoplasm. Here there is a net gain of two ATP. Also, NAD+ is reduced to NADH, which is to say it now is "holding" two "high energy electrons". These electrons will be used to generate more ATP with the "electron transport chain".

During Glycolysis, the glucose will have been broken down into two molecules of pyruvate.

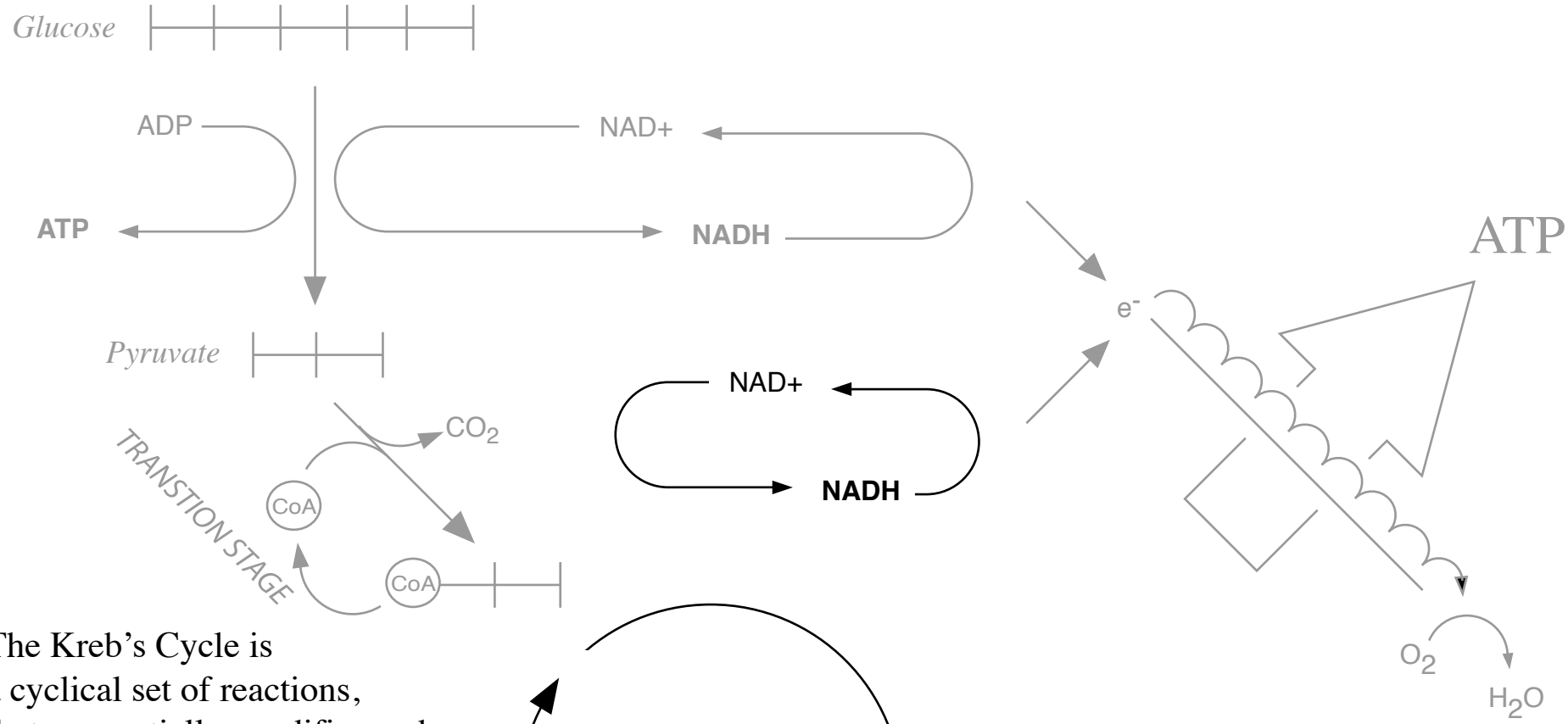




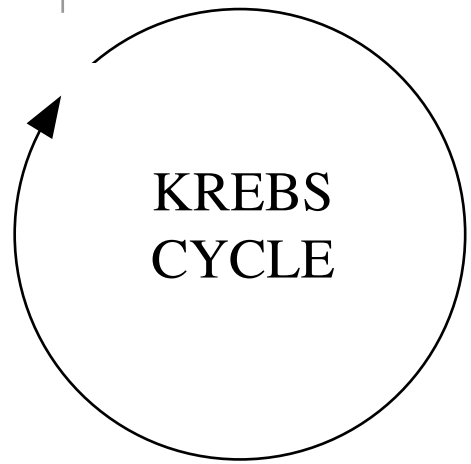
Once pyruvate is formed, it enters into the MITOCHONDRIA, where it is "transitioned" into a cyclical set of reactions call the Kreb's Cycles.

Although there is no ATP production during the transition stage, NAD+ is reduced and will again be used to carry "high energy electrons" to the "electron transport chain, where signification ATP production occurs.

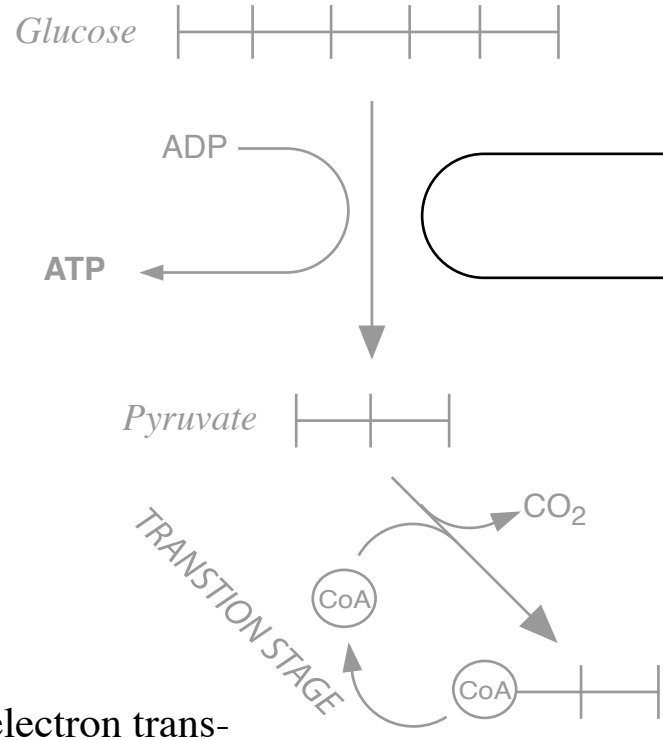
You may want to recall that during this stage, a CO2 is lost resulting in an acetyl group, which is attached to a Coenzyme A forming Acetyl CoA. The acetyl group is now incorporated into the Krebs' Cycle. The CoA can again receive another acetyl group.

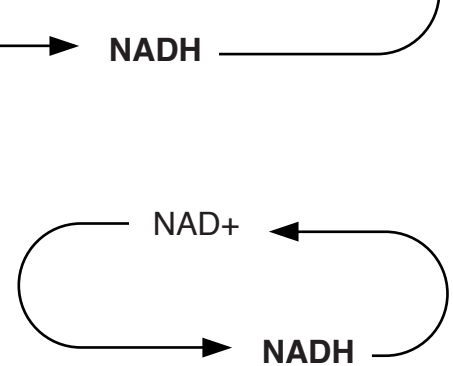


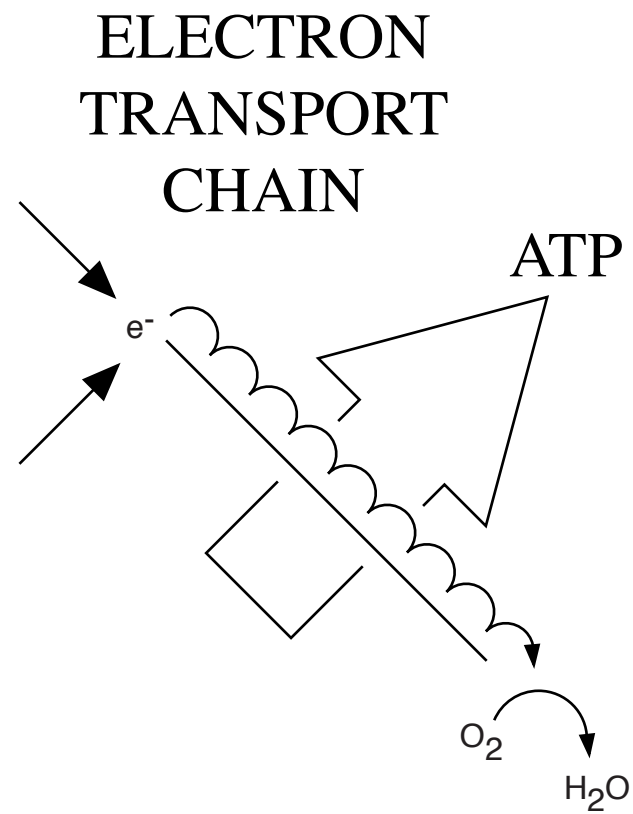
The Kreb's Cycle is a cyclical set of reactions, that sequentially, modifies and breaks down the organic compounds "fed" into it. In the process, substantial "high energy electrons" are "harvested" by way of NAD+ being reduced to NADH. These electrons will again be "fed" into the "Electron Transport Chain" for ATP generation purposes.



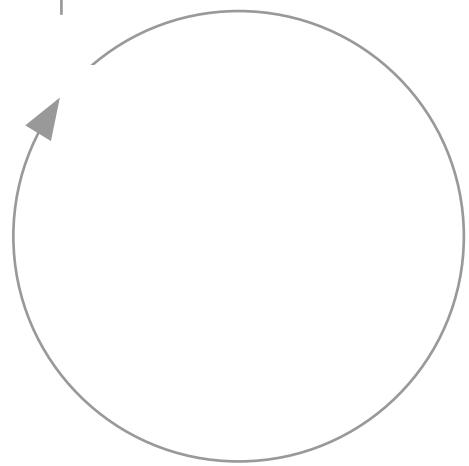
You may also want to recall that during this process, CO2 is liberated (and will subsequently be exhaled), and that two ATP are generated. In addition, FAD is reduced to FADH2, and will likewise deliver electrons to the electron transport chain.





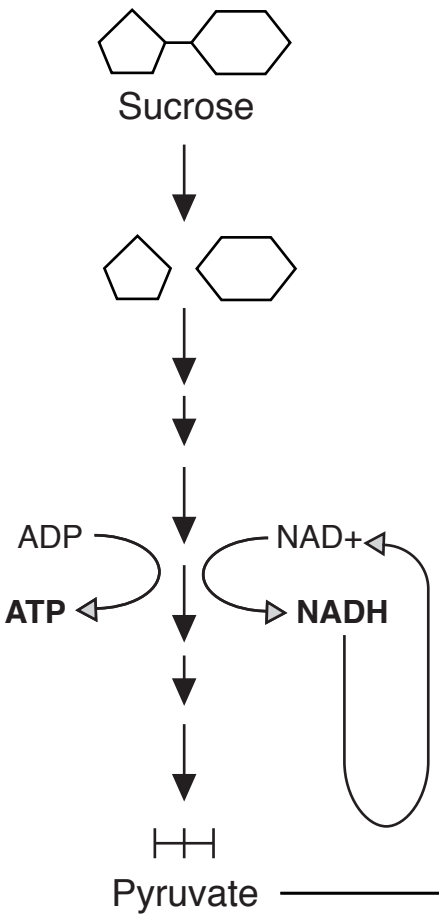


The electron transport chain consists of a series of molecules that receives the "high energy electrons". These electrons will be allowed to go to lower energy states, and the energy released will be used to generate much ATP. At the end of the line, the now "low energy electrons" will be received by O2 as waste, and the oxygen will be reduced to water. Oxygen is the final electron acceptor and is the only reason by we need oxygen.



You may also wish to recall that during this process, the energy released by the electrons going to lower energy states will be used to pump H+ into the inter-membrane space. This will generate an "electro-chemical gradient" which will drive ATP production. As the hydrogens return to the mitochondrial matrix through ATP synthase, ATP will be produced.

Fermentation



Lactic Acid
Streptococcus
Lactobacillus
Bacillus

Ethanol and CO_2
Saccharomyces
(Yeast)

Propionic Acid, Acetic Acid, CO_2, and H_2
Propionibacterium

Butyric Acid, Butanol, Acetone
Isopropyl Alcohol, and CO_2
Clostridium

Ethanol, Lactic Acid
Succinic Acid, Acetic Acid,
CO_2, and H_2
Escherichia
Salmonella

Ethanol, Lactic Acid
Formic Acid, Butanediol,
Acetoin, CO_2, and H_2
Enterobacter

Modified from Microbiology, 10th Edition
by Tortora, Funke, and Case