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Biology 123-05

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Oxygen Energy

Metabolism is the collective chemical reactions that occur in a living cell or organism that fuels life processes, and a recent discovery has determined that the presence of oxygen has been an important adaptation to multicellular life. In the March 24th 2006 online issue of *The Scientist*, Melissa Lee Phillips published an article "How Oxygen Changed Metabolism" about research on the importance of oxygen and metabolic reactions.

After appearing on the Earth 2.2 billion years ago, oxygen has become one of the most important elements required for the largest and most complex networks. Jason Raymond of Lawrence Livermore National Laboratory in California stated that in aerobic organisms, (organisms that require oxygen) anoxic enzymatic reactions (enzyme reactions that are deficient in oxygen) were later replaced with new enzymes and newer reactions (Phillips). Raymond and Boston University's Daniel Segré wanted to find if this discovery held true to all metabolic pathways so they planned an experiment "to simulate metabolic networks that could develop under different conditions" (Phillips). After about 100,000 simulations, with anywhere from 10 to 100 randomly chosen starting metabolites, a substance necessary for or taking part in a metabolic process, the outcome concluded the generated metabolic networks can be summed into four major categories with one group having a 95% resemblance in reactions and

metabolites while the smaller groups contained reactions and metabolites also present in larger ones.

Raymond and Segre concluded, "the largest and most interconnected of the four groups was only reached in simulations that included molecular oxygen"(Phillips). Networks of this group generated as many as 1000 more reactions than those networks without oxygen. Networks do not depend on oxygen for individual reactions to occur but networks rely on it for the reaction as a whole to happen.

Researchers have also noticed a pattern with oxygen and organisms; they noticed that organisms with anoxic (an absence of oxygen) enzymes, they tend to fall into the same genome-based phylogenies, while organisms with enzymes that need oxygen for metabolism range in phylogenies and have no bias on whether they prefer aerobic or anaerobic conditions. Researcher's findings are leading Raymond to hypothesize that "adaptation to molecular oxygen occurred independently in different lineages or through horizontal gene transfer after all three domains of life appeared"(Phillips).

In the *Biology Science* textbook, oxygen is present in almost every metabolic process because as chapter two states "oxygen in the most electronegative of all elements" (Freeman 26). Oxygen is used as an electron acceptor in cellular respiration, such as photosynthesis and glucose oxidation, because "O_2 is so electro negative it create a huge potential energy drop for electron transport chains… As a result organisms that use O_2 as an electron acceptor in cellular respiration can produce more ATP" than can organisms that use other electron acceptors.

Bibliography

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