SDU







Department of Biochemistry and Molecular Biology





Jakob Møller-Jensen
Head of Department

The Department of Biochemistry and Molecular Biology (BMB) has established itself as one of the leading research environments at the University of Southern Denmark's Odense campus. The department comprises more than 200 employees across five research sections. Here, researchers, students, and technical staff come together in an international and interdisciplinary environment characterised by ambition, diversity, well-being, and drive.

At BMB, we explore the molecular mechanisms of life. We study how cells function, communicate, and adapt, in both health and disease. Our research spans from fundamental biochemical and molecular biological processes to mechanisms underlying diseases such as cancer, metabolic disorders, neurodegenerative conditions, and infections. Using advanced technologies, bioinformatics, and integrated omics approaches, we map gene function, protein dynamics, and complex cellular regulatory networks.

The department hosts excellent research environments where high academic standards go hand in hand with a culture that promotes collaboration, talent development, and innovation. We work closely with hospitals, companies, and international partners, because we know that the greatest breakthroughs happen at the intersection of disciplines.

BMB educates around 600 students at the bachelor's and master's levels within Biochemistry and Molecular Biology, Biomedicine, and Computational Biomedicine. We train highly specialised graduates for the life science sector, one of Denmark's key growth industries, where they contribute to research, innovation, and development across healthcare, biotechnology, and the pharmaceutical industry.

Innovation is an integral part of our work. We actively translate fundamental scientific discoveries into societal value, for example through spinout companies, strategic partnerships, and industry-oriented educational formats that bring students closer to real-world applications. For us, curiosity is driven by the ambition to make a difference.

BMB is a place where ambition and responsibility go hand in hand, and where the next generation of researchers and specialists is shaped in an environment that prioritises quality, relevance, and community.

At the Department of Biochemistry and Molecular Biology (BMB), we consider staff, guests, and students an integral part of the department's community. Our academic strength is built on the people who contribute every day to research, teaching, and collaboration.

We are committed to creating a healthy physical and psychological working environment, as well-being is essential for high-quality research and education. A strong workplace and study environment is a shared responsibility that we build together. Therefore, we prioritise both academic and social activities across the department and within smaller communities, where knowledge sharing, collaboration, networking, and a positive atmosphere are a natural part of everyday life.

BMB as an International Workplace

BMB is an international environment with staff, guests, and students from more than 25 countries. This cultural and academic diversity brings new perspectives to our research and teaching and strengthens the quality of our work.

We are ambitious and innovative and strive to deliver excellent research and inspiring, research-based teaching for the benefit of society. At the same time, our culture is characterised by openness, helpfulness, and responsibility. We maintain an informal tone and treat each other with respect and professionalism.

Student Life at BMB

Students are a central part of everyday life at the department. We emphasise that students thrive, both academically and socially, and experience a strong sense of belonging to their programme and peers.

The transition from upper secondary school to university can be significant, and we actively work to create a safe and motivating start to the programme. The student association, Cellebiologisk Forening Odense (CFO), and many engaged students contribute to a strong academic and social community.

Faculty members and senior students help new students settle into their studies and study groups, ensuring they feel prepared for the demanding, but also inspiring, academic development that university education entails.

Research and Innovation

Research at BMB is organised into five sections, which together cover key areas within biochemistry, molecular biology, and biomedicine. On the following pages, the sections present their research areas and provide insight into their work on understanding the molecular mechanisms of life.

The department's research also forms the foundation for innovation and collaboration with companies and other external partners. On the final pages of this brochure, we present examples of how research at BMB is translated into solutions, collaborations, and activities in partnership with industry.





Biomedical Mass Spectrometry and Systems Biology



What Sets Us Apart?

We develop and apply advanced mass spectrometry, omics technologies, and bioinformatics to understand biological systems, ranging from proteins, metabolites, and lipids to the molecular mechanisms that govern cells and tissues in health and disease.





Cambridge professor Stephen Oliver said at the beginning of the new millennium that "Odense is to proteomics what Nashville is to country music." The comparison still holds true: in the Section of Biomedical Mass Spectrometry and Systems Biology, we push the boundaries of what modern proteomics can do.

Proteomics is a branch of molecular biology that studies proteins, the building blocks of life. Our primary technique is mass spectrometry. With it, we can both zoom in to reveal how individual proteins are built and how they change, and zoom out to map how thousands of proteins vary in abundance, are activated or inactivated, or move around within the cell, and increasingly how these molecular networks operate in complex biological systems such as brain and liver organoids.

Our research spans a broad range. Some of us work with the "microscope" aimed at proteins' dynamic structure and the composition of protein complexes: how small molecular changes can alter their three-dimensional structure and thus their function. Such changes are often chemical modifications of proteins. Using methods we have developed and refined, we can identify both the type and the location of thousands of such modifications across large sample sets.

We use these enormous datasets to draw detailed pictures of biology in action: how cells function, and what goes wrong in diseases such as diabetes, Parkinson's disease, and schizophrenia; why cells break away from their normal regulation and develop cancer; how the cell's centrosome, an essential structure for cell division and organisation, is regulated; and how environmental stressors such as air pollution and noise influence cellular signalling and human health.

To make sense of these volumes of data, we combine advanced measurements with bioinformatic analyses and the latest AI tools. Computational power helps us detect patterns and connections that would otherwise remain hidden, and we achieve the most through close collaboration across disciplines. Interdisciplinarity is essential when the goal is to understand complex biological systems.

Method development has always been a driving force for us, and techniques developed here are now used globally. At the same time, we continue expanding the toolbox: we explore negative ion-mass spectrometry and map lipids and other metabolites, thereby shedding light on how they influence the body's balance.

For us, it is often the pursuit of the "impossible" that leads to the biggest breakthroughs. This open and ambitious approach gives graduates a strong starting point, both in academia and in the thriving biotech industry. Mass spectrometry has long been a beacon at the Department of Biochemistry and Molecular Biology at SDU, and with the newest instruments, collaborations with leading companies, and strong funding support, the future looks both bright and exciting.

Functional Genomics & Metabolism



Research in Functional Genomics & Metabolism focuses on the molecular mechanisms that regulate gene activity and metabolism during the development of obesity, liver disease, cancer, and diabetes.

In the Functional Genomics & Metabolism research section, we work to understand how specific cell types regulate the activity of their genes. We investigate how this affects cellular properties and contributes to the function of disease-relevant organs such as the liver and adipose tissue.

We also examine how cells in these organs communicate with each other and analyse the signalling pathways that regulate their interactions. In addition, we study how changes in gene activity and metabolism contribute to the development of diseases such as obesity, liver disease, cancer, and diabetes.

We use a wide range of advanced molecular biology technologies, including high-throughput DNA and RNA sequencing, to investigate how cells regulate gene activity. These analyses are performed on tissue samples, advanced mini-organs (organoids), patient-derived cells, as well as animal models and cell lines.

We then apply advanced computational models to analyse the large amounts of data generated. This allows us to understand biological complexity in detail and study precisely how cells respond to different influences. In this way, we identify new relationships between genes, cellular functions, and tissue processes in both health and disease.

With detailed knowledge of different cell types and insight into their interactions with each other and their environment, we can begin to understand even complex disease processes. This forms the foundation for developing new and more targeted treatments.



Questions

- Which molecular processes drive the development of obesity, liver disease, and cancer?
- How do genes regulate cellular function?
- How do different cell types communicate in healthy and diseased tissues?
- Why are individuals affected differently by obesity, and what role do genes play?
- How do obesity and liver disease influence the development of other chronic diseases such as cancer and neurological disorders?

Quantitative Cell Biology and Bioimaging

Using advanced microscopy, quantitative analysis, and molecular and cellular biology, we investigate how living systems are organized and function across scales, from single molecules and cells to tissues and complex model systems. Our work reveals how cells respond to stress, communicate, and change during development and disease.

A defining strength of the section is the integration of biological questions with imaging innovation and computational analysis. We develop and apply advanced imaging and spatial analysis approaches that allow us to visualize dynamic processes, molecular organization, and cellular interactions with high precision. By combining quantitative imaging with data science and multimodal data integration, we generate insights that connect molecular detail to cellular behaviour and physiological function.

Our research programs span genome stability in cancer and developmental disorders, cellular metabolism, membrane trafficking, and advanced tissue systems, as well as disease-relevant models in areas such as cancer and inflammatory skin disease. Across all projects, quantitative imaging is not only a method, but a conceptual framework that links fundamental biology to translational applications and future therapeutic strategies.



What makes us unique?

- Dynamic live-cell imaging
- Single-molecule & super-resolution microscopy
- Correlative & multimodal imaging
- Automated image analysis & machine learning
- Strong interdisciplinary synergy between biology, physics, and data science

From Image to Insight

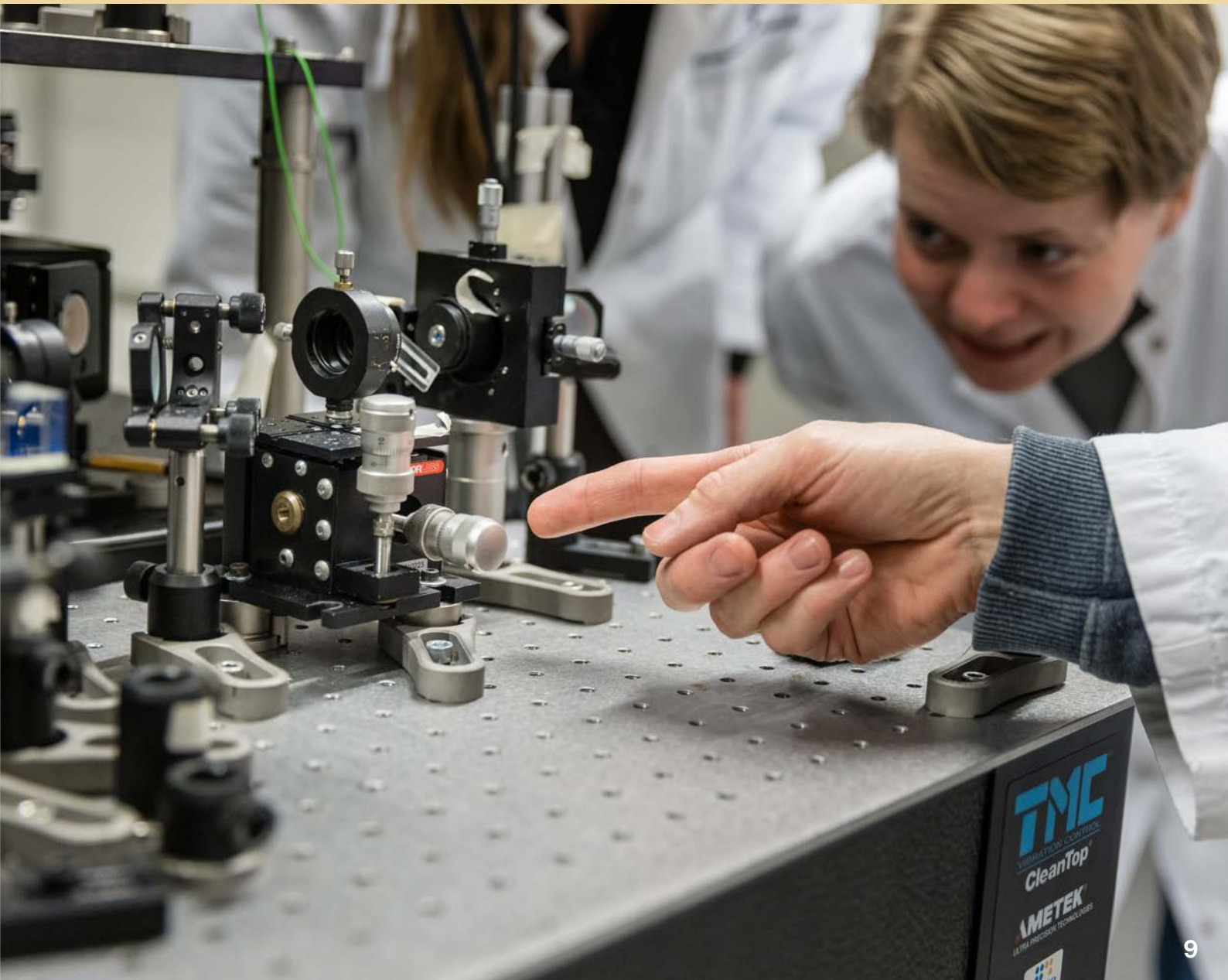
Images contain far more information than the eye can perceive. We convert images into quantitative data and biological insight through:

- Machine learning & deep learning
- Single-molecule tracking & trajectory analysis
- High-content imaging, feature extraction & classification
- Image simulations and computational modelling
- Correlative & multimodal imaging and data integration

What do we study?

- How DNA is accurately replicated during the cell cycle to protect genetic information
- Cancer biology & therapeutic opportunities
- Membrane trafficking and lipid/cholesterol biology
- Cell signalling and metabolism
- Neurodegenerative and inflammatory skin diseases
- Development of microscopy and imaging technologies
- Artificial skin, organoids, and tissue models

We place particular emphasis on dynamic processes in living cells and physiologically relevant model systems.



Molecular Microbiology

Research in Molecular Microbiology is aimed at understanding the basic molecular physiology of bacteria, with the goal of contributing to the prevention and treatment of infectious diseases.

The pathogenic bacterial species studied include *Escherichia coli* (urinary tract infections), methicillin-resistant *Staphylococcus aureus* (MRSA infections), antibiotic-resistant A*cinetobacter baumannii* (hospital-acquired pneumonia), and the foodborne *Listeria monocytogenes* (listeriosis). Research is also conducted on model bacteria such as *Caulobacter crescentus*, which has a complex life cycle, and *Thermus thermophilus*, which grows at high temperatures.

In the section, researchers, technical staff, and students collaborate in an open and dynamic working environment where knowledge, methods, and equipment are shared. The ambition is to create strong synergy between our core research areas:

- Virulence mechanisms and pathogenesis
- Interactions between host and bacteria
- Antibiotic resistance, how it arises, functions, and can be combated
- Antivirulence compounds and their mode of action
- Identification and function of RNA modifications
- Bacterial responses to environmental stress
- Polymicrobial interactions and bacterial communities
- New molecular methods for studying bacteria, including single-cell sequencing

We conduct both research and development in close collaboration with international academic and industrial partners, with a focus on both combating infections and developing bacterial-based technologies for health and environmental challenges. Through this collaboration, basic research in bacterial molecular biology is translated into innovative and societally relevant solutions, a core value of ours.



The methods we use are diverse and continuously evolving, but the following are routinely applied:

- Classical molecular microbiological techniques
- Antibiotic resistance and susceptibility assays
- Infection assays
- Next-generation sequencing (DNA and RNA sequencing)
- Studies of protein–nucleic acid interactions
- Mass spectrometry and HPLC
- High-resolution fluorescence microscopy of live cells
- High-throughput chemical screening
- Synthetic biology

The strong sense of job satisfaction and innovative drive that characterise the section stem from its diversity and collaborative environment.

When Innovation Meets Basic Research

In Molecular Microbiology, our primary focus is to understand the molecular biology of bacteria. At the same time, we translate this fundamental knowledge into innovative solutions that address real-world challenges through interdisciplinary collaboration. In partnership with researchers from the Department of Physics, Chemistry and Pharmacy at SDU, we are developing bacterial-based technologies to detect and remove microplastic particles from water.

We also host SDU student teams participating in the international synthetic biology competition iGEM. A recent spinout project from the 2023 team is developing bacterial enzymes to degrade persistent PFAS compounds ("forever chemicals") in drinking water.



Translational Biology



The Translational Biology section is driven by curiosity to understand fundamental processes in human cells in health and disease and to use this knowledge to develop improved diagnostics and treatments.

Translational Biology is a broad research section covering several aspects of human molecular biology. Our expertise spans RNA biology and cellular metabolism, including lipid and cancer metabolism, as well as studies of how cells develop and age in a disease context.

We focus on the development of precision medicine, particularly RNA-based medicine, where we characterise the effects of disease-causing mutations. We use synthetic RNA molecules and small RNA-binding compounds and investigate their therapeutic potential across a range of diseases.

An important part of our research is understanding how cancer cells develop, reprogram metabolic pathways, and acquire resistance. A key goal is to use this knowledge to improve cancer treatment. We are also particularly interested in the complex relationship between cancer and senescent cells, which can both promote and inhibit cancer.

We study metabolic regulation both at the systemic level and at the molecular level, including how lipid metabolism is influenced by genetics as well as environmental factors. In this way, we investigate disease mechanisms across conditions such as obesity, diabetes, cancer, and neurological disorders to improve diagnostics and treatment.

Part of our research is based on human cell studies, including 3D cell cultures and patient-derived material. We use CRISPR technology to edit cellular DNA, and to validate our findings in a physiological context, we use mouse models. We apply advanced techniques such as next-generation RNA sequencing to study gene expression and splicing across approximately 23,000 human genes.

We also use advanced mass spectrometry to study metabolic changes at the molecular level through metabolomics and lipidomics. In addition, single-cell microscopy and AI-based image analysis are used to track molecular effects of treatments and cellular development over time, and cell sorting using FACS allows us to characterise and isolate specific cell types. A key part of the section's research is the integration of these experimental approaches with advanced bioinformatic data analysis.





Research, Innovation and Collaboration

At the Department of Biochemistry and Molecular Biology, collaboration with companies is an integral part of our work. We translate research results into solutions that create value beyond the university, for the benefit of society, healthcare, and industry.

Through partnerships, joint projects, and spinout companies, we bring our knowledge into practical use. This also provides students and researchers with the opportunity to work at the intersection of research and practice and contribute to innovation within life science.

VitroZymes

VitroZymes develops enzyme-based solutions for the degradation of environmental pollutants, including PFAS, with a focus on applications in water purification and wastewater treatment. The company originates from student projects at the University of Southern Denmark and is based on biotechnological research in microorganisms and enzymes.

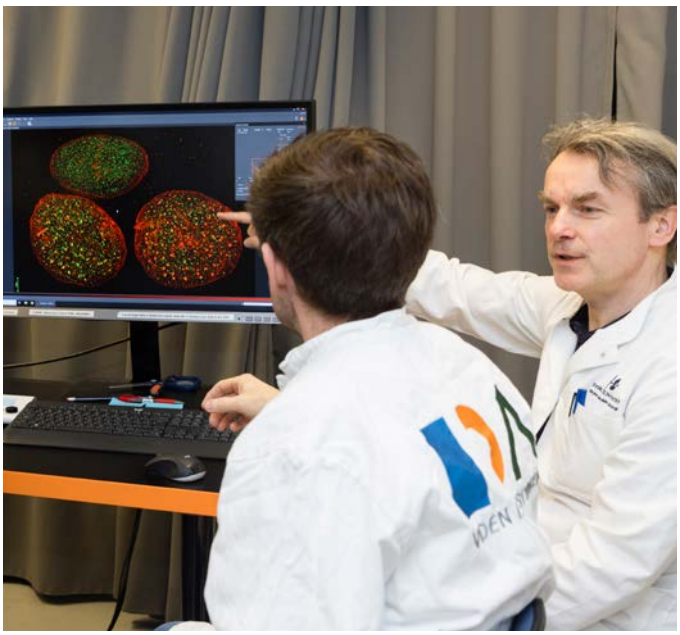
VitroZymes is an example of how ideas from the laboratory can develop into solutions with the potential to address global environmental challenges.

Inverna Therapeutics

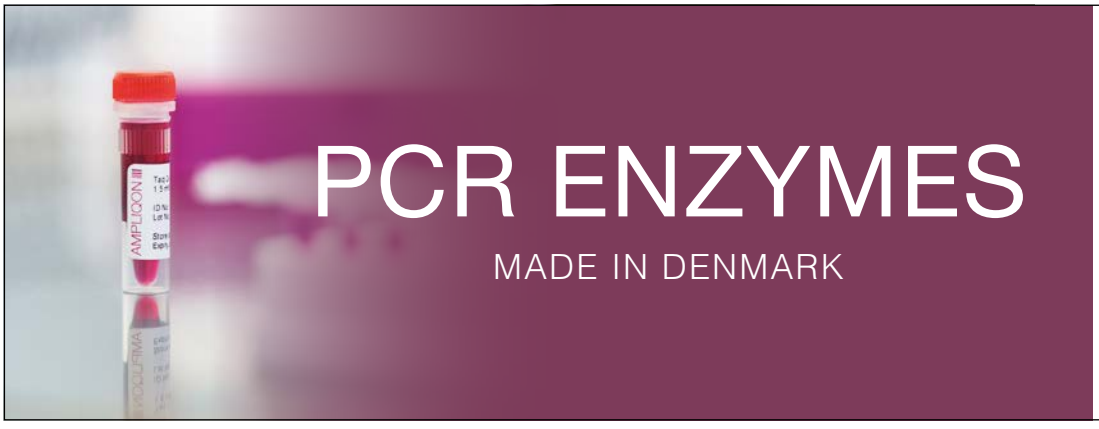
Inverna Therapeutics develops RNA-based medicines focused on genetic diseases. The company originates from the research environment at BMB, Translational Biology.

GlyProVac

GlyProVac develops vaccines against bacterial infections with a focus on combating antibiotic resistance. The company builds on research into bacterial protein modifications and develops new vaccine solutions based on its own technology.







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Programmes at the Department of Biochemistry and Molecular Biology

Bachelor's Programmes
- **Biochemistry and Molecular Biology**
- **Biomedicine**

Master's Programmes
- **Biochemistry and Molecular Biology**
- **Biomedicine**
- **Computational Biomedicine**

Biochemistry and Molecular Biology
Do you want to uncover the deepest secrets of the cell?

In the Biochemistry and Molecular Biology programme, you will learn about cell structure, genetics, the translation of DNA into proteins, and protein structure and function. You will use advanced analytical techniques, such as DNA sequencing, to gain new insights into how cells function. If you were interested in biotechnology or chemistry in upper secondary school, this may be the right programme for you.

Biomedicine
Do you want to help cure the diseases of the future?

As a biomedicine student, you will explore the human body. You will learn to understand diseases such as cancer, diabetes, and Alzheimer's at the molecular, cellular, and physiological levels, and build an important bridge between natural science and medicine.

Computational Biomedicine
Do you want to find the biological needle in the haystack?

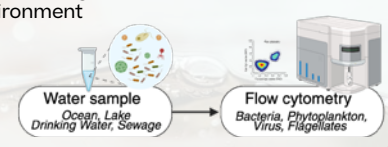
In this English-language master's programme, you will gain deeper insight into the body's functions and diseases while learning computational methods for handling large datasets in biomedicine and biology, including omics approaches. Omics refers to methods that analyse large amounts of biological molecules, such as proteomics, genomics, and metabolomics.

Career Opportunities
There are strong employment opportunities for graduates with a degree in natural sciences. At the Department of Biochemistry and Molecular Biology, we place great emphasis on preparing students for the job market, whether in research, industry, hospitals, education, public administration, or other sectors.

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