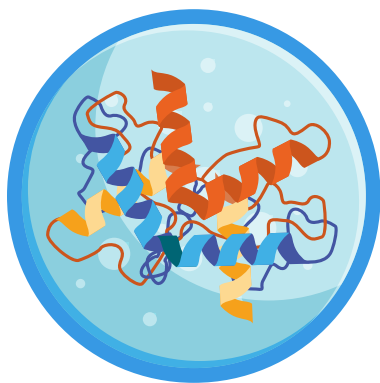


MICROSCOPIC ORGANISMS FOR MORE SUSTAINABLE CHEMICALS

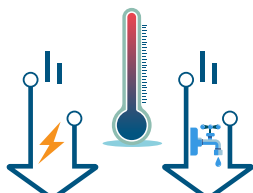


Nature is an abundant source of chemicals, inspiring sustainable alternatives to fossil-based products. Key to this effort are scientific breakthroughs, such as in genetic tools, which serve as linchpins in fostering a sustainable economy.

Exploring the Power of Enzymes



Enzymes, ubiquitous proteins, **speed up chemical reactions** through catalysis, making processes more efficient and eco-friendly.



They operate at **lower temperatures and moderate pH levels**, reducing energy and water usage.



Microorganisms, including bacteria and fungi, harness enzymes for diverse tasks, **producing valuable products like yogurt and beer.**

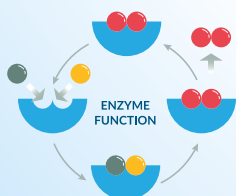


Genetic engineering manipulates DNA **to enhance production**, with recent advancements enabling comprehensive cellular redesigns.



Enzymes and microorganisms lead the development of eco-friendly materials, sustainable fuels, and pollution solutions, with applications in agriculture for improving soil quality and reducing chemical use. **These innovations promise a future where biological solutions drive sustainability across sectors.**

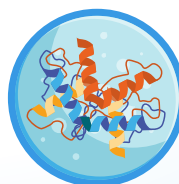
How do Enzymes Operate?



Enzymes accelerate chemical reactions by either **facilitating the bonding of different molecules** or catalysing their separation.



What are the benefits? Using enzymes as catalysts **not only accelerates the chemical processes but also renders them more cost-effective**, in line with the principles of green chemistry.



Numerous chemical reactions necessitate elevated temperatures and/or pressures, which escalate energy expenditures. Moreover, heightened temperatures often entail extensive water usage for cooling, further inflating costs. **To mitigate these adverse environmental effects, enzymes emerge as formidable allies, capable of substantially mitigating or entirely eliminating these drawbacks.** Operating with precision, enzymes exhibit biodegradability and conduct their reactions at relatively low temperatures and moderate pH levels. Additionally, due to their ability to remain unchanged post-reaction, enzymes persist in catalyzing subsequent reactions. Consequently, even minute quantities of enzymes can facilitate industrial-scale chemical transformations.

The power of microorganisms



Microorganisms, comprising microscopic single or multi-celled organisms, encompass a diverse array of life forms, including bacteria, yeast, micro-algae, and fungi. **Ubiquitous in their distribution, microorganisms permeate our environment, inhabiting the water we drink, the air we breathe, and even the inner recesses of our bodies.**

Enzymes are inherent components of all microorganisms. Through billions of years of evolution, these microbes have honed remarkably intricate functionalities, enabling them to thrive, proliferate, and perpetuate their existence.



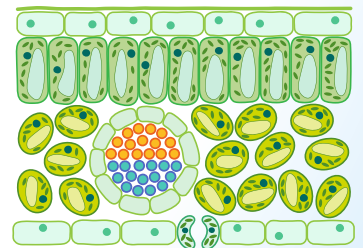
Functionally akin to miniature factories, microorganisms undertake a multitude of biologically significant tasks, generating a diverse range of valuable products. **For instance, bacteria excel in breaking down lactose to yield yogurt and fermenting sugar to produce beer.** Operating akin to a well-oiled factory, microorganisms utilize raw materials—such as nutrients—and process these compounds within specialized cellular compartments to yield biochemicals, their end products.



What are the benefits? While natural organisms primarily produce biochemicals essential for their survival rather than striving for high yields, the manipulation of molecular assembly lines within microorganisms presents an avenue for enhancing production volumes of desired products. **By engineering novel molecular pathways or refining existing ones, these modifications empower microorganisms to efficiently churn out large quantities of targeted biochemicals, heralding a host of practical benefits.**

From genetic engineering to synthetic biology

Genetic engineering involves the deliberate manipulation of an organism's DNA. In the 1980s, scientists created the first genetically engineered organism capable of producing insulin on an industrial scale, thereby circumventing the reliance on insulin derived from animal sources. Initially, this process was constrained to the modification, insertion, or deletion of individual genes. However, advancements in genetic technology have propelled the field forward, allowing for increasingly intricate modifications. **In recent years, a proliferation of cutting-edge genetic technologies has empowered scientists to undertake comprehensive redesigns of cellular systems.**



Enzymes and microorganisms are currently at the forefront of developing environmentally friendly materials, sustainable fuels, and solutions for pollution cleanup, all while bolstering food security. Their versatile applications extend to treating wastewater, degrading plastics, and remediating heavy metal pollutants. Moreover, they exhibit the capacity to capture greenhouse gases and convert them into valuable chemicals or fuels. Furthermore, they can be engineered to serve as 'biosensors', swiftly detecting the presence of toxins, hormones, pathogens, and other environmental contaminants.

In the realm of agriculture, their impact will be transformative. Microbial biosensors are already in development to identify crop diseases. Modified bacteria and algae hold promise as agricultural probiotics, augmenting soil quality, improving water efficiency, enhancing nutrient availability, and curbing reliance on chemical fertilisers and pesticides.

These advancements herald a future where enzymatic and microbial solutions play a pivotal role in fostering sustainability across various sectors.