Bio Base Europe Pilot Plant vzw – Stage-Internship (master/bachelor degree)

Below is a list of topics for which we have internship vacancies as of May 2023

TOPIC 1 - Process development and scale-up for the fermentative production of L-lactic acid from 2G feedstocks (Interns selected - Closed)

In the framework of the Flemish FUCATIL project, this research will focus on the sustainable production of biobased L-lactic acid (L-LA), starting from second-generation (2G) feedstocks such as old paper and cardboard. An efficient production process for L-LA will be developed that goes far beyond the state of the art. An engineered industrial yeast strain will be used which efficiently produces L-LA by anaerobic fermentation. Yet, to obtain an industrially competitive process, advanced fermentation development and fine-tuning is key. Therefore, this internship aims to investigate different fermentation strategies, including batch, fed-batch, continuous with or without cell recycle, and to optimize the most important process parameters such as pH, temperature, aeration and medium composition.

Besides this, the sustainable and economical recovery of purified LA presents the principal challenge in fermentative LA production today. Therefore, in situ product recovery (ISPR) will be assessed as an innovative strategy to improve the fermentation performance and efficiently obtain purified LA. Different techniques will be investigated, including (reactive) extraction, enzymatic esterification, and adsorption to specific resins. Then, the integrated production and isolation of high-purity L-LA will be fine-tuned and scaled up to industrially relevant scale (150 L). [PDB, EU]

TOPIC 2 - Microbial production of 1,3-butanediol with zero CO2 emissions (Interns already selected - available from August 2024)

Biotechnology, which makes use of microorganisms and their enzymes to produce chemical compounds plays an important role in the transition towards greener production routes. In the framework of the Flemish GREEN-B2B project, this research will focus on the sustainable conversion of waste paper into 1,3-butanediol (1,3-BDO), an important industrial platform molecule. Furthermore, a cutting-edge novel process will be designed that combines liquid and gas fermentation technology and allows the production of biobased 1,3-BDO while

avoiding any CO_2 emissions. For this, state-of-the-art engineered strains of Knall-gas organisms will be applied that are capable of reincorporating emitted CO_2, using H_2 gas as an energy input, to boost 1,3-BDO production beyond the theoretical limit.

During this internship, pioneering research will be performed that will considerably contribute to the shift towards a true bio-economy. In an initial phase, the lithoautotrophic growth of these bacterial strains on CO_2 and H_2 will be investigated and their production of 1,3-BDO will be evaluated. Then, the production organism will be grown in a state-of-the-art 1L pressure gas fermenter using waste paper as a feedstock. Finally, this leading production process will be optimized and key process parameters including the composition of the fermentation medium, H_2 gas input, pH and temperature will be fine-tuned. [PDB, EU]

TOPIC 3 - Cultivation of industrial high-value biomass with enhanced viability (interns already selected - not available anymore)

The commercial interest in functional foods that contain live microorganisms, also named probiotics, has been steadily increasing over the past decade. While lactic acid bacteria have become a fixed value in the dairy industry, the wide use of yeast biomass in foods and nutritional supplements is well-known. This has forced the creation and optimisation of industrial high-value biomass production processes, where innovative technologies are continuously being developed. Indeed, the efficient production of high-value biomass with high cell viability and minimal contamination remains a major challenge up to date.

This research project aims to develop state-of-the-art cultivation strategies to tackle these challenges. Firstly, this involves high cell-density cultivation, where high amounts of biomass are produced by using advanced feeding strategies and close monitoring and control of process parameters such as temperature, pH, oxygen supply and nutrient availability. Secondly, the accumulation of stress metabolites will be induced to prepare the cells for drying later in the process. For this, stress conditions will be imposed in the final stage of fermentation, such as nutrient starvation, osmotic shock or thermal shock. Thirdly, advanced downstream processing (DSP) techniques such as centrifugation, cross-flow filtration and decantation will be evaluated to prepare high-value biomass products while maintaining high quality and cell viability. Finally, the developed global production process will be taken to the next level, where scale-up to 150 L pilot scale will take place alongside experienced engineers. [PDB, EU]

TOPIC 4 - Process modelling, optimization and techno-economic evaluation for the fermentative production and purification of L-lactic acid

(Available from June 2024)

The industrial production of renewable chemicals and materials through fermentation presents an excellent case of a sustainable biorefinery concept that can boost the transition towards a circular bioeconomy while reducing the dependency on fossil resources. Yet, this relies on the availability of low-cost feedstocks, the efficiency, scalability and sustainability of the various process steps, as well as the final yield and market potential of the obtained target products. This research will focus on the sustainable production of biobased L-lactic acid, using engineered industrial yeast strains in advanced fermentation processes. Here, the efficient and economical recovery of purified LA presents the principal challenge in fermentative LA production today. Various state-of-the-art

purification techniques will hence be considered, including (ion exchange) resin adsorption, solvent extraction and membrane filtration.

Yet, to get a clear view on the economic and industrial feasibility of these innovative production routes towards biobased L-lactic acid, and to identify the most promising strategy, the different fermentation and downstream purification processes will be modelled using the SuperPro Designer software, and a comprehensive and in-depth techno-economic assessment (TEA) will be conducted. The latter will comprise technical (performance) and economic (cost) considerations of each process step, as well as a thorough sensitivity analysis, while being applicable from an early TRL level up to full industrial scale. This will allow to compare various production approaches and technologies and to benchmark these against current fossil-based processes to produce L-lactic acid. From a broader point of view, this will also assist the chemical industry in Flanders to implement novel sustainable processes and ultimately, in their transition towards a true bioeconomy.

This internship takes place at Bio Base Europe Pilot Plant (BBEPP), a non-profit SME that assists companies and research groups to bridge the gap between laboratory research and industrial implementation of their innovations. BBEPP is equipped with all process and analytical tools which allow to perform high-quality research in an industrial environment. [EU, ST]

For this internship knowledge and experience in SuperPro Designer is required.

TOPIC 5 - Fermentation and DSP development for the sustainable production of CO2-based bioplastic (Closed)

Plastic has become indispensable in our contemporary society, yet the ever-increasing use of this mostly fossil-based material has a disastrous impact on the environment. In this context, bioplastic derived from renewable resources has attracted attention as promising substitutes. As such, poly-hydroxybutyrate (PHB) is an increasingly investigated biopolymer, known for its excellent biodegradability under various conditions. Its applications are diverse, ranging from compostable food packaging to medical components owing to their biocompatibility.

PHB is obtained by the cultivation of bacteria accumulating the biopolymer as intracellular carbon storage in response of physiological stress. This internship will focus on the development of a biological process to produce PHB using acetate as carbon source. Recently, research at BBEPP showed that acetate can efficiently be obtained from the microbial conversion of CO2, hence, the proposed strategy enables the production of CO2-based bioplastic. In addition, the downstream processing (DSP) to extract the PHB from the microbial cells will be examined. This involves the evaluation of different methods for cell disruption, PHB separation, and purification.

The goal of this internship will be to establish a complete bioprocess including the cultivation of an already modified bacterial strain on CO2-derived acetate, the development of a fermentation in a bioreactor, and the investigation of several DSP technologies. The practical work will be performed in cooperation with experienced engineers at BBEPP by using a wide range of specialized equipment available in house. This research frames within the EU-funded CO2SMOS project for which the obtained results will serve as a starting point for further scale-up (https://co2smos.eu/). [EV, KQ]

TOPIC 6 - Developing a yeast cultivation and propagation strategy for

the production of biofuels from MSW (Interns already selected - not available anymore)

The development of a fermentative production process of isobutanol from paper and cardboard waste comprises three main steps:
1. The saccharification of cardboard to glucose and xylose using a special enzyme cocktail;
2. The propagation of an engineered S. cerevisiae strain up to a very high cell density culture;
3. The fermentation of the saccharified cardboard to isobutanol using the freshly propagated yeast culture.
In situ product recovery (ISPR) of isobutanol during the fermentation will be required to keep the isobutanol below its toxicity concentration.

This internship will mainly focus on the development of a yeast propagation on 7L bioreactor scale, aiming to improve yields and to minimize the overall cost prize. However, the saccharification will also be further improved at labscale and different ISPR methods will be further explored. [CVC]

TOPIC 7 - Meat the future, today! (Temporarily closed)

Global food consumption keeps rising and to keep up with the demands of an est. 10 billion people by 2050, especially the conventional meat industry is far from sustainable. Also, a rising consumer concern for animal welfare and the burning issue of climate change, we must urgently revolutionize the foundations of this industry.

Many meat processing companies envision cultured meat as promising alternative to (partly) replace traditional animal-derived raw materials. With the arrival of cutting edge cultured meat technologies, Flanders has everything what it takes to be a pioneer in this field – a leading role in biotechnology on a scientific level, a strong food industry, and a history of expertise in fermentation (cell growth) technologies, both in research and industry.

Animal cell cultures have been used for over a century in research and medical settings providing the basic principles of cell culturing. However, the culturing of these cells for food production comes with its own set of challenges, as this for one requires a low media cost and high cell densities to become economically relevant. During this internship, you will be involved in tackling the challenging task of developing an industrially scalable cell proliferation and differentiation process for an embryonic cell line. This will be achieved by medium engineering, optimizing the feeding strategy, agitation, temperature etc. An optimized process will subsequently be scaled-up to enable the development of a downstream processing method that meets the demands for application in food products. [MVB]

TOPIC 8 - Innovative and sustainable recovery of fermentatively produced 2,3-butanediol (Temporarily closed)

As sustainability is gaining importance in the industry, production processes are becoming more biobased. A biobased process often goes hand in hand with the production of biogenic CO_2 coming from processes such as fermentation or biomass combustion. It is therefore crucial that technologies are developed to capture and convert this CO_2 into value-added chemicals, a process which occurs naturally in many microorganisms. Because of the low energy content in CO_2, energy sources are required in the form of CO and/or H_2. The mixture of these

three gases results in what is known as syngas.

One such value-added chemical, which can be produced via syngas fermentation, is 2,3-butanediol (2,3-BDO), a promising bulk chemical. While different fermentation processes already exist, the main bottleneck of fermentatively produced 2,3-BDO is and remains the recovery of the product after fermentation. Traditional downstream processes such as filtration techniques are expensive and often do not result in the required product purity. Your project will comprise the development of a process that integrates gas fermentation and downstream processing of 2,3-BDO in an innovative and sustainable way using state-of-the-art lab equipment. The goal is to integrate the different parts of the process to ensure maximal reuse and minimal waste.

All experiments will be performed with advanced equipment in the industrial environment of Bio Base Europe Pilot Plant and you will have the opportunity to develop the process from start to finish. Your results will contribute to the EU-funded project CO2SMOS, which focusses on the transformation of biogenic CO2 into biobased chemicals. [EVH, KQ]

TOPIC 9 - Capturing biogenic CO2 into biobased intermediates through gas fermentation (Temporarily closed)

Due to its adverse effects on our climate, the accumulation of CO2 in our atmosphere is and remains a serious challenge. Yet, where CO2 was previously considered as a burden, it is now seen as a possible green resource for the synthesis of chemical intermediates and added-value compounds. This concept is known as carbon capture and utilisation (CCU) and can help to reduce CO2 emissions across industries. Industrial CO2 can be abiogenic, when it comes from fossil carbon, or biogenic, in case it originates from a natural resource. As CO2 has a low energy content, energy sources are required, which come in the form of CO and/or H2. The resulting gas mixture of CO2, CO, and H2 is called syngas.

This internship will focus on producing acetic acid via gas fermentation on syngas produced from biogenic CO2. The optimal process set-up will be evaluated in both batch, and continuous fermentation mode on scales ranging from up to 10 L. The process will be further intensified by means of cell recycle and the use of elevated pressures, aiming to improve the acetic acid productivity. The resulting acetic acid stream will be processed downstream and used for further conversion into high-value compounds in a second fermentation step.

The internship is framed within the EU-funded project CO2SMOS, which focusses on the transformation of biogenic CO2 into biobased chemicals in a truly renewable manner. With the support of experienced engineers, you will get the opportunity to perform work with state-of-the-art gas fermentation equipment, with the final aim of developing an industrially relevant gas fermentation process. (KQ) (EVH)

TOPIC 11 - **Development of fermentation process to convert 2G feedstocks into acetic acid with 100% carbon conversion efficiency. (Available from June 2024)**

In the framework of Flemish AC2GEN project, this research focusses on the production of biobased acetic acid (AA) using anaerobic bacteria (acetogens), starting from second generation feedstocks. Acetic acid serves as a versatile commodity chemical with a variety of applications in both chemical and biotech industries. Acetogens have a diverse metabolism, with advantages such as pathways which allow conversion of all saccharides, including hexoses, pentoses,

di-,tri-, oligo- and polysaccharides, into AA, 100% carbon efficiency of sugars to AA, hydrolytic capabilities, resistance to and even degradation of typical inhibitors, and more.

These characteristics have the potential to significantly increase the carbon efficiency on 2G feedstocks, beyond that of other biochemical pathways.

The first goal of this internship is to screen a variety of commercially available acetogenic strains and evaluate their performance to convert 2G sugars into AA. The best performing strains will be cultivated on real 2G hydrolysates, containing mixtures of 2G sugars, as well as typical inhibitors such as hydroxymethylfurfural. Analytical procedures such as HPLC and HPAEC will be used to follow up the consumptions of the substrates, as well as the accumulation of the target product and other metabolites. Then, the acetogenic fermentation process will be thoroughly studied in bioreactors, and optimized in terms of carbon efficiency and productivity.

The screening and identification of promising strains will be executed using serum bottles, to increase the experimental throughput, while the in-depth optimization of the fermentation process will be executed in bioreactors. To this end, batch fermentations will be performed in BBEPP's state-of-the-art 4x1L bioreactors, and the process will be scaled-up to 10L scale. The practical work will be executed at BBEPP, in collaboration with a team of experienced engineers. (NP)

TOPIC 12 - Process development and scale-up for the fermentative production of amphiphilic compounds isolated from marine and extremophilic microorganisms (temporarily closed)

Project: SECRETed

In the framework of the EU-H2020 SECRETed project, this research will focus on the sustainable production of amphiphilic compounds such as biosurfactants and siderophores derived from marine and extremophilic microorganisms. Hereby, the development of an efficient and industrially relevant production process is essential to produce these newly discovered compounds in a cost-effective way. Therefore, this research project aims to evaluate and combine several state-of-the-art fermentation and downstream processing (DSP) strategies for these high-value compounds.

During the first part of the research project, a set of different production hosts will be investigated as possible candidates for efficient microbial production of these amphiphilic compounds. Hereby, different bioreactor set-ups and feeding strategies including batch, fed-batch, repeated fed-batch and continuous fermentation will be evaluated and optimized along with key process parameters such as temperature, pH and medium composition. In addition, the use of low-cost substrates and waste streams will be evaluated to boost cost-competitiveness. Simultaneously, sustainable DSP techniques will be developed to purify these promising compounds. During a second stage of this project, the top-performing production candidate(s) with their fine-tuned process parameters will be selected to move from lab-scale to pilot scale (150L), an industrial scale-up challenge which will take place alongside experienced engineers.

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quality research in an industrial environment.

TOPIC 13 - Marine enzymes: production and industrial applications (Available from June 2024)

Project: Enzymares

Enzymes are remarkable biological catalysts, playing a key role towards a sustainable economy. They are widely used in industrial applications and their demand is continuously increasing. Biodiversity has been explored in the search for novel enzymes. The marine habitats, characterized by diverse and extreme conditions, host an amazing, unique and vast source of biodiscovery. The enzymes produced by marine organisms possess unique features, as they can withstand high salt concentrations, a broad range of temperature, pressure, pH, organic solvents and surfactants. Therefore, marine enzymes constitute a group of exceptional biocatalysts, often suitable for a variety of industrial applications.

In the framework of the Flemish ENZYMARES project, this research will focus on the production and applications of industrially relevant enzymes, obtained from marine organisms. Fermentative processes will be developed and optimized in advanced and automated bioreactors up to 10L scale. Further research will focus on the development and optimization of downstream processes for enzyme recovery, concentration and formulation. Finally, the performance and application potential of the newly produced enzymes will be evaluated. To this end, different enzymatic conversion reactions will be assessed, optimized and compared to benchmark industrial processes.

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TOPIC 14 - Plastic-degrading enzymes for sustainable development (Available from October 2024)

Project: REPurpose

Plastic waste build-up in the environment is an enormous ecological challenge. Biocatalytic depolymerization mediated by enzymes has emerged as an efficient and sustainable strategy for plastic treatment and recycling. A variety of plastic-degrading enzymes have been discovered from microbial sources. Meanwhile, protein engineering has been exploited to modify and improve enzymes performances.

This research project will focus on the sustainable production and use of enzymes that depolymerise plastic wastes. In a first stage, fermentative processes will be developed and optimized on lab scale, using advanced and automated bioreactors. Enzyme production will be followed by downstream processing (DSP). Different state-of-the-art techniques for cell disruption, enzyme separation and purification will be tested and further optimized. Then, a depolymerization process, which employs the plastic-degrading enzymes produced, will be assessed. Research will focus on finding the optimized reaction conditions for obtaining monomeric and oligomeric fractions suitable for further re-polymerization into clean recycled plastic. The final aim of this project is to develop a sustainable, efficient and scalable enzymatic process that enables to transform plastic wastes into new polymer building blocks.

This internship frames within the EU-funded REPurpose project (https://www.repurposeproject.eu/) and takes place at Bio Base Europe Pilot Plant (BBEPP), a non-profit SME that assists companies and research groups to bridge the gap between laboratory research and industrial implementation of their innovations. BBEPP is equipped with all process and analytical tools are available to perform high-quality research in an industrial environment.

TOPIC 15 - Process development and optimisation for the fermentative production of PHAs (Available from January 2025)

Around 98% of plastic materials, used within industry and in domestic fields nowadays, is fossil fuel-based. With a growing interest in more climate friendly options, substitutes such as PHA (polyhydroxyalkanoate) can contribute to waste management issues and emission reduction. The fermentative production of PHA has been investigated by many researchers worldwide, but its high production cost limits the implementation in the plastic market.

This thesis topic will focus on the cultivation of bacteria accumulating PHAs as intracellular carbon source using industrial acetate streams. Various fermentation conditions will be explored and optimized, such as medium composition, pH, temperature, feeding strategies, etc… Innovative production strategies, for instance medium recirculation and continuous fermentation, will be assessed in this project. Furthermore, an optimized process will be scaled-up to 30L scale with the guidance of experienced engineers. The generated product will be utilized to optimize the subsequent downstream processing (DSP) to isolate the biopolymer. A thorough comparison of biological, chemical and physical purification techniques will be made.

The thesis or internship will be performed in the industrial environment of the Bio Base Europe Pilot Plant (BBEPP), a non-profit SME that assists companies and research groups to bridge the gap between laboratory and industrial implementation of their innovations. BBEPP is equipped with all process and analytical tools to perform a high-quality research in an industrial environment. The minimum duration for this research is 6 months.

ONDERWERP 16: Bachelor stage QA (open)

Welke stage kunnen wij jou aanbieden?

Je zal kunnen meewerken aan de optimalisatie van het BBEPP kwaliteit managementsysteem voor de voedselveilige productie van innovatieve voedingsingrediënten vervaardigd uit industriële biotechnologie.

- Je helpt mee met de implementatie van software modules voor kwaliteits- en voedselveiligheid management systemen.
- De focus zal hierbij liggen op de creatie en het beheer/onderhouden van het document management systeem en de HACCP databases.
- Je helpt mee met het verder uitbouwen van ons leverancierskwaliteitssysteem.
- Je voert administratieve ondersteunende taken uit in kader van de kwaliteits- en voedselveiligheid management systemen.
- Je werkt samen met en onder leiding van QA.

Jouw profiel?

- Je werkt georganiseerd, zelfstandig, nauwgezet en pragmatisch. Je hebt oog voor detail.
- Kwaliteit nastreven is voor jou prioritair
- Je bent leergierig en streeft constant naar verbetering en vernieuwing.
- Je bent vlot meertalig in Nederlands en Engels.
- Je stage kadert binnen een opleiding agro- en biotechnologie of voeding- en dieetkunde

Ons aanbod?

We bieden een dynamische, internationale en innovatieve werkomgeving en een volledige leerervaring, waarbij je begeleid wordt door ervaren werknemers.

Je werkt vanuit de Bio Base Europe Pilot Plant, gelegen in de haven van Gent, waardoor je je steentje kan bijdragen tot een meer duurzame samenleving en de bio-economie.

De stageduur hangt af van de topics, maar minimaal 3 maanden.

Which student profile do we require?

Requirements are:

- You are studying for a degree in bio-engineering or related (bioprocessing, chemistry, biotechnology, cell- and gene technology) for the master internship.
- You are studying for a bachelor degree (agro- en biotechnologie of voeding- en dieetkunde) for the bachelor internship.
- Some experience with bacterial, yeast or fungal hosts is an asset
- Some relevant experience with biocatalytic processes for the production of chemicals, food ingredients or cosmetics is an asset
- The duration of your internship is at least 6 months.

What do we offer?

We offer a dynamic, international and young working environment and a full learning experience. You are based at the Bio Base Europe Pilot Plant, situated in the port of Ghent in Belgium.

The internship runs for a minimum of 6 months fulltime to preferably a whole academy year fulltime.

https://www.bbeu.org/