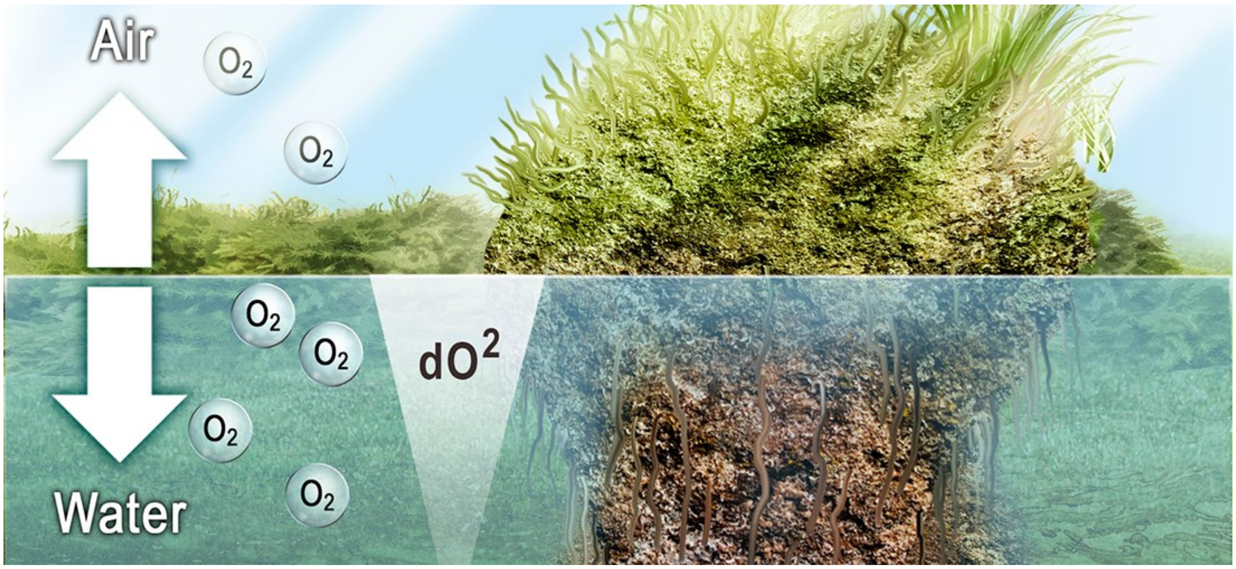
Inspiration Catalogue for Student Project s – 2025
Enzyme Ecology research group, IGN

You can use this Student Project Idea Catalogue to get inspiration for you own project. The projects can be adjusted to fit a normal project, BSc or MSc thesis. You are always welcome to come by our offices at Rolighedsvej 23, to discuss your ideas.

1 Enzymatic Degradation of Biomass in Oxygen-Constrained Environments



The aim of this project is to investigate the activity of enzyme cocktails on both pure and complex biomass substrates, under varied oxygen conditions.

The enzyme family of Lytic Polysaccharide Monooxygenases (LPMOs), working in combination with other biomass degrading enzymes, have been shown to greatly increase sugar yields in industrial scale biomass conversion and biofuel production. In laboratory experiments, these enzymes are usually tested on pure cellulose together with energy-rich co-substrates such as vitamin C, oxygen or hydrogen peroxide – all compounds that are short-lived. Unsurprisingly, it has been hard to apply reactions conditions optimized for pure cellulose degradation to complex biomass degradation, e.g. wheat straw, peat and wood.

The project will give the student an opportunity to learn an array of skills within enzyme chemistry. These include enzyme characterization assays, HPLC, calorimetry, anaerobic chamber work, and other.

Contact person: Søren Brander (sbd@ign.ku.dk).

2 Oxygen consumption in decomposing wood under varying moisture and temperature conditions

Carbon dioxide is stored in the trunks of trees through years of hard "work". When trees die and become subject to decomposition, low oxygen concentrations in the wood likely protect carbon from release. But what is it that controls oxygen levels and, thus, potentially the life-time of wood-stored carbon?

We have a unique possibility to perform a range of experiments investigating oxygen levels in decomposing wood.

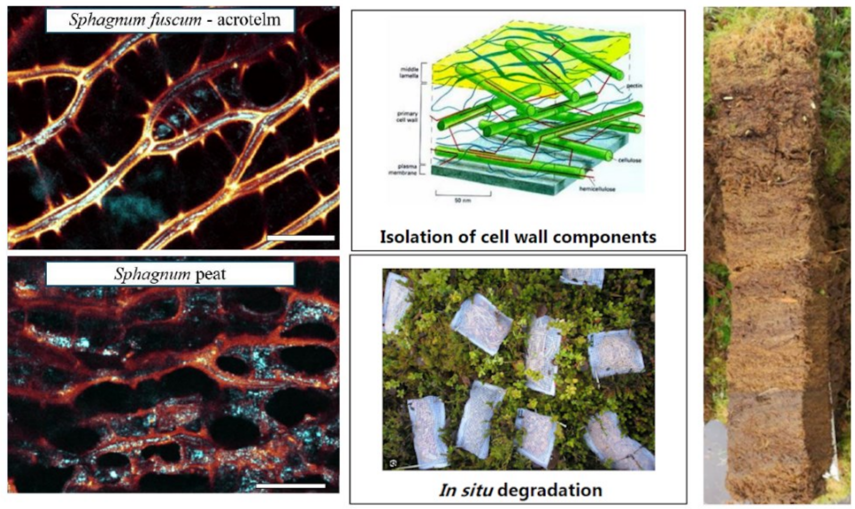
During microbial turnover of wood, oxygen is consumed and likely limits decomposition. At the same time, decomposers in the wood could have an evolutionary advantage if they can function under low oxygen conditions. Temperature and moisture conditions in the wood vary in natural habitats and are also likely to affect oxygen conditions. However, the influence of these conditions on decomposition rates is not straight forward to understand. Temperature is likely to increase decomposition and reduce oxygen levels. Moisture is a prerequisite for microbial activity but also limits the diffusion of oxygen.

Join us in this project and help us find out how oxygen levels in decomposing wood depend on temperature and moisture!

Contact person: Signe Lett (signe.lett@ign.ku.dk).

3 Investigation of Sphagnum moss growth and morphology changes under varied conditions

Peatlands store the largest known reservoirs of organic carbon (C) among ecosystems and most of this C is accumulated in one bryophyte genus: Sphagnum. With the warming of our climate, Sphagnum changes its shoot morphology. However, the importance of these changes are unknown.



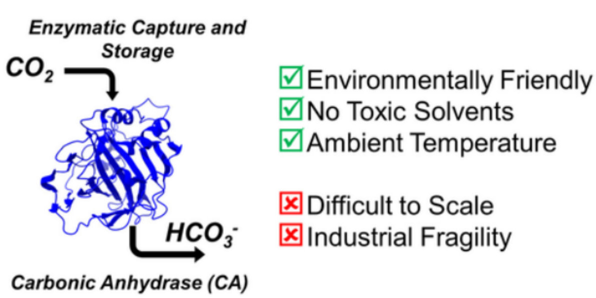
In this project, you will gain experience with setting up growth experiments of important Sphagnum species. Conditions, such as temperature and moisture, will be varied, in order to study the responses on the plant's growth and morphology, as well as the microstructure of the specialized cell types along the temperature gradient.

You will also gain experience in compositional analysis and microscopy. You will assess the content of cell wall polysaccharides and polyphenols. In addition, plant cell size and cell-wall thickness will be imaged and measured with bright field microscopy, electron microscopy and confocal laser scanning microscopy. You will learn to perform preparation, sectioning and staining with histological dyes and labelling of specific cell-wall epitopes, using fluorescent antibodies.

Do a project with us and help us gain better understanding of the important Sphagnum species, which cover a large portion of our planet's surface.

Contact persons: Signe Lett (signe.lett@ign.ku.dk) & Helle Jakobe Martens (hjm@ign.ku.dk).

4 Carbonic Anhydrase for direct CO_2 Removal

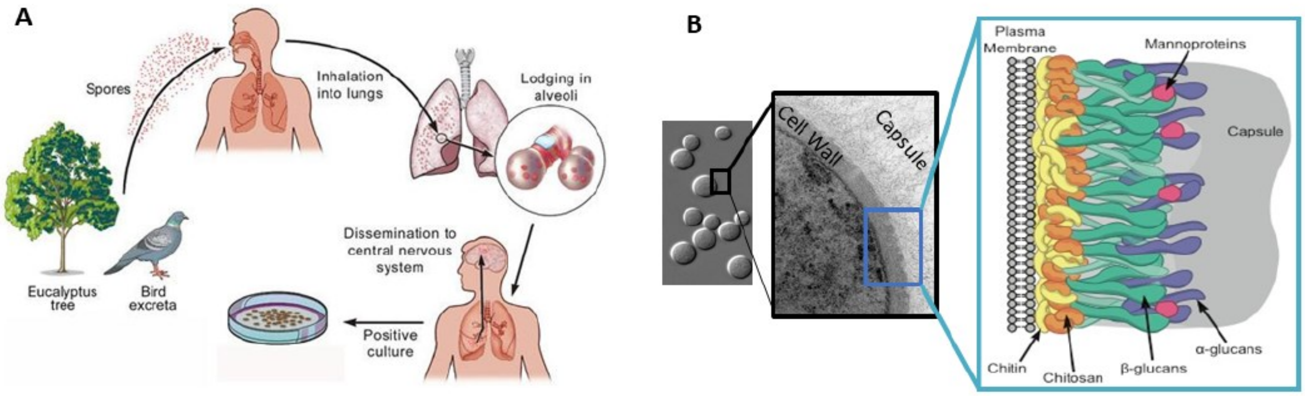


In the quest to combat climate change, capturing carbon dioxide (CO_2) is essential. Carbonic anhydrase, a powerful enzyme that naturally converts CO_2 into bicarbonate, offers a solution that is scalable to industrial levels. This project investigates ways to measure carbonic anhydrase activity and the effect of a series of inhibiting and activating compounds.

This project will give the student an opportunity to learn an array of skills within enzyme chemistry. These include enzyme kinetics, inhibition studies, structure analysis, calorimetry, and other.

Contact person: Søren Brander (sbd@ign.ku.dk).

5 Studying the Role of LPMOs in the Human Pathogen *Cryptococcus neoformans*



This project will study LPMOs and other enzymes from the human pathogenic fungus *Cryptococcus neoformans*.

Fungi often adapt to environmental stress by altering their size, shape, or rate of cell division. These morphological changes require reorganization of the cell wall, a structural feature external to the cell membrane composed of highly interconnected polysaccharides and glycoproteins.

Lytic polysaccharide monooxygenases (LPMOs) are copper-dependent enzymes that catalyze initial oxidative steps in the degradation of complex extracellular biopolymers, such as chitin and cellulose. However, their roles in fungal cell wall modification and stress response are poorly characterized.

Despite the importance of LPMO enzymes for pathogen virulence, we know very little in the expression patterns and biological function of these proteins. LPMOs, therefore, hold great potentials for being future drug targets against fungal pathogenesis.

Depending on your department and interests, the project can include working with *Cryptococcus neoformans* fungal cultures in our GMO-2 laboratory, protein and enzymatic analysis by use of immuno-pull down, activity assays, western blot, determination of transcriptions profiles by the help of RT-qPCR and other.

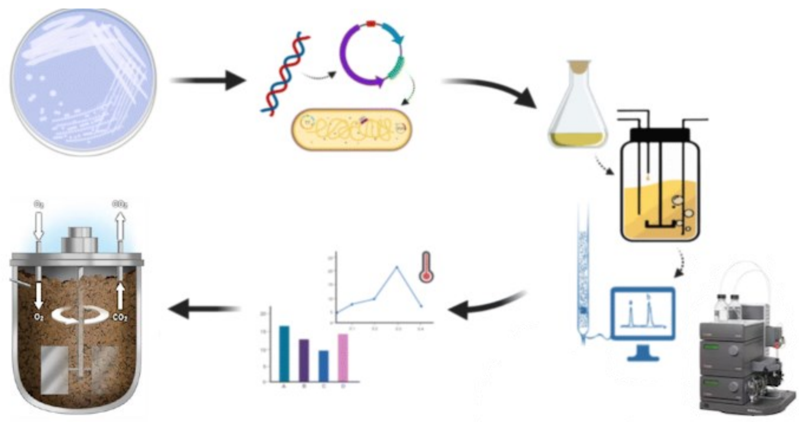
The work will be performed in the department of Plant & Environmental Sciences (PLEN), with some work in the department of Geosciences and Natural Resource Management (IGN).

Contact person: Magnus Hallas-Møller (mahm@ign.ku.dk).

6 Investigation of Novel Carbohydrate Oxidases

In the quest to combat climate change, it crucial that we utilize renewable resources, such as agricultural and forestry waste. This project focusses on a new enzyme family of carbohydrate oxidases with significant potential for application in bioethanol refineries.

Depending on your interests and time, this project can follow the full path of enzyme research - protein expression, purification, characterization (f. ex enzyme kinetics), and, possibly, application studies.



This project will give the student an opportunity to learn an array of skills within enzyme chemistry. These include enzyme kinetics, protein expression & purification, bioinformatics, HPLC, calorimetry, and other.

Contact person: Søren Brander (sbd@ign.ku.dk).

7 Characterization of an Industrially Relevant Carbohydrate Oxidase from *Microdochium nivale*

A commercially used oxidase enzyme from *Microdochium nivale* is produced by Novonesis A/S for the dairy industry, in order to control production of lactic acid. The oxidase seems to operate in two different modes, probably controlled by a molecular "pH-switch".

The aim of this project is to, firstly, confirm and characterize the changes in enzyme activity and substrate profile, upon changing pH. Secondly, to elucidate the complex structure-function relationships behind the switch. To facilitate the latter, several enzyme mutants with substitutions in relevant amino acid residues have been made available by Novonesis A/S.

This project will give the student an opportunity to learn an array of skills within enzyme chemistry. These include enzyme kinetics, structure analysis, HPLC, calorimetry, anaerobic chamber work, and other.

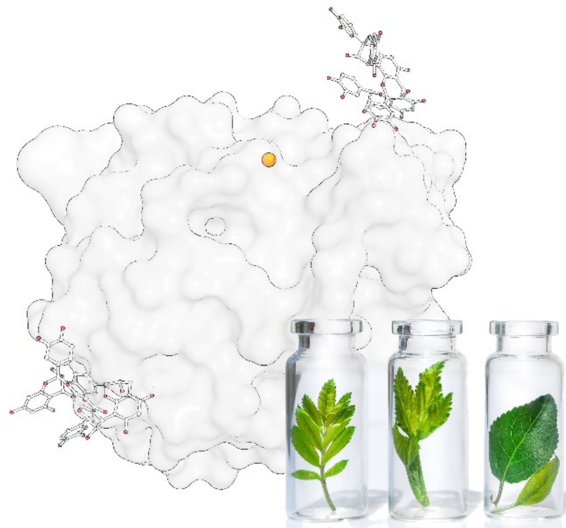
Contact person: Søren Brander (sbd@ign.ku.dk).

8 Utilizing Nature's Vast Chemical Library for the Discovery of LPMO Inhibitors

Lytic polysaccharide monooxygenases (LPMOs) are copper-dependent enzymes that catalyze initial oxidative steps in the degradation of complex extracellular biopolymers in nature, such as chitin and cellulose.

Despite the importance of LPMO enzymes for pathogen virulence, the control of the enzymes' activity has remained not fully explored. The project will investigate how to modulate the activity of LPMOs.

We know that organisms, such as plants and fungi, have the ability to produce defense compounds against microbial pathogens. The project will try to utilize nature's vast catalogue of compounds to investigate LPMO inhibition and inactivation. Depending on your department and interests, the work can include preparation of extracts from biological samples, enzyme assays, HPLC, inhibition of microbial growth and other.



LPMO inhibitors can hold a great potential for agricultural and pharmacological applications, and may contribute to the development of tailored antimicrobial agents and pathogen-resistant crops.

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