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Food Preservation
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Fermentation

How it Differs from Anaerobic Respiration

From Extremely Rancid Microbe Enzymes (to) Nice Tasty And Tangy Ingestibles Overflowing (with) Nutrients

Fermentation is the ideal way to preserve food because it prevents the decomposition of food, promotes gut health, and strengthens the immune system.

For thousands of years, the process of fermentation has been used by many cultures around the world to preserve food and to promote a healthy immune system. Fermentation can be traced back nearly ten thousand years to Neolithic China where archaeologists have found fermented brews of rice and honey. Later on people made beer, wine, chicha from maize, and cali, or pulque, from the agave cactus. Many advanced civilizations in the past have discovered the secrets of fermentation and used them as a way to live a healthier lifestyle.

The term fermentation was first used in the 1900 hundreds by Louis Pasteur to describe the changes brought by yeast and microbes breathing anaerobically. Fermentation is an anaerobic cellular process in which adenosine triphosphate(ATP) is released by organic food being converted into simpler compounds. ATP is a type of chemical energy that is used in many important bacterial processes. Apart from fermentation, living organisms make energy by breaking down sugar, which can be done by two ways: aerobic respiration, which

uses oxygen as a final electron acceptor, and anaerobic respiration. Both ways begin with the breaking down of 6-carbon sugar molecules into two 3-carbon pyruvate molecules. Then the pyruvate is converted into acetyl coenzyme A. In addition, hydrogen atoms are turned into electron carrier molecules, NADH and FADH2, which take the charged electrons to the electron transport chain, which consists of multiple enzymes and cofactors in the cell membrane, where it is made into ATP.

Here is where aerobic and anaerobic respirations differ. Aerobic respiration uses oxygen as the final electron acceptor, while anaerobic respiration will use other molecules, such as sulfate or nitrate ions. However, a common mistake is that anaerobic respiration and fermentation are the same. They may both be anaerobic, but fermentation does not use the electron transfer system. In fermentation, after glycolysis results in pyruvate in lactic acid fermentation and acetaldehyde in alcohol fermentation the next step is the final electron acceptor.

In fermentation, electrons from sugar molecules are transferred to an organic molecule, which produces the least energy. In anaerobic respiration, electrons from sugar molecules are transferred to an inorganic molecule, which produces less ATP than aerobic respiration but more than fermentation. In aerobic respiration, electrons from sugar molecules are transferred to an inorganic molecule, which produces the most energy.

Fermentation can happen in both prokaryotes and eukaryotes, such as humans. Humans use anaerobic respiration when there is a high demand for ATP,

but not enough oxygen, but if ATP is needed very quickly muscle cells will use the faster lactic acid fermentation. High ATP demands usually occur during strenuous exertion. However, as soon as a stable oxygen supply is available, muscle cells will return to aerobic respiration due to its higher ATP yield. Fermentation is also used in our body by mature red blood cells, which don't have mitochondria. Mature blood cells use lactic acid fermentation so they do not use the oxygen they are carrying. Maximum efficacy. While most organisms use fermentation as a last resort, some, like obligate anaerobes, which solely use fermentation to biosynthesize ATP. An example of obligate anaerobes are the symbiont fungi genus Neocallimastix, which live in the rumen of herbivore animals and help digest cellulose through fermentation.

The genus Bactericides are also obligate anaerobes that live in human colonic flora and degrade sugar derivatives from plants to make energy through fermentation. Many animals have gut bacteria that ferment foods that animals cannot digest. Humans rely on fermenting bacteria in the large intestine to get rid of excessive amounts of certain molecules such as fructose. Some organisms are facultative anaerobes, which choose fermentation over aerobic respiration even when oxygen is readily available, especially if pyruvate is gathering too quickly to be processed. Bakers yeast(Saccharomyces cerevisiae) and fission yeast(Schizosaccharomyces pombe) use fermentation over respiration, so basically bread is a fermented food. In contrast, Kluyveromyces lactis is a type of yeast that uses fermentation only in completely anaerobic conditions and prefers

respiration. In fact, the word fermentation comes from the latin word "ferments", which meant yeast. Even some fishes, such as goldfish, can use fermentation to produce ethanol in myotomal muscles, or use lactic acid fermentation.

Aerobic respiration is superior to fermentation in some ways, but inferior in others. Aerobic respiration yields 38 ATP per glucose molecule, while due to the partial oxidation of organic matter, fermentation yields only 2 ATP. Aerobic respiration uses extra steps, fermentation is shorter. Fermentation also makes NADH, a high energy molecule. NADH is made when glyceraldehyde phosphate is oxidized so H+ ions can join with NAD+. Then the remaining energy is used to make pyruvate, which in turn is used for electron transfers from NADH to pyruvate or its derivatives. This generates NAD+, which is used in glycolysis.

Fermentation is used in many ways by the food industry. Bread, yogurt, cheese, wine, and many other commercial food items are made with fermentation. The texture and taste of these common foods depend on the fermentation process used. Lactic acid fermentation, which results in lactic acid, is by fungi and bacteria to make yogurt and cheese. Alcohol fermentation, which results in alcohol, is used by yeasts to make wine. All yeast fermentation needs sugar. In winemaking, yeasts eat the sugars in the juice and make alcohol. Yeasts in bread dough eat the sugars in the dough, and release CO2 which helps the bread rise.

Anoxic environments are places with no oxygen, and these include mud, soil, and hydrothermal vents under the sea. Anaerobic bacteria live in and have a positive effect on these desolate places, and by making energy they release

by-products that make the niche habitable for other creatures. The bacteria Pseudomonas stutzeri is well known for denitrification, or the turning nitrate into nitrite and dinitogen gas(n2). Desulfovibrio and Desulfuromonas bacteria reduce sulfate and elemental sulfur, respectively, and yield sulfide(S2-). The bacterium Acetobacterium woodii and methanogenic archaea reduce carbon dioxide and make acetate and methane, respectively. Archaea use hydrogen as an electron donor and carbon dioxide as an electron acceptor, and yield methane(if sulfate is the acceptor, it yields sulfide).

Lactic acid fermentation occurs in the cell cytosol. There are two types of lactic acid fermentation, homolactic fermentation and heterolactic fermentation. Homolactic fermentation is when the by-products are only lactate. Heterolactic, which probably means something in latin, is when there are multiple by-products, including lactate. Few bacteria are homolactic, due to that fact that lactic acid is fairly toxic to most bacteria and limits colony growth. Most fermentation end products are usually less toxic than lactic acid, and aerobic respiration has mostly non-toxic end products.

Heterotrophic bacteria need organic molecules to make energy. The energy process includes electron-transfer reactions where electrons are transferred from one molecule to another with energy trapping reactions which creates ATP. Some heterotrophic bacteria metabolize sugars or carbohydrates to produce energy, and these bacteria need to make a cartiant amount of proteins and enzymes, proteins to break polysaccharides into sugar and enzymes to make sugar into metabolic

intermediates, such as glucose. Sugar metabolism makes energy through three processes: aerobic respiration, anaerobic respiration, and fermentation. Sugars and amino acids are then broken down into smaller organic molecules, which will accept electrons released by the breakdowns, which create ATP.

Movements of the electrons through the electron transfer chain are matched with protons(hydrogen atoms) moving across the membrane to leave the cell. Electrons moving make the positively charged ions go to the exterior of the cell and the negative ions go to the interior. This is called an ion gradient. Ion gradients acidify the external medium and energize the plasma membrane. Ion gradients are a common energy generation and storage system in all living things. The photon gradient is used for nutrient transport and rotation of the flagella, which enables moving.

Another type of fermentation is fermentative hydrogen production is when an organic compound is converted into hydrogen gas(H2) by fermentation. Certain bacteria and protozoa have enzymes that enable this process. When light energy is required, it is called photofermentation, and when light is not needed it is called dark fermentation.

Although fermentation is not as efficient as other methods, it is the best way to preserve food due to the fact that we all depend on it in our day to day lives. Without fermentation, we would not be where we are today.

Works Cited

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