BSC 2085: Glycolysis and Cellular Respiration

BACKGOUND INFORMATION:

You should know this material before you begin studying Glycolysis and Cellular Respiration:

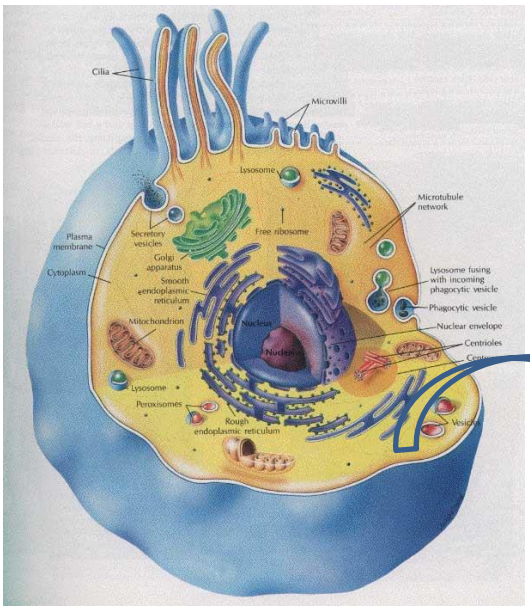
I. What is the function of mitochondria?
   a. Production of **ATP**, a molecule that stores and releases energy for cells to use.

II. Key Molecules that are involved during Cellular Respiration:
   a. **ATP**: Adenosine Triphosphate, a carrier of energy
   b. ADP: Adenosine Diphosphate, the molecule that is produced when one phosphate group leaves from **ATP**
   c. NAD: Nicotinamide Adenine Dinucleotide, a coenzyme that removes Hydrogen ions from a reaction. Once the reaction occurs, NAD becomes NADH.
   d. FAD: Flavin Adenine Dinucleotide, a regulated coenzyme that removes Hydrogen ions from a reaction. Once the reaction occurs, FADH becomes $FADH_2$.

III. Cellular Respiration is a process where the cells of the body produce ATP.
   a. Each step of Cellular Respiration will produce ATP molecules.
   b. Occurs in three steps:
      i. Glycolysis: Breakdown of Glucose into Pyruvate. This takes place in the cytosol.
      ii. Citric Acid Cycle: Breakdown of Acetyl Co-A and Carbon Dioxide. This takes place in the mitochondrial matrix.
      iii. Oxidative Phosphorylation: Generation of ATP. This takes place in the inner mitochondrial membrane.

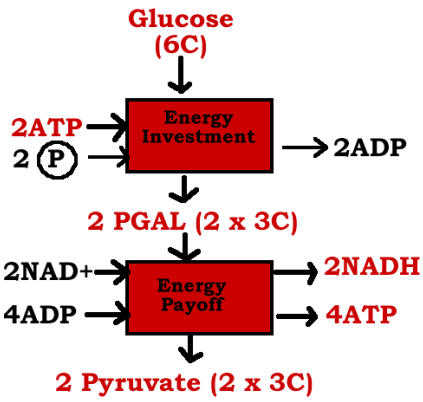
IV. There are many processes that occur in the cells that aid in the production of ATP, the end result of Cellular Respiration. The most important factor to remember during this process is that these steps have to occur in order, or in other words; the end result of one process begins or starts the second process.

The Cell



In the Cytosol:

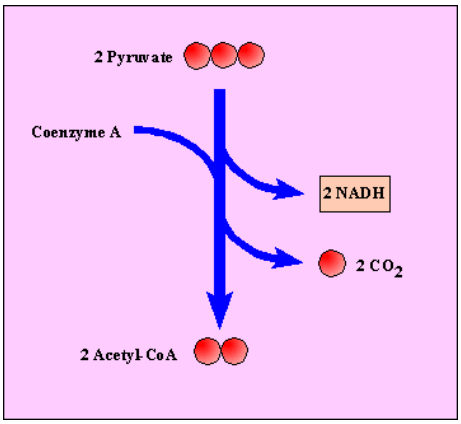
Glucose, a six-carbon chain sugar, is broken down into two three-carbon chain molecules, pyruvate. This process is known as glycolysis, which occurs in a series of seven steps:



- During Glycolysis, 4ATP molecules are created, but 2ATP molecules are used during the process of Glycolysis. The net result of ATP molecules created from Glycolysis is 2ATP.

4 ATP created (energy payoff) - 2 ATP used (energy invested) = 2 ATP created

- Once Glycolysis is completed, Pyruvate is converted into Acetyl Co-A:



- Acetyl Co-A then travels to the Mitochondria to begin the Citric Acid Cycle.
    - The Citric Acid Cycle is a process that removes Carbon Dioxide and produces 1 ATP molecule during each turn of the cycle.
    - Remember during Glycolysis, Glucose, a six-carbon structure is broken down into 2 two-carbon structures known as Pyruvate. Since there are two pyruvate molecules, each pyruvate molecule can enter the Critic Acid Cycle once. So with one glucose molecule, we can have two cycles of the Citric Acid Cycle.

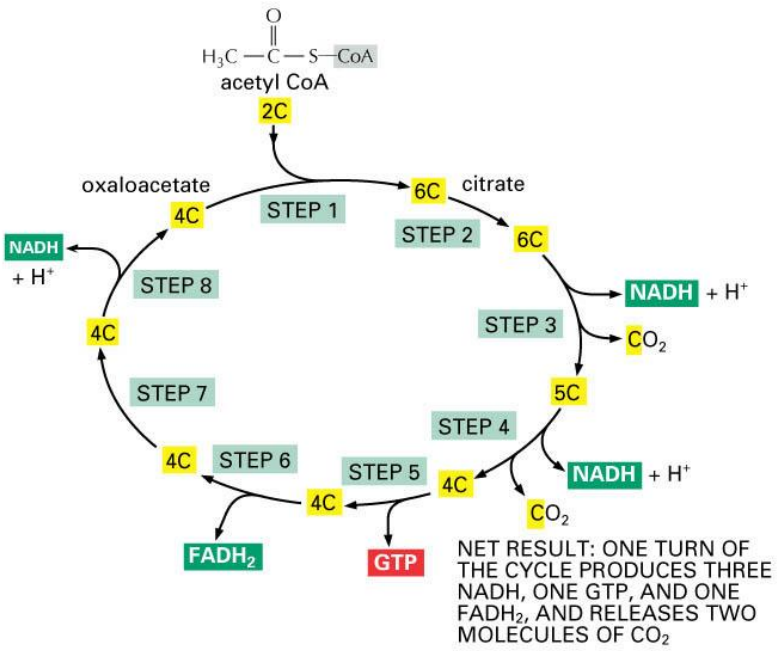
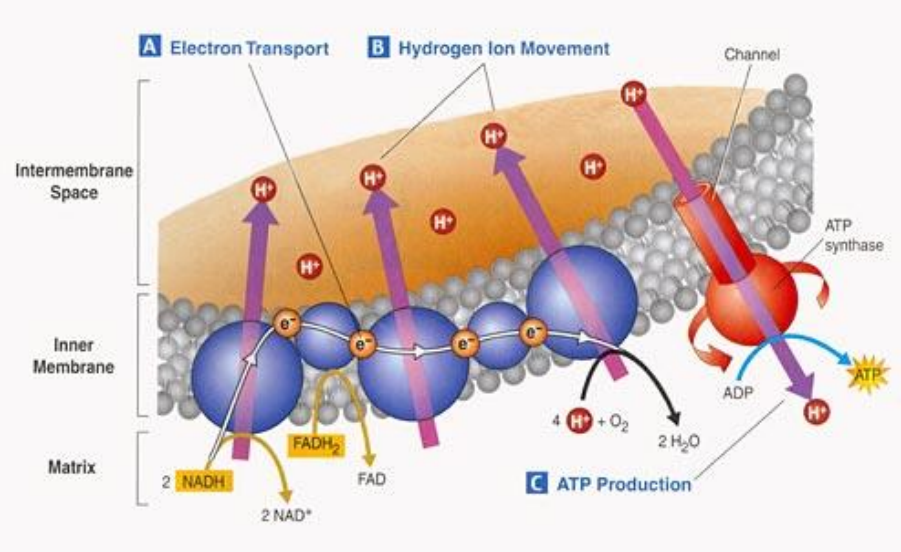


Figure 13-11 Essential Cell Biology, 2/e. (© 2004 Garland Science)

- Once the Citric Acid Cycle is completed, NADH and $FADH_2$ enter the inner mitochondrial membrane and 'dumps off' the hydrogen ions into the Electron Transport Chain.
- The Electron Transport Chain consists of a sequence of proteins called cytochromes that transfers/releases the hydrogen ions (also called electrons) from one cytochrome to another until reaching Oxygen.



- Once the Electron Transport Chain is completed, there will be a total of 32 ATP molecules generated, bringing the total amount of ATP generated during Glycolysis and Cellular Respiration to 36 ATP.

Images Courtesy of:

Animal Cell Image:
http://howard.nebrwesleyan.edu/hhmi/fellows/shircher/cell2.html

Citric Acid Cycle Image:
http://www.google.com/imgres?imgurl=http://www.accessexcellence.org/RC/VL/GG/ecb/ecb_images/13_11_citric_acid_cycle.jpg&imgrefurl=http://www.accessexcellence.org/RC/VL/GG/ecb/overview_citric_acid_cycle.php&h=580&w=780&sz=78&tbnid=aeC2E_ZDwyrrmM:&tbnh=76&tbnw=102&prev=/search%3Fq%3Dcitric%2Bacid%2Bcycle%26tbm%3Disch%26tbo%3Du&zoom=1&q=citric+acid+cycle&usg=__7Y_y92e7ac__buK1i7sMyMpyMr0=&docid=K3pXB0Oybc9TAM&sa=X&ei=j2n0UOHOD4SI9QSc3IHoBg&ved=0CEAQ9QEwAg&dur=191

Glycolysis image:
http://www.google.com/imgres?q=glycolysis&hl=en&sa=X&tbo=d&rls=com.microsoft:en-us:IE-SearchBox&rlz=1I7ADRA_enUS445&biw=1280&bih=819&tbm=isch&imgrefurl=http://staff.jccc.net/pdecell/bio122/cellresp.html&tbnid=R83Hvk9GHtTQ4M&docid=3t7Xk6AA-29TIM&ved=0CEsQhRYoAg&ei=X2qdUJbBHIyW8gSO5ICYAQ&dur=NaN

Pyruvate Decarboxylation Image:
http://www.google.com/imgres?imgurl=http://www.uic.edu/classes/bios/bios100/summer2002/glyco03.gif&imgrefurl=http://www.uic.edu/classes/bios/bios100/summer2002/lect10.htm&h=326&w=358&sz=5&tbnid=1S5tX1LU9gUdoM:&tbnh=90&tbnw=99&prev=/search%3Fq%3Dconversion%2Bof%2Bpyruvate%2Bto%2Bacetyl%2Bcoa%26tbm%3Disch%26tbo%3Du&zoom=1&q=conversion+of+pyruvate+to+acetyl+coa&usg=__YYAt1Ckj-eOx4sF1i2bUzjRMzs0=&docid=jTUXogxrGEOPvM&sa=X&ei=-WL0UOCGLJOO9AT3soDIDw&ved=0CEYQ9QEwBA&dur=1504

Electron Transport Chain Image:
http://www.google.com/imgres?imgurl=http://www.biologycorner.com/resources/electron_transport_chain.jpg&imgrefurl=http://www.biologycorner.com/APbiology/cellular/notes_cellular_respiration.html&h=304&w=494&sz=29&tbnid=3Tc89kgnbs_GKM:&tbnh=78&tbnw=126&prev=/search%3Fq%3Delectron%2Btransport%2Bchain%26tbm%3Disch%26tbo%3Du&zoom=1&q=electron+transport+chain&usg=__cTlZEnkWP7Gzxu40UwIJUd73jac=&docid=k7WrYBpo2DT7iM&sa=X&ei=yGv0UMDbMYn49gSmylHQAw&ved=0CEYQ9QEwBA&dur=186