UiO : Faculty of Mathematics and Natural Sciences
University of Oslo

Thematic Research Initiatives within Life Sciences

The Faculty of Mathematics and Natural Sciences

INTRODUCTION

UiO:Life Science is the largest priority area in the history of the University of Oslo (UiO), closely associated to the construction of Norway's largest research building. The Life Science Building will be a significant aspect of the priority area of life sciences, as described in the UiO strategy for the life sciences. Interdisciplinary integration across academic environments is a key element of the life sciences initiative, with a stated vision of convergence.

The Vice-Rector has commissioned a report from the Faculty of Medicine (MED), Faculty of Dentistry and the Faculty of Mathematics and Natural Sciences (MN), related to professional development towards the Life Sciences Building, with mapping and recommendations of the thematic research areas within life science. The future work will include development of the activities that will be moving to the Life Sciences Building in 2024. An overall goal of the present process is a unified recommendation for the entire UiO.

Future professional activity in the building will include following existing activities:

- The Department of Pharmacy (MN)
- The Department of Chemistry (MN)
- The Norwegian Center for Molecular Medicine – NCMM (MED in collaboration with MN)

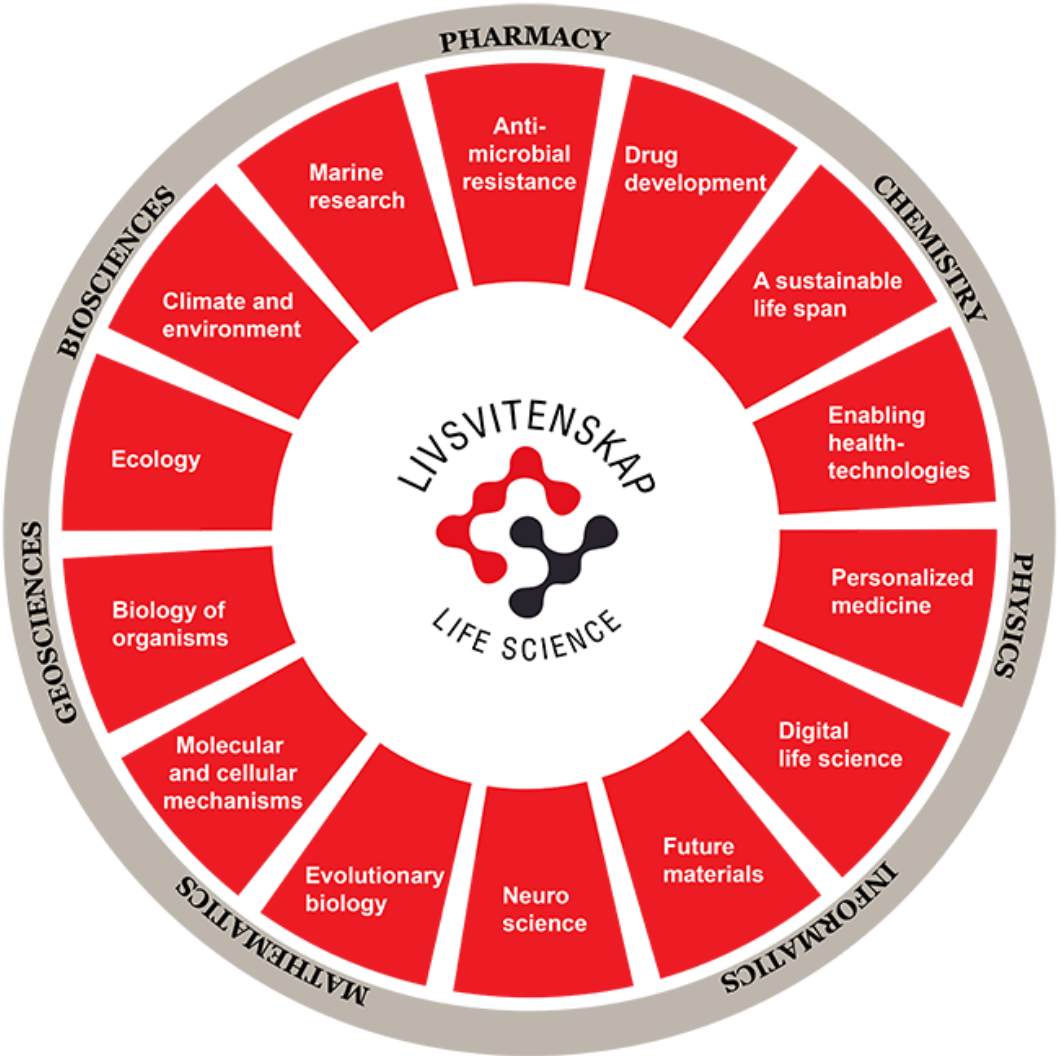
Activities under development for allocation in the free research areas of the Life Science Building include:

- Computational Life Science (incl. Center for Bioinformatics (CBI) at MN and Oslo Center for Biostatistics and Epidemiology (OCBE) at MED)
- Upcoming centers of excellence and innovation (CoE and CRI, respectively)
- Technology-heavy, cutting-edge environments and interdisciplinary research groups linked to core facilities in the building

An important premise for MN is that majority of Faculty's life science activities will be taking place outside the Life Sciences Building. The Department of Biosciences will not move into the new building. Furthermore, life sciences-related research and education takes place at the Departments of Informatics, Mathematics and Physics. Moreover, the Department of Geosciences participates in a multidisciplinary center for climate and environment. It has therefore been crucial for MN to include the entire field of life sciences at the Faculty in the process. The aim has been to develop thematic areas representing the breadth of the Faculty's activities within life sciences, pointing to future priorities.

All departments at the Faculty that have activities within life sciences have been involved in the process, which was led by Faculty's research dean and driven forward by contributions from the management and academic environments at the Department of Pharmacy, the Department of Chemistry and the Department of Biosciences. We have worked closely with UiO:Life Science, the Faculty of Medicine and the Faculty of Dentistry, and have also involved other faculties at the University of Oslo and the Centre for Gender Research in the process.

Blindern, December 2019
Solveig Kristensen, research dean MN, leader
Henrik Schultz, head of the Department of Pharmacy
Rein Aasland, head of the Department of Biosciences
Jo Døhl, head of the Department of Chemistry (until October 31.th 2019)
Einar Uggerud, head of the Department of Chemistry (from November 1.th 2019)
Odd Stokke Gabrielsen, professor at the Department of Biosciences
Nataša Nikolić, advisor, secretary


PHARMACY
CHEMISTRY
PHYSICS
INFORMATICS
MATHEMATICS
GEOSCIENCES
BIOSCIENCES
Anti-microbial resistance
Drug development
A sustainable life span
Enabling health-technologies
Personalized medicine
Digital life science
Future materials
Neuro science
Evolutionary biology
Molecular and cellular mechanisms
Biology of organisms
Ecology
Climate and environment
Marine research
LIVSVITENSKAP
LIFE SCIENCE

BACKGROUND

The Faculty of Mathematics and Natural Sciences (MN) is a steward of a long-standing tradition of knowledge built on collegial values and free, independent research. The cornerstone of the Faculty's activities comprises basic long-term research on mathematical and natural sciences and technology.

In mathematics, natural sciences and technology, as well as in the professional pharmacy program, the Faculty has many communities that deliver research results at a high international level. The employees and students are divided across nine departments and the Norwegian Center for Science Education. *Life sciences* is one of four thematic initiatives at the Faculty, the other three initiatives are *Earth and space sciences*, *Energy and materials sciences* and *Digitalisation and computational science* (Fig. 1).

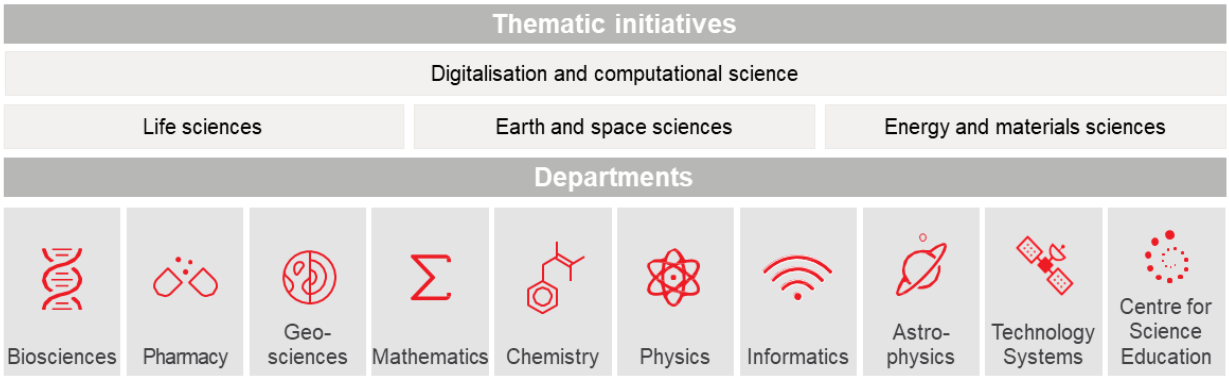


Figure 1. Thematic initiatives and departments at MN. The Faculty has programs of study at the bachelor's and master's levels covering the entire breadth of mathematics, natural sciences and technology, a five-year professional pharmacy program, and a program for educating secondary school teachers in mathematics and natural sciences. There are 6000 bachelor students and 800 doctoral students, in addition to 2000 employees at MN. The Faculty is hosting three Centers of Excellence (CoE), one Center for Research-based Innovation (CRI) and one Center of Excellent Education.

The Faculty's strategy from January 2019 - *Knowledge development in a changing world,* describes life sciences as followed:

"*Life sciences are all about understanding the make-up, structure and function of living organisms, and how living organisms mutually affect each other and interact with their environments. Life sciences are of key importance for enabling society to meet major challenges in respect of health, food, climate and the environment. The Faculty's focus on life sciences represents a large and important part of UiO:Life Science, which is a large interdisciplinary initiative to enhance the level of quality and interaction in research, education and innovation life sciences across the various units at the University of Oslo.*"

Two of Faculty's departments have life sciences as their main activity: Department of Biosciences and Department of Pharmacy. Research activity at all departments, with the exception of the

Department of Theoretical Astrophysics and the Department of Technology Systems, embraces life sciences to some extent.

Research at MN contributes developing international knowledge base that is necessary to achieve many of the UN's sustainability goals (Fig. 2). Graduate students at MN are a crucial resource the community needs to steer development in a sustainable direction. Within the field of life sciences, MN contributes to research and education that directly includes sustainability goals 3 Good health, 6 Clean water and sanitation, 13 Climate action, 14 Life below water, 15 Life on land, with further influence on most of the other goals. This important aspect should be underlined as the field of life sciences at UiO is being strategically lifted through thematic areas and initiatives.

Figure 2. UN's sustainability goals (attend.com).

UiO represents a national center of knowledge within both human and biological understanding of life. MN has a particular strength within basic, experimental, natural and computational sciences. This constitutes a driving force for an interdisciplinary approach to complex issues within the breadth of the life sciences field. Several environments at MN combine basic biological / mechanistic research with metrics, and close collaboration has been established between researchers in various academic environments at MN. Furthermore, there is extensive established collaboration between researchers at MN and MED, the Faculty of Dentistry and Oslo University Hospital (OUH). Potential for further synergies with these, and other academic environments at UiO, including researchers at the faculties of Humanities, Law, Social Sciences, Educational Sciences, and to a certain extent also the Faculty of Theology and Center for Gender Research, is however great and not explored to its full potential. Some of the collaboration possibilities available across UiO are outlined further in the document.

The Life Sciences Building will facilitate realization of UiO's ambitions within the field of life sciences as described in the strategy, where interdisciplinary approach and stated vision of convergence are key elements. In 2024, the Depts. of Pharmacy and Chemistry will move to the new building, which will set the premises for the activity throughout the building. Although the Life Sciences Strategy was developed in parallel with the planning of the new building, it embraces all life sciences at UiO. An overall goal is that many academic environments at UiO will contribute and benefit from facilities and offers in the building, extending far beyond the professional environments that will be moving in. It is a fact that majority of the life science activities at UiO and MN will be taking place outside the Life Science Building, with main emphasis on the environments at UiO's two health faculties MED and Dentistry, but also the Dep. of Biosciences at MN and Natural History Museum. In order to succeed with the Life Science Strategy, it is a prerequisite that the Life Science Building develops into a benefit for the life science activities at the entire UiO. This involves, among other things, exploiting the great potential that lies in creating synergies; between activities within the new building as well as within other buildings with extensive life science activities, such as Kristine Bonnevie's house at MN, and at other faculties. This relies on synergies between synergies at various sites.

Life Sciences Building is expected to have major national and regional impact. Connection to the innovation district of Oslo Science City is central in this context, with the ambition that "research communities, commercial community, the public, students and hospitals will empower each other and work more efficiently to apply knowledge and create sustainable solutions for the future". UiO is a partner and the Life Sciences Building is located in the heart of this innovation district, in close proximity to the National Hospital / OUH. This offers unique opportunities for the future.

THEMATIC RESEARCH AREAS WITHIN LIFE SCIENCE AT MN

Based on the inputs from the departments, MN presents 14 thematic areas of life sciences at the Faculty (Figure 3). Table 1 shows the thematic areas at the strategic level. These will form the basis for future priorities at MN and UiO, and will facilitate good communication with the outside world. To prevent a static situation related to the development of the life sciences field at MN, the Faculty will conduct an annual review of the selected thematic areas and this document.

Figure 3. Thematic research areas within life sciences at the Faculty of Mathematics and Natural Sciences

Table 1. ***Thematic research areas within life sciences at the Faculty of Mathematics and Natural Sciences – strategic level***

1. ANTIMICROBIAL RESISTANCE *Interdisciplinary approaches for combating an emerging global crisis*	**8. NEUROSCIENCE** *From synapse to brain*
2. DRUG DEVELOPMENT *Novel approaches for diagnostics, therapy and vaccines*	**9. EVOLUTIONARY BIOLOGY** *The origin of life*
3. A SUSTAINABLE LIFE SPAN *Prevention and treatment from cradle to grave*	**10. MOLECULAR AND CELLULAR MECHANISMS** *The machinery of life*
4. ENABLING HEALTH-TECHNOLOGIES *For health challenges of the future*	**11. BIOLOGY OF ORGANISMS** *From molecules to organisms*
5. PERSONALIZED MEDICINE *Targeted diagnostics, treatment and follow-up*	**12. ECOLOGY** *Interplay among organisms in nature*
6. DIGITAL LIFE SCIENCE *Interdisciplinary solutions to complex problems*	**13. CLIMATE AND ENVIRONMENT** *Interdisciplinary solutions to pollution and climate crisis*
7. FUTURE MATERIALS *For tomorrow's health- and climate changes*	**14. MARINE RESEARCH** *Providing knowledge for a healthy ocean*

The 14 thematic areas cover the entire field of life sciences at MN and thus include research that will be taking place inside- and outside of the Life Science Building. Research field of life sciences at MN is based on a strong collaboration between disciplines including biology, molecular biology,

physics, chemistry, mathematics, computer science and geosciences; the health profession of pharmacy, as well as other health professions as medicine, dentistry, psychology and nutrition. Of the 14 thematic areas of life sciences at MN, following 7 will be fully or partially physically represented by research environments that are planned to be moved into the Life Sciences Building:

- Antimicrobial resistance
- Drug development
- A sustainable life span
- Enabling health-technologies
- Personalized medicine
- Digital life science
- Future materials

During further discussion on the thematic areas, we include core facilities that are planned into the building. In this context, we also refer to the preparation of UiO's Roadmap for Infrastructure in Life sciences, which will be an important basis for prioritizing investments and applications for infrastructure in the years ahead. The description that follows includes the operational level for each thematic area, which mainly represents the underlying subject areas. However, these are not limited to the specific thematic areas as there is a large degree of collaboration and overlap in thematic and technology between several of the areas. The description within each area is not intended to be complementary, but rather reflective of important current activity.

1. ANTIMICROBIAL RESISTANCE

Interdisciplinary approaches for combating an emerging global crisis

Antimicrobial resistance is a fundamental threat to global health, affecting several key areas of modern medicine. Solution to this highly relevant problem demands an interdisciplinary, integrated approach from a range of disciplines including medicine, pharmacy, biology, chemistry, statistics, psychology, law, economics, simulation and computational and digital sciences. Expected impact is high, including reduced morbidity and mortality, and reduction of healthcare-related costs in a population with an increasing life expectancy.

Infection biology
Microbiology
Biofilm
Drug formulation

Research within this field is broad, ranging from evolution, molecular and cellular mechanisms of microorganisms' action, to their interactions within populations and drug development. Global, digital systems for surveillance of antimicrobial resistance in bacteria, animals and environment is an important aspect of modern research within this field, in accordance with the "One Health" principle.

Antimicrobial resistance is a focus of research at the Dep. of Pharmacy. Relevant topics include synthesis of new compounds, diagnostics and development of novel formulation principles for controlled and targeted drug release, and modulation of drug accessibility at the infection site. The department's collaboration within this area is broad, including Faculty of Dentistry, Nordic Institute of Dental Materials and Norwegian University of Life Sciences. Natural Deep Eutectic Solvents – the "NADES"-project initiative at the Dep. of Pharmacy, is currently applying for funding to support further commercial development. Nanoparticle packaging of drugs is an important task, which, in addition to pharmacy, involves organic-, polymer- and peptide chemistry. Dep. of Chemistry has an ongoing collaboration within this field with the NCMM.

All use of antibiotics contributes to resistance development. Optimal use and appropriate drug handling within both human and veterinarian medicine are important at individual- and population level. In accordance to the "One Health" principle, fish medicine is an important research area at the Dep. of Pharmacy, focusing on the development of fish vaccine (funded by the Research Council of Norway (RCN) via FORNY). Centre for Disease and Ecology and Evolution at the Dep. of Biosciences integrates ecology and evolution as a basis of understanding the epidemics and transferrable diseases. The center will be applying for a CoE at next call. Researchers at the Dep. of Informatics have developed a District Health System (DHIS2), one of UiO's biggest international successes. With a recently developed app for registration of antimicrobial resistance data, the system has revolutionized health information accessibility in many of world's most underdeveloped countries. Covering 2.28 billion people, the WHO appointed the Dep. of Informatics an official collaboration center. Future success in combating antimicrobial resistance will depend on strong collaboration and commitment of several external partners in Norway - National Institute of Public Health, OUH, Hospital Pharmacies, Norwegian Medicinal Agency and the Norwegian Cancer Society. Infrastructure within this topic includes Zebrafish Core Facility UiO (NCMM), Mass spectrometry laboratory, UiO Structural Biology Core Facilities and Life Science Electron Microscopy Consortium.

2. DRUG DEVELOPMENT

Novel approaches to diagnostics, therapy and vaccine

Relying on close interaction between natural sciences and pharmaceutical technology, drug-related research creates convergence and forms the basis for a technology-based value creation. This area of research is essential for developing efficient prevention, diagnostics and treatment of diseases.

Drug synthesis

Synthesis method development

Drug formulation

Drug production

Drug analysis

Vaccine development

Immunology

Biomaterials

Bio-nano technology

3D-drug printing

PET and radiopharmaceuticals

MN contributes significantly to research within all aspects of drug development – from synthesis and basic mechanisms of action to formulations. Whereas drug-related research and education are primary activities of the Dep. of Pharmacy; chemistry, biology and physics are highly relevant disciplines, with an increasing need for mathematics and bioinformatics. 3D-drug printing is a rapidly developing research area, well represented by a large Nordic collaboration project, partially financed by NordForsk – "Nordisk Pop", which includes 10 Nordic and 5 universities from the Easter Sea region, opening up for new possibilities for international grant applications and development. Light-activated drug formulations for treatment of bacterial infections and cancer is a collaboration project involving researchers from Dep. of Pharmacy, OUH, NOFIMA, NIOM, NORILIA and IFE. Innovation projects within fish vaccine development are important areas of research at the Dep. of Pharmacy involving industrial partners. Drug analysis is a highly perspective field of research, particularly considering future diagnostics as a part of external grant applications. Dep. of Pharmacy has recently received a grant from RCN within this field, and application for an ERC-advanced grant is under preparation. Gastrointestinal research is prioritized via UiO:Life science changing environment with both Dep. of Pharmacy, NHM, MED and other faculties as participants. Dep. of Physics has, in collaboration with Bayer and Norsk medisinsk syklotronsenter (NMS), applied for a CRI. Positron emission tomography (PET)-related research should be prioritized and strengthened in Oslo-region. Radiopharmaceutical chemistry constitutes an important part of this research, where UiO has a strategic advantage in housing a strong PET-environment, access to cyclotron at the Dep. of Physics and collaboration with both NMS and IFE (radiopharmacy). PET is translational research ranging from molecules to humans; from chemical synthesis to clinical testing, implying participation from several departments (Chemistry, Pharmacy, Physics, Informatics), faculties (MED), clinics (OUH) and companies (NMS). Current processes aim to increase collaboration and maximize exploitation, financing and sustainable drive of expensive instrumentation and infrastructure. This includes *in vivo* rodent facilities and establishment of PET-scanners, preferably at *in vivo* laboratories at MED. Potential for innovation and collaboration with established pharmaceutical industry, small biotech-companies and research institutions is great within this area of research. Other examples of potential partners, in addition to the above-mentioned, are GE Healthcare, Photocure, PCI Biotech and others.

3. A SUSTAINABLE LIFE SPAN

Prevention and treatment from cradle to grave

Many of today's global and national health challenges are related to lifestyle, age, gender, environmental impact and genetics. Degenerative, metabolic, oral and digestive conditions, mental disorders and cancer are examples of conditions falling into this category. These conditions all represent a great bourdon to both individuals and the society. Research within this field aims to contribute to healthy development and aging, both nationally and globally, with an emphasis on implementation of user participation from research to clinical practice.

Lifestyle- and age-related disorders

Pharmacology

Pharmacodynamics

Pharmacokinetics

Pharmacoepidemiology

Immunology

Clinical pharmacy

Social pharmacy

Epigenetics

Common goal of research on prevention, treatment and follow-up of diseases at different stages of life - from cradle to grave, is to find measurable benefits for good health and increased quality of life. Fundamental understanding of the molecular background of the disease is the basis of efficient prevention and treatment. Mapping of safety and efficacy of drug use at individual and societal level are key elements, which in turn rely on large-scale analyzes of national and international individual-based health registries and databases, linked to biological and patient-generated data.

Interdisciplinary work within this field is substantial, as exemplified by the Faculty's changing environment PharmaTox, involving researchers from Deps. of Pharmacy, Biosciences, Mathematics and Informatics. The environment has an ERC StG and an established collaboration with many external national and international partners - hospitals, government agencies and other faculties and universities. Emphasis is on medications prescribed during pregnancy and potential role in development of neurodevelopmental disorders. The environment will apply for a CoE at the next call. Brain plasticity, related to both drug use and environmental factors (e.g. exercise and exposure to toxins), is an important research area within pharmacology. Clinical pharmacy is a relatively new, yet rapidly growing field of study at UiO. Quality assured drug use, improved quality of life and fewer drug-related problems are common goals of this socially relevant research field. Dep. of Pharmacy has an increasing external portfolio, making it an attractive collaboration partner. As a part of the innovation initiative at MN, the department was awarded with two PhD fellowship positions through a collaboration project with the British-Swedish pharmaceutical company, Astra Zeneca (AZ). The department is also coordinator in a recently submitted CRI application with partners from AZ, OUH, The Morbid Obesity Center Vestfold Hospital, NTNU, and four smaller entrepreneurial companies. The goal of collaboration between industry and academia is to shorten the path from basic research to drug development fighting diabetes and obesity, which are growing public diseases. Life Science Electron Microscopy Consortium, High Throughput Chemical Biology Platform, Mass Spectrometric Joint Laboratory, UiO Structural Biology Core Facilities and Nuclear Facility for Bioinformatics (BCF) / Elixir help desk UiO are among important core facilities.

4. ENABLING HEALTH-TECHNOLOGIES

For health challenges of the future

Innovative health technology is based on interdisciplinary basic research and scientific knowledge. It includes innovative development and applications of technologies, equipment and methods to solve health problems and improve quality of life. An aging population and an increase in lifestyle diseases are major challenges in today's and future health care systems, which require increased focus on new health-technology solutions.

Biotechnology

Medical technology and intstrumentation

Medical imaging diagnostics

Medical physics

Artificial intelligence

Robotics

3D-drug printing and helping devices

Research in innovative technology spans from development of ready-to-use technology to individual components or scientific principles for application in future health technology. The faculty focuses on research within basic physical processes of life forms, diagnostics and therapeutic applications in medicine, and the development of biomaterials, medicinal instrumentation and technology. Research within health-technology is conducted in many disciplines, including informatics, physics, chemistry and pharmacy, through both internal- and external collaboration with the health care system and commercial partners.

Enabling technologies open possibilities to recreate different processes in the body and test how it responds to medical influence. The Center for Bio Hybrid Technology is a CoE that brings together researchers from MED and MN (Deps. Of Chemistry and Physics) aiming to develop "organ on chip". Proton therapy is a new form of radiotherapy and is a major life science initiative with the construction of the new Proton Therapy Center at Radiumhospitalet 2023/2024. Department of Physics and OUH are heavily involved with established research activity in proton therapy, aiming to improve cancer treatment with fewer side effects for more patients. An application for a CoE at the next call has been initiated.

Oslo Bioimpedance and Medical Technology Group is a collaboration between the Dep. of Physics and OUH, with long experience in medical sensor technology. The environment has a well-established interdisciplinary collaboration with researchers at the Deps. Of Pharmacy and Chemistry through the changing environment Diatech and Dep. of Informatics, as well as the Intervention Center at OUH and a number of companies. The environment has furthermore several patents and has received UiO's and Inven2's innovation awards. At the Dep. of Informatics, research is conducted on robotics and systems that include artificial intelligence in smartphone for customized and automated treatment for mental disorders, as well as artificial intelligence and user experience as part of multi-sensor care systems for the elderly (project funded by RCN). «Analysis on chip» is also a central area for the field of drug analysis at the Dep. of Pharmacy, which is supported by the RCN.

The research activity in this thematic area will support UiO Structural Biology Core Facilities and Mass Spectrometric Common Laboratory, especially with regard to drug analysis.

5. PERSONALIZED MEDICINE

Targeted diagnostics, treatment and follow-up

Through the National Strategy for Personalized Medicine in the Health Service, the authorities are placing a spotlight on a paradigm shift in medicine, from the perception of the "average patient" and "One drug fits all" principle, to personalized prevention, diagnostics, treatment and follow-up, based on individual biological conditions.

Genetics

Chemical biology

System biology

Pharmacogenomics

Pharmacokinetics

Proteomics

Metabolomics

Drug analysis

Drug formulations

The term "personalized medicine" has previously mainly referred to genomics. Strong research environment at the Dep. of Pharmacy have advanced in this particular field of clinical treatment. In the future, personalized medicine will be focused on targeted, individually-adjusted treatment, understanding of genetically-based treatment responses (pharmacogenomics), novel use of existing drugs ("drug repurposing") and implementation of new technologies in clinical practice. At the international level, first cases of drugs developed for individual treatment are being reported. Progression within this field requires new technological production solutions which will enable production based on individual needs, such as 3D-printed drugs.

Research on personalized medicine extends widely, from molecular data to clinical parameters for the individual patient, where information on lifestyle and environmental impact is essential. Multidisciplinary research is central, and MN houses a broad range of researchers with key competencies in systems biology, pharmacy, chemical biology, and computation-oriented subjects (bioinformatics, biostatistics and biomathematics). Interaction potential with NCMM and other environments at MED and OUH is great. Socially relevant effects of this thematic area are improved patient care, shorter hospital stays and reduced costs in the health care system. Clinical Pharmacy is a rapidly developing area with representatives from the Regional Health Authorities and collaboration possibilities with clinics. Regulatory pharmacy is a new focus area at the Dep. of Pharmacy, intended to strengthen Faculty's connection to clinical trials in Norway, increase regulatory competence related to registration of advanced products and develop various forms of patient services for Norwegian companies. Realization of the great potential that lies within the field of personalized medicine requires an interdisciplinary approach from innovative health-technology and large-scale analyzes that provide information on genomics, proteomics, metabolomics and biomarker levels. Unique access to national individual health registers in Norway, combined with the development of mathematical, predictive models and new digital tools will be crucial elements. Digitalization and e-health open up new opportunities within electronic decision support systems, mobile applications and portable devices (patient-generated data). Deps. of Informatics and Mathematics are attractive partners in this field. Important core facilities are Mass Spectrometric Joint Laboratory, Life Science Electron Microscopy Consortium and Core Facility for Bioinformatics (BCF) / ELIXIR help desk UiO.

6. DIGITAL LIFE SCIENCE

For interdisciplinary solutions to complex problems

Digitalization is an important driver of convergence between disciplines. With increasing complexity in the experimental measurements, there is also a growing need for new analytical methods and models. Computational science is becoming an increasingly important part of the modern life science research.

Bioinformatics

Image representation

Bio modelling

Biostatistics

Integrated computational- and experimental neuroscience

System biology

eHealth

Digital science is a strategic focus area at MN, both as a methodological research and as a tool for solving complex scientific problems. Large biological data sets are generated and collected at increasing rate. Expertise from mathematics, physics, bioinformatics and biostatistics is required to add socially relevant value to these data. The Center for Bioinformatics (CBI) was initiated and established by MN to strengthen research within bioinformatics and have a broad profile towards UiO's researchers, as well as external partners. Center for Digital Life Norway is a national center where MN is an active partner represented by the Dep. of Biosciences. MN houses some of the country's and the world's foremost environments within computational science. The Hylleraas Center for Quantum Molecular Sciences is a CoE in collaboration with UiT, where the Dep. of Chemistry is a host. This is one of only three research environments in Norway that have been awarded two subsequent CoEs. At Hylleraas Center, World's leading scientists in quantum chemistry are developing new computational methods to understand and control complex biological, chemical and physical systems under extreme conditions. Research at the Hylleraas Center has a clear link to other strategic initiatives within computational science, including the establishment of a center for "data science and computational science" across the departments at MN. In addition to developing methods for managing and analyzing data, the center will develop domain-specific platforms for handling large complex data sets. Physics-based modeling provides deeper insights into experimental analyzes, and is part of a well-established interdisciplinary collaboration within experimental life sciences in changing environment that will apply CoE at the next call.

Digital technology offers untapped opportunities to achieve health policy goals of better quality, increased patient safety, more efficiency and better use of resources. According to the National eHealth Strategy, eHealth will provide citizens with user-friendly services that can simplify meeting with the health care system. The e-health solutions will help to prevent and manage disease, relieve the health care system, increase safety and efficiency and make data more accessible for research and quality assurance. E-health is a research area that is developing within community pharmacy, with great potential for collaboration with, among others, clinical medicine, OUH and the hospital pharmacies, and with a natural link to research environments at the Dep. of Informatics. Relevant facility is Core Facility for Bioinformatics (BCF) / ELIXIR help desk UiO.

7. FUTURE MATERIALS

For tomorrow's life science

Today's research and tomorrow's medicine depend on understanding and using materials in the interfaces between chemistry, biology and medicine. Development of the material science of the future requires a basic understanding of interactions between solids, nanoparticles and biological systems, and ranges from biomolecules and cells to nanoparticles and implants.

Materials for energy purposes and catalysis

Biomaterials and bio - adhesion

Catalysis and enzymology

Bio-nanoparticles

Natural and synthetic cell membranes

Life sciences-relevant materials include inorganic, organic-inorganic hybrid and biomaterials. Future development in materials science requires advanced capabilities in synthesis, characterization and modeling, and requires collaboration with users in medicine, pharmacy and dentistry. MN has high and broad professional expertise within material development. Research groups within electrochemistry, inorganic materials chemistry and catalysis at the Center for Materials Sciences and Nanotechnology (SMN) focus on renewable energy, with high scientific productivity and degree of external funding (EU's Synergy Grant). The research at SMN is considered world leading, and although the focus is on basic research, the goal is that SMN will be an important contributor to innovation and value creation in Norway.

Inorganic materials are finding applications in biology and health, where inorganic nanoparticles targeting biological systems are a major interdisciplinary field. Understanding the interactions between biological systems where these meet solids and nanoparticles is central to the convergent material science of the future at the interface between chemistry, physics, biology, pharmacy and medicine. Regenerative cell growth, antibacterial purposes, medical nanomaterials, biosensors and biocompatibility with focus on implant use, as well as materials for 3D printing of drugs, are all examples of relevant areas with great interdisciplinary collaboration potential.

Chemical life sciences at the Dep. of Chemistry gather significant resources in biological structural chemistry, bioassay and bio-inspired materials, and are associated with NCMM through two strategic group leadership positions in the manipulation and mobility of artificial cell structures and interactions with surfaces, as well as interactions between DNA and regulating proteins. This cooperation is expected to increase the developmental potential and facilitate possible long-term recruitment.

The activity within this field will build on RECX national infrastructure for X-ray diffraction and scattering, UiO Structural Biology Core Facilities and Life Science Electron Microscopy Consortium, which are several of the core facilities planned in the Life Sciences Building. SMN is UiO's user of MiNaLab (today's laboratory facility for nanotechnology). The environment needs the planned bio-nano facilities to be able to develop its activity within the field of life sciences, and will be able to take responsibility for the operation of these laboratories.

8. NEUROSCIENCE

From synapse to brain

The brain is our most complex organ. Brain health determines function and activity throughout life - from fetal development to old age. Understanding brain's normal behavior, development and structure is a major research challenge. Investment in neuroscience research can lead to great social value creation.

Cell biology

Neurophysiology

Bio modelling

Physics-based modelling

Integrated computational- and experimental neuroscience

Neuroscience is a large field of research with long traditions at UiO. This field attracts many talented candidates from various disciplines, and can thus be a natural bridge-builder between medical/natural sciences and humanities/social sciences at UiO. The research questions in neuroscience require an interdisciplinary approach, and the link with strong, computationally heavy environments represents a great potential that can strengthen both neuroscience and life sciences in general. Researchers at the changing environment CINPLA integrate physics with experimental biology. By combining experimental activities with calculations, researchers at CINPLA aim to solve unresolved questions within neuroscience. CINPLA has grown to be a strong environment with high success in obtaining external funding from various arenas, including the FRIPRO Research Project and Toppforsk. CINPLA's interdisciplinary profile is the only established environment in physics-based modeling and analysis in the life sciences, with close collaboration with actors in the region (MN, MED, OUH, Simula, NMBU), but also in collaboration with NTNU, industry and international partners such as UCSD, Harvard University, University of Pennsylvania, Human Brain Project, Allen Brain Institute. Several project applications are under evaluation, including the ERC CoG finalist. The RCN-funded project ICT-PLUSS, 'Bio-inspired neural networks for artificial intelligence', enables establishing a new direction in which experimental neuroscience and insight into artificial intelligence algorithms will mutually drive each other forward. The close link between calculations and experiments provides a special national and international advantage and a strength in the forthcoming plans to apply for a CoE. CINPLA has a clear ambition to become a strong international research and education environment and is the driver behind MN's Center for Excellent Education and Honors program. Neuroscience is an important research area at the Dep. of Pharmacy as well, where primary focus is identifying new drug targets for prevention and/or treatment of stroke and other neurodegenerative diseases. This is a research area with great collaboration potential with other strong researchers at UiO (see later description). The RITMO Center for Interdisciplinary Research on Rhythm, Time and Movement is a CoE center with researchers from faculties of Humanities, Social Sciences and MN. Neuroscience assumes experimental biological research activity, and CINPLA is the environment at MN that today stands out as being able to take responsibility for the rodent part of the *in vivo* facilities in the Life Sciences Building. The research activity requires co-location with computationally oriented physics. Other important core facilities are the Core Facility for Advanced Light Microscopy and the Life Science Electron Microscopy Consortium.

9. EVOLUTIONARY BIOLOGY

The origin of life

Evolution is the basis for the diversity in nature. Modern evolutionary biology research studies the interplay between evolutionary mechanisms and ecology; and how genes, genomes and epigenetics underpin evolution and ecological adaptation. Whereas the focus of macroevolution is on processes leading to origin and loss of species, microevolution is about genetic and phenotypic variation, adaptation and selection at the population and individual levels.

Genetic variation

Evolutionary genetics

Evolution and ecology

Comparative genomics

Population genomics

Evolutionary developmental biology

Phenotypical plasticity

A significant part of the research at the Dep. of Biosciences has its roots in evolutionary issues at various levels. A broad spectrum of approaches in several of the department's sections address this topic. The basic research stands as a key knowledge provider in the efforts of achieving the UN's sustainability goals; especially 14 Life under water and 15 Life on land and 3 Good health.

The Center for Ecological and Evolutionary Synthesis (CEES) was a CoE from 2007-2017 with an overall focus on the interaction between ecology and evolutionary processes. Research within this field at the Dep. of Biosciences is strong and multidisciplinary. An example is the convergence environment COMPARE (Center for comparative and evolutionary genomics), which builds on top expertise in genomics and comparative immunology, addressing basic questions about the immune system in both fish and humans. The department further houses strong professional environments working on hybridization, polyploidization and species formation in various systems such as birds and plants. This area also includes research activities within evolutionary systematics and phylogeny.

Comparative approaches and evolutionary issues are central to several other research activities at the Dep. of Biosciences, such as comparative physiology and developmental biology. Important research questions related to genotype-phenotype relationships are matter of research interest both in populations - in a broad, ecological setting - and in molecular and mechanistic studies in a number of areas, e.g. developmental biology and microbiology. This includes theme for the CEDE (Center for Epigenetics, Development and Evolution). Pathogens are found in reservoirs in the wild and can be transmitted between species causing disease and epidemics in both humans and animals. Such processes can be affected by changes in both climate and ecology. This research is important for the understanding of the origin, spread and development of infectious diseases, providing basis for the treatment-related assessments including the development of antimicrobial resistance (Thematic Area 1). The Center for Disease Ecology and Evolution (CDEE) at the Dep. of Biosciences integrates ecology and evolution as a basis for understanding how epidemics of infectious diseases occur and will apply for a CoE at the next call. Bioinformatics, evolutionary and comparative genomics, statistical methods and modeling are central to evolutionary biology. The changing environment CELS (Center for Computational Inference in Evolutionary Life Science) addresses basic evolutionary biology issues related to the phenotype-genotype paradigm using computationally oriented methods.

10. MOLECULAR AND CELLULAR MECHANISMS

The machinery of life

Basic molecular and cellular understanding is the basis of all life sciences. It is within this field that the underlying mechanisms reveal how the machinery of life works. Therefore, breakthroughs in the field have been rewarded with a large number of Nobel prizes. Underlying causes of a number of diseases can be identified at the level of mechanisms, forming the basis for new approaches to disease treatment. This represents an important part of the area's social relevance. The close link between UiO and the university hospitals provides a solid platform for driving this fundamental knowledge development within life sciences forward.

Molecular biology

Cell biology

Biochemistry

Structural biology

Gene regulation

Epigenetics

Microbiology

Biotechnology

Molecular and cellular mechanisms are the focus of research at many units at UiO. The forerunner of today's initiative, UiO: Life science, was MLS - Molecular Life Science, where this theme was central. Several of UiO's CoEs have had such mechanistic focus. This is therefore a thematic area that is particularly suitable for collaboration across units at UiO and OUH. MN has very strong environments within this area, with several of them already being a part of various strategic and interdisciplinary initiatives.

The Dep. of Biosciences is a large biological institute with broad academic coverage of research within basic biological processes and mechanisms. Research within this thematic area extends from molecular to the level of entire organism. Research is focused on the basic biochemical and molecular biological mechanisms underlying both natural, biological processes, as well as conditions of disease. Important research activities within this field include protein biochemistry, enzymology and structural biology, as well as whole-genome strategies for studying epigenetics and gene regulation. Relevant research methods include *in vitro* models, in cell cultures, but also animals and plants as model organisms. Basic mechanisms behind cancer development and regulation of body's cold and fat tolerance are examples of important and highly relevant research objectives. Cell's transport and function of vesicles and neural interaction and formation of synapsis are research areas on the cellular level. Signaling mechanisms, gene regulation and epigenetics are important both in general context, and as a part of developmental biological processes. Immunological molecular mechanisms are an important area providing the basis for new immunological technological methods. Research activity within this field has been part of a CoE: CIR (Center for Immune Regulation) from 2007-2017, with outstanding results, and has resulted in an extensive innovation and commercialization. A number of core facilities planned in the new building will be able to support research within thematic area: UiO Structural Biology Core Facilities, Mass Spectrometric Common Laboratory, Life Science Electron Microscopy Consortium, High Throughput Chemical Biology Platform and Core Facility for Bioinformatics / ELIXIR.

11. BIOLOGY OF ORGANISMS

From molecules to organisms

Biology of organisms explores function of animals, plants and microbes and adaptation of organisms to their environment at a molecular, cellular, physiological and individual level. This research is important to understand the development and function of organisms under both normal and pathological conditions.

Physiology

Immunology

Cancer biology

Genetics

Genomics

Developmental biology

Bio modelling

This thematic area explores molecules and cells in an organism context. Organisms obtained from natural populations or model organisms are kept in dedicated laboratories. Physiological and developmental biological processes are explored using methods ranging from genetics and molecular biology to cell biology and physiology. The Dep. of Biosciences uses a number of organisms in such research, including bacteria and fungi, nematodes, plants, fish and rodents. Research within comparative physiology explores adaptation of organisms to extreme environmental conditions such as anoxia, re-oxygenation and climate change. The Dep. of Biosciences has a unique vertebrate model for anoxic tolerance, and collaborates with MED, OUH and the Faculty of Theology in a UiO:3DR convergence environment, focusing on physiological and ethical aspects of organ transplantation and survival.

Relationship between physical activity and muscle phenotype and muscle memory is a focus within the field of muscle physiology. Physical inactivity is a risk factor for development of many age-related diseases that are a growing health problem in today's society - such as heart attack, stroke, type 2 diabetes, osteoporotic fractures and some types of cancer. Several changes in body composition that are often attributed to increasing age, are associated to physical inactivity. Increasing understanding of the contraction-induced processes in muscles is thus highly relevant to identify new approaches of prevention and treatment of these diseases. This field of research has obvious link to activities described under Thematic Area 3 A sustainable life cycle and 5 Personalized medicine.

The Dep. of Biosciences has a long tradition in cancer biology research. While part of this research involves molecular and cellular mechanisms, studies of these processes in living animals are under development. An example is research on the role of androgens in the development of prostate cancer. The department has recently established the nematode *C. elegans* as a model organism to study regulation of body fat and cold tolerance, facilitating for a highly bio-medically relevant research aiming to increase understanding of diseases such as obesity and cancer. Studies within developmental biological mechanisms, epigenetics and the relationships between genotype and phenotype focus on determining how genetic and epigenetic information gives rise to development, form and function. *Arabidopsis* is an important model organism in this context. Organisms with deep branches on the tree of life are important in studies of the origin of basic biological processes. Research within this thematic area overlaps with activities under several previously described initiatives, e.g. molecular and cellular mechanisms, neuroscience, evolution, ecology, and marine research. The research uses a wide range of methods and infrastructures, and is typically dependent on dedicated facilities for animals (mice, rats and fish) and plants.

12. ECOLOGY

Interplay among organisms in nature

Research field of ecology focuses on interactions between populations of organisms in nature. Adaptation to and influence of physical and chemical conditions (abiotic factors), as well as other species and populations (biotic conditions) are important aspects of this research. Population dynamic processes are central. Interaction and energy turnover in food chains, networks and cycles of essential nutrients are also important. Ecology provides an understanding of basic processes in ecosystems and is therefore fundamental to understanding and evolution, pollution, environment and climate, as well as sustainable utilization of natural resources.

Ecology and climate changes

Modelling of eco systems

Evolutionary ecology

Population dynamics

Microbial ecology

Paleoecology

Macro ecology

Metagenomics

Strategies of life history

Host-microbe interactions

Comprehensive research in the field of general ecology is conducted at the Dep. of Biosciences, including studies of processes occurring at the population, community and ecosystem level, with a particular focus on population dynamics, species interactions, demographics, life history strategies, vector-borne diseases / zoonoses and biodiversity. This applies to ecosystems both on land, in freshwater and in the sea, and includes most groups of animals, plants, algae and microbes. The department is further involved in ecological research in different regions of the world, but with a focus on northern and arctic ecosystems. Related to this research, the department has high expertise in the taxonomy of the various organisms

Ecotoxicology-related activity is important at the Dep. of Biosciences, including research in both Arctic and tropical waters, micro plastics, oil-related pollution and the transmission of environmental toxins in trophic chains. An important part of the activity in the newly established Center for Biogeochemistry in the Anthropocene (CBA) is the carbon cycle in ecosystems, the turnover of other important elements, as well as the interaction with climate-related processes on different scales from genomes to ecosystems. CBA has a wide field of impact, and is discussed in more detail under next Thematic Area 13 Environment and Climate. The center is important in promoting MN's multidisciplinary focus on climate and environmental research, and is highly valuable for UiO's green profile and efforts in relation to the UN's sustainability goals. Same goes for research at the Dep. of Biosciences that compares terrestrial and aquatic ecosystems with a particular focus on environmental conditions, biodiversity, and the distribution and effect of pollutants. Modern ecology relies on new life science technologies that include high-throughput sequencing, single-cell approaches and meta-omics to study, for example, biodiversity, hybridization, species formation and other ecological and evolutionary dynamics. Furthermore, "big data", statistical and mathematical modeling is important for ecology, especially in conservation biological, biogeographic and macro ecological studies.

13. CLIMATE AND ENVIRONMENT

Interdisciplinary solutions to pollution and climate crisis

Climate change and pollution are two of the greatest challenges humanity faces. Whereas there is a strong consensus regarding human impact on the climate change, there is uncertainty considering long-term effects on nature and society. This is an area with large knowledge gaps, and even greater potential consequences.

Environmental chemistry

Biogeochemistry

Chemical analysis and modelling

Eutrophication

Carbon cycle

Toxicology – toxins and environmental pollutants

Toxicology – effect on organisms

Phenotypical plasticity

Climate development is mainly regulated by the large biogeochemical cycles of carbon and key elements such as phosphorus, nitrogen, silicon, iron and calcium. Understanding the interaction between ecosystem responses, climate and the biogeochemical processes, is one of the biggest research tasks we face today.

The faculty's focus on environment and climate is well reflected through the activities of the Center for Biogeochemistry in the Anthropocene (CBA), which is an interdisciplinary, system-integrating center with participants from the Deps. of Biosciences, Geosciences and Chemistry. The CBA links the three disciplines, with carbon- and water cycle as an integrating element. CBA has a well-established collaboration with Natural History Museum and partners outside UiO (NMBU and the CIENS institutes), as well as a large international network. Research focus of the center is broad - from microbial processes to entire ecosystems. Such an interdisciplinary environment that addresses key aspects of the links and feedbacks between climate, biogeochemical cycles and ecosystem effects will provide crucial insights at a fundamental level, but also enhance collaboration between the faculties, especially between the environments of biology, geosciences and chemistry, creating synergy and adding value to research. This research field targets a central theme in MN's commitment to several of the UN's sustainability goals (climate, water and land, but also hunger, water management and cooperation). Researchers within CBA are preparing an application for a CoE. Environmental pollution and toxicology are also areas with considerable activity at the Dep. of Biosciences. This applies to spreading of pollutants and toxins in nature and in the food chain, as well as their absorption and effect on living organisms. Researchers at the Dep. of Biosciences contribute considerably within this field; among other things to the large national cooperation project The Heritage of Nansen, focusing on the polar sea areas. Toxicological research is also topic of the UiO: Life Sciences Convergence Environment AnthroTox. All these research activities contribute to the internationalization of UiO's research environments, highlighting environmental and climate research at UiO as a visible focus area. Research is thus in line with UiO's visions of a green and sustainable initiative. Infrastructure supporting this research area includes a number of facilities both in the laboratories of the Dep. of Biosciences, at UiO's research vessels and research stations in Finse and Drøbak, as well as infrastructures operated by other institutions.

14. MARINE RESEARCH

Providing knowledge for a healthy ocean

UiO has a long tradition of marine teaching, research and monitoring. The emphasis of marine research lies with the MN departments of Biosciences and Geosciences. In collaboration with the University of Agder, NMBU, Institute of Marine Research, Norwegian Institute of Water Research and Meteorological Institute, UiO participates in a recently proposed joint national initiative focusing on the Skagerrak-Kattegat-Oslo fjord. This ocean area is of great relevance for studying human impact on ecosystems and developing sustainable use of this important ocean and coastal area.

Marine biodiversity

Marine ecology

Environmental and human activity

Marine resources

Polar research

Biotechnology

The Dep. of Biosciences is the largest contributor to marine research at UiO, covering processes from the molecular- and organism level to ecosystem studies. The Department conducts research on fundamental issues, as well as environmental studies related to human impact on nature. Relevant activities include research in fields and expeditions, in laboratories on campus, as well as extensive use of statistics and modeling. The Dep. of Geosciences covers the entire breadth of the geosciences within this field. This includes the hydrological research oriented towards surface processes, estimating water balance elements and climate-induced effects on water balance and the occurrence of extremes. Oceanographic research focuses on turbulent mixing, ocean transport processes, and large-scale ocean currents both globally and in our nearshore areas.

Other relevant research at the Dep. of Biosciences is related to ecology, taxonomy, evolution, behavior, toxicology and food chain relationships. Among the organisms that are studied are bacteria and benthic algae, phytoplankton, seagrass, zooplankton, fish and seabirds. Many of these species and ecosystems are of great economic importance.

An important field of research within this area is marine evolutionary genomics where cod and cod-related fish are central species. Focus of this research is genetic and evolutionary basis for adaptation of different populations to different environments and climate change.

The research within this thematic area is conducted both locally and globally, ranging from habitats from the Oslo-fjord to the Arctic and Antarctic, in addition to tropical waters. Research within this area requires access to a variety of infrastructures, both in laboratories on campus and on various research vessels and research stations (including the Marine station in Drøbak). The Faculty of MN has two research vessels in the Oslo Fjord: F / F «Trygve Braarud» and F / F «Bjørn Føyn», the former of which is a floating field laboratory with modern instrumentation. F / F «Trygve Braarud» is old, and a new research vessel for operation in the Oslofjord, Skagerak and Kattegat is under consideration. Emphasis will be on teaching facilities, modern instrumentation for marine research and environmentally electrified operation. Our researchers also use research stations and research vessels owned and operated by other institutions.

LIFE SCIENCE AT UiOs RESEARCH ENVIRONMENTS OUTSIDE THE FACULTIES OF MATHEMATICS AND NATURAL SCIENCES, MEDICINE AND DENTISTRY

Life sciences embrace substantial amount of research at UiO taking place outside the faculties of Mathematics and Natural Sciences, Medicine and Dentistry. To identify potential collaboration possibilities within proposed thematic areas among environments within humanities and social sciences, we have included research deans from the Faculties of Social Sciences, Humanities, Educational Sciences and Law in the present process. Moreover, we have had a dialogue with the Center for Gender Research.

Neuroscience is the thematic area that most clearly stands out as a natural bridge-builder between strong research environments across UiO. There are, furthermore, many collaborative opportunities within **Sustainable life span, Digital life science, Environment and climate, Personalized medicine and Enabling health-technology**.

Several research environments at the Faculty of Social Sciences have activities within life sciences, with clear collaboration opportunities in **Neuroscience** and **Sustainable life span**, including:

- Endestad Brain Imaging Group (**Neuroscience**)
- Research group for clinical neuroscience (**Neuroscience**)
- Multimodal brain imaging (**Neuroscience**)
- Neurocognition (**Neuroscience**)
- Center for life course changes in brain and cognition (**Neuroscience** and **A sustainable life span**)

Particularly relevant research environments at the Faculty of Humanities that have links to proposed thematic areas at our Faculty are:

- Center for philosophy and the sciences; CPS (**Neuroscience**)
- Literature, Cognition and Emotion; LCE (**Digital life sciences**)
- Oslo School of Environmental Humanities; OSEH (**Sustainable life span, Environment and climate**)
- The Lifetimes research community at the Department of Cultural Studies and Oriental Languages; IKOS (**Sustainable life span**)
- RITMO Center for Interdisciplinary Research on Rhythm, Time and Movement, SFF (**Neuroscience**)
- Center for Multilingualism in Society across the Lifespan (Multilingual), SFF (**Sustainable life span**)
- Practical Ethics at the Department of Philosophy, History of Ideas and Art; IFIKK (**Personalized medicine**)
- Linguistics-driven machine learning to decipher the molecular language of immunity (ImmunoLingo) (**Digital life sciences**).

Number of research areas at the Faculty of Educational Sciences can be embraced by life sciences and fall within several of the proposed thematic areas at our Faculty:

- Challenges of Sustainability in Educational Research; COSER (**Environment and climate**)

- Science Education for Action and Engagement towards Sustainability; SEAS (**Environment and climate**)
- Tracking human development (**A sustainable life span**)
- Developing and applying ambulatory assessments, assessments on the fly (**Personalized medicine**)
- Digitalization for adaptive testing and gathering new types of data (**Digital life sciences**)
- Research on human learning and development (young children to adults) at the Department of Education (**A sustainable life cycle**)
- Aphasia, dementia, language development, stuttering, language learning in light of brain plasticity (**Neuroscience**)
- Telemedicine treatment for aphasia, development of exercise apps, etc. (**Digital life sciences** and **Enabling health-technology**)
- Individual effects of non-pharmaceutical programs / services (**Personalized medicine**)

The research at this faculty is interdisciplinary, with an established collaboration with the Dep. of Pharmacy (joint project on the association between mother's drug use during pregnancy and child development), Oslo University Hospital and Sunnaas hospital.

Research at the Faculty of Law addresses several legal disciplines of particular interest to the life sciences:

- Health and secondary law
- Climate Law
- Privacy Law
- Intellectual property (especially patent law)
- Criminology
- Human Rights
- EU / EEA

The Faculty of Law has its own website for Life Sciences and has recently hired an associate professor within the field:

https://www.jus.uio.no/ior/forskning/omrader/livsvitenskap/

The Center for Gender Research has an overall goal of conducting interdisciplinary research, teaching and dissemination in the field of gender research. The center participates in an CoE application for the Center for Sustainable Aging (CSA) at the FACULTY OF DENTISTRY and thus represents a strong collaborative environment within the thematic area of A **Sustainable life span.**

THEMATIC AREAS IN THE FREE RESEARCH AREAS IN THE LIFE SCIENCE BUILDING

Premises

MN initially believes that there is a need for a thorough discussion regarding the premises that will form the basis for the use of the free life science areas. Previous documents present certain guidelines, but new guidelines may be added. Furthermore, there has been a lack of discussion regarding the process around the selection of thematic areas themselves and specific activities in the building.

The Faculty proposes that the following criteria be used for the use of the free research areas in the Life Sciences Building:

- Areas allocated to 1-2 CoE / CRI / ERC winners within the field of life sciences
- Some areas reserved for shorter research stays (1-12 months) for individuals and small groups
- Computational life science (CBI and OCBE) is allocated space in the building - based on a more thorough analysis of area requirements
- Other research activities that are prioritized should be linked to experimental activities

Additionally, following should be emphasized:

- Excellent research
- Technology-heavy and interdisciplinary research environments related to core facilities within the building
- Interdisciplinary research creating convergence according to strategy for life sciences at UiO
- Collaboration with Oslo University Hospital and other public companies
- Activities facilitating cooperation with commercial partners and innovation
- Contribution to meeting the societal expectations of the new building's added value and increasing UiO's reputation as a key social actor
- Synergy-promoting experimental environments that have no place in the Life Sciences Building
- Contribute to innovation and innovative education within life sciences

The thematic areas selected for allocation in the free research areas of the Life Science Building must not be determined prematurely. Much can happen by 2024, including an ongoing CRI process and an upcoming CoE process, ERC calls, infrastructure announcements etc. These factors will characterize the development of our subject areas and clarify future opportunities. A very strong academic environment that will move into the Life Sciences Building is the Center for Materials Science and Nanotechnology. This environment is currently focused on renewable energy, but has recently implemented life science in its strategy. It is not natural for MN to point out "Future materials" as a priority area in the free research area at this point, but this can quickly change as the environment builds up life-science-focused activity. This will depend on the access to bio-nano facilities in the building,

and the Center for Material Science and Nanotechnology will be able to take responsibility for operating these.

The proposed thematic areas must outline an opportunity space we can work towards and communicate to the world outside, but must not function exclusively or inhibit the development of the life science field or the building.

Based on these considerations, the faculty proposes the following 6 thematic areas, which are divided into two categories, for a further process for placement in the free research areas in the Life Sciences Building:

Thematic areas planned placed in the building:

• ANTIMICROBIAL RESISTANCE (Thematic Area 1)

• A SUSTAINABLE LIFE SPAN (Thematic Area 3)

• PERSONALIZED MEDICINE (Thematic Area 5)

The faculty's new initiatives for thematic areas in the Life Science Building:

• ENABLING HEALTH-TECHNOLOGIES (Thematic Area 4)

• NEUROSCIENCE (Thematic Area 8)

• MOLECULAR AND CELLULAR MECHANISMS (Thematic Area 10)

Faculty grounds

ANTIMICROBIAL RESISTANCE

Multidisciplinary solutions for a global health challenge

This is an overarching theme of high social relevance, which is a priority area also for MED and OD, and with an important link to Oslo University Hospital. Solutions to this problem are of critical social importance that require an interdisciplinary and integrated approach from many different disciplines, including medicine, pharmacy, dentistry, biology, chemistry, biostatistics, economics, simulation and computational technology (bioinformatics), and digital science.

Highlighting this area as an investment in the Life Sciences Building on behalf of UiO and in close collaboration with Oslo University Hospital, will place UiO on the map as a leading university in the field of health, both nationally, regionally (Oslo Science City) and internationally. Based on the large academic breadth and strength of UiO and Oslo University Hospital, a commitment to antimicrobial resistance should facilitate the acquisition of external funds, both within disciplinary and thematic calls nationally and internationally. Importantly, this will be a commitment that society needs and wants, which is easy to

communicate, and which can respond to the added value of investments in the Life Sciences Building.

MN has strong professional environments in this area, both outside (Deps. of Biosciences and Informatics) and in the building (Deps. of Pharmacy and Chemistry), in addition to CBI and OCBE, which will be of great importance for any future investment.

A SUSTAINABLE LIFE SPAN

Prevention and treatment from cradle to grave

Similarly to antimicrobial resistance, this is also a priority area for MED and the Faculty of Dentistry. Lifestyle and age-related diseases are increasing in scope, representing a major burden to both individual patient and society, with major challenges for the health care sector with increasing organizational and financial consequences. Faculty of Social Sciences and Center for Gender Research both have projects linked to this field (see information above), but the area facilitates even broader collaboration opportunities with research environments at the Faculties of Educational Sciences and Law. The theme can thus improve interdisciplinary research supporting the desired convergence principle at UiO. Research within this area is easy to communicate, as it addresses an important social issue, with great positive reputation potential for the entire university.

Research activities within humanities and social sciences are generally not experimental. As such, the degree of their placement in the Life Science building is questionable. An important aspect of consideration is formation of a collaboration arena and new start-ups in the building, which would not occur at the expense of experimentally designed activity! A hub-node model with experimental activities in the new building and other non-experimental resource environments that are nodes outside the building can be an approach that can also contribute to the Life Science building being perceived as a an important resource for environments outside the building.

PERSONALIZED MEDICINE

Targeted diagnostics, treatment and follow-up

Personalized medicine is an area of rapid development. It extends widely, from molecular data to clinical parameters for the individual patient. Information on lifestyle and environmental impact is essential. Multidisciplinary research is central, and with its wide breadth, MN has researchers with key expertise in important disciplines in this context, such as systems biology, pharmacy, chemical biology and computationally oriented subjects (bioinformatics, biostatistics, and biomathematics) and mathematics. There are great interaction opportunities with NCMM, which is planned to be moved into the building, as well as other environments at the Faculty of Dentistry, MED and Oslo University Hospital, working in the field. Personalized medicine is a priority area also for the MED and the Faculty of Denistry.

The National Strategy for Personalized Medicine in the Health Service emphasizes this area on national level. The social relevance is obvious, with targeted and better treatment of the individual patient, shorter length of stay and reduced costs in the health care system. An investment in the free life sciences areas will create added value for the building with synergies towards the breadth of UiO's expertise within life sciences, science and technology and towards OUS. Furthermore, the field should raise interesting questions in areas such as ethics and law, with interaction opportunities with other disciplines. The development of new technological solutions, diagnostics and medicines for individually targeted treatment opens up for innovation activity and collaboration with commercial partners. The area is described in more details under Thematic Area 5.

ENABLING HEALTH-TECHNOLOGIES

For health challenges of the future

Health technology is rapidly evolving and increasing its impact on the health and care field, both in surgery, drug delivery, remote diagnostics, clinical follow-up of home-dependent patients, sensor technology, use of robots, etc. Artificial intelligence may affect this area in unpredictable ways. This is a great opportunity field for UiO, which already has established collaborations between basic scientists and clinicians also involving external partners.

An interesting research environment at the Dep. of Physics is the Oslo Bioimpedance and Medical Technology Group, which develops sensor technologies for medical diagnostics and characterization. Current activity of the group includes Parkinson's disease and diabetes; work on organ-on-chip (convergence environment, with nano-electronics at the Dep. of Informatics, robotic surgery (with Dep. of Informatics and the Intervention Center at Oslo University Hospital), cardiology, psychology (technology for mental health) and anesthesia (needle positioning). The group contributes significantly to the innovation part as several of the projects lead to commercialization, with an extensive collaboration with commercial partners. The environment has received UiO's and Inven2's innovation awards. The collaboration with Oslo University Hospital is close, with permanent scientific group members from UiO and hospital; two with positions at both places.

A commitment to this environment in the Life Sciences Building could have a great synergy effect on MED and Oslo University Hospital, strengthen collaboration with commercial partners, and significantly increase the innovation potential in the building. The research group would co-localize with today's collaborative environments at MED and Oslo University Hospital, and to other partners at Deps. of Pharmacy, Chemistry and Informatics. The group currently consists of 16 researchers (including fellows and postdoctoral fellows).

Commitment to this environment in the Life Sciences Building can also have a positive impact on the education program at UiO with great interdisciplinary interest. The Norwegian Institute of Public Health has requested establishment of education within medical technology. There is a national lack of comprehensive expertise in this field, and as of today, the Medicines Agency manages quality assurance and approval for the Norwegian market. The Bioimpedance environment headed by Ørjan Martinsen, led the preparation of a Bachelor's

program in medical technology at MN on the initiative of the dean in 2012. This initiative has not come to reality yet, but together with strong management and quality assurance expertise at the Dep. of Pharmacy, as well as with collaborating partners at MED, Oslo University Hospital and Dep. of Informatics, the group will be able to contribute significantly to this field. Given there is increasing need for the development of medical technology within the health care sector, a commitment to this is easy to communicate, it can contribute to the added value of investments in the Life Sciences Building and can increase collaboration with business and innovation activity.

NEUROSCIENCE

From synapse to brain

Integrated experimental and computational neuroscience

Neuroscience in different facets is a major field of research at many of the faculties at UiO (see description above). This will be a possible thematic area in the free area of the Life Science Building. Such a commitment could serve as a bridge builder between strong environments within natural sciences and medicine on one side, and researchers in the field of humanities, social sciences and law on the other side, creating convergence. Research in neuroscience is represented by the Dep. of Pharmacy, but can be significantly strengthened by the presence of several research environments in the building.

The research questions in neuroscience require an interdisciplinary approach. The link with strong, computationally heavy environments represents a great potential that can strengthen both neuroscience and life sciences in general. In this context, the CINPLA changing environment at MN is very interesting, as it specializes in integrated experimental and computational neuroscience. CINPLA will fit well into a commitment to neuroscience in the Life Sciences Building, preferably together with neuroscience researchers from MED, social sciences (psychology) and environments at the Faculties of Humanities and Educational Sciences. CINPLA has a very interdisciplinary profile, which is the only established environment within physics-based modeling and analyzes within life sciences. The group collaborates closely with important regional actors (MED, OUH, Simula, NMBU). The link to CBI and OCBE in the Life Sciences Building is obvious. CINPLA has grown to be a strong, high-performing environment when it comes to obtaining external funding from various arenas. CINPLA is the ERC CoG finalist and is now working on a CoE sketch. CINPLA is described in more detail under Thematic Area 8 Neuroscience.

A robust computational environment will be a resource for establishing links to other experimental activities both in the building and outside environments. This type of computationally oriented business can be part of a comprehensive focus on Digital Life Sciences, and moving this activity can trigger the potential that lies in closer interactions with several strong preclinical, experimental environments at Institute for Basal Medicine and KlinMED / OUS that may lack the computational component. The focus on neuroscience, including the placement of CINPLA in the building, can be an important contribution to

meeting the convergence goal. The initiative will be well communicable, underpin the importance of the Life Sciences Building and initiative, and increase UiO's reputation.

MOLECULAR AND CELLULAR MECHANISMS

The machinery of life

Among MN's thematic areas within life sciences, thematic area 10 Molecular and cellular mechanisms can form a strong basis for allocating activities in the free research areas of the Life Sciences Building. Assuming that the building will have a professional profile related to human biomedicine, we propose the following formulation of a possible thematic area for the free areas in the Life science Building:

MOLECULAR AND CELLULAR MECHANISMS

Knowledge of the machinery of life: causes of illness - basis for the treatment

This area includes a spectrum of research activities at the Dep. of Biosciences, where molecular and cellular mechanisms are a focus of research in systems based on plants, animals (including humans) and microorganisms. By establishing Molecular and Cellular Mechanisms as one of the thematic areas in the free research areas, we will facilitate synergy within the Life Sciences Building with research environments outside the building, including the Dep. of Biosciences' very strong research environments in Kristine Bonnevie's house and many strong environments at MED and the Faculty of Dentistry. A number of core facilities planned in the new building could support this type of research, such as High Throughput Chemical Biology Platform, Proteomics and Mass Spectrometric Joint Laboratory, UiO Structural Biology Core Facilities (X-ray Crystallography, cryoEM, NMR), Bioinformatics Nuclear Facility (BCF) / Elixir helpdesk , Life Science Electron Microscopy Consortium, and a future core facility for advanced light microscopy. Some research groups in the area will also need animal models such as mice, rats and zebrafish.

FACULTY'S COMMITMENT TO PROPOSED THEMATIC RESEARCH AREAS

The Dep. of Pharmacy has an ambition to increase uptake of students to 100 after moving to new building. Consequently, number of permanent scientific positions within the first five thematic areas of life sciences (Table 1) will also increase. Three of these thematic areas are proposed as priority areas in the free research areas of the building. There is an increasing demand for pharmacists within several sectors including pharmacies, health care, industry and industry. Thus, pharmacy education attracts highly qualified students and has a high degree of completion. Increased focus on pharmacy education is necessary to meet the needs of the society, and as such represents a solid financial priority area for the entire faculty. There is great potential for increased research and education collaboration between the Dep. of Pharmacy and Oslo University Hospital, as well as for increased innovation activity and collaboration with pharmaceutical and biotechnology companies - several within Oslo Science City. There is currently no discussion regarding the specific frames of how to obtain these goals. Never the less, this should be a good dialogue opportunity for UiO and the Ministry of Education and Research about increased admission frame as part of the commissioning of the new building. Furthermore, the Faculty has a limited degree of flexibility when it comes to number of permanent scientific positions. New priorities are always considered when replacing natural departures, but there are also other considerations, including those related to education. However, investment in thematic areas will be part of future assessments when announcing permanent scientific positions in life sciences at MN.

The recruitment positions from the Ministry of Education (“KD positions”) are Faculty's most important strategic resource, which is used to support the faculty's international research position in line with UiO's and MN's adopted overall strategies. The faculty has at present. 301 KD positions, of which 86 are distributed among the institutes and the rest are distributed annually according to adopted priorities and processes. Use of these positions will support outstanding research, EU challenges and improve gender balance in leading positions. In addition, the KD positions are important as deductibles in large applications for CoE, CRI, ERC Grants and the joint promise within FRIPRO. In the future, the free KD positions will also be used strategically to strengthen the faculty's own initiatives within, among others, data science and life sciences, which will be included as a criterion for future allocation processes.

CONCLUSION

Based on inputs from the institutes, MN proposes 14 thematic areas within the field of life sciences (Table 1). The first 7 thematic areas will be partially represented by research communities already planned to move in the Life Sciences Building. According to present organizational plan, activities related to thematic areas 8-14 will be taking place entirely outside the Life Science Building.

Overall guidelines defined in background documents (Concept selection study and UiO's life science strategy), such as quality, convergence, innovation, resource, synergy-building within UiO and in the region, as well as the benefit of being located in the building and a forward-looking research profile, MN suggests that the following thematic areas are considered in a further process for placement in the free research areas:

- ANTIMICROBIAL RESISTANCE (Thematic Area 1)
- A SUSTAINABLE LIFE SPAN (Thematic Area 3)
- PERSONALIZED MEDICINE (Thematic Area 5)
- ENABLING HEALTH TECHNOLOGY (Thematic Area 4)
- NEUROSCIENCE (Thematic Area 8)
- MOLECULAR AND CELLULAR MECHANISMS (Thematic Area 10)

The first 3 thematic areas proposed for placement in free research areas will be represented by research environments already planned moved into the building, while the last 3 are the faculty's new initiatives on thematic areas in the Life Sciences Building.

RELEVANT BACKGROUND DOCUMENTS

1. The Life Sciences Building - overall strategy and organization
2. MN Working note on professional development within LV December 2018
3. UiO strategy for life sciences
4. MN strategy - Knowledge development for a world in change