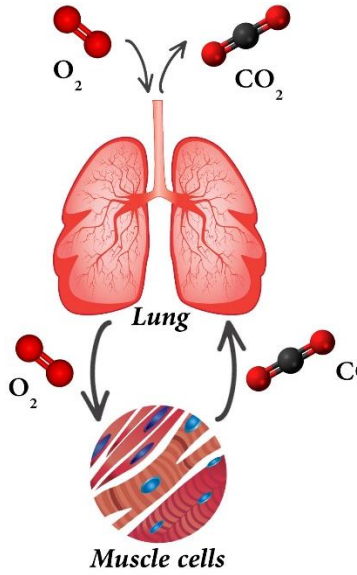
Name: _____ Period: _____ Date: _____

Cellular Respiration Guided Notes

Respiration

After you hear word 'respiration', you may now think about breathing. During breathing, the _____ is entered with each inhale and _____ _____ is released with each exhale. You may have noticed that breathing is a part of physiological respiration and functions because it bring oxygen into the lungs and expel carbon dioxide. Cellular respiration is a chemical process by which energy is obtained within individual cells from biomolecules like _____. All living organisms from a single cell to the most enormous creature all over the world, undergo respiration.

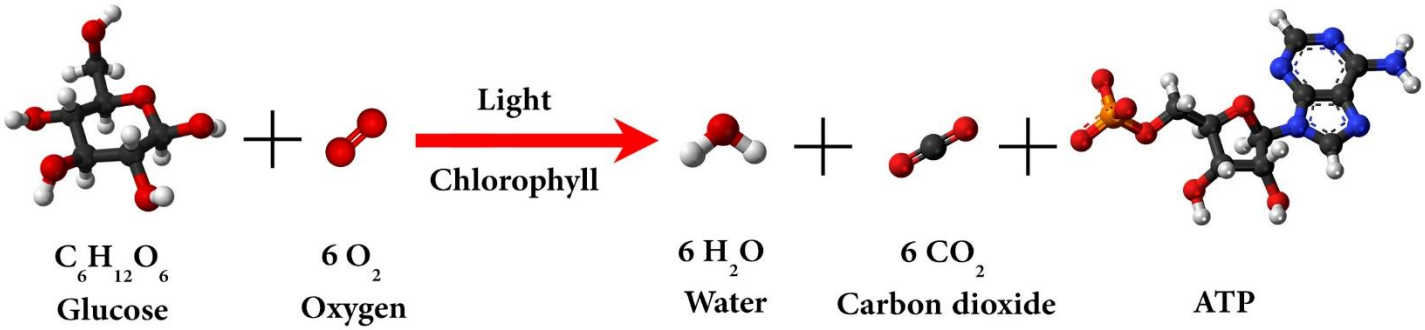


Breathing

Cellular Respiration

$$C_6H_{12}O_6 + 6O_2 \rightarrow 6CO_2 + 6H_2O + 25ATP$$

Cellular respiration is the process by which cells obtain energy by breaking down the high energy molecules produced by photoautotrophs. Cellular respiration is the opposite of _____ that need oxygen molecules and release carbon dioxide. During cellular respiration, the glucose is broken down into _____ _____, _____ and some ___ molecules are produced. The equation of cellular respiration is composed of reactants that include glucose and oxygen (for aerobic respiration), and the products that contain carbon dioxide, water, and ATP.



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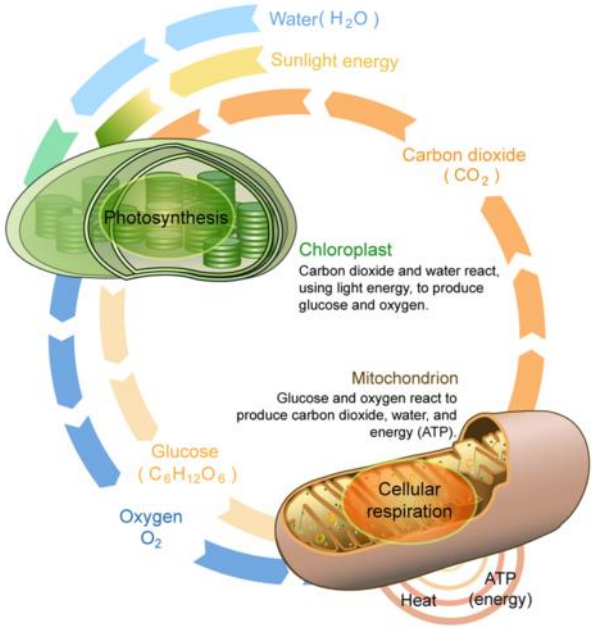
Cellular Respiration Guided Notes

Balance with Photosynthesis

You may notice that respiration is the contrast of the photosynthesis, in which carbon dioxide and water are utilized by photoautotrophs along with sunlight energy, to produce glucose and oxygen. Photoautotrophs include any photosynthesizing organisms, such as _____ and _____, all of whom also undergo respiration. The glucose and oxygen which are the products of photosynthesis are taken by heterotrophs who cannot make their own energy. The carbon dioxide and water which are the byproducts of respiration are then used in photosynthesis.



Phases of cellular respiration

Cellular respiration involves three phases: **glycolysis**, **the citric acid cycle**, and **the electron transport chain**. Respiration takes place in the cytosol and in the mitochondria. Mitochondria are considered the powerhouses of eukaryotic cells, and typically contain high surface areas of membrane folds where respiration process can be maximized.

Glycolysis takes place outside the mitochondria and does not require the presence of oxygen so, glycolysis is considered as _____ process. The other two phases of cellular respiration occur inside the mitochondria, where oxygen is the final acceptor of electrons. Therefore, the citric acid cycle and electron transport chain is considered as _____ processes. Throughout these phases, CO_2 and H_2O are the byproducts of cellular respiration, and ATP, is the main products.

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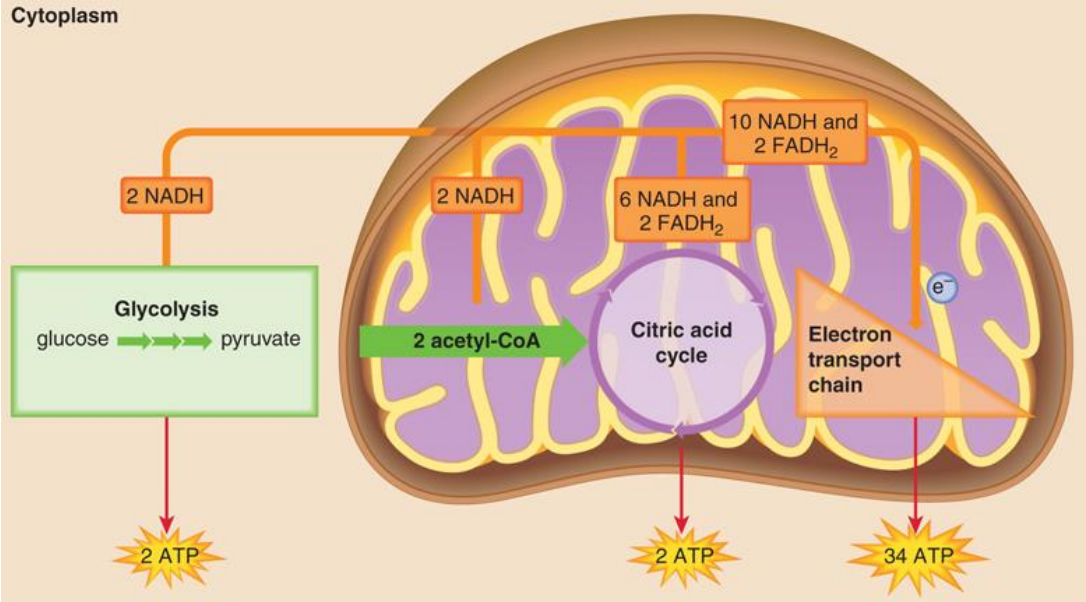
Cellular Respiration Guided Notes



During the breakdown of the glucose molecule into carbon dioxide and water some ATP is produced directly in the reactions and usually much more ATP is produced later in a special process called oxidative phosphorylation. The oxidative phosphorylation is triggered by the movement of electrons through a series of proteins that embedded in the inner mitochondrial membrane known as the electron transport chain.

These electrons that originally come from glucose molecule are transferred to the electron transport chain on electron carriers NAD^+ and FAD which converted to NADH and $FADH_2$ after they gain the electrons. To be clear, this is what's happening in the diagram above when it says NADH or $FADH_2$. The molecule isn't appearing from scratch, it's just being converted to its electron-carrying form:

$$NAD^+ + 2e^- + 2H^+ \rightarrow NADH + H^+$$

$$FAD + 2e^- + 2H^+ \rightarrow FADH_2$$

Let's discuss the three stages of the cellular respiration

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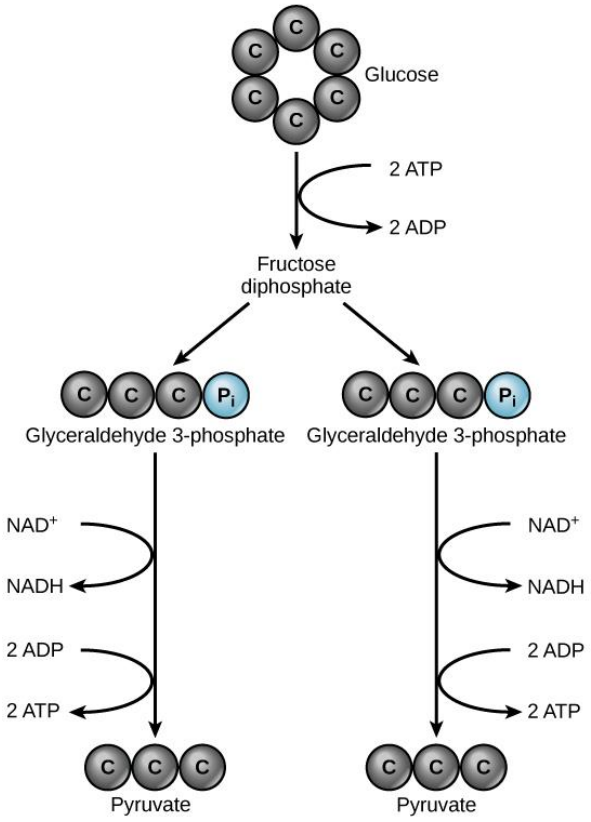
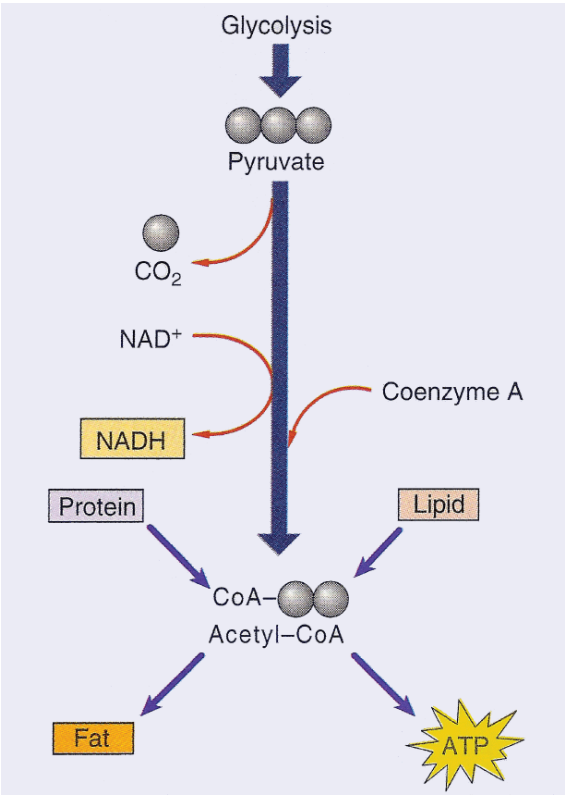
Cellular Respiration Guided Notes

1. Glycolysis

Glycolysis [glycos = sugar, and lysis = splitting] is the breakdown of _____. The glucose molecule (___ carbon molecule) undergoes a series of chemical reactions to produce two pyruvate molecules (_____ carbon molecule) in the _____. In these reactions the NAD^+ molecules is converted to NADH and ATP is produced. The pyruvic acid is finally oxidized into CO_2 and water, leaving a _____ molecule that called acetyl-CoA.





2. Citric acid cycle

The citric acid cycle occurs in the mitochondrial matrix. Each acetyl CoA molecules react with a 4-carbon molecule, forming two _____ citrate molecules. As citrate molecules goes through a cycle of biochemical reactions, NADH and FADH2 molecules are produced, and two CO_2 per citrate are released. The citric acid cycle is also able to produce one ATP molecule per turn. Because of the two acetyl groups that enter the cycle per glucose molecule, the cycle turns _____.

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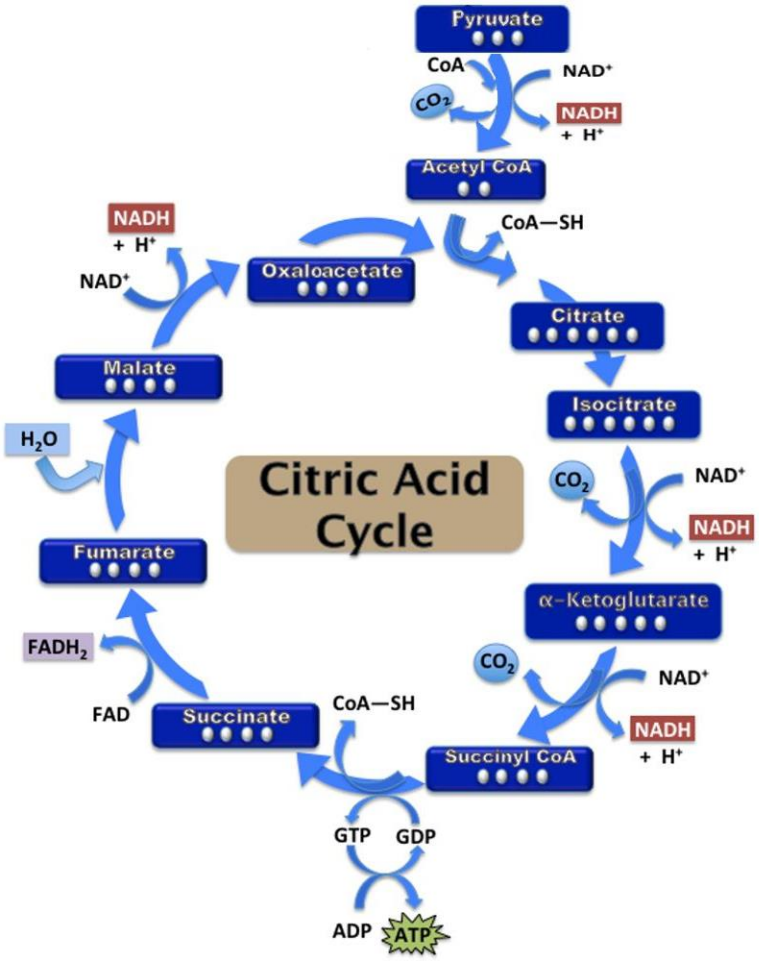
Cellular Respiration Guided Notes



3. Electron transport chain

The electron acceptor molecules (NADH and $FADH_2$) deposit their electrons into the electron transport chain and return into the empty forms NAD^+ and FAD. The energy is released as the electrons move down the chain. This energy is used to pump H^+ ions in high concentration from the matrix to one side of the plasma membrane forming a concentration gradient. The hydrogen ions (protons) flow back to the matrix through the ATP synthase enzyme, generating about 32 ATP. The remaining electrons are taken by oxygen that also combines with free hydrogen to form water.

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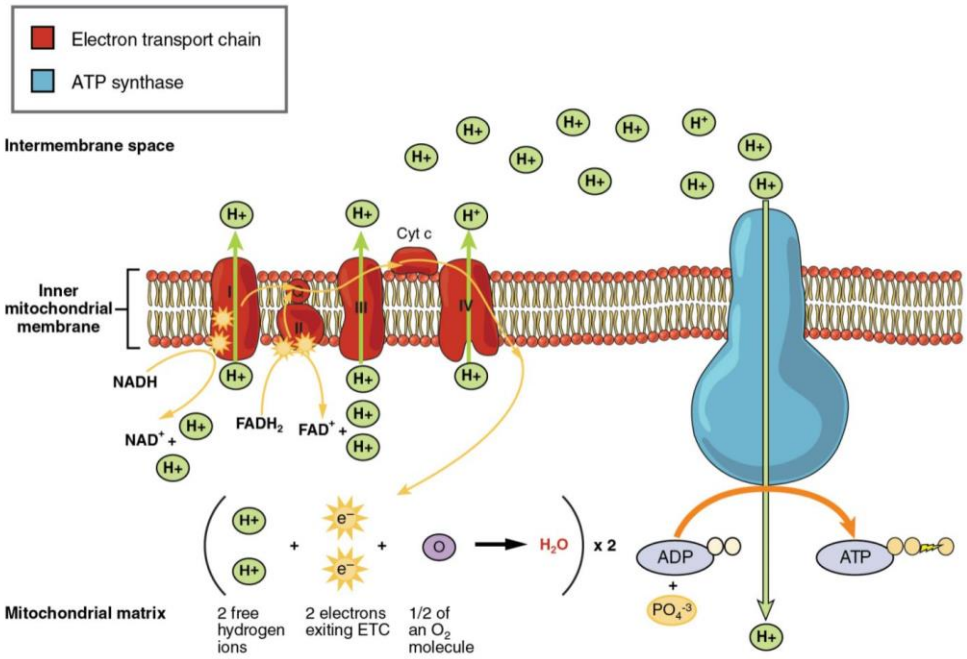
Cellular Respiration Guided Notes



Anaerobic Respiration

The cell undergoes the previously described stages if there is sufficient amount of oxygen that is able to receive the hydrogen released in the electron transport chain, therefore this type of cellular respiration is called _____ i.e. in free _____. But, when oxygen is missing or in low quantity, cells of living organisms respire by _____ respiration i.e. in the lack of oxygen. This is also called fermentation, and it doesn't need oxygen, but it takes place in the presence of some special enzymes.

Anaerobic respiration begins with the same beginning of the aerobic respiration. The Glucose molecule is decomposed into two molecules of _____ ____, with the formation of two molecules of NADH + H^+ and a small quantity of energy (___ ATP molecules). The next step depends on the type of cell doing this respiration.

1. **<u>In case of animal cells, especially muscle fibers and Bacteria,</u>**

When the muscles exert vigorous efforts or exercises, they consume most of the oxygen. The cells tend to convert pyruvic acid into lactic acid after its reduction by combining with hydrogen on NADH. This is known as muscular fatigue or acidic fermentation. If oxygen becomes available, lactic acid is converted into _____ ____ again and then into _____ ____.

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Cellular Respiration Guided Notes

2. **<u>In case of Yeast fungus, or in some plant cells,</u>**

Pyruvic acid is reduced into ethyl alcohol and carbon dioxide. This process is called _____ Fermentation and is used in the industry of some products like alcohol and beverages.