

Respiration Notes

Cellular respiration is the chemical reactions that happen in the cells of living organisms to sustain life, by breaking down food substances to release biochemical energy. A reaction involved is catabolic reactions, which break large molecules into smaller ones, releasing energy in the process as they break high-energy bonds. Respiration is one of the key ways a cell gains useful energy to fuel cellular activity. Nutrients that are commonly used by animal and plant cells in respiration include glucose and molecular oxygen. Organisms that use oxygen in respiration are described as aerobic, while those that do not are anaerobic. The energy released in respiration is also used to produce ATP to store this energy. The energy stored in ATP can then be used to drive processes requiring energy, including biosynthesis, locomotion or transportation of molecules across cell membranes.

Aerobic respiration requires oxygen in order to generate energy. Although carbohydrates, fats, and proteins can all be processed and consumed as reactant, this is the preferred method of respiration. Aerobic metabolism is up to 15 times more efficient (36 mol ATP for every mol of glucose) than anaerobic metabolism (2 mol ATP for every 1 mol glucose). It can be expressed in $C_6H_{12}O_6 + 6O_2 > 6CO_2 + 6H_2O + \text{Energy}$. Complex organisms respire aerobically as they need large amounts of energy to survive. Such organisms need the energy to synthesise new protoplasm, synthesise proteins from amino acids, conduct active transport, contract muscles, transmit nerve impulses and conduct cell division.

Anaerobic respiration is a form of respiration without oxygen. Anaerobic respiration is energetically less efficient than aerobic respiration. It occurs when more energy is needed than the body is able to produce by aerobic respiration, normally for about 30s. Anaerobic respiration is used mainly by prokaryotes that live in environments devoid of oxygen. Many anaerobes are obligate anaerobes, meaning that they can respire only using anaerobic compounds and will die in the presence of oxygen. E.g. of anaerobes include yeast, where Ethanol fermentation takes place ($C_6H_{12}O_6 > 2C_2H_5OH + 2CO_2 + \text{Energy}$). Ethanol is used to brew alcohols like beer, wines and hard liquor. Ethanol is also used as an organic solvent and disinfectant. Ethanol can also be used as a biofuel for cars. Ethanol can be mixed with petroleum in ratios as low as 1:9 to running a car entirely on ethanol. Ethanol is renewable energy as ethanol can be produced from biomass. Anaerobic respiration also takes place in muscle cells when the limit of oxygen pumped per minute has been reached. Aerobic respiration isn't able to release energy fast enough to meet the demand and extra energy has to be released through anaerobic respiration. Lactic acid is formed in the process ($C_6H_{12}O_6 > 2C_3H_6O_3 + \text{Energy}$). The small amount of energy released is enough to help the muscles to continue contracting. Since there is insufficient oxygen to meet the required oxygen during vigorous muscle contractions, there is an oxygen debt. Lactic acid builds up slowly and may eventually become high enough to cause fatigue and muscular pains. During rest, the breathing rate continues to be fast for some time so that sufficient oxygen can be taken in to repay the oxygen debt. Lactic acid is transported to the liver and some of it is oxidised to release energy. The rest is converted