GLOBAL BIOECONOMY SUMMIT 2020

ESAB European Society of Applied Biocatalysis

ENZYMES, BIOCATALYSIS AND THE BIOECONOMY

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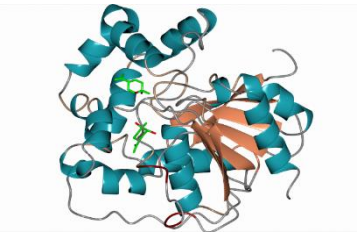
University of Exeter, UK

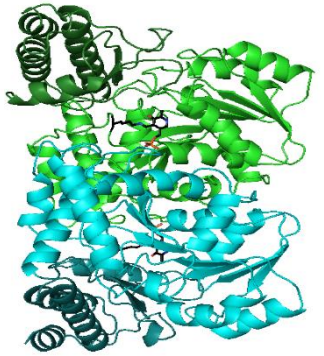
How to shape education for a sustainable Bioeconomy?

The importance of Biocatalysis towards a successful Bioeconomy

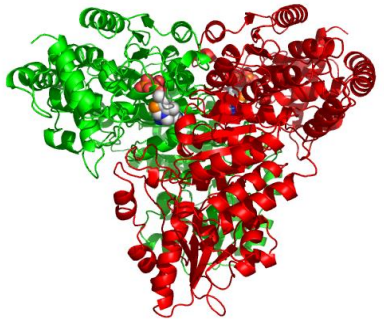
Subworkshop d) 16th November 2020



IMPORTANCE OF BIOCATALYSIS



- APPLICATION OF ‘NATURES’ CATALYSTS IN IMPORTANT ASPECTS OF OUR EVERYDAY LIFE
- CARRY OUT IMPORTANT REACTIONS IN BIOSYNTHESIS OF SAFER NEW DRUG MOLECULES - HEALTHCARE
- USE IN RECYCLING OF WASTE MATERIALS TO MAKE NEW CHEMICALS AND BIOMATERIALS –CONTRIBUTE TO THE CIRCULAR ECONOMY WHERE NOTHING GOES TO WASTE
- ENZYMES FOR THE DETERGENT, COSMETIC AND FOOD INDUSTRIES
- ENZYMES FOR CARBON DIOXIDE CAPTURE
- ENZYMES REPRESENT SUSTAINABLE PROCESSES THAT ARE ENVIRONMENTALLY FRIENDLY AND CARRY OUT REACTIONS UNDER AQUEOUS CONDITIONS AND AT AMBIENT TEMPERATURES
- SAFER PROCESSES AND REDUCTION OF TOXIC WASTE
- REDUCTION OF PETROLEUM BASED PRODUCTS



ENZYME DISCOVERY
Novel Thermophilic Genomes and Metagenomes

We still have a limited understanding of the **metabolic capacity of life** and only a small proportion of ‘nature’s catalysts’ have been utilised for industrial biotechnology.
There are still new metabolic pathways and new enzyme activities to be discovered and many of these will occur in the large proportion of **micro-organisms that cannot be cultured** and within their associated viruses.
The number of enzymes explored to date remains within the range of **1-2% of known diversity.**
This in itself illustrates the untapped functionality which is still available
Enzymes from **organisms that live under extreme environments**, both terrestorial and in the deep oceans are **more robust** for industrial applications.

Biocatalysis Centre -Enzymes for Healthcare products

Stains and sustainability

Some oils from human skin (sebum) cannot be fully broken down by current washing detergents, leaving yellow-brown stains and odours on clothes after repeated washing. Enzymes have been identified that could break these persistent oils down, preventing the buildup of stains and odours.

New products under development that could work at **20°C**, using up to **70% less electricity**

New enzyme testing methods and models of sebum and developed **for industry use**

Exeter University, Unilever

Innovate UK

Unilever

bbsrc
biotechnology and biological sciences research council

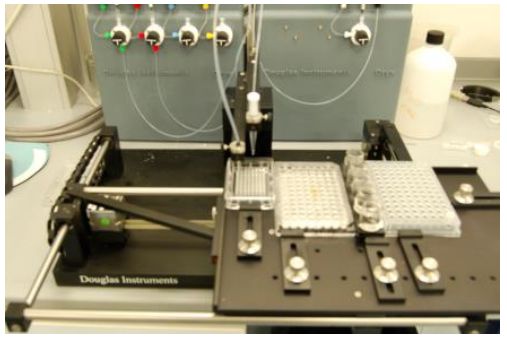
Discovery and Applications of Enzymes for New Drugs

Hot Spring Sample

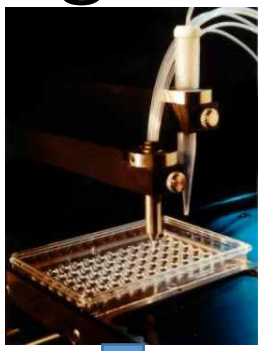
DNA

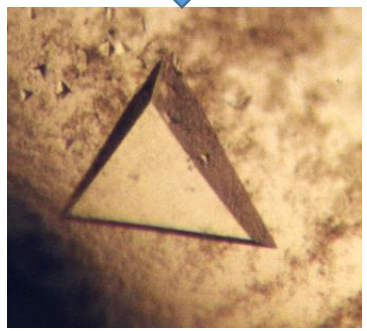
MLYVYMDGEFVPENE
AKVSIFDHGFLYGDGV
FEGIRAYNGRVFRLKE
HIDRLYDSAKAIDLEIPI
TKEEFMEIILETLRKNN
LRDAYIRPIVTRGIGDL
GLDPRKCQNPSIIVITK
PWGKLYGDLYEKGLT
AITVAVRRNSFDALPP

Protein sequence and purification

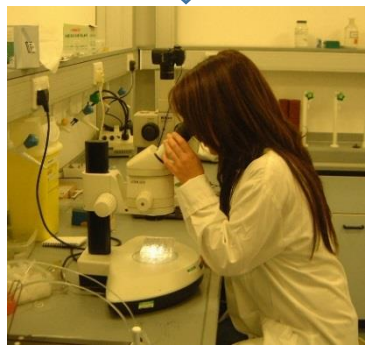


Crystallisation Robot

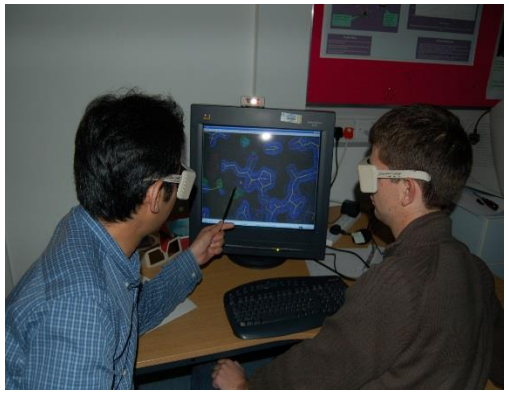




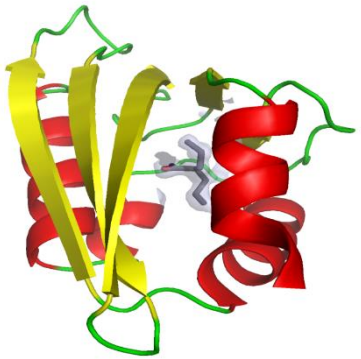
Protein Crystal



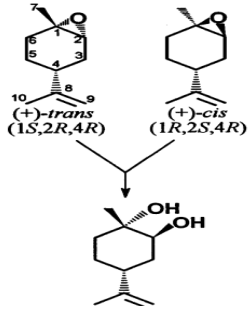
Diamond Synchrotron



Fitting Protein Chain



Cartoon of 3D Structure

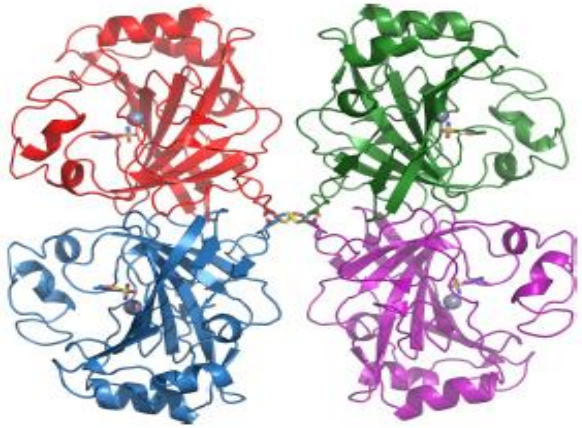


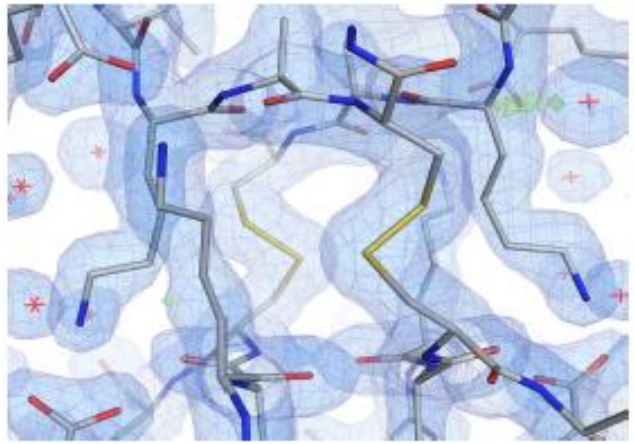
Enzyme Chemistry
Building blocks

New Drugs

ENZYME FOR CARBON DIOXIDE CAPTURE

α-carbonic anyhdrase from *Thermovibrio ammonificans* – bacteria that uses CO2 for growth in deep sea hydrothermal vents

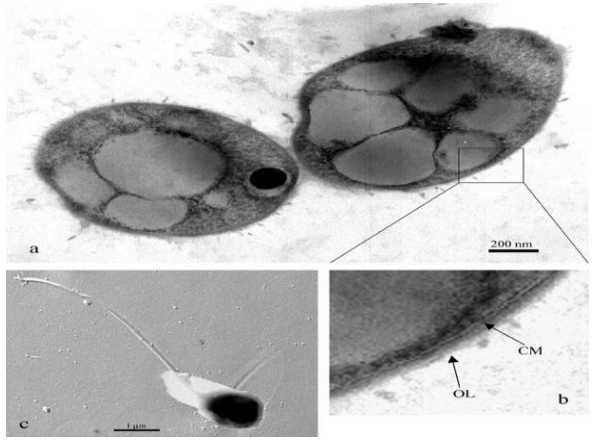


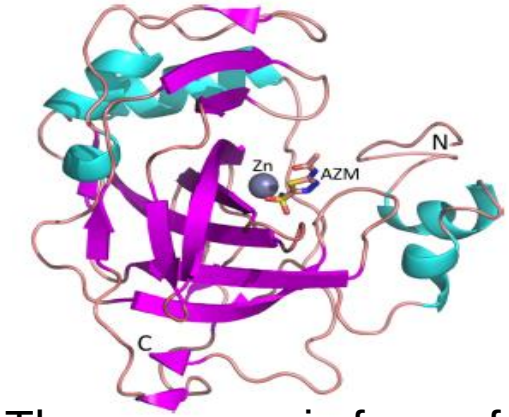


Thermostability
Retains 90 % activity after incubation at 70 ˚C for one hour

The oligomeric state of the enzyme is a tetramer held together by two pairs of disulfide bonds at the central core. This is a unique structure where the disulfides are lined by lysine residues

Vetriani et al., (2004), J Systematic and Evolutionary Microbiology





The monomeric form of the zinc containing enzyme.

James et al., (2014)
Acta Cryst D70, 2607-2618 in collaboration with Statoil and CO2 solutions

Statoil equinor CO2 SOLUTIONS

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EGENIS CENTRE

Dedicated to researching the nature, historical precedents, and philosophical, social, and scientific applications of the modern biosciences.

UNIVERSITY OF EXETER Biocatalysis Centre

Use of natures catalysts, enzymes in industrial biotechnology

KEY TO PROVIDE EDUCATION IN MULTI-DISCIPINARY AREAS TO ADDRESS ALL OF THESE IMPORTANT ASPECTS THAT ARE CONTRIBUTING TO THE OVERALL BIOECONOMY

Undergraduate, **Masters** and PhD programmes to provide the necessary expertise and broader understanding to address these important challenges for the overall bioeconomy