The Enzyme: Source of Green Energy

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ABSTRACT

All living existence's need energy for the metabolism and growth. To accomplishthisnecessity different sources of energy used by diverseorganisms. One of the cheapest and easy sources is the renewable/ green sources used by the vast number of organisms for their growth and development. Some soil bacterium uses the atmosphere hydrogen as energy source. Enzymes acts as catalyst in metabolic reactions. This article tells us around the recent study of enzyme activity (Huc) in soil bacterium (Mycobacterium smegmatis) whichproduce the electric current using hydrogen from the atmosphere.

INTRODUCTION

Green energy or Renewable energy is an important part of the puzzle in meeting growing energy demands and modifying climate change. Water, wind and sunlight are some sources for the generation of green energy besides this some soil bacterium uses atmosphere hydrogen as energy sources. In recent finding enzymes from bacterium uses hydrogen to yield electricity which gives new line for the generation of green energy. When H2 is considered as the energy of survival, we are dealing with concentrations below the threshold level desired for growth and reproduction (Morita, 1999). Rising human inhabitants and intensifying levels of consumption have raised up energy demands, placing increasing burdens on the environment – particularly on the global climate. In a conversion to clean sources of energy, much energy growth will come from renewable energy sources and, as of 2016, 176 nations have set targets to obtain certain proportions from so-called 'green' energy sources.

Enzymes

A biological catalyst, which are produced in living cells, generally protein in nature that can catalyse biochemical reactions without their consumption in the reactions. As a biocatalyst that speed up a variety of chemical processes. Without enzymes, the chemistry carried out by living cells would proceed at a rate that was too slow for the organism to remain alive. They are specific in their reactions so different enzymes at physiological temperature and conditions catalyse each reaction. Enzymes made of protein molecules, and so are made up of amino acids. These amino acids are joined together in a long chain, which is folded to produce a unique 3D structure. Speeding up chemical reactions, required minute amounts and specific nature are some Characteristics of enzymes. Enzyme specificity means that each chemical reaction inside a cell is catalysed by a unique enzyme. By lowering the activation energy needed to start the reaction speed up it. Besides this some others characteristics are exhibit all properties of proteins like proteins, they can be denatured by changes in pH and temperature ,They have their specific isoelectric points at which they are least soluble, The enzyme-catalysed reactions occur below 100oC, at atmospheric pressure and nearby neutral pH ,undergo physical changes during the reaction but revert to their original form at the end of the reaction and The rates of enzymatically catalysed reactions are 106 - 1012 times greater than those of the corresponding uncatalyzed reactions. Enzymes are Classified in 6 types by International Union of Biochemists (IUB) in 1964 based on reactions catalysed with a four number code. CLASS –I: Oxido-reductases, CLASS – II Transferases, CLASS – III Hydrolases, CLASS – IV Lyases, CLASS- V Isomerases and CLASS – VI Ligases. These six categories did not change for many years until a new class, the translocases (EC7), was added in August 2018(Tao et a.l 2020).

How enzyme Operates:

There are at least 21 various theories for how enzymes can catalyse organic reactions have been presented. Among all these theories, a common one is that enzymatic processes are usually initiated by the production of an enzyme-substrate structure (or E-S complex), from which the catalysis happens.

- Lock-and-key hypothesis: This is the simplest model to represent how an enzyme works. An enzyme is the lock into which the substrate (the key) fits. In this model, the active site of the unbound enzyme is complementary in shape to the substrate (Fig. 1).
- Induced-fit hypothesis: In this approach, the structure of enzyme converts shape as the substrate compounds get closer. When a substrate trends to bind to enzyme, the interactions of different functional groups on the substrate, with specific enzyme groups are initiated, and these reciprocal interactions cause a conformational change in the enzyme. After the substrates have been bound, the active site forms a shape supplementary to the substrate (Fig1).

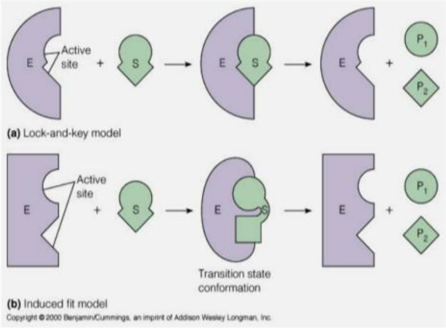

Figure 1: Models of enzyme activity

Energy source of bacteria:

Many bacteria from various environments have the capacity to oxidize atmospheric H2, and some ecosystems, like hyper-arid polar soils, seem to be primarily powered by atmospheric energy sources (Bay *et al*.2021).The soil bacteria

Mycobacterium smegmatis has the ability to scavenge the atmospheric H2 at trace amounts. Most ecosystems include trace levels of molecular hydrogen (H2) from human, biological, geochemical, and atmospheric sources. This energy-dense gas is used by aerobic bacteria to sustain respiration and carbon fixation, even at ambient concentrations. Contrary to what was previously believed, information presented here suggests that aerobic H2 consumers are prevalent throughout soils and other aerated ecosystems. Atmospheric H2 may be consumed by bacterial cultures from at least eight main phyla. H2 consumers are numerous, diversified, and active over a wide range of soil types at the ecosystem scale and are important primary producers in harsh conditions like hyper-arid deserts.

Recent Findings

According to recent research, the enzyme generates an electrical current using the little quantities of hydrogen present in the environment. The Monash University Biomedicine Discovery Institute in Melbourne, Australia-based research team, led by Dr. Rhys Grinter, Ashleigh Kropp, and Professor Chris Greening, generated and examined a hydrogen-consuming enzyme from a common soil bacterium (Mycobacterium smegmatis).

About Bacteria (Mycobacterium smegmatis):

An acid-fast bacterial species belonging to the phylum Actinomycetota and the genus Mycobacterium is. It measures 3.0 to 5.0 m in length, has a bacillus form, and may be stained by fluorescent auramine-rhodamine method. It is generally considered a non-pathogenic microorganism; however, in some very rare cases, it may cause disease (Reyratand Kahn 2001). It is commonly used in work on the Mycobacterium genus due to it being a "fast grower" and non-pathogenic(Fig.2).

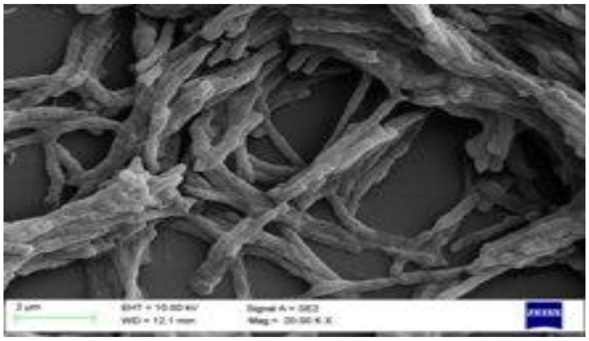

Figure 2: Mycobacterium smegmatis

How mechanism works Actual:

In nutrient-poor conditions, a lot of bacteria use atmospheric hydrogen as a source of energy. The researchers isolated the enzyme needed to use atmospheric hydrogen from the bacteria (Mycobacterium smegmatis). They demonstrated how the Huc enzyme converts hydrogen gas into an electrical current. The enzyme is incredibly effective and may use as little as 0.00005% of the hydrogen in the air we breathe to consume hydrogen below atmospheric levels.

They use several cutting-edge methods to reveal the molecular blueprint for hydrogen oxidation in the atmosphere. They used advanced microscopy (cryo-EM) to determine its atomic structure and electrical pathways, pushing the boundaries to produce the best-solved enzyme structure to date using this method. Using electrochemistry, they demonstrated that purified enzymes generate electricity at trace hydrogen concentrations. Using molecular modelling and simulations, they identified specific regions of the protein that allow hydrogen gas to enter the active site of the converted protein, but block oxygen from passing through (Grinteret al.2023).

CONCLUSION

Huc is a "natural battery" that produces a sustained electrical current from air or added hydrogen. Although this research is still in its early stages, Huc's findings have great potential for developing small air-powered devices, for example, as an alternative to photovoltaic devices. The bacteria that produce enzymes like Huc are common and can be grown in large quantities, meaning we have access to a sustainable source of the enzyme. A key objective for future work is to scale up Huc production. "Once we produce Huc in sufficient quantities, the sky is quite literally the limit for using it to produce clean energy."

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