Aerobic/Anaerobic Encyclopedia Article

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Until Louis Pasteur investigated the production of alcohol by yeasts, it was believed that life was only possible in the presence of air, i.e., under aerobic conditions. This is true for higher organisms, but many bacteria and some protozoa can grow only in the total absence of air, i.e., under anaerobic conditions, and are referred to as strict or obligate anaerobes. Some bacteria, fungi, and protozoa (facultative anaerobes) can grow in either the presence or absence of oxygen. Organisms that require oxygen are classified as strict or obligate aerobes. Some microorganisms, classified as microaerophiles, require low concentrations of oxygen and do not grow at atmospheric oxygen pressure or in the absence of oxygen.

Oxygen is required by aerobes for two purposes: (1) to serve as a terminal electron acceptor for theelectron transfer system, and (2) to participate in very small amounts in certain enzymatic reactions (e.g., in the oxidation of hydrocarbons, the addition of molecular oxygen to the hydrocarbon molecule is required). In general, under aerobic conditions, reduced carbon materials such as carbohydrates are metabolized to carbon dioxide, water, metabolic intermediates, cellular materials, and energy. Many intermediate steps are involved in the overall reaction. Breakdown of some organic compounds also may result in the release of inorganic nutrient ions such as nitrogen, sulfur, and phosphorus.

Under anaerobic conditions, metabolism of organic compounds takes place much more slowly than when oxygen is plentiful. The products of anaerobic metabolism include a variety of partially oxidized compounds such as organic acids, alcohols, and methane gas. Anaerobic metabolism releases relatively little energy for the organisms involved. The end products still contain a significant amount of energy, so products such as alcohol and methane can be used as fuels. The most common anaerobic heterotrophic reactions are that of fermentation, where an oxidized compound such as a sugar is converted to an alcohol or acid, carbon dioxide, and energy, and that of methane production, where hydrogen and carbon dioxide are converted to methane, water, and energy.