CALL FOR STUDENTS NOMINATIONS

AUTUMN 2023

Research Experience Abroad in Engineering at Danmarks Tekniske Universitet (DTU)

With the aim of offering high-performing students at Tec de Monterrey a multicultural environment that contributes to their global perspective, academic, research and personal development in institutions of recognized international prestige, the Vice-Rector's Office for Internationalization, in collaboration with the School of Engineering and Sciences of Tec de Monterrey as well as the research groups and centers at the Danmarks Tekniske Universitet (DTU) at campus Lyngby, invites pre-graduate students to carry out research experience in Autumn 2023.

This call is addressed to Students of Tec 21 and study plans prior to 2019

The deadline for the submission of the documentation will be February 23, 2023

Each of the research positions offered in this call has particular requirements and skills. Find all detailed information (requirements and project description) at the end of this document.

GENERAL REQUIREMENTS

- To apply to Autumn 2023, you must be enrolled in the 6th semester by the time of submitting the application.
- A minimum general average of 90
- Proof of English language proficiency from the minimum TOEFL ITP 550 or equivalent such us TOELF iBT 80, or IELTS 6.5 (current or expired).
- Demonstrated participation and experience in research projects.
- Highly motivated, able to work independently, well organized and a good team player.
- Passionate about tackling grand challenges.

GENERAL GUIDELINES

1. It is the candidate's responsibility to carefully read this document as well as search additional information about the research groups, center, laboratory and scientist associated with the research project of interest. Please, do not contact any of the DTU researchers before indicated as only preselected students will have a chance to meet the DTU scientist for a final interview.

2. Have a VALID national passport at the time of submitting the application to this call and with sufficient validity to remain in Denmark if selected. If you don't have Mexican nationality, consider when applying for the visa, that extra time could be required. If you have a valid European passport, it is your responsibility to check the steps to be legally registered in Denmark.

3. This is a full-time internship (Monday to Friday). Starting and ending date will be defined once the student is selected and it will be done together with the DTU supervisor based on the calendar, with a minimum of 16 weeks in the semester term.

4. This call does not include funding for accommodation, food or any personal expenditure. Financial support will not be provided by the DTU or Tec de Monterrey. Students are encouraged to apply to national or/and international scholarships.

5. Students must have sufficient funds to support themselves in Denmark as well as appropriate Medical Insurance. Before completing your application, please, notice Denmark is one of the most expensive countries in Europe, especially accommodation. An estimation of living cost for a semester can be found here. Making a budget will help you to identify if you can afford coming to Denmark. Also, it is highly recommended that you get in contact with TEC students who were already at DTU to get their advice on finding accommodation.

6. Once students are selected and confirmed by TEC and DTU, it is their sole responsibility to continue with the VISA application. You must have sufficient funds in your bank account. Accepted students are expected to complete and pay for the corresponding visa process, including traveling to Mexico city. You can see all VISA requirements in this link. Student VISA cost is around $6,000 MXN plus travel expenses and documentation.

7. Students will work under the core supervision of a DTU research scientist as well as a TEC professor.

8. Some researchers at DTU are willing to welcome students who have a project idea aligned with their research goals; you can include 1-2 pages of your project description as part of the documentation when applying, as additional information.

9. Due to the nature of the projects and the intellectual property involved, the student must sign a confidentiality agreement at DTU.

10. All positions announced at this call are not remunerated. Students are encouraged to apply to national and international scholarships.

HOW TO APPLY

1) The student must update his/her profile at:

Mi Tec -> Mi Experiencia Internacional -> Estudiante Interesado -> Actualiza tu Perfil

2) The student must send his/her application by February 23th, 2023, including the program code **DIN-5EVI-005A** at:

Mi Tec -> Mi Experiencia Internacional -> Estudiante Solicitante -> Realiza tu solicitud

3) Shortly after the application is sent, the application status will be updated, and the student must accept the preselection. It is particularly important to keep in mind that **this is NOT the result**. The candidate selection depends on the decision of a selection committee, and it will be communicated by the International Programs Office.

4) Next, the student will have access to the Document Submission and must upload the required documents by February 23, 2023.

HOW AND WHERE TO SUBMIT THE DOCUMENTS

Students are ONLY allowed to apply to ONE project in this call.

Documents must be digitized in 1 single PDF file named with the prospective first name and first family name, and the project number. For example: "Dafne_Peña_Project 3". ***Applications will not be received if the documents come in multiple files***.

Use the following link to apply:

https://www.jotform.com/build/230234006560846

Deadline February 23, 2023.

Without exception, applications will not be accepted after the deadline. Candidates with incomplete documentation will be automatically rejected. Please, be sure you enclose all documents before submitting.

Students might also be contacted and offered a different project, according to each profile and skills.

We thank all students for their participation. **We will only communicate with those who are preselected for an interview.**

We encourage you to apply as soon as possible as we are continuously reviewing and calling for interviews every week since this call is open.

DOCUMENTATION

Documentation to submit in **one integrated document (pdf)** must include the following:

1. A motivation letter (maximum of 1 page), addressed to the DTU research professor, in English, where you explain why you are interested in this project and the skills and knowledge that make you a clear suitable candidate.
2. A copy of your CV (free format) in accordance with the skills requirements specified in the project description.
3. A letter, signed by your Academic Coordinator, which clearly states your authorized Tec credits.
4. Letter of recommendation in English from one TEC researcher
5. Proof of English language proficiency from the minimum TOEFL ITP 550 or equivalent, TOEFL iBT 80 or IELTS 6.5 (Current or expired).
6. Copy of passport with a validity of minimum 6 months after coming back from Denmark.
7. Additionally, to a specific project, you can also include in your documentation a project idea to continue the development and prototype at DTU. Please, discuss this with your Academic Coordinator or researchers Tec de Monterrey to check the viability of your proposal.

When writing your motivation letters and CV, please, be very specific in both CV and motivation letters on how they can prove you have the skills and abilities required, describing a bit of the project and what task you performed or outcomes.

PROCESS CALENDAR

a) Students submit application, in International Programs office portal and in the formulary.	From January 31st , 2023
b) Closing application date	February 23, 2023
c) Analysis and evaluation of the candidacy will be carried out by Tec de Monterrey. International Programs Office will send the list of qualified candidates directly to the research project leading professor at DTU.	January 31st – March 2nd
d) Preselection of candidates and online interviews by TEC researchers and DTU researchers	February - March
e) Email confirming final candidates selected by DTU researchers and nomination to FDTU.	March
f) Student's documentations to TEC International Program (medical insurance, pre departure meeting), VISA and DTU online application to get acceptance letter, accommodation arrangement, etc. DTU International Office sends you the procedure to start the VISA	April- May

application once you have registered yourself in their system.	
g) DTU Supervisor sends project description	May
h) Orientation meeting with students	May
i) Students travel to Denmark for a research semester abroad	August/September to December/January

After final interviews, we will announce the final resolution and students will have a couple of days to accept or reject the offer. Once accepted, students will have further instructions to move forward to apply to DTU and start their VISA application. The committee's decision is final at all times.

SOME CONSIDERATIONS TO KEEP IN MIND FOR SELECTED STUDENTS.

• The starting and finishing date will be arranged in individual cases by the student and the DTU researcher. **Official Autumn at DTU is September-December. However, students can discuss with their supervisors to stay August/September-December or late January. Students need to complete at least 16 weeks of research internship**. Students are welcome to arrive a few weeks before the internship starts to settle down.

• Be fully aware that, as a selected student, you are part of the image of the institution, so in addition to complying with the norms and standards of DTU, you remain under the code, rules, values and the General Regulation of Students at Tec de Monterrey when being abroad.

• The selected students are encouraged to be proactive and committed with their learning process, dedication and contribution during their research internship. Occasionally, students might be asked to read some bibliography and/or dedicate some hours in the lab in order to be better prepared.

• Visa process will take from 2 to 3 months. Students should cover their visa process cost. You can visit New Denmark for further information about cost and process.

TUITION

The tuition to be paid will be directly at the corresponding Tec de Monterrey campus. Payment will be made according to the number of units/credits registered in the period August-December 2023.

REGISTRATION AND ACCREDITATION OF COURSES

Students of academic plan prior to 2019:

The number of units to be accredited will be defined in the letter, signed by your Academic Coordinator, which clearly states your authorized Tec credits, and which must be submitted in the online application. The number of units to be enrolled and credited in each semester is:

Minimum: 8 units
Maximum: 32 units

Students of academic plan Tec 21:

The student will enroll 18 credits per semester. Prior to participation the student should review with their Academic Coordinator the accreditation in the study plan and enclose the letter, signed by your Academic Coordinator, which clearly states your authorized Tec credits, and which must be submitted in the in the online application.

The courses to be revalidated from the student's study plan will be defined by the Academic Coordinator and informed to the International Programs Office of the student´s campus.

Once accepted, students must complete their course registration for each period in the International Programs platform at TEC.

It is the student's responsibility to validate with the Academic Coordinator the availability of the subjects to be revalidated by a project in which they participate. Any application which does not include the letter, signed by your Academic Coordinator, which clearly states your authorized Tec credits, will be dismissed.

Students will have assigned a Tec professor who will evaluate and define the student final scores of the research abroad experience, considering the following policy.

ADDITIONAL INFORMATION

Important

Remember that you must be registered in both Tecnológico de Monterrey and Danmarks Tekniske Universitet during your Research Abroad experience. Please consider the following information:

DTU:

All students must register 20 ECTS credits at Danmarks Tekniske Universitet (DTU) in order to be able to apply for a student visa.

Tecnológico de Monterrey:

All students must register 18 credits at Tecnológico de Monterrey. These 18 credits must be paid to Tec de Monterrey.

This is a full-time research program and no courses are allowed to be registered at DTU unless it is a direct request from your supervisor and no accreditation will be done if it is not approved by your Academic

Coordinator through a letter which clearly states your authorized credits. Please consider this letter must be signed by your academic coordinator.

Please keep in mind that if you consider an extension of your internship, you must register at least 6 Tec credits for the additional semester.

Any point not covered in this call will be resolved by the selection committee in conjunction with the competent authority of Tec de Monterrey as the case may be.

Inquiries about the Application Process
Contact the student advisor at the International Program Office of your campus.

PROJECT DESCRIPTION

In this section you can find a project description and the skills and requirements to apply. Some undergraduate programs are more suitable than others. However, those students who qualified for the project vacancies, despite the study program at TEC, are encouraged to apply if they can demonstrate skills and knowledge required at the project description and selection criteria.

Project 1) Department of Chemical and Biochemical Engineering

No. spots: 1-3

TEC Participating programs: IBT, INCQ, IFI, IQP, ITC, IIA, IMD, IDS, IQ, and all students with a proven experience background Biotechnology, Process Design, Business Development, Modeling.

DTU Supervisor: Dr. Seyed Soheil (Associate Professor in Systems Design)

TEC partner: Dr. Roberto Parra, Elda Melchor, Eduardo Sosa, Mariel Oyervides

PROJECT SUMMARY

At the Department of Chemical and Biochemical Engineering our research is built on the technological core subjects and engineering scientific disciplines.

We investigate the interface of technology, economics, environment and society to address the grand challenges of today's society through delivering methods, tools and education. We aim to develop more sustainable products and process systems by understanding the challenges from the atomic and molecular levels all the way to enterprise and societal wide domains.

We work on grand challenges in a multi-national multi-cultural research environment that encompasses various engineering and human science aspects. We work closely with industry to obtain research results that are applicable to industry and society. Within our research centers (Process and Systems Engineering

Centre and CHEC Research Centre) we carry out a wide range of specialized chemical and biochemical engineering research through field experiments, experiments in lab scale, pilot facilities and in industrial scale.

Our main activities are in the areas of product design, process design and production in the chemical, biotechnological, pharmaceutical, food and energy as well as developing concepts based on agile computational tools such as AI and Quantum Computing.

List of projects where the students will be allocated:

- Artificial intelligence and quantum computing
- Computational chemistry for molecular scale property prediction for applications such as stone wool insulation, surfactant based organic synthesis (micellar catalysis) and phase transfer catalysis
- Process design, control and monitoring of chemical, biochemical and pharmaceutical processes
- Multi-scale modeling of process and systems
- Drug delivery
- Sustainable process development (techno-economic-sustainability assessment)

Key words: Biotechnology, Process Design, Business Development, Modeling, Experimental work

website:

Project 2) Experimental and Translational Immunology (XTI)

No. Spots: 1-2

TEC participating programs: INCQ, INA, IBT and students in Nanotechnology, Biology, Physics, Biomedical Engineering, Biomedical microtechnology are preferred.

DTU researcher: Dr. Yi Sun. This researcher doesn't accept student project proposals.

TEC partners: Roberto Parra, Elda Melchor

The Department of Health Tech educates the engineers of the future and develops new technology and solutions to improve people's life before, during and after they are patients. This is done in close collaboration with the health sector, industry, academia and other health partners.

Project description:

These internships are within the Experimental and translational immunology (XTI).

Students will be placed in projects related to development of nanoparticle-based drug delivery systems.

Students must demonstrate they have the right skills and knowledge to join the project. This must be clearly stated in curriculum vitae or in the motivation letter, or both, and during the interview.

You can read about project types in this link

Project 3) DTU Nanolab - National Center for Nanofabrication and Characterization

No. Spots: 1-3

TEC participating programs: INCQ, INA, IMD, IBT

DTU supervisor: Dr. Stephan Keller (Professor)

TEC partners: Israel Martínez and Daniel Olvera

PROJECT SUMMARY:

As a national non-profit open access organization, DTU Nanolab collaborates with world class research groups from all over Europe directly or through collaboration with research institutes.

A comprehensive range of state-of the-art micro- and nanotechnology processing equipment provides the tools to pursue advanced research in material growth, micro- and nanostructuring and characterisation.

DTU Nanolab has a strategic partnership agreement with several academic and research institutions in order to promote the research and development within micro- and nanofabrication. Use DTU Nanolab facilities to exploit the benefits of micro- and nanofabrication or ask about strategic partnership conditions.

The Intern will provide support to the research activities of the Biomaterial Microsystems (BIOMIC) through a collaboration with one of the team's researchers. They will jointly present a research project at the end of the term. The intern will experience all the steps involved in the scientific work; which might include literature search, experimental work and discussion/presentation of the obtained results. Literature search, sample preparation/testing and a final presentation of the results.

The Biomaterial Microsystems (BIOMIC) group led by Assoc. Prof. Stephan Sylvest Keller is part of the National Centre for Nano Fabrication and Characterization (DTU Nanolab). Our research group aims at the creation and development of new strategies for fabrication of (bio)polymer and carbon microstructures and microsystems and creating new paradigms for life science, health tech and energy applications. The group has been historically working on devices for oral drug delivery, carbon based micro-electro-mechanical systems (C-MEMS), and lately with an emphasis on bio-inspired and bio-integrated technologies.

We are a highly multidisciplinary research group with a team of chemists, physics, biologists and engineers and are interested in exploiting a wide range of areas.

TEC students must include in their motivation letter which project (1-6) they would like to apply. Students must demonstrate they have the right skills and knowledge to join the project. This must be clearly stated in curriculum vitae and motivation letter.

Six are projects available:

Project 3. 1.Fabrication of free-standing 3D hierarchical carbon microstructures for electrochemical and energy applications

Skills required: INCQ, IMD, IBT and students with physics, chemistry and polymer engineering backgrounds or similar fields are welcome to apply for this project. Familiarity with design software can be helpful but is not necessarily required.

Carbon has a wide variety of allotropic forms that possess a diverse range of properties and is explored in a broad spectrum of applications in many areas of science and technology. Among the various carbon materials, glass-like amorphous carbons obtained by pyrolysis of various polymeric precursors in an inert atmosphere have been used extensively in electrochemical and energy storage applications. By altering the chemical composition of the precursor and tuning pyrolysis conditions, the physicochemical properties of the derived carbon can be tailored. Moreover, geometrical patterning of the precursors and subsequent fabrication of three dimensional (3D) pyrolytic carbon micro- and nanostructures provides substantial advantages for various electrochemical applications. The significantly higher specific surface area of the 3D carbon electrodes potentially provides a larger electrode/electrolyte interface and thereby improved electrochemical behaviour, lower resistivity and higher sensitivity. With common manufacturing approaches, it is impossible to fabricate complex free-standing 3D carbon electrodes with well-defined geometrical structures. Therefore, more facile, cost-effective and innovative fabrication techniques are required to achieve structurally complex and tailorable 3D carbon electrodes for electrochemical and energy storage applications.

The aim of this project is to evaluate the potential of using digital light processing (DLP) 3D-printing technology to fabricate superfine carbon structures, and serve them as electrodes in electrochemical and energy storage applications. The effect of different 3D printing and pyrolysis parameters on the electrochemical performance of the electrodes will be systematically evaluated.

Keywords: digital light processing (DLP) 3D-printing, Pyrolysis, electrochemical capacitors, free-standing electrodes, amorphous carbon, energy storage.

Project 3.2. Microstructuring of porous carbon nanofibers and fabrication of interdigitated electrodes for on-chip energy storage.

Skills and abilities required: Students with physics, chemistry and polymer engineering backgrounds or similar fields are welcome to apply for this project. Familiarity with design software can be helpful but is not necessarily required.

Carbon nanofibers (CNF) produced from pyrolysis of electrospun polymeric precursors has been one of the most popular topics in carbon-based nanomaterials synthesis due to their promising potentials for various applications. This is mainly due to their unique characteristics, such as high specific surface area, interconnected porosities, low density, high thermal expansion, and high mechanical strength. By altering the chemical composition of the nanofibers precursor, electrospinning parameters and tuning the pyrolysis conditions, the physicochemical properties of the derived CNFs can be tailored. The proposed project aims at developing on-chip interdigitated electrodes based on porous carbon nanofibers for electrical energy storage. The main goal of this project is to evaluate the potential of engineered porous carbon nanofibers for promoting the performance of supercapacitor.

Keywords: porous carbon nanofibers, electrochemical capacitors, interdigitated microelectrodes, on-chip supercapacitor, electrospinning

Project 3.3. Pyrolytic carbon interdigitated structures for sensing applications

Skills and abilities required: Students in physics or nanotechnology

Conventional electrochemical sensor platforms rely on rather thin (2D), macroscopic metal electrode geometries, which inhibits the sensitivity of the devices. By using advanced cleanroom processing techniques we can make micron-sized 3D electrodes in polymer-derived pyrolytic carbon (Hemanth et al., 2017) to increase sensitivity. Though pyrolytic carbon offers several advantages over metals such as being more chemically inert (Kamath & Madou, 2014) or being easier to structure in 3D, they also have disadvantages including higher resistivity than metals and deformation (shrinkage) of structures during pyrolysis lowering the actual resolution of defined structures (Hassan et al., 2017; Natu et al., 2018).

In this project, we will try to come up with innovative methods and solutions to either improve or bypass these disadvantages, and maybe even turn them into advantages. The project could include Finite EleMent (FEM) Multiphysics simulations using COMSOL, cleanroom fabrication and processing and electrochemical characterization, and we will discuss how to accommodate the project to your interests.

Hassan, Y. M., Caviglia, C., Hemanth, S., Mackenzie, D. M. A., Alstrøm, T. S., Petersen, D. H., & Keller, S. S. (2017). High temperature SU-8 pyrolysis for fabrication of carbon electrodes. Journal of Analytical and Applied Pyrolysis, 125, 91–99. https://doi.org/10.1016/j.jaap.2017.04.015

Hemanth, S., Caviglia, C., & Keller, S. S. (2017). Suspended 3D pyrolytic carbon microelectrodes for electrochemistry. Carbon, 121, 226–234. https://doi.org/10.1016/j.carbon.2017.05.090

Kamath, R. R., & Madou, M. J. (2014). Three-dimensional carbon interdigitated electrode arrays for redox-amplification. Analytical Chemistry, 86(6), 2963–2971. https://doi.org/10.1021/ac4033356

Natu, R., Islam, M., Gilmore, J., & Martinez-Duarte, R. (2018). Shrinkage of SU-8 microstructures during carbonization. Journal of Analytical and Applied Pyrolysis, 131(February), 17–27. https://doi.org/10.1016/j.jaap.2018.02.015

Project 3. 4. Microfabrication of a microneedle-based electrochemical sensor for transdermal diagnostics

Skills and abilities required: Students in Nanotechnology, Physics, Biomedical Engineering and Biomedical Microtechnology are most suitable for this project.

Micro- and nanotechnology is able to provide novel tools for diagnostics and health care. Microneedles have been introduced as a novel method for minimally invasive transdermal drug delivery. However, so far only few studies on in situ sensing with microneedle-based devices have been presented. At the same time, electrochemistry offers a large range of methods for measurement of biomolecules in physiological fluids.

In this project we would like to fabricate microneedles for in situ electrochemical sensing of biomarkers in the skin. The objectives of the project include the design and fabrication of the microneedle sensor in the DTU Nanolab cleanroom and in vitro testing of the devices.

Project 3. 5. Optoelectrical neural probes for regenerative medicine

Skills and abilities required: Students in Nanotechnology, Physics, Biomedical Engineering, Biomedical microtechnology are preferred.

In the last decade, optogenetics has allowed selective modulation of neural activity by illuminating neurons with light at a specific wavelength. This is achieved by genetically modifying neurons to express specific light sensitive proteins called opsins. Channelrhodopsin-2 (ChR-2) is one such non-specific cation channel used to depolarize the neuron. Optical stimulation of neurons offers high temporal and spatial resolution when compared to electrical stimulation. Moreover, it is possible to modulate neurotransmitter release from optogenetically modified neurons. However, optogenetic modulation of neurotransmitter release directly in the brain necessitates uniform illumination of a large population of neurons to achieve a therapeutic effect.

The goal of this project is to continue our efforts on the fabrication and characterization of an optical-electrical neural probe containing a leaky optical waveguide and pyrolytic carbon electrodes capable of optical stimulation and real time electrochemical detection of dopamine exocytosis from a population of optogenetically modified dopaminergic neurons. The main focus of the project will be the fabrication of the neural probes and the initial characterization using optical and electrochemical methods. Finally, the mechanical stability will be tested in an in vitro brain model.

Reference: S. Vasudevan, J. Kaitez, A.-I. Bunea, A. Gonzalez-Ramos, T. Ramos-Moreno, A. Heiskanen, M. Kokaia, N.B. Larsen, A. Martínez-Serrano, S.S. Keller, J. Emnéus, “Leaky optoelectrical fiber for optogenetic stimulation and electrochemical detection of dopamine exocytosis from human dopaminergic neurons”, Adv. Sci. (2019)

Project 4) Quantitative Modeling of Cell Metabolism group

No. Spots: 1 - 3

TEC participating programs: IBT, IFI, IMD, IIS, ITC, ISC IBT, IFI, IMD, IIS, ITC, ISCA and every student who is passionate about computational biology. Background on biostatistics and previous knowledge of some programming language (R, Matlab, Python, ...) are desirable but not exclusive.

Students will develop and apply computational methods based on mechanistic modeling, machine learning, data analysis and omics integration to unveil molecular mechanisms underlying diseases with strong metabolic component namely brain, breast or prostate cancer and endotheliopathy.

DTU researcher: Dr. Igor Marín (Senior Researcher- leader group Quantitative Modelling of Cell Metabolism)

Dr. Roberto Parra and Eduardo Sosa

PROJECT SUMMARY:

The Quantitative Modelling of Cell Metabolism group focuses on developing mathematical models to explore and explain the molecular basis for homeostasis – the self-regulating processes evolved to maintain metabolic equilibrium.

Studying homeostasis is relevant for the understanding and treatment of complex diseases, particularly with the emergence of personalised medicine.

It is equally important when we seek to repurpose the cellular machinery for the production of desired chemicals, materials and pharmaceuticals. In this process, the cells' homeostatic control mechanisms must be either disabled or exploited.

Cellular reactions are catalysed by enzymes. In order to model homeostasis, we need to model the kinetics of all the enzymes involved in cellular metabolism and the regulation of their expression.

The section's main objectives are to:

- Develop the tools needed to formulate and fit large network kinetic models
- Explore several aberrant metabolic phenotypes, including the Warburg Effect in cancer cells, and common genetic disorders of red blood cell metabolism
- Explore several product models in E. coli and yeast in order to guide superior cell factory designs

The ultimate aim is to be able to automatically convert the omics "parts" lists (genome, transcriptome, proteome, metabolome), now routinely collected for many individuals, into accurate cellular physiomes to guide treatment and design.

The Quantitative Modelling of Cell Metabolism group is located at The Novo Nordisk Foundation Center for Biosustainability, DTU Biosustain.

The Group currently has a wide variety of projects where TEC students can carry out tasks of different kinds according to student profile and knowledge. We highly encourage students to participate if they fit the selection criteria.

Selection criteria: We are seeking for a highly motivated, independent, and well organized person, who is passionate about computational biology. Background on biostatistics and previous knowledge of some programming language (R, Matlab, Python, ...) are desirable but not exclusive.

Student main tasks: develop and apply computational methods based on mechanistic modeling, machine learning, data analysis and omics integration to unveil molecular mechanisms underlying diseases with strong metabolic components namely brain, breast or prostate cancer and endotheliopathy. Research area: Computational modeling of cell metabolism, machine learning and data analysis focused on health.

There are 5 projects available and 1-3 students will be selected.

Project 4.1: UNVEILING THE IMPACT OF ALTERNATIVE SPLICING AND PH IN TUMOR PROGRESSION AND MALIGNANCY IN PROSTATE CANCER BY MULTI-OMIC DATA INTEGRATION INTO CONSTRAINT-BASED MODELING METHODS

Alternative splicing of RNA is a crucial process for changing the genomic instructions into functional proteins. It plays a critical role in the regulation of gene expression and protein diversity in a variety of eukaryotes. Cancer cells exhibit remarkable transcriptome alterations partly by adopting cancer-specific

splicing isoforms. These isoforms drive of cancer progression or small but significant contributors to specific cancer hallmarks. On the other hand, the glutaminase enzymes regulating the conversion of glutamine to glutamate as input into the citric acid cycle is particularly important in cancer cells which experience the Warburg effect. In this sense, certain alternative splicings in glutaminase have been reported to be associated with tumor progression and malignancy acquisition. In addition, Glutaminase activity alters the pH which in turn is reported to regulate the activity of certain alternative splicing of Glutaminase. Thus, understanding this mechanism is crucial to understand the metabolic reprogramming associated with tumor progression and metastasis. In this context, genome-scale metabolic models (GSMM) have emerged as a valuable platform to integrate different omics data to study cancer metabolism from a holistic perspective. However, this systems biology tool does not account for alternative splicing. Thus, it is imperative to develop novel computational tools allowing a better understanding of alternative splicing and the role of pH in the current GSMM reconstruction analyses.

The project: The project is aimed to develop and test a computational framework to incorporate information of alternative splicing and pH into GSMMs. As a case of concept we will study the metabolism of two clonal subpopulations from a prostate cancer cell line (PC-3). In this dual cell model, PC-3/S cells express Epithelial-mesenchymal-transition markers and display high invasiveness and low metastatic potential, while PC-3/M cells present the opposite phenotype and higher proliferative rate. To achieve this aim the student will integrate transcriptomic, metabolomic, physiologic and specific information about alternative splicing of glutaminase into a computational analysis of the whole metabolism. This study will provide a holistic view of the molecular processes and mechanisms underlying tumor progression and metastasis in prostate cancer which ultimately can unveil potential therapeutic targets. This project is a joint venture between Prof. Lars Keld Nielsen lab (DTU, Denmark) and Prof. Marta Cascante's group (University of Barcelona, Spain) that will be under the direct supervision of Dr. Igor Marín.

The role: The successful appointee will develop and apply a pipeline based on constraint-based methods to: i) incorporate information of the alternative splicing and pH into GSMM and ii) integrate multi-omic data from prostate cancer cells. Finally the results will be analyzed and interpreted in order to describe the evolutionary mechanisms underlying the metabolic reprogramming associated to tumor progression and metastasis prostate cancer

Criteria: We are seeking for a highly motivated, independent, and well organized person, who is passionate about computational biology. Background on biostatistics and previous knowledge of some programming language (R, Matlab, Python, ...) are desirable but not exclusive.

Project 4.2. MODEL-DRIVEN ANALYSIS OF CANCER-ASSOCIATED ALTERATIONS IN LIPID PROFILE BY DEVELOPING NOVEL ALGORITHM-BASED METABOLIC NETWORK RECONSTRUCTION

It is increasingly clear that significant alterations in the lipid profile of cancer cells accompany tumor progression and metastasis. These changes are induced by a metabolic reprogramming which is aimed to enhance malignant phenotype in cancer cells.

In this context, genome-scale metabolic models (GSMM) have emerged as a valuable platform to integrate different omic data to study cancer metabolism from a holistic perspective. However, far too often lipid

associated pathways are poorly annotated in these metabolic networks which limits the scope of GSMM-based methods to study the altered tumor metabolism.

Thus, it is imperative to develop novel computational tools that allowing a better integration of high-throughtput lipidomic data into the current GSMM reconstruction analyses. It is expected that these computational tools will enable a more in-dept understanding of the metabolic mechanisms underlying lipid profiles alterations of multifactorial diseases with a strong metabolic component such as cancer with potential clinical applications

The project: The project is aimed to develop and test a computational framework for automatically expand and improve the lipid-associated metabolic pathways of the current computational models of cell metabolism.

As a case of concept we will study the metabolic alterations associated to the chronic exposure to Endocrine disruptors (ED) in prostate cancer . To achieve this aim the student will apply different strategies to integrate transcriptomic, metabolomic and lipidomic data into a computational analysis of the whole metabolism. This study will provide a holistic view of the molecular processes and mechanisms underlying tumor progression and metastasis associated to the chronic exposure to EDs in prostate cancer which ultimately can unveil potential therapeutic targets. This project is a joint venture between Prof. Lars Keld Nielsen lab (DTU, Denmark) and Prof. Romà Tauler's group (IDAEA-CSIC, Spain) that will be under the direct supervision of Dr. Igor Marín.

The role: The successful appointee will develop and apply a pipeline based on constraint-based methods to expand and improve the lipid-associated metabolic pathways of a current GSMM. Secondly, the student will integrate and analyze transcriptomic, metabolomic and lipidomic data from DU145 before and after a chronic exposure to different EDs. Finally the results will be analyzed and interpreted in order to describe the evolutionary mechanisms underlying the metabolic reprogramming associated to the chronic exposure to EDs in prostate cancer

Criteria: We are seeking for a highly motivated, independent, and well organized person, who is passionate about computational biology. Background on biostatistics and previous knowledge of some programming language (R, Matlab, Python, ...) are desirable but not exclusive.

Those students who are interested in join this project can contact to Igor Marín (igmar@biosustain.dtu.dk)

REQUIREMENTS

We are seeking for a highly motivated, independent, and well organized person, who is passionate about computational biology. Background on bioinformatics

Project 4.3. COMMUNITY MODEL-DRIVEN ANALYSIS TO UNVEIL METABOLIC ALTERATIONS IN HETEROGENEOUS BRAIN METASTASIS.

The major cause of death from cancer is due to metastases that are resistant to therapy. In this sense more than 40% of cancer patients develop brain metastasis (BRM).

The chemotherapy treatment of BRM faces the problem of the impaired delivery of chemotherapy into the CNS due to the impenetrability of the blood–brain barrier (BBB). Additionally, the coexistence within the same tumor of subpopulations, featuring different phenotypes (intra-tumoral heterogeneity) confers

an extreme flexibility and adaptability to tumors. Thus, both BBB and intra-tumoral heterogeneity are associated to BRM and represent a challenge for diagnostic and treatment approaches (Renovanz et al Front Oncol 2014).

Therefore, the complex molecular mechanisms occurring in these heterogeneous populations must be approached from a global perspective integrating the whole metabolism and regulatory mechanisms while accounting for intra-tumoral heterogeneity.

In this context, Constraint-based genome-scale metabolic models (GSMMs) have emerged as a potential solution to decipher the complex metabolic mechanisms underlying cancer in a holistic manner (Mardinoglu et al J Intern Med 2012). GSMMs gather all the biochemical reactions encoded by an organism's genome and offer an appropriate framework to integrate a variety of omic data. However, GSMM methods consider tumor as a homogeneous tissue rather than a heterogeneous ecosystem. In this sense mass spectrometry imaging (MSI) techniques may identify intratumoral subpopulations by their unique chemical fingerprints (Palmer et al Anal Chem 2015).

To tackle these biologically and clinically problems, it is imperative to develop novel model-driven methods accounting for tumor heterogeneity to unveil molecular drivers in BRM. It is expected that these computational approaches will enable a more in-deep understanding of the complex molecular mechanisms underlying tumor progression and metastasis associated to brain cancer.

The project: The project is aimed to study the metabolic alterations underlying BRM by developing and applying novel constraint-based methods that consider the tumor as a community of intratumoral subpopulations. To achieve this we will: i) use multivariate approaches to analyze the metabolomic data in order to identify the different intratumoral subpopulations and ii) apply different strategies to integrate transcriptomic, metabolomic and lipidomic data into a computational analysis of the whole metabolism of the different intratumoral subpopulations. This study will provide a holistic view of the molecular processes and mechanisms underlying BRM which ultimately can unveil potential therapeutic targets.

This project is a joint venture between Prof. Lars Keld Nielsen lab (NNF-CFB DTU, Denmark), Prof. Romà Tauler's group (IDAEA-CSIC, Spain) and MD. Algels Sierra‘s group (Clinic Hospital of Barcelona, Spain) that will be under the direct supervision of Dr. Igor Marín.

The role: The successful appointee will apply multivariate analysis to identify the different intratumoral subpopulations and/or a pipeline based on constraint-based methods to integrate and analyze transcriptomic, metabolomic and lipidomic data from the different intratumoral subpopulations. Finally the results will be analyzed and interpreted in order to describe the evolutionary mechanisms underlying the metabolic reprogramming associated to the chronic exposure to EDs in prostate cancer

Criteria: We are seeking for a highly motivated, independent, and well organized person, who is passionate about computational biology. Background on biostatistics and previous knowledge of some programming language (R, Matlab, Python, ...) are desirable but not exclusive.

REQUIREMENTS

We are seeking for a highly motivated, independent, and well organized person, who is passionate about computational biology. Background on bioinformatics

Project 4.4. COMBINE MODEL-DRIVEN AND MULTIVARIATE ANALYSIS TO UNRAVEL POTENTIAL THERAPEUTIC TARGETS CONSIDERING INTER-TUMORAL HETEROGENEITY

Constraint-based analysis of genome-scale metabolic models has become a key methodology to gain insights into functions, capabilities, and properties of cellular metabolism. This systems biology tool has been widely used in cancer research to predict potential vulnerabilities in the metabolic network in the form of synthetic lethal. In brief, synthetic lethals are sets of reactions/genes where only the simultaneous removal of all reactions/genes compromises the viability of the tumoral cell. However, the intertumoral heterogeneity between patients)even with the same cancer type at the same stage) represents an important challenge to be overcame in order to apply these computational approaches in systems medicine approaches.

In addition, since their inception, the size and complexity of genome-scale metabolic reconstructions has significantly increase, thus more computational resources are needed to analyze these systems. This fact is enhanced by the exponential increase of simulations required to unravel potential synthetic lethal genes/reactions as a potential anti-tumoral targets.

Thus, the complexity and size of the metabolic networks together with the large number of simulations needed for synthetic lethal analysis and the inter-tumoral heterogeneity between patients with the same tumor type and stage, make, in practice unfeasible an in-deep study of the mechanisms underlying tumor progression and vulnerabilities via model-driven methods as a translational tool in the scope of systems medicine.

Thus, it is necessary to develop a strategy to reduce the dimensionality of the problem and find more effective ways to develop potential multiple target treatments in complex and multi-factorial diseases such as cancer.

The project: This project is aimed to develop a computational approach combining multi-variate data analysis and model-driven methods that will allow an in-deep discovery of multi-taget metabolic and gene regulatory targets with potential anti-tumoral effects. More specifically it will be achieved by applying three strategies:

1. Computational metabolic model reduction and compaction
2. Patients clustering in representative groups based on trascriptomic data
3. Multivariate analysis in combination with algorithm for the rational reduction of redundant simulations to detect pairs, triplets and quadruplets of genes/reactions with anti-tumoral effects

The two first approaches will drastically reduce the number of required simulations while the third will permit to further analyze the behavior of the system.

It is expected that these computational approaches will enable a more in-deep understanding of the complex molecular mechanisms underlying tumor progression and the discovery of novel multi-target therapies towards personalized medicine, that otherwise couldn’t be addressed by current approaches.

This project will be carried out in Prof. Lars Keld Nielsen lab (NNF-CFB DTU, Denmark) and will be under the direct supervision of Dr. Igor Marín.

The role: The successful appointee will apply one or several of the strategies previously mentioned. Finally the results will be analyzed and interpreted in order to describe the mechanisms underlying tumor progression and the discovery of potential novel multi-target therapies.

Criteria: We are seeking a highly motivated, independent, and well organized person, who is passionate about computational biology. Background on biostatistics and previous knowledge of some programming language (R, Matlab, Python, ...) are desirable but not exclusive.

Those students who are interested in join this project can contact to Igor Marín (igmar@biosustain.dtu.dk)

REQUIREMENTS

We are seeking for a highly motivated, independent, and well organized person, who is passionate about computational biology. Background in bioinformatics.

Project 4.5. HYBRID APPROACH COMBINING MODEL-DRIVEN AND MACHINE LEARNING METHODS TO UNVEIL THE MOLECULAR MECHANISMS UNDERLYING SHOCK INDUCED ENDOTHELIOPATHY

Systems Medicine (SM) is an interdisciplinary emerging field building on the increasing amount of omics - and clinical data provided by different high-throughput platforms to study the human body as part of an integrated whole, incorporating biochemical, physiological, and environment interactions. To this aim an important topic in SM is to develop computational mechanistic models (CMM) and machine learning algorithms (MLA) that describe disease progression of individual patients and the effect of current and future therapeutic interventions as the first step towards truly personalized medicine.

Multi Organ Dysfunction Syndrome (**MODS**) in critically ill patients represents a paradigmatic case to illustrate the potential of systems medicine as this is the main cause of morbidity and mortality in the intensive care unit (ICU).

The limited efficacy of the reductionistic approaches to improve survival of MODS patients for decades led Prof. Johansson at Rigshospitalet to investigate >2.500 shocked trauma and sepsis patients, finding that MODS developed secondary to systemic microvascular endothelial damage triggered by sympathetic over-activation. This novel disease entity, entitled shock induced endotheliopathy (**SHINE**) independently predicted MODS development and mortality [10]. To study SHINE pathobiology Prof. Johansson´s group identified four distinct endothelial cell SHINE phenotypes (**ENDOPHENOTYPES**) that were independent of trauma severity and shock. A follow-up study in 100 trauma patients confirmed the existence of four ENDOPHENOTYPES that were associated to significantly different types and incidences of MODS as well as mortality (15% vs. 73%).

The project: In order to unveil the molecular mechanisms underlying this novel pathology, blood samples from 1.500 critically ill patients provided by Prof. Johansson´s group at the Rigshospitalet will be used will be analyzed to extract multi-omics data (namely proteomics, transcriptomics, genomics, metabolomics and lipidomics). To extract clinically relevant information from such extensive amount of heterogeneous data, novel computational methods need to be developed. In this project two different approaches to will be applied and combined: i) Data-driven machine learning methods and ii) Mechanistic model-driven methods.

The proposed approach has the potential to provide information on structure harbored in mechanistic models to machine learning activities, yielding transparent ‘‘white-box’’ causal insights. This project will

move systems medicine field beyond the current state-of-the-art, enabling us to address pivotal translational challenges in a variety of other complex and multifactorial diseases paving the way for developing personalized decision support systems for the clinical practice. This project is a joint venture between Prof. Lars Keld Nielsen lab (DTU, Denmark) and Prof. Pär Johansson's group (Rigshospitalet, Denmark) that will be under the direct supervision of Dr. Igor Marín.

Criteria: We are seeking for a highly motivated, independent, and well organized person, who is passionate about computational biology. Background on biostatistics and previous knowledge of some programming language (R, Matlab, Python, ...) are desirable but not exclusive.

Project 5) Enzyme Technology group

No. Spots: 1-2

TEC participating programs: IBT, INCQ, IQ, IDS, IMD and students with the right background.

DTU researcher: Caio De Olivira Gorgulho Silva. This researcher doesn't accept student project proposals.

TEC partner: Elda Melchor

DTU Bioengineering provides both a fundamental and applied understanding of biological and molecular systems, which are used in biotechnology and biomedicine. A key focus is to provide the technological and biological means to discover new bioactive molecules, proteins/enzymes or biologics (microorganisms or microbiomes) for biomedical or biotechnological purposes.

The mission of the *Enzyme Technology* research group is to conduct research that provides new knowledge, new enzymes, and new innovative process strategies for resource utilization, industrial bioconversion processes, and new products supporting a sustainable development. The research group is also dedicated to hatching top-qualified MSc and PhD candidates through research-based teaching and structured supervision. Our research also involves sustainability assessment and separation technology research in the context of bioenergy and biorefinery processes.

More information about the group visit this link.

Project description:

Are you interested in enzyme technology for sustainable processes and products? Are you keen on molecular biology and protein chemistry?

This project aims to discover and characterize new fungal enzymes that can help convert plant waste biomass (e.g. agricultural residues) into value-added products (e.g. biofuels, green chemicals, and biomaterials).

Lytic polysaccharide monooxygenases (LPMOs) are central oxidative enzymes in plant biomass degradation by fungi, as they can depolymerize all major polysaccharides in the plant cell wall. Yet, it remains unclear how LPMOs are fueled with electrons and H_2O_2 (required for their activity) during fungal action on lignocellulose. This is possibly achieved in multiple natural ways. Recent evidence shows that LPMOs might benefit from co-secreted enzymes that are active on lignin (an aromatic component of plant cell walls) or lignin building blocks.

Our overall goal is to discover and characterize new partner enzymes that can fuel LPMOs by modifying lignin-derived compounds. Such understanding can be used to design powerful enzyme systems for efficient biomass processing in biorefineries.

The position is oriented to students in Biotechnology or other biology-related areas. The student will gain experience in molecular biology, heterologous expression techniques, protein purification, and biochemical characterization of oxidative enzymes.

Keywords: Biotechnology or other biology-related areas. "

Criteria: IBT, INCQ, IQ, IDS, IMD and every student with a background on molecular biology, microbiology, protein purification and enzymology.

The student joining this project will gain experience in molecular biology, heterologous expression techniques, protein purification, and biochemical characterization of oxidative enzymes.

Project 6) Systems Environmental Microbiology Group

No. spots: 1-2

TEC participating programs: IBT, INCQ, IQ, IMD, IDS.

DTU researcher: Dr. Pablo Iván Nikel. This researcher doesn't accept student project proposals.

TEC partner: Dr. Jorge Donato Garcia García

Group: Systems Environmental Microbiology

Project description:

Metabolic engineering and synthetic biology of bacteria for bioproduction of new-to-Nature compounds - See details and type of projects at sem-cfb.com

Criteria: Background and courses on molecular biology, microbiology, biochemistry, biotechnology, systems biology, microbiology lab, genetic engineering. Hands-on experience in cloning and microbiology would be highly valuable.

Project 7: Manufacturing Engineering

No. spots: 1

TEC participating programs: IBT, INCQ, IQ, IMD, IDS, ITC, ISS and all students who can fulfill the selection criteria are eligible.

DTU researcher: Dr. Guido Tosello. This researcher doesn't accept student project proposals.

DTU Group: Department of Mechanical Engineering, Manufacturing Engineering

Project description:

DTU Mechanical Engineering conducts teaching and research in basic mechanics, advanced design tools, product development, energy systems, coastal hydrodynamics and marine technology.

Projects in this internship will be related to materials engineering, manufacturing engineering, Industry 4.0, digitalization, sustainable production.

Project description:

Materials engineering, manufacturing engineering, Industry 4.0, digitalization, sustainable production.

Example of projects:

1. Automated vision-based inspection of mould and part quality in injection molding
2. Multi-instrument characterization of dental implants; Downscaling micro-injection molding lab-on-a chip
3. Simulation, production, optimization
4. Watermark evaluation in float-zone crystal growth of silicon production based on deep learning
5. Machine learning algorithms for surface gloss inspection
6. Surface replication fidelity of structured surfaces

Selection criteria: Knowledge of materials science, production technology, data analytics and statistics, FEM/CFD simulation, programming. When writing your motivation letter, you can mention the type of project you are interested in working with from the numbered list above.

We invite you to visit https://orbit.dtu.dk/en/persons/guido-tosello

Project 8: Yeast Natural Products Lab

No. spots: 1-2

TEC participating programs: IBT, INCQ, IQ and all students who can fulfill the selection criteria are eligible.

DTU researcher: Dr. Pablo Cruz- Morales

TEC researcher: Cuauhtémoc Licona

DTU Group: The Novo Nordisk Foundation Center for Biosustainability

Project description:

Synthetic biology for drug discovery and chemical production

https://www.biosustain.dtu.dk/Research/Application-Areas/Natural-Products.

Selection criteria: Knowledge of Chemistry, Biology, genetics, bio engineering.

Keywords: Synthetic biology, sustainability, medicines, biosynthesis

Project 9: Food Production Engineering

No. spots: 1-2

TEC participating programs: IBT, IIA and any student with the right background and experience in insect protein.

DTU researcher: Federico Casanova. National Food Institute. Research Group for Food Production Engineering

TEC researcher: Celeste Ibarra

DTU Group: National Food Institute. Research Group for Food Production Engineering

Project description:

Projects related to interfacial properties of insect proteins, food production engineering

To know more about the type of projects:

- https://orbit.dtu.dk/en/persons/federico-casanova
- https://www.food.dtu.dk/english/research/food-production-engineering

Keywords: Synthetic biology, sustainability, medicines, biosynthesis

Project 10. Microbial Biotechnology and Biorefining

No. spots: 1-7

TEC participating programs: IBT, IIA, INA, INCQ and students who can demonstrate enough knowledge and skills

DTU researcher: Claus Heiner Bang-Berthelsen & Radhakrishna Shetty

TEC researcher: Cristina Chuck / Sayra Nayely Serrano Sandoval

DTU Group: National Food Institute. Research Group for Microbial Biotechnology and Biorefining

Some of the individual projects could/might be handled in combination.

Project 10.1: Isolation of Propionibacterium sp. from plant sources and biosynthesis of vitamin B12 during fermentation using liquid food side stream medium.

Project background:

Vitamin B12 deficiency exists in vegan communities, vegetarians and populations of underdeveloped countries or in one who eats low intake of animal food products. Solution: We like to investigate the biosynthesis of vitamin B12 by Propionibacterium sp. by fermentation using agroi-ndustry food sidestreams which contains protein residues. Roadmap: Propionibacterium sp which will be isolated from plant sources. Isolated potential Propionibacterium will be used for fermentation processes and further

optimization will be carried out (shaker flask and bioreactor optimization) will be carried out. Finally we will quantify amount of vitamin B12 produced during and in final fermented prototypes. In addition to this, during the process, we study microbial growth and metabolism of sugars and organic acids, protein and fat etc.

Learning objectives:

1. Learning and applying isolation of microbes from plant sources.
2. Learning and applying fermentations techniques and optimization
3. Learning different analytical methods HPLC for sugar and acids, proteins and fats
4. Learning prototyping plant-based fermentation with vitamin B12
5. Learning to learn manuscript preparation or report

Project specifications

Main tasks:

- Isolation of Propionibacterium sp. from various plant sources and identifying MLADI-Biotyper and culturing in various mediums.
- Shake flask and bioreactor (table top) fermentations and optimization.
- Different analytical methods HPLC for sugar and acids, proteins and fats
- Prototyping plant-based fermentation with vitamin B12
- Manuscript preparation or report

Main deliverables & expected outcome:

Report (manuscript format), poster, testimonial with pictures, participation in seminar.

Students profile: Looking for one student with strong knowledge in microbiology, fermentation biotechnology & lab work (techniques)

Expected outcome: Hope in this project we expect to produce possible vitamin B12 in *Propionibacterium* fermented plant based prototype from agro-sidestream This will be cost effective and alternative to meat derived vitamins B12 and will address the needs of specific groups.

Relevant bibliography:

Vitamin B12 production from crude glycerol by Propionibacterium freudenreichii ssp. shermanii: optimization of medium composition through statistical experimental designs. Kośmider A, Białas W, Kubiak P, Drożdżyńska A, Czaczyk K.Bioresour Technol. 2012 Feb;105:128-33. doi: 10.1016/j.biortech.2011.11.074. Epub 2011 Dec 1.PMID: 22178491

Production of Propionibacterium shermanii biomass and vitamin B12 on spent media. Gardner N, Champagne CP.J Appl Microbiol. 2005;99(5):1236-45. doi: 10.1111/j.1365-2672.2005.02696.x.PMID: 16238755

Ultra-high performance liquid chromatographic and mass spectrometric analysis of active vitamin B12 in cells of Propionibacterium and fermented cereal matrices.Chamlagain B, Edelmann M, Kariluoto S, Ollilainen V, Piironen V.Food Chem. 2015 Jan 1;166:630-638. doi: 10.1016/j.foodchem.2014.06.068. Epub 2014 Jun 21.PMID: 25053103

Biosynthesis, fermentation and application of vitamin B12--a review.Ma H, Wang L, Zhang C, Yi H.Sheng Wu Gong Cheng Xue Bao. 2008 Jun;24(6):927-32.PMID: 18807971.

Improving the drying of Propionibacterium freudenreichii starter cultures.Jeantet R, Jan G.Appl Microbiol Biotechnol. 2021 May;105(9):3485-3494. doi: 10.1007/s00253-021-11273-3. Epub 2021 Apr 22.PMID: 33885925

Project 10.2. Bioinformatics/genetics: Characterization and comparative genome analysis of novel fructophilic LAB species and its relevance for the production of mannitol.

Additionally, Phenotypical mannitol production based on HPLC might be relevant to include.

We have been isolating an unexplored group of LAB called fructophilic LAB for biotechnological purposes. These species have been found and isolated from fructose-rich niches such as honeybees, bees hives, flowers, and some fruits. The idea is to explore the capabilities that those species could provide to the biotechnology industry. In this particular case, we are interested in their carbohydrate consumption and mannitol production genes for their application in large-scale production of mannitol from biological waste streams. Therefore, we would like to characterize them from their whole genome sequencing data and perform comparative genomics. After that, the idea is to study and understand their carbohydrate metabolic pathways and its relation to mannitol production.

Tools to use:

a. Genome trimming and assembling.

b. Functional annotation (Prokka) and comparative genomics (Roary, Scoary).

c. Phylogeny studies (MEGA11, BioEdit, ClustalW).

d. Phenotypical analysis: Mannitol production using artificial media (HPLC).

Project 10.3. Bioinformatics/genetics: Full characterization and comparative genome analysis of different lactobacilli strains and its relevance for their usage in plant-based fermentations for dairy-like products development.

a. Also, it could be for leuconostoc, pediococci and lactococci (or all).

b. Some phenotypical antinutrient and off-flavor screening might be relevant to include. For example, tannins, saponins and glykoalkaloids.

We have 234 whole genome sequenced LAB strains considered QPS (applicable for food industry) to explore for their use in plant-based dairy fermentations. Those strains are divided into lactobacilli, leuconostoc, pediococci and lactococci families. The idea is to investigate, based on genome analysis, what species/strains could be relevant to further explore in the laboratory to produce plant-based dairy alternatives such as yogurt. Genes related to the antinutrient degradation, off-flavor removal, protein degradation, EPS production, biogenic amines production, dairy flavors production, etc, could be relevant to focus on.

Tools to use:

a. Functional annotation (Prokka) and comparative genomics (Roary, Scoary).

b. Phylogeny studies (MEGA11, BioEdit, ClustalW).

c. Functional mapping (KEGG) of relevant pathways.

d. Blast.

Project 10.4. Experimental/ LAB courses: High-throughput phenotypical screening of QPS LAB strains for antinutrient and off-flavors removal.

We have 234 whole genome sequenced LAB strains considered QPS (applicable for food industry) to explore for their use in plant-based dairy fermentations. Those strains are divided into lactobacilli, leuconostoc, pediococci and lactococci families. The idea is to investigate phenotypically which strains are

able to remove antinutrients (phytic acid, raffinose, saponins, tannins, glykoalkaloids, etc) and off-flavors (hexanal, 2-pentylfuran, nonanal, 1-octen-3-ol) mainly present in plant-based raw materials.

a. Basic microbiology.

b. Absorbance and fluorescence assays.

c. HPLC, GC-MS and LC-MS.

d. Enzymatic assays.

e. Fermentation assays.

Project 10.5. Experimental laboratory: Off-flavor removal analysis of fermented pea, oat and potato milks using lactobacilli (or leuconostoc, pediococci, lactococci).

The idea is to discover what LAB species is mostly capable of removing off-flavors from potato, pea and oat, stablishing a species-off-flavor removal network. For that, we have multiple strains of different LAB species to test. The project will consist of picking 5-10 strains of each LAB species and ferment pea, potato or/and oat analyzing the volatiles produced/reduced from those after the fermentation.

a. Basic microbiology.

b. GC-MS.

c. Fermentation assays.

Project 10.6. Experimental lab: Droplet-based microfluidics design for high-throughput phenotypical screening of LAB species for diacetyl production (2024).

The purpose could be different, but it needs to be related to plant-based dairy alternatives such as: i. Production of dairy flavors; ii. Removal of off-flavors; iii. Removal of antinutrients; iv. Plant protein degradation.

The idea is to setup a droplet-based microfluidic system for high-throughput screening of traits related to the elimination of unwanted compounds present in plant-based milks by LAB fermentation. Droplet-based microfluidics is a high-tech technology that allows thousands of independent reactions to happen at the same time by encapsulating single cells into single droplets. Droplet-based microfluidics workflows usually

consist of three stages; droplet generation, assay reaction and droplet sorting. The first stage consists of encapsulating thousands of cells in thousands of pico-liter droplets at a ratio 1 cell per droplet approximately, following the Poisson distribution. The second stage consists of inducing the cells to produce/eliminate/grow inside the cells based on the analytical setup that you want to implement. For instance, the design could be production of diacetyl after 24h of cell-in-droplet incubation (it needs to be a fluorescence-based assay). The third stage is to sort the positive droplets based on the phenotype tested which is based on fluorescence signaling.

Based on that, the purpose of this project is to establish a robust screening assay based on the microfluidics system and compare it with traditional systems (or less throughput) such as 96-well plate readers.

a. Basic microbiology.
b. Droplet generator (Onyx).
c. Droplet sorter (FACS).
d. Fluorescence-based assays.

Project 10.7. 1. Experimental laboratory: FTIR/NIR spectroscopy for fermentation monitoring of plant-based fermentations (using MILKOSCAN).

FTIR/NIR is a spectroscopy technique that uses infrared light to study the vibrational and rotational modes of a molecule. MILKCOSCAN is an equipment that uses FTIR/NIR and has been used to monitor and predict the milk fermentation for many years in terms of protein, carbohydrate and lipid changes over fermentation time. Nevertheless, plant-based milks are chemically different and therefore their infrared spectra. The idea is to understand and establish a robust analytical method to analyze fermented plant-based milks using FTIR/NIR (MILKCOSCAN) over time.

Therefore, the LAB-based fermentation of pea, oat and potato milks will be analyzed and monitored using this high-tech technique.

a. Basic microbiology.
b. Analytical chemistry (LC-MS, GC-MS).

c. FTIR/NIR.

d. Plant-based fermentation experiments.

Project 11. Food Allergy.National Food Institute. Head of the group

No. Spots: 1-2

TEC participating programs: LBC, IBT, INCQ, IQ, IDS, IMD and students with the right background.

DTU researcher: Katrine Lindholm, Head of the group

TEC partner:

DTU Department: Research Group for Food Allergy. National Food Institute.

Project description:

One major challenge in the transition towards non-animal based diets is the introduction of novel proteins while safeguarding human health. A main human health risk related to ingestion of novel food proteins, is the risk of introducing new food allergies, either as de novo sensitisation to the novel proteins (development of new allergies) or via cross-reactions to known food and respiratory allergens (eliciting reactions in already allergic individuals). While this aspect of the green transition has received very limited public attention, the actual problems, and unmet needs, are significant. Food allergy affects around 5-8% of young children and 2-4% of adults, and appears to be an increasing problem. Thus, it is important to avoid fueling the drivers of food allergy. There is a need for a deep understanding of the relationship between novel food proteins, food processing and allergenicity to pave the way for an accelerated uptake of new biomasses in food ingredients and products. No specific properties are recognised for being predictive of allergenicity, and the impact of processing cannot be foreseen. Whether a specific processing procedure will increase or decrease the allergenicity of a specific protein source, will solely rely on the given proteins. Consequently, before new proteins can be introduced on the marked and be ingested an allergenicity evaluation will need to be performed.

Student's main tasks:

- Conducting careful literature research on history of use of source material
- Performing in silico analysis
- Assessing the digestive stability
- Performing various ex vivo analyses for identification of cross-reactive potential to know respiratory and food allergens
- Performing in vivo experiments, in Brown Norway rats simulating individuals predisposed to develop allergies, for assessment of the inherent sensitizing capacity and hence introduction of new allergies in individuals without previous allergies
- Investigating the impact of different processing technologies
- Data analyses and visualisation of results
- Writing a report about obtained results
- Present and discuss results orally

Students skills: students with proven skills in in silico analysis, Animal experiment, Digestibility studies, Immunological assays, Data analysis and report writing

Project 12. DTU Health Tech & IDUM

No. Spots: 1-2

TEC participating programs: INA, INCQ, IBT

DTU researcher: Isidro Badillo

TEC partner: Mirna A. Gonzalez

DTU Department: Health Tech and IDUN

The center for Intelligent Drug delivery and sensing Using microcontainers and Nanomechanics (IDUN) is a center of excellence funded by the Danish National Research Foundation and the Villum Foundation. The center is divided into two parts: IDUN Drug and IDUN Sensor, focusing on drug delivery and nanomechanical sensors, respectively.

With the two main research areas in close contact at the center, IDUN explores the great synergy between sensor development and search for new pharmaceutical tools and materials. IDUN Sensor gets, through IDUN Drug, access to unique polymers and biomolecules. Through IDUN Sensor, IDUN Drug is able to characterize, among others, small volumes of materials and molecules, which are today not possible to analyze by any standard technologies. By maintaining and strengthening the coupling between sensor and material development, IDUN creates a unique international environment with high creativity across scientific borders.

Project description: Development and validation of antibiotic detection in a nanostructured and automated microfluidics sensing system - DTU Health & IDUN

In this project the student will develop a sensing method, using optical spectroscopic methods and nanostructured systems, in an automated microfluidics system, in order to detect and quantify antibiotics at low concentrations in complex matrices, eg. blood and/or plasma.

More information:

https://idun.dtu.dk/research/sensor

https://www.linkedin.com/in/idun-research-section-7561b1139/

Student requirements: skills in analytical chemistry; Handle of Biological samples; Basics of spectroscopy; Data analysis. Desired skills and knowledge: Management of general chemical instrumentation, preparation of solutions, management of biological samples, management of analytical instrumentation, principles in data treatment and analysis, knowledge in nanotechnology.

Project 13. Biomass Conversion and Bioprocess Technology

No. Spots: 1-2

TEC participating programs: IBT, INA, INCQ, IQ

DTU researcher: Solange Musatto

TEC partner: Roberto Parra, Elda Melchor

DTU Department: Biotechnology and Biomedicine - Biomass Conversion and Bioprocess Technology Group.

Project title: Use of lignocellulosic biomass to produce bioplastics .

BCDT develops activities in the following areas: biomass fractionation, hydrolysate detoxification, CO2 utilization/conversion, development of robust strains, bioprocess optimization and intensification, downstream processing and sustainability assessment.

Read more about the research group at www.bcbtgroup.com

Student profile: experience with fermentation process will be a plus, but will not be mandatory for the selection of the student. Students main tasks: Lab experiments related to biomass conversion, pretreatment, hydrolysis and fermentation; strain improvement, statistical analysis and/or sustainability assessment

Project 14. Microbial and Chemical Ecology

No. spots: 1-2

TEC programmes: Biotech students with an IT background in bioinformatics, or IT students with a background in understanding microbiology

DTU researcher: Mikael Lenz Strube

TEC peer: Adriana Pacheco Moscoa

DTU Department: Bioengineering. Section for Microbial and Chemical Ecology. Bacterial Ecophysiology and Biotechnology.

Project description and tasks:

Microbial bioinformatics, biostatistics, software development.

Example projects:

-Machine learning for microbiome time-series

-Extension of the RibDif software (https://github.com/mikaells/RibDif);

-Automated creation of taxa specific primers

-Data driven discovery using network theory

Students profile: extensive coding ability in the Linux environment and understanding of microbiology. Software development, hypothesis generating research, scientific writing

Project 15. Aquaculture

No. spots: 1-2

DTU researcher: Kim Joao DeJesus Gregersen

TEC peer: Eduardo Sosa

DTU Department: AQUA

Project description:

Evaluating impact of UV on organic matter and bacterial activity in RAS water and biofilters.

Goal: study the effect of UV irradiation on the dynamics of biomass transfer in different places in aquaculture systems, mainly bioreactors, in order to evaluate new efficient forms of biomass removal.

Research site and facilities are located outside Copenhaguen, in the North Sea Science Park in Hirtshals, Jutland. This means, students will need to live in Hirtshals and not in Copenhagen.

Read more about the facilities in Hirtshals
https://www.aqua.dtu.dk/english/about/facilities/aquaculture_facilities

Please, be aware that the project might be different, and related to fish feeding, recircularity in aquaculture systems, microbial activity, etc. We encourage you to visit this link to learn more about the project type and research lines in the Aquaculture department.

Student criteria: different engineering disciplines who are interested about sustainable fishery production and aquaculture.

Project 16. Sustainable Innovation Office

No. spots:1-2

TEC programmes: IBT, INCQ, and all students who can demonstrate significant skills for this vacancy.

DTU researcher: Sumesh Sukumura

TEC peers: Roberto Parra / Elda Melchor

DTU Department: Novo Nordisk Foundation Center for Biosustainability

About:

The Sustainable Innovation Office guides the innovation by quantifying, and potentially reducing the broader set of impacts of bio-based technologies. The Sustainable Innovation Office is a multi-

disciplinary unit, responsible to assess innovations in improving the current state of production, while simultaneously enhancing economic and environmental performance, inherent to the products.

The team works together with experimental units to fasten the deployment of biotechnological solutions by quantitative sustainability assessment of materials, enzymes, building-block chemicals and microbial food.

For more information, visit: https://www.biosustain.dtu.dk/innovation/sustainable-innovation-office

Project description: Quantitative evaluation of environmental performance and economic viability of bio-based products.

Students should prove enough knowledge and skills to tackle assessing biotechnological solutions to produce chemical, enzymes and subsequently derived materials for meeting global needs and address regional challenges.

Project 17. Circularity & Environmental Impact

No. spots: 1-2

DTU researcher: Anders Baun

TEC programmes: INA, IBT, IQ, and related minors to ecotoxicology

TEC peer: Analuisa Rubalcaba

DTU Department: Environmental and Resource Engineering

Projects related to nanomaterials, environmental risk and ecotoxicology.

Students need a solid background in chemistry, nanotechnology, biology with strong interest in environmental risk. Students will work in the laboratory with nanomaterials and ecotoxicological tests, risk assessment procedures.

Project 18. Bacterial Synthetic Biology

No. Spots: 1-2

TEC programmes: IBT and LBC

DTU researcher: Rubén Vázquez

DTU peer: Marion Emilie Genevieve Brunck

DTU department: Bacterial Synthetic Biology section at DTU Biosustain- Novo Nordisk Foundation Center for Biosustainability

My group works broadly within microbiology as it applies to industrial biotechnology and human health. We have developed and applied novel technologies within the fields of microbiome research, functional metagenomics, synthetic biology, biosensors and cultivation-based multiplexed phenotyping.

We study the microbiome-immune-brain axis in health and various diseases (e.g. obesity, NASH, Parkinson's and cancer).

In addition, I currently lead a project studying the genetic stability of live biotherapeutic products during scale-up production in collaboration with the pre-pilot plant at the Novo Nordisk Foundation-Biosustain center.

Student requirements: biotechnology and bioscience with expertise in microbiology lab such as PCR, clonation, protein gel, etc.

visit:

https://www.biosustain.dtu.dk/research/research-groups/bacterial-synthetic-biology-morten-sommer

https://www.biosustain.dtu.dk/research/research-groups/bacterial-synthetic-biology-morten-sommer/projects-morten-sommer

https://www.biosustain.dtu.dk/research/research-groups/bacterial-synthetic-biology-morten-sommer/publications-bacterial-synthetic-biology