CALL FOR STUDENT'S NOMINATIONS

Spring 2024

Research Experience Abroad 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 Spring 2024.

This call is addressed to Students of Tec 21 and students enrolled in academic plans prior to 2019.

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

GENERAL REQUIREMENTS

- To apply to Spring 2024, you must be enrolled in the 5th semester by the time of submitting the application and have completed 72 credits by the time of applying.
- A minimum general average of 92.
- 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, high work quality, 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 for 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 for 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. 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 are 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.

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

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

9. All positions advertised in this call are not remunerated. Students are encouraged to apply to national and international scholarships.

10. Students must have participated in research projects besides their regular classes from their undergraduate program at Tec. For example; a Tec semester of research experience only.

HOW TO APPLY

Follow 3 steps:

1. Update your profile at:
   MITEC -> MI EXPERIENCIA INTERNACIONAL -> ESTUDIANTE INTERESADO -> ACTUALIZA TU PERFIL
   Tutorial: https://www.youtube.com/watch?v=orFahJzO6uM
   It takes 16 working hours to validate it.

2. Once your profile has been validated, you can send your application:
   MITEC -> MI EXPERIENCIA INTERNACIONAL -> ESTUDIANTE SOLICITANTE -> REALIZA TU SOLICITUD
   Code: DIN-5EVI-005A
   Period: Febrero – Junio 2024 (Preselección)
   Tutorial: https://www.youtube.com/watch?v=A2Hfzir6N5Q

   Key points:

   - The preselection programs are not part of the regular application calendar of the study abroad and international exchange programs. Therefore, if this is the research abroad program you are most interested in, **DIN-5EVI-005A** is the only code you must register for on your application. You do not need to include any other code or any other period.
   - Shortly after the application is sent, you will receive an e-mail to notify you that you must accept a "pre-selection." It is important to keep in mind that this is only an automated status of the platform to continue with the next step. It is NOT the official selection of students. The International Programs Office will inform the official selection by e-mail on October 23, 2023.

3. Submit your documents:
   MITEC -> MI EXPERIENCIA INTERNACIONAL -> ESTUDIANTE SOLICITANTE -> ENTREGA DE DOCUMENTOS DE ADMISIÓN

   Once you have accepted the pre-selection status on the platform, you must submit the listed documents.

Application deadline: September 5, 2023

DOCUMENTS TO SUBMIT

Submit all documents in **PDF** format:

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. You will find a template of this letter in the corresponding document description in the platform.
4. Letter of recommendation in English from a Tec researcher professor with the following characteristic's:
   - Detail description of your activities during the research period.
   - It must be signed by the researcher professor.
   - Projects inside regular classes do not count as research experiences.
   -You should have the research experience at least one semester before you apply to this program.
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. Project selection format, specify the projects that students are interested in.

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.

Document submission deadline: September 5, 2023

Applications will not be accepted after the deadline, without exception. Incomplete documents will not be considered to participate in the program.

Students can apply to a maximum of 3 different projects. Notice you will need to upload your files correctly, there's no chance to make any corrections afterwards.

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.

SELECTION PROCESS

It is divided into two parts:

1. **Pre-selection by the Tec de Monterrey.** It involves a review of the files, an analysis, and evaluation of the candidates based on the documentation and requirements. Tec de Monterrey will send the pre-selected candidates' files to the Academic Delegation of Tec de Monterrey in Denmark.
2. **Confirmation of an interview.** The Academic Delegation will read your documents and make sure you have the profile for the projects you have proposed. If appropriate, then candidates will be invited for an interview.
3. **Selection by the researchers from DTU.** After the interview, DTU researches, will make a decision students acceptance to the program and will send a report to the Director of Academic Delegation of Tec de Monterrey in Denmark.

Once the selection process concludes, the selected students will receive an e-mail from the International Programs Office on October 23, 2023, with instructions to complete the registration process of DTU and Tec de Monterrey.

Please consider that if your selection is not satisfactory, you cannot postulate to another program as the last day to do so is October 12, 2023; besides, you cannot submit two applications on the International Programs platform simultaneously. Therefore, you will have to plan another academic activity for the semester.

PROCESS CALENDAR

A) Students submit applications, in the International Programs office portal.	From August 15, 2023,
B) Closing application date	September 5, 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.	August 15 to September 10, 2023,

D) Preselection of candidates and online interviews by TEC researchers and DTU researchers	September - October
E) Email confirming final candidates selected by DTU researchers and nomination to DTU.	October 23, 2023
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 application once you have registered yourself in their system.	October - November
G) DTU Supervisor sends project description	November - December
H) Orientation meeting with students	November
I) Students travel to Denmark for a research semester abroad	January/February to June/July

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 always final.

TO THE SELECTED STUDENTS

The starting and finishing date will be arranged in individual cases by the student and the DTU researcher. **Students will agree with their supervisors whether to start in January/ February and end June or late July. 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 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.

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:

Students will enroll in 18 credits per semester. Students in conjunction with the Academic Coordinator should evaluate the transfer of the credits to the study plan before the student participates in the research abroad program.

To students of both academic plans:

The academic units (subjects) that will receive credits for the research abroad program must be defined and authorized by the Academic Coordinator. It is the student's responsibility to validate with the Academic Coordinator the availability of the academic units of the study plan to be accredited by the project they will participate in. Once it is determined, students must complete their registration in the International Programs platform:

MITEC -> MI EXPERIENCIA INTERNACIONAL -> ESTUDIANTE SOLICITANTE -> REGISTRA TUS MATERIAS

A professor from Tec de Monterrey will evaluate the student's research abroad and grade the academic performance according to the policy.

TUITION AND PARTICIPATION FEES

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 February - June 2024.

Selected students will pay a participation fee: 1,600 MXN. Payment may be made in MiTec.

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) to be able to apply for a student visa.

Tecnológico de Monterrey:

All students of academic plan Tec 21 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. Note that your Tec scholarship may not be applicable during this semester extension.

Any point not covered in this call will be resolved by the selection committee in conjunction with the proper authority of Tecnológico de Monterrey as the case may be. Please consider that this call is subject to change without notice; this might involve costs, projects, vacancies, dates, or any other. Any problem or doubt regarding the application process should be communicated promptly to the International Programs Office at your campus.

Professors, Labs, Projects, and project description

In this section you can find a project description and the skills and requirements to apply. 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: Manufacturing Engineering

No. spots: 1

TEC 21 programs: IM, IMT, IE, IFI, IRS, ITC and those students from different study programs who can demonstrate knowledge and skills as described in the selection criteria below.

DTU researcher: Guido Tosello.

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:

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

Selection criteria (skills and knowledge): 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 2: Interfacial properties of insect proteins.

No. spots: 1

TEC 21 programs: IAL, IBT, IQ and those students from different study programs who can demonstrate knowledge and skills as described in the selection criteria below.

DTU researcher: Federico Casanova.

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

About

The Research Group for Food Production Engineering is focused on food processing with the aim of contributing to sustainable and effective food production, optimizing resource consumption, utilizing side streams and developing technologies and food products for specific requirements.

The Food Production Engineering Research Group (FPE) has its focus on a deeper mechanistic, primarily physical and chemical, understanding of food processing. This is supported by mathematical modeling and the use of advanced methods for monitoring of food production systems and distribution systems.

The goal is to provide new, cutting-edge knowledge of principles of industrial food processing and the creation of novel technologies within this field. The group's research will enable food manufacturers to produce and distribute healthy, safe and resource cost-effective foods of high quality with a minimum of waste. This is crucial for meeting the increasing demands to the food supply chain from the rapidly growing world population as well as the world-wide urbanization.

Project description:

Projects related to interfacial properties of insect proteins, food production engineering. You can read more about the type of projects in this link.

Selection criteria: Skills in synthetic biology, sustainability, medicines, biosynthesis, previous work with insect proteins.

Project 3. Microbial Biotechnology and Biorefining

No. spots: 1-3

TEC 21 programs: IBT, IAL, INA, IQ and those students from different study programs who can demonstrate knowledge and skills as described in the selection criteria below.

DTU researcher: Claus Heiner Bang-Berthelsen & Radhakrishna Shetty

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

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

Project 3.1: 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.

Selection criteria: 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 3.2. 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 (selection criteria/main tasks):

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 3.3. 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 (selection criteria/main tasks):

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 3.4. 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.

Selection criteria/ main tasks:

a. Basic microbiology.

b. Absorbance and fluorescence assays.

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

d. Enzymatic assays.

e. Fermentation assays.

Project 3.5. 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.

Selection critera/ main tasks:

a. Basic microbiology.

b. GC-MS.

c. Fermentation assays.

Project 3.6. 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.

Selection criteria/main tasks:

a. Basic microbiology.

b. Droplet generator (Onyx).

c. Droplet sorter (FACS).

d. Fluorescence-based assays.

Project 3.7. 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.

Selection criteria/main tasks:

a. Basic microbiology.

b. Analytical chemistry (LC-MS, GC-MS).

c. FTIR/NIR.

d. Plant-based fermentation experiments.

Project 4. Allergies in nobel food.

No. Spots: 1

TEC 21 programs: LBC, IBT, INA, IQ, and students who can demonstrate the right background.

DTU researcher: Katrine Lindholm

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:

- 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
- 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
- Investigating the impact of different processing technologies
- Data analyses and visualisation of results
- Writing a report about obtained results
- Present and discuss results orally

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

Project 5. DTU Health Tech & IDUM

No. Spots: 1-2

TEC 21 programs: INA, IBT, IQ and those who can demonstrate the selection criteria

DTU researcher: Isidro Badillo

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: Desarrollo y validación de detección de antibióticos en un sistema de sensado nanoestructurado y automatizado de microfluídica.

En este proyecto el alumno desarrollará un método de sensado, empleando métodos espectroscópicos ópticos y sistemas nanoestructurados, en un sistema automatizado de

microfluídica, con la finalidad de detectar y cuantificar antibióticos a bajas concentraciones en matrices complejas, ej. sangre y/o plasma.

Más información:

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

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

Selection criteria: Manejo de instrumentación química general, preparación de soluciones, manejo de muestras biológicas, manejo de instrumentación analítica, principios en tratamiento y análisis de datos, conocimiento en nanotecnología.

Student requirements: skills in analytical chemistry; Handle of Biological samples; Basics of spectroscopy; Data analysis.

Project 6. Microbial and Chemical Ecology

No. spots: 1-2

TEC 21 programs: IMD, IDM, IBT, ITC, IRS and students who can demonstrate the right background and selection criteria.

DTU researcher: Mikael Lenz Strube

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

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

Project 7. Circularity & Environmental Impact

No. spots: 1-2

DTU researcher: Anders Baun

TEC 21 programs: INA, IBT, IQ, IFI and students with related minors to ecotoxicology

DTU Department: Environmental and Resource Engineering

Projects related to nanomaterials, environmental risk and ecotoxicology.

Selection criteria: 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 8. Protein engineering based on machine learning.

No. spots: 2-4

TEC 21 programs: IBT, IDM, IFI, ITC, IRS and students who can demonstrate the right background and selection criteria.

DTU researcher: Carlos Acevedo Rocha

DTU Department: Computational Protein Engineering (CPE) group at The Novo Nordisk

Foundation Centre for Biosustainability (DTU Biosustain)

Challenges

Protein engineering is a crucial research area in academia and industry, with directed evolution being one of the most successful methods. Directed evolution improves protein properties through consecutive rounds of gene mutagenesis, expression, and selection. Thisscientific area was co-awarded the Nobel Prize for Chemistry in 2018 for its importance in the sustainable production of food, chemicals, biofuels, pharmaceuticals, etc. (1). One of the greatest challenges in protein engineering is to rationally-control the improvement of enzyme activity – in contrast to other traits like selectivity (2), stability (3) , or solubility (4). Enzyme activity is important for developing cost-effective microbial cell factories and biocatalytic processes for natural products or biochemicals as many enzymes involved in the biosynthesis of such compounds did not evolve to be highly active or are tightly regulated. Another great issue for engineering proteins is our inability to predict the effect on one parameter when combining two or more mutations – to say nothing of several ones on multiple parameters (5). This is due to nonadditive mutational interactions, known as epistatic effects, e.g., two or more beneficial mutations present in a genetic background may not be beneficial in another genetic background. Machine learning has the potential to address these issues, but high-quality data is lacking in the field. To harness the

potential of machine learning to predict activity and epistatic effects, we need to gather “big mutational data” at a large scale. This can be enabled by combining enzyme activity with genetic selection or ultrahigh-throughput screening approaches (e.g., fluorescent-activated droplet screening).

Project description:

In this project, we will combine high-throughput data generation based on genetic selection and bioinformatics of enzyme variants that are members of pathways in the biosynthesis of natural products , coenzymes (7) and amino acids (8), . The resulting data will be used to train machine learning algorithms to guide the engineering of protein activity of different protein families. The predicted variants will be tested in the laboratory and the best resulting enzyme mutants will be characterized in vitro and in silico. Our contributions will be important for the field of machine learning-guided directed evolution (9), evolutionary biology and epistasis (10).

Candidates

We are looking for two types of profiles:

1. **Biologists.** For assistance in lab work. The ideal candidate should have these skills:

   o Microbiology: Knowledge for cultivating and engineering E. coli, P. putida, yeast, etc.

   o Molecular Biology: Gene assembly and cloning with USER, Gibson, GoldenGate.

   o Protein biochemistry: Protein purification using affinity tags, enzyme kinetics, assays.

   o Bioinformatics: Knowledge in NGS (Illumina, Nanopore, PacBio) and RNAseq is a plus.

2. **Computer scientists**: We also need assistance with the following skills:

   o Software development: Experience with various programming languages and data management systems (Jupyter Notebooks, Python, R, and others).

   o Machine Learning: Knowledge of algorithms in machine and deep learning as well as development of pipelines and deployment of libraries for benchmarking.

   o Biology: Interest in proteins, microbiology, and bioproduction is very important.

Team

The newly established Computational Protein Engineering (CPE) group at The Novo Nordisk Foundation Centre for Biosustainability (DTU Biosustain) aims to engineer proteins more effectively using state-of-the-art research approaches, while contributing to the development of

novel tools for in silico prediction of protein function. We are an interdisciplinary group of scientists working at the interface of data science and machine/deep learning as well as protein modelling, directed evolution, biochemistry, enzymology, and metabolic engineering. The main goal is to develop innovative and sustainable solutions to the most pressing issues facing our societies in terms of bioproduction and bioremediation.

References

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Project 9. Antibodies technologies

No. Spots:1-2

Tec 21 programs: IBT, INA

DTU researcher: Esperanza Rivera de Torre

DTU Department: Center for Antibody Technologies (CAT) at Biotechnology and Biomedicine Department (DTU Bioengineering)

About CAT:

We specialize in antibody discovery, protein engineering, synthetic biology, and digital biotechnology and work with a multitude of protein scaffolds. These include human monoclonal antibodies, nanobodies, and other binding proteins that we utilize as precision molecules to combat and diagnose diseases, engineer microbiomes, and solve challenges within industrial biotechnology.

We believe that science should be conducted for the benefit of society. To achieve this, our research focuses both on scientific and technological insight, as well as translational aspects and practical applications. Moreover, we actively engage in innovation and entrepreneurship, and have successfully spun out several biotech companies.

Why now?
Drug and antibiotic resistance, food security, and globally spreading pathogens are key societal challenges that will affect our infrastructure and pose great risks to human health and well-being for many decades to come.

Why us?
Our work has already led to critical advances in antivenom research, ultra-low-cost binding proteins, and new methodologies for antibody discovery. We aim to enable other researchers to seamlessly integrate our approaches in their own discovery and engineering pipelines.

Main activities/ tasks to perform by the students:

Students will be involved in research activities ranging from bioinformatics to wet-lab antibody development. We will design a project in which the student will be the main responsible for self-organization and planning in collaboration with a CAT host. Students will be integrated not only in research but also in regular lab meetings and social activities.

Selection criteria: Biotechnology, chemistry, biology, biochemistry, immunology, or bioinformatics background.
