Metabolism

Cellular Co-Operation Project

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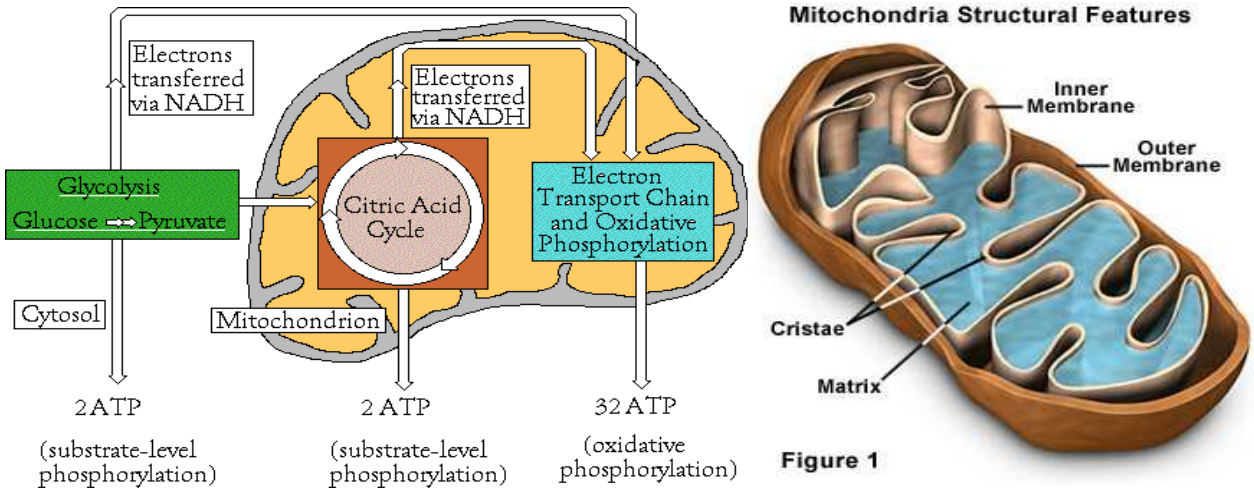
The cells that make up our body serve a variety functions; the most important one being the ability to ultimately give life to the many different organisms living in our world. However, intracellularly there are various processes taking place that allow for life to be possible. That is, cells actively undergo processes such as intracellular digestion, metabolism, cellular respiration, photosynthesis, and transport. Perhaps the most crucial process the cell must undertake to sustain life is metabolism; that is, the ability to produce energy to break down food (catabolism) and to construct the inner components of cells (anabolism).

So what makes a cell tick? The key to this answer lies in the fact that each individual cell is made up of co-dependent organelles that perform specific functions. In the case with metabolism, it is the mitochondria and the chloroplasts that play the largest part in the process, but other organelles such as the cell membrane, Golgi apparatus, lysosomes, and vesicles are needed in order to for it to be quick, efficient, and complete. Without these organelles, particles would be unable to penetrate the cell, digested, be processed, packaged, or distributed around the cell.

When we think catabolism, for instance, we usually associate it with digestion. At the cellular level, the process is similar to phagocytosis. You have a large particle either permeates the plasma membrane or is actively transported through it and is then encapsulated into a vesicle as it pinches off a piece of the cell membrane, and then finally broken down by digestive enzymes within lysosomes. From there it is either used directly within the cell or excreted outside of it for use by other cells or as waste products. However, catabolism also digests particles made within the cell. For instance, the proteins synthesized by ribosomes within the cell may later be broken down within the cell by lysosomes. With catabolism, digestion takes place carefully step by step; for example with carbohydrate digestion, polysaccharides like starch or glycogen would be broken up into multiple monosaccharides like glucose or fructose, and lastly undergo glycolysis to produce energy and a smaller molecule (i.e. pyruvate acid). This same concept holds true for essentially any other macromolecule, including substances such as lipids and proteins.



Above are two diagrams explaining the process of cellular respiration within the mitochondria displaying its individual components

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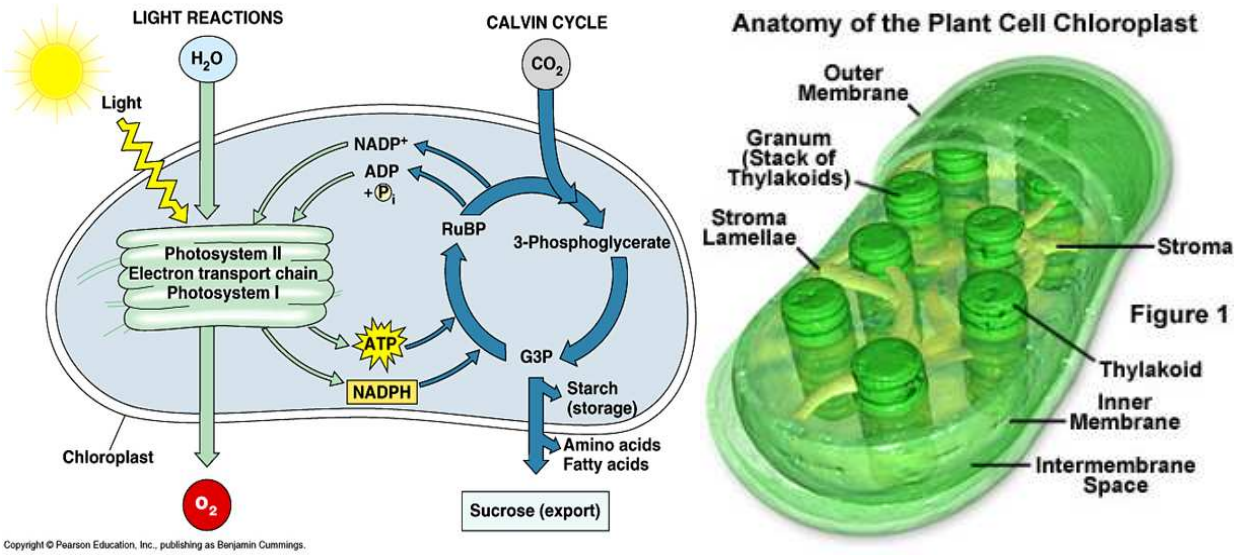
The best example of catabolism is cellular respiration, as it describes the reaction that occur within cells to obtain energy and remove cellular waste. What happens is that a simple macromolecule such as glucose enters the cell membrane through endocytosis, enveloped by a vesicle, and then transported to the mitochondrion where the oxidizing agent oxygen reacts with it to produce carbon dioxide, water, and ATP ($C_6H_{12}O_6 + 6O_2 \rightarrow 6CO_2 + 6H_2O + 38ATP$). The ATP produced form this reaction is used within the cell to perform its day to day functions. In the case with humans, the carbon dioxide thereafter is diffused out of the body and the water consumed by other cells; any excess water is then excreted out of the body.

Anabolism, on the other hand, is the total opposite of catabolism. At the cellular level, this particular process can be likened to synthesis. In this case you have simple monomers such as monosaccharides, nucleotides, and amino acids that enter or are created within the cell. With the help of energy in the form of ATP, are reacted to create polymers such as polysaccharides, nucleic acids, and proteins. These include substances like glucose, maltose, DNA, and RNA. Depending on what macromolecule is being synthesized, you will have either the chromatin in the nucleolus undergoing DNA and RNA synthesis, the chloroplasts of plant cells going through photosynthesis, ribosomes synthesizing proteins, or just the processing and modification of proteins and lipids in the Golgi apparatus.



Above are two diagrams explaining the process of photosynthesis within the chloroplast and displaying its individual components

Photosynthesis, which is fundamentally cellular respiration in reverse, is perhaps the most common example of anabolism. As the diagram above indicates, oxygen and carbon dioxide enter the chloroplast of a plant cell and spontaneously react as the sunlight penetrates its membrane to produce a simple sugar (usually glucose), water, and oxygen. The sugar is either used up right away (cellular respiration) or stored within a cell vacuole for later use.

Just as the mitochondrion is the powerhouse of the cell, the chloroplast is its food production center. As such, it is expected that both cellular respiration and photosynthesis are crucial in the survival and function of a cell. Photosynthesis especially is important as it only occurs in plant cells; ultimately, all of the foods we consume as humans come from other plants.

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King,Christopher. "Cell (biology)." Microsoft Student 2008 DVD. CD-ROM.2008 ed.Microsoft,2008.
Please note that the metabolism, catabolism, anabolism, photosynthesis, and cellular respiration linked articles and web links were also accessed from Encarta's article on cells

Pictures:

Cellular Respiration:

http://home.earthlink.net/~dayvdanls/FormingATP.GIF
http://www.cartage.org.lb/en/themes/sciences/zoology/AnimalPhysiology/Anatomy/AnimalCellStructure/Mitochondria/mitochondria.jpg

Photosynthesis:

http://www.progressivegardens.com/knowledge_tree/photosynthesistotal.jpg
http://www.williamsclass.com/SeventhScienceWork/ImagesCells/chloroplast3.jpg

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"Cell (biology) - Wikipedia, the free encyclopedia." Wikipedia. 15 23 2007. Wikipedia. 23 Oct 2007 <http://en.wikipedia.org/wiki/Cell_%28biology%29>.
Please note that the metabolism, catabolism, anabolism, photosynthesis, and cellular respiration sub-links were accessed on the Wikipedia website in addition to the page on cell biology