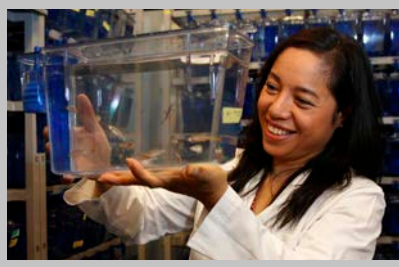
UiO : Life Science
University of Oslo

Recommendation for thematic areas within life sciences in the new life science building at the University of Oslo



LIVSVITENSKAP
LIFE SCIENCE

Preface

The University of Oslo (UiO) is currently in the process of constructing a new building for life sciences, chemistry and pharmacy – the life science building, which is to be inaugurated in 2024. This will be the largest and most complex university building in Norway, and the government has great expectations concerning how it will contribute to value creation and international competiveness. The life science building will realize UiO's strategic ambitions in the life science field, as described in the *UiO strategy for the life sciences*. Extensive interdisciplinary cooperation – convergence – is an primary perspective.

On request by the UiO management, the Faculty of Mathematics and Natural Sciences, the Faculty of Medicine, and the Faculty of Dentistry in December 2018 submitted input to an overall plan for scientific and professional development towards the life science building, including suggestions for possible *thematic areas* within life sciences in the building.

The subsequent process has further investigated such thematic areas, aiming to reach a unified recommendation from all the units at UiO. In May 2019, the same three faculties were asked by the university management to prepare by the end of the year overall plans for the development and prioritization of their own activities in life sciences, with particular emphasis on future interactions with the life science building.

At the same time, UiO:Life Science was asked to support the three faculties in their work, as well as to facilitate involvement and coordination across UiO.

The present report summarizes the outcome of the individual processes at the life science faculties in the autumn of 2019, the work of UiO:Life Science in the same period, and the input gathered at three meetings between December 2019 and February 2020 involving units across UiO. The recommendations of this report will serve to inform and guide the development of the activities within life sciences at UiO to make the best possible use of the life science building from 2024.

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Summary

Internal processes at the Faculty of Mathematics and Natural Sciences, the Faculty of Medicine and the Faculty of Dentistry, seminars involving all UiO faculties and the UiO:Life Science Strategic Advisory Board, input from external players, and advice from relevant universities abroad have led to the following recommendation for thematic areas within life sciences in the new life science building:

- ANTIMICROBIAL RESISTANCE
- A SUSTAINABLE LIFE SPAN
- NEUROSCIENCE
- PERSONALISED MEDICINE
- ENABLING HEALTH TECHNOLOGIES
- OPEN LIFE SCIENCES

Research teams working within these areas are expected to partly fill the laboratory space designated for free life science in the new UiO life science building to be inaugurated in 2024. The three overarching premises are **societal challenges**, **free basic research** and **innovation**, with *convergence, excellence* and *synergy* as basic elements for all activities.

A funding scheme for future activities need to be established in a separate process, involving all pertinent departments and faculties as well as UiO:Life Science.

1. Introduction

Life sciences at UiO

In the UiO strategy the life sciences,[1] *life sciences* are defined to include all scientific disciplines studying the composition, structure and functions of living organisms. Medicine and biology constitute the core, backed by chemistry, physics and mathematical subjects. This strategy also includes the social sciences and humanities when these examine causal relationships between behaviour or consciousness and the biological foundation, or analyse challenges arising in the encounter between the application of the life sciences and society's values and priorities.

The life science building will accommodate several thousand square meters of "wet labs", i.e. laboratory space designed to handle various types of chemicals and potential "wet" hazards. These are set to operate in tandem with an array of experimental equipment and scientific infrastructure requiring high skilled users. Taking this into account, and not disregarding important activities elsewhere, UiO has considered that researchers and research groups from the Faculty of Mathematics and Natural Sciences, the Faculty of Medicine and the Faculty of Dentistry are prime candidates to move into such laboratories.

From the Faculty of Medicine, Centre for molecular medicine Norway (NCMM), which is the Norwegian node of the Nordic EMBL Partnership for Molecular Medicine, will move into the life science building. The centre is a greenhouse for young talented researchers, and group leaders are recruited for a period of 5+4 years. At present, NCMM has 11 research groups. For the Faculty of Medicine it will be of great importance to secure and maintain collaboration and networks between research groups located in the life science building with the majority of groups residing at other locations at the university and university hospitals.

From the Faculty of Mathematics and Natural Sciences, the Department of Pharmacy and the Department of Chemistry will move into the building. An important premise for this faculty was that the majority of its life science activities will take place outside the life science building. In particular, the Department of Biosciences will not move into the new building. Furthermore, life science-related research and education take place also at the Departments of Informatics, Mathematics and Physics. Moreover, the Department of Geosciences participates in a multidisciplinary centre for climate and environment.

A strategic building and a strategy for life sciences

The life science building at UiO is one of two construction projects that has been prioritised in the Government's Long-term plan for research and higher education. The planning of a life science building began three decades ago when the Department of Chemistry and Department of Pharmacy buildings were no longer suitable for modern laboratory work. When the Norwegian Ministry of Education and Research chose to incorporate the interdisciplinary subject life sciences into the planning of a new building for chemistry and pharmacy, the concept of the building went from being an urgent necessity in terms of health, environment, safety and poor infrastructure to becoming a strategic tool that could make Norway increasingly competitive in the area of life science and that would also bolster the Norwegian economy.

To prepare the organization for the building, UiO in 2014 developed a strategy for life sciences[1] and established UiO:Life Science as an interdisciplinary initiative to implement it. The strategy states:

> **The 21st century is frequently described as "The century of the Life Sciences", based on the knowledge revolution that provides us with a completely new understanding of life and life processes. This paves the way for better health, sustainable environmental measures and a growing green bioeconomy. UiO's vision is to be an important actor nationally and globally in this development, by delivering high quality and high value research, by educating candidates with expertise and talent, and by contributing to**

> **innovation in health and the environment for the benefit of society. In order to succeed, UiO must develop "convergence" – closer interaction between a diversity of research environments and disciplines – to ensure quality and relevance.**

The new life science building in Gaustadbekkdalen will open in 2024, six years after the government granted start-up funds in 2018. As the technologically most advanced university building in Norway, it will be instrumental for UiO in reaching both its own ambitions and the society's expectations within life sciences. The recently released UiO Strategy 2030[2] follows up on this:

> **UiO will exploit all the opportunities that the new life science building provides in responding to society's expectations.**

In the building, extensive interdisciplinary cooperation – *convergence* – will contribute to solving grand challenges related to health and the environment. Closer collaboration with health enterprises, the local government and the business sector will enhance quality and relevance in research and education of the future labour force. Better exploitation of the innovation potential in research is another goal. The building, with comprehensive scientific equipment and core facilities, will be a resource for the entire Oslo region and contribute towards ensuring that Norway is internationally competitive in the area of life sciences, at a time when there is a great need for value creation, renewal and restructuring of the Norwegian economy. The building will be at the heart of the first innovation district in Norway – Oslo Science City.

Achieving *excellence* is an overall goal for activities in the building, which will specifically be used as a main criterion for selection of research falling under the thematic area of OPEN LIFE SCIENCES (see below). Furthermore, the life science building is conceptually the first university building in Norway planned on the *convergence* principle. An overall goal is *synergy* between many academic environments that will contribute and benefit from facilities in the building, not limited to those that will physically be moving in. Research based on interdisciplinary cooperation will become increasingly important in order to conduct groundbreaking research that contributes towards solving grand challenges.

Who and what will be in the building?

With respect to who and what will be in the building, the instructions from the UiO vice rector and management to UiO:Life Science in May 2019, in referring to previous documents, identified the following future activities:

Existing units

- Department of Pharmacy at the Faculty of Mathematics and Natural Sciences
- Department of Chemistry at the Faculty of Mathematics and Natural Sciences
- Centre for Molecular Medicine Norway (NCMM) at the Faculty of Medicine

To be developed

- Convergence environments
- Computational life sciences
- Frontline technology groups linked to core facilities
- *Thematic areas*

Careful selection of researchers and groups belonging to the latter four categories is needed to reach overall goals with respect to excellence, facilitate convergence and ensure optimal use of scientific core facilities in the building.

Activities in the building will have a human-biomedical profile, but will also support other human and non-human experimental life sciences at other locations at UiO. Importantly, the life science building will be an incubator for the future generation of competent students and young researchers, especially linked to the experimental core facilities and the learning areas located in the building.

Convergence environments at UiO

UiO:Life Science has since it was established in 2015 gained valuable experience with interdisciplinary research projects through two allocations of *convergence environments*, six in 2017 and eight in 2019, which each gets three or four PhD or postdoc positions plus running expenses. The 14 groups together have principle investigators from eight different faculties, pinpointing the broad definition of *life sciences* at UiO.

Most projects are still in their early stages, but experience gained, including an evaluation carried out in the autumn of 2019, indicate some promising outcomes:

- Most environments report that their research would never have been executed without this funding, i.e. ample measures to stimulate interdisciplinary research make a change.
- Creating meeting points, such as mandatory “speed-dating” events as part of the application process, where researchers are required to sit down and talk to colleagues from other disciplines, is useful and rewarding.
- Most people involved agree that working in such an environment has changed their mind-set towards more interdisciplinary questions.
- All involved PhD students express that being involved in a convergence environment has been a good career choice for them.

There are also reports of the challenges involved. It seems to be of major importance to allocate sufficient amount of time for communication across disciplines. All of this should provide useful lessons for the planning of activities in the life science building.

Computational life sciences

The UiO Centre for Bioinformatics and Oslo Centre for Biostatistics and Epidemiology (OCBE) are candidates to move into the life science building, where they will represent important competence in bioinformatics and biostatistics and thus represent valuable resources and partners in many research activities. Additionally, The Hylleraas Centre for Quantum Molecular Sciences, a Centre of Excellence funded by the Norwegian Research Council (NFR), has the Department of Chemistry as host and will be in the building. The centre aims to develop and apply computational methods to understand, interpret, and predict new chemistry, physics, and biology of molecules in complex and extreme environments.

Frontline technology groups linked to core facilities

The life science building will house a large selection of advanced experimental infrastructures, defined in a separate UiO process as *core facilities*. The status as a core facility implies a defined set of obligations, including service to internal and external users. Each core facility must be operated by an expert group of researchers, highly skilled in their fields and capable of providing the requested service at top international level.

Thematic areas

Thematic areas within life sciences in the new life science building should be dynamic initiatives with interdisciplinary research profiles designated to

- solve fundamental scientific and societal challenges
- build on the strengths of UiO within life sciences and further increase international competitiveness in the field
- contribute to convergence between disciplines
- train skilled candidates with competence of national and international importance
- act as motors for life science-related innovation and serve as incubators for start-up companies
- be attractive and preferred cooperating partners for external players within the health industry and in academia

Research groups within the thematic areas, selected after an extensive UiO-wide process described in the present report, will occupy an as yet undefined part of the 2200 m^2 laboratory area reserved for *free life sciences*, which holds ten different laboratories with around 200 seats in total.

The portfolio of *thematic areas* will be critical to reach the ambitious goals for the overall activities in the building set by UiO. Their time horizon should be long enough to make it attractive and worthwhile for external groups to move into the designated laboratory areas. The life span of four years for UiO:Life Science convergence environments in this context seems too short.

2. Methods

The Faculty of Mathematics and Natural Sciences, the Faculty of Medicine and the Faculty of Dentistry

The three *life science faculties* handed in their first reports on thematic areas in December 2018.[3-5] In May 2019, they received new instructions from the UiO vice rector and management:

Professional development towards the life sciences building – activity development life sciences 2020–2025

in which they were commissioned to prepare individual reports addressing the following:

- Based on ongoing mapping of scientific core facilities and the development of UiO's roadmap for infrastructure, prioritize activities and facilities for location in the life science building. In parallel, propose own technology-heavy environments suitable for securing links between research activities and core facilities in the building.
- Discussion of activities intended to be developed inside and outside the building.
- Propose prioritised development of thematic areas for placement in the life science building. Make plan for realization through own priorities, including stimulation of academic innovation, recruitment of scientific staff, and strategy for securing external funding, in particular larger procurement such as centres of excellence, as well as collaboration with external players such as the university hospitals, and other educational and training research institutions.
- Give their views on contributions to the entire societal mission based on activities localised in the life science building, including innovation and education as described in the UiO strategy for the life sciences.

Close collaboration was established between research deans at the three faculties in order to coordinate the process in cooperation with UiO:Life Science.

The Faculty of Mathematics and Natural Sciences

All departments at the faculty that have activities within life sciences were involved in the working process. The aim has been to develop thematic areas representing the breadth of the faculty's activities within life sciences, pointing to future priorities.

The process was led by the research dean of the faculty and driven forward by contributions from the respective heads and the academic environments at the Department of Pharmacy, the Department of Chemistry and the Department of Biosciences. Additionally, the faculty has included other UiO faculties, as well as the Centre for Gender Research in this work.

On December 18th 2019, the faculty submitted a comprehensive overview of life science-related activities, including initial recommendation of prioritised initiatives for the allocation in the free research area of the life science building.[6] In this report, the faculty defines 14 thematic areas in life sciences, Figure 1.

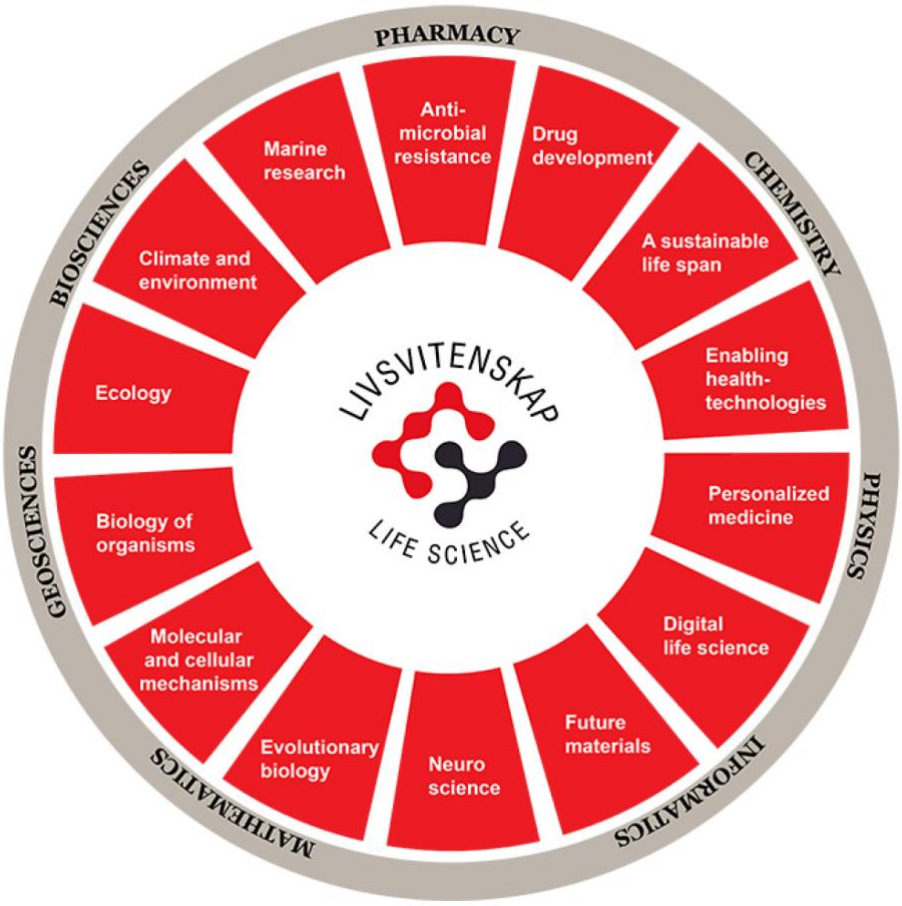

Figure 1. Thematic research areas within life sciences at the Faculty of Mathematics and Natural Sciences.

The Faculty of Medicine

The 2019 process at the faculty started with an open meeting on September 6th where all employees were encouraged to propose thematic research areas and suggest how to create a research environment with close collaboration and partnerships between groups within and outside the life science building on a dedicated web site.

The working group who prepared the Dec 2018 report,[4] was re-established, and it revised the report based on a compilation of suggestions from employees, a draft road map for research infrastructure at UiO, UiO strategy 2030 suggestions within health research and education, a report on coordination of facilities for comparative medicine in the Oslo area, and the two reports from UiO:Life Science. The faculty's revised report on scientific development of life sciences in the life science building was submitted to the UiO December 16th 2019.[7]

The report was presented to all employees in an open meeting at the faculty January 23rd 2020 for comments and suggestions prior to the following meetings with UiO faculty leaders and the preparation of a unified report from UiO:Life Science.

The Faculty of Dentistry

In its December 2018 report,[5] the faculty highlighted own thematic areas that could fit into the life science building. In 2019, the program committee for research and research education discussed the matter again and came up with the same thematic areas as the year before.

At internal faculty meetings, including one with the director of UiO:Life Science as invited speaker, the dean and the vice deans provided information and updates on the ongoing process. The steering board at the faculty received suggestions from the vice dean for thematic areas that could fit the life science building. A new report submitted from the faculty December 18th 2019.[8]

As is also the case with the Faculty of Medicine, all activities at the Faculty of Dentistry can be defined as life sciences, and these two faculties see no need to distinguish between research fields that are, or are not, candidates for moving into the life science building.

UiO:Life Science

In parallel with the work by the three life science faculties, UiO:Life Science received its own instructions:

Professional development towards the life science building – mapping and recommendation of thematic areas within life sciences

The present report was therein requested to consider the following:

- *On the basis of a mapping of the organisation at other Scandinavian institutions, present possible organisation of thematic areas*
- *Discussion and summary of input from external players*
- *Provide summary of meeting with and input from all relevant units at UiO*

The first point was addressed by conducting a survey of how thematic areas within life sciences are organised at relevant institutions abroad, expanded beyond Scandinavia to include 11 institutions in Sweden, Denmark, Finland, the UK, the Netherlands, Austria and USA. The report *Organisation of thematic areas in life sciences at international universities* was completed on November 6th.[9] A summary is presented in Chapter 3.

For the second point, input was collected in three meetings with a total of 20 invited people representing three different categories of external players:

- the health industry,
- business clusters, incubators, and regional health and biotechnology companies
- other higher education and research institutions

The report *Thematic areas in life sciences: summary of input from external players* was completed on November 29th.[10] A summary is given in Chapter 4.

Relevant units at UiO, point three, were involved on three different occasions:

- December 12th, 2019: Faculty deans and research deans of the three life science faculties, as well as department heads.
- January 29th, 2020: Deans and research deans across UiO, including also vice-rector Per Morten Sandset.
- February 10th, 2020: Research deans of the life science faculties, two representatives of external players, members of the UiO:Life Science strategic advisory board (SAB).

The different inputs gathered in these meetings, in further discussions and from an additional note from The Faculty of Mathematics and Natural Sciences[11] are incorporated in Chapter 5.

3. Organisation of thematic areas in life sciences at international universities

Thematic areas of research exist at a number of international universities. Usually these operate as *virtual centres* and have not been founded to fill specific physical workspaces.

The organisation of thematic areas come in two distinct flavours with different functions and purposes.

1. *Strategic level* themes are defined in a strategic process at the management level to be communicated externally for branding purposes.
2. *Operational level* themes usually arise from bottom-up processes and serve both to organise the researchers and to describe main research projects and collaborations internally.

The former are typically very broad, such as "*Environment and sustainability*", while the latter are more specialised, e.g. "*Regenerative Medicine & Stem Cells"*, but nevertheless often have an interdisciplinary profile. Most universities have both levels. Some thematic areas may be defined at either level, e.g. "Cancer" and "Neuroscience".

In many universities, research is almost entirely conducted within the framework of *research institutes* rather than in traditional departments, schools or colleges. This appears to be motivated by either by a realisation that the most important challenges facing humankind today need to be handled by interdisciplinary teams of researchers, or by the fact that internal and external funding sources demand interdisciplinary teams.

Being classified as a thematic area (or something equivalent) does not normally entail institutional funding for positions and running expenses, but some institutions use recruitment group leader positions actively. These are then time-limited for anything from 6 to 6 + 6 (12) years.

The way of organising research into thematic areas is quite new in most places, but the different informants overall consider this action as successful and something worth continuing, especially when initiated by researchers at the operational level. These are typically open to join for anyone interested.

Important advice was to build on strength, be generous with funding, not force cooperation and co-location, and not fill the new life science building too fast; it is much harder to undo structures that have been set than to expand structures that are successful. These are not surprising advices, but worth paying attention to in the process that UiO is in at the moment.

4. Input from external players

In the input UiO:Life Science has received from representatives of external institutions and companies, a number of life science-related research fields were repeatedly suggested to have high potential for innovation and business development:

Personalised medicine
Diagnostics
Immunotherapy and cancer
Radiopharmacy
Bioinformatics, genetics and genomics
Drug development
Preventive healthcare
Artificial intelligence and big data

Among other important research fields mentioned were:

Neurology
Immunology
Biomaterials
Antimicrobial resistance
Heart disease
Mental health
Age-related diseases
Microbiome
Medical imaging
Biostatistics

In order to attract important players in the health industry and facilitate entrepreneurship and start-ups, the participants emphasised that the life science building must offer:

- high quality core facilities, certified if possible, and superior support functions overall
- strong leadership encouraging and facilitating collaboration with the health industry
- good information to potential users, including information desk and instructive web pages
- predictability, stability, and security
- research candidates with excellent disciplinary skills as well as training and motivation to work in an interdisciplinary culture
- dedicated work space (office & meeting rooms) for the health industry for easy access and visibility within the life science building

All academic research should be characterised by excellence, with Centres of Excellence and K. G. Jebsen centres as obvious and desired flagships. It should be possible for external users to access core facilities both as a service and in collaboration with in-house researchers. The presence of both established pharmaceutical companies and incubators is important.

5. Thematic areas

5.1 Premises for selecting thematic areas

Premises for single activities

The document *Strategic utilization of VEV (the life science building) in life sciences*[12] defined a set of premises to guide the selection of research activities in the life science building. For the roundtable meeting February 10th 2020, these were slightly updated:

The research must:

- Contribute to international competitiveness (**Quality**)
- Strengthen convergence and contribute to collaboration and synergy between strong research environments across disciplinary boarders (**Convergence and synergy**)
- Contribute to making the life science building a resource to the whole life science community at UiO (**Resource**)

The research activities should preferably:

- Have a research profile with a large innovation potential and potentially also collaboration with industry (**Innovation potential**)
- Interact with research groups located in the life science building, in particular within chemistry and pharmacy (**Synergy in the building**)
- Collaborate with and involve research groups outside of the life science building (**Synergy within UiO**)
- Contribute to collaboration with specialised or generic research fields at other regional institutions, including Oslo University Hospital (OUS), Akershus University Hospital (Ahus) and the Norwegian University of Life Sciences (NMBU) (**Synergy beyond**)
- Have a clear advantage of being located in the building rather than elsewhere on campus (**Benefit of placement**)
- Have a visionary research profile dealing with an important societal challenge in life sciences that is also suitable for external funding applications (**Visionary**)
- Should incorporate and address one or more of the United Nations Sustainable Development Goals (**Sustainability**)

The last premise is new and has been added to follow up and corroborate the strong focus on sustainability in *The University of Oslo: Strategy 2030*.[2] We note that few if any projects will satisfy all the last seven items on this list.

Overarching premises for the portfolio of activities in the free life sciences area

It is important to emphasize that in addition to the above guidelines for individual research projects, the selection process for thematic areas must also consider how every single one of them fits into the overall set of the activities. This is needed to ensure, among other things, that essential core facilities, both instrument-based laboratories and *in vivo* facilities for animals and fish, maintain a highly skilled and qualified in-house user base. Dependence on the staff of the Departments of Pharmacy and Chemistry and NCMM, and/or external users will in most cases be insufficient.

We furthermore propose that the research activities of groups relocated into the free life science research area of the life science building must satisfy at least one the following premises:

- **Societal challenges**
- **Free basic research**
- **Innovation**

E*xcellence, convergence* and *synergy* are common basic elements for each. These premises preserve the three-pillar structure addressing excellent science, global challenges and innovation, as proposed in Horizon Europe 2021–2027 and the strategy of NFR. As also indicated by the list of premises for activities above, demands for *convergence* and *synergy* go beyond the life science building, which in many cases is expected to serve as a hub in a network with one or more external nodes.

5.2 Suggested thematic areas within life sciences

We suggest that activities within the following thematic areas are prioritised for allocation of research laboratories dedicated to *free life science* in the life science building:

- ANTIMICROBIAL RESISTANCE
- A SUSTAINABLE LIFE SPAN
- NEUROSCIENCE
- PERSONALISED MEDICINE
- ENABLING HEALTH TECHNOLOGIES
- OPEN LIFE SCIENCES

ANTIMICROBIAL RESISTANCE

Interdisciplinary approaches for combating an emerging global crisis

Bacteria that have gained broad resistance to antibiotics constitute a formidable public health threat and affect several vital areas of modern medicine. The increasing incidence of such multi-resistant microorganisms will present major challenges for individuals and societies, locally and globally, both in terms of prevention and treatment. Solutions to this problem are of critical social importance and require an interdisciplinary and integrated approach from many different disciplines, including medicine, pharmacy, dentistry, biology, chemistry, biostatistics, economics, law, simulation- and computational science, digital science as well as social sciences.

ANTIMICROBIAL RESISTANCE overlaps with the Faculty of Mathematics and Natural Sciences thematic area Molecular and cellular mechanisms, Figure 1. Basic molecular and cellular understanding is essential for elucidating biological processes, including antimicrobial resistance, and represent a natural part of this thematic area. Moreover, focusing on revealing underlying cellular and molecular mechanisms of antimicrobial resistance will strongly promote synergy with the environments outside the building, in line with premises defined in *The Strategic utilization of VEV in life science*.[12]

Research on antimicrobial resistance is perceived as highly beneficial to the society and is expected to generate great interest from public and business players, both locally, nationally and internationally, with particular emphasis on public partners, given the declining prioritization over time on the industrial side.

A SUSTAINABLE LIFE SPAN

Prevention and treatment for 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 burden to both individuals and the society. Concurrent use of multiple medications, i.e. *polypharmacy*, is common in the elderly – with the risk of adverse drug events, drug-interactions, medication non-adherence, reduced functional capacity and multiple geriatric syndromes. At the other end of the life span is the fetus and new-borns exposed to prenatal and perinatal environmental factors which may determine the development of human diseases in adulthood, and the infant and child lacking commercially available drug treatment.

Research within this field aims to contribute to delay or prevent aging and age-related diseases, both nationally and globally, with an emphasis on implementation of user participation from research to clinical practice. Underlying causes of a number of diseases can be identified at the level of mechanisms, paving the way for process-driven research that aim not just to describe, but also to explain causal relationships and thus contribute to better interventions and more targeted treatment. Multidisciplinary expertise is needed to integrate large amounts of data from different disciplines. Investigations of molecular and cellular mechanisms in process-driven projects are essential and will fit well in the life science building, where, among other things, there will be great expertise in bioinformatics. Due to the large societal consequences of an aging population and possible far-reaching consequences of interventions to curb aging, interdisciplinarity and collaboration with the humanities, social sciences, and responsible research and innovation (RRI) will also have a natural place in research on a sustainable life cycle.

NEUROSCIENCE

From synapse to brain

Neuroscience in different facets is a major field of research at many of the faculties at UiO. UiO has outstanding groups in neuroscience at both the Faculty of Medicine and the Faculty of Social Sciences. The thematic area 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. The research questions in neuroscience requires an interdisciplinary approach. A strong link to computationally heavy environments, including Centre for Bioinformatics and OCBE, represents a great potential that can also serve to strengthen life sciences in general.

A robust computational environment will be a resource for establishing links to other experimental activities both in the building and outside environments at the Faculty of Medicine and the university hospitals that lack a computational component, i.e. in a hub-and-node fashion. Integrated experimental and computational neuroscience already established at the MN-faculty may serve as a model. The focus on neuroscience can be an important contribution to meeting the convergence goal. The thematic areas will be easy to communicate, underpin the importance of the life sciences building and raise UiO's reputation.

PERSONALISED MEDICINE

Targeted diagnostics, treatment and follow-up

Personalised medicine is in rapid development and extends widely, from research on molecular and cellular mechanisms to determination of clinical parameters and tailored drug design for the individual patient. So far, research has been primarily focused on genomics and understanding how germline mutations that causes disease can possibly be corrected or treated and how new mutations in tumours can produce malignant transformation. In the future, personalised medicine is likely to be more about targeted treatment for each individual. In this context, information on lifestyle and environmental impact is essential. The vision of the right drug at the right dose to each patient is central, relying on a broad range of research involving different aspects of drug delivery and drug targeting.

Realization of the great potential that lies within the field of personalised medicine further requires an interdisciplinary approach from innovative health-technology and large-scale analysis. UiO has scientists with key expertise in important disciplines in this context, such as medicine, systems biology, pharmacy, chemical biology and computationally oriented subjects (bioinformatics, biostatistics, and biomathematics). Unique access to national health registers, combined with the development of mathematical predictive models and new digital tools will be crucial elements in understanding e.g. drug responses in light of genetic background (pharmacogenomics). Regulatory pharmacy is a new and highly relevant focus area in this context, intending to strengthen connection to clinical trials in Norway, increase regulatory competence related to registration of advanced products and develop various forms of patient services for variety of companies.

The development of new technological solutions, diagnostics and medicines for individually targeted treatment opens up for collaboration with commercial partners and subsequent innovations. There are also great opportunities for increased interactions with the university hospitals. Furthermore, the field should raise interesting questions in areas such as ethics and law.

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 pose serious challenges in todays and future health care systems, which require increased focus on new health-technology solutions. The life science building may thus become a relevant and highly attractive host for research in cutting-edge new biomedical technologies with elements from nanotechnology, 3D-(bio)printing, cell therapy, immunotherapy, gene therapy, regenerative medicine, drug delivery, biomaterial development, imaging and sensor technology.

The technologies can be used e.g. in drug delivery and to repair and rebuild damaged or dysfunctional tissues, bones and organs. This is based on a common understanding of how foreign materials work in the body, and how such materials can be designed and tailored to best fit into the body's biological and biomechanical environment. Combined with digitalization, e-health and collection of real time data, this opens new opportunities within electronic decision support systems, mobile applications and portable devices. In order to use the latest technologies, insight and knowledge are needed from biology, chemistry, physics, medicine, pharmacy, dentistry, mathematics, statistics, computer science, humanities, law, and ethics.

OPEN LIFE SCIENCES

Room for groundbreaking research on unforeseen challenges

OPEN LIFE SCIENCES has been included as the sixth thematic area to emphasise that UiO embraces any excellent research, regardless of whether it falls into the other five named thematic areas or not. OPEN LIFE SCIENCES stress our commitment and efforts towards promoting excellent research and our readiness to handle emerging, unexpected health threats, such as the pandemic SARS-CoV-2 outbreak.

Groups who are rewarded a Centre of Excellence or Centre for Research-based Innovation from NFR, or have received ERC grants, should be obvious candidates to fall into this category. Furthermore, OPEN LIFE SCIENCES should have the capacity to welcome novel, excellent initiatives, preferentially by open calls. Utilization of experimental core facilities in the building should then be especially considered.

5.3 Thematic areas and premises for the portfolio of activities

Societal challenges

Two thematic areas stand out as particularly relevant in addressing major societal challenges of today's world: ANTIMICROBIAL RESISTANCE and A SUSTAINABLE LIFE SPAN. These two research fields address emerging, global challenges, aiming to achieve sustainable development goals for people and the planet. Together with NEUROSCIENCE and PERSONALISED MEDICINE they can embrace several other research areas within life sciences, fulfil the other premises for the free life science areas, i.e. **free basic research** and **innovation**, and target several strategic areas of the proposed NFR strategy, i.e. Health and Welfare, Technology and Digitalization, and also Solidarity and Globalization.

Associated research activities will support core facilities and infrastructure in the life science building. The faculties at UiO (i.e. also those located outside the building) must take joint responsibility for development of activities within the category of **societal challenges**.

Innovation

Synergy-promoting activities in collaboration with e.g. OUS and commercial external partners are of vital importance for boosting the innovative capacity of UiO and fulfil international and national goals of transformational innovation. In this context, the localization of the life science building at the core of Oslo Science City is a great advantage for developing strategic partnership.

As knowledge and skills are our foremost resources for all future investments, innovative education will make a substantial part of innovative initiatives in the building. An important goal would be to facilitate and support innovation derived from research, and provide students with high-quality tuition in innovation and entrepreneurship. Together with The Norwegian Institute of Public Health and national partners, UiO has recently taken an initiative to establish a university-level education within *medical equipment and technology.* Thus, ENABLING HEALTH TECHNOLOGIES is the fifth prioritised thematic area in the free life science area of the building, which is also in line with the proposed NFR strategy, which is highlighting *Technology and Digitalization* and *Health and Welfare*.

Free basic research

The UiO:Life Science Strategic Advisory Board has emphasised groundbreaking, fundamental, cutting-edge research and the relevance of open calls in its recent evaluation of the strategic life science initiative. The thematic area OPEN LIFE SCIENCES has been included specifically to address this concern. The quality and breadth of basic research taking place at UiO forms a basis for raising the institution to the top European level of research-intensive universities, and investing in excellent, fundamental science inside the building will promote synergy between many scientific environments.

Figure 2 illustrates the interplay between the core basic elements *convergence, excellence* and *synergy*, the portfolio premises and the suggested thematic areas.

5.4 Thematic overlap

The five regular thematic areas described above are quite broad with no sharp borders between them. This implies that certain research fields could belong to two or even three different areas depending on the specific project and choice of perspective. Examples include *formulation of drugs*, which in some cases would fit with ANTIMICROBIAL RESISTANCE, while PERSONALISED MEDICINE would be more appropriate for other projects. Other pharmaceutical disciplines would be suitable for inclusion in A SUSTAINABLE LIFE SPAN.

5.5 Use of incentives to support thematic areas and achieve convergence

For winners of a Centre of Excellence, Centre for Research-based Innovation or recipients of large grants from the European Research Council (ERC), the contribution of UiO would be to provide lab space in the free area of the life science building, with associated office space and a daily life in close vicinity to experimental core facilities.

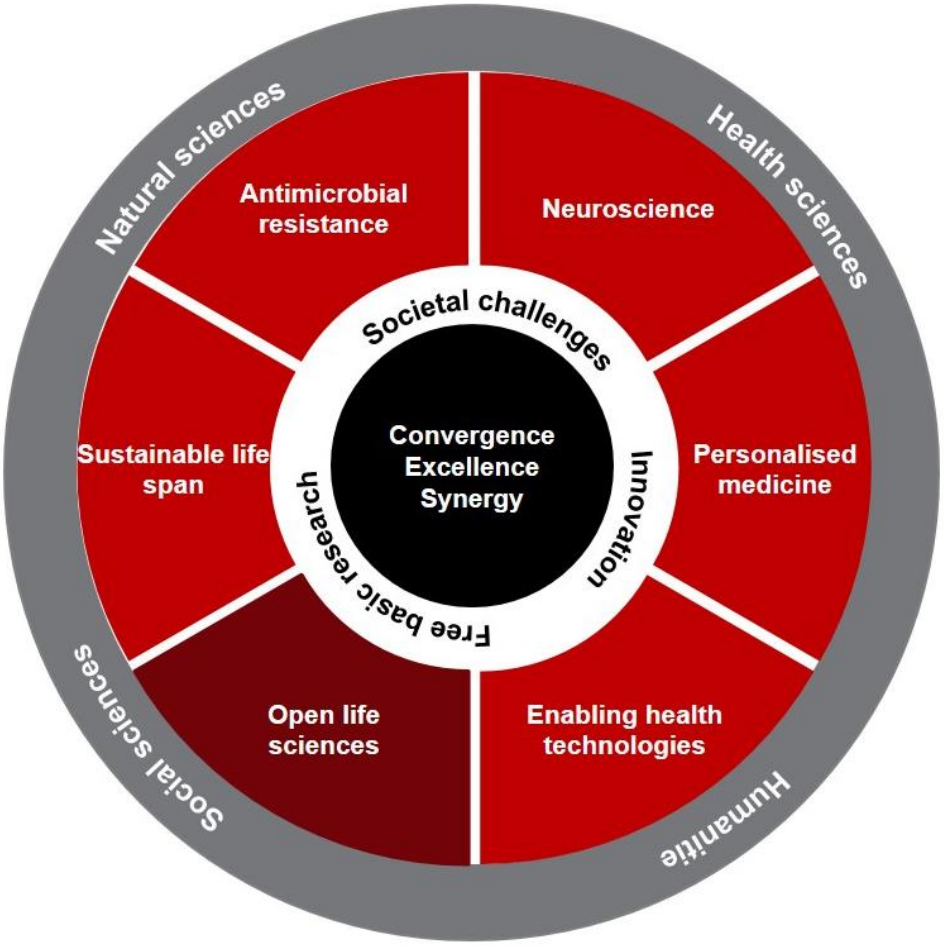

Figure 2. Prioritised thematic areas for allocation of research groups into the free life science area of the life science building.

As a mean to direct research efforts at UiO towards the defined thematic areas, there should additionally be regular funding calls for research within these areas. A plan describing possible funding schemes and sources should be developed in a separate process involving the managements and boards of pertinent departments and faculties as well as UiO:Life Science.

The authors of this report suggest that UiO:Life Science should contribute to the funding process by directing some of its resources towards the selected thematic areas. As real change with respect to research activity and culture is most efficiently boosted by recruitment of new academic staff members, pertinent departments and units all over UiO should furthermore carefully study future calls within thematic areas when new employments are planned. Allocation of sufficient supporting PhD and postdoc. positions should be part of such strategic considerations.

5.6 Use of available laboratories

The 2200 m^2 lab area reserved for free life sciences should be divided between users belonging to four different groups, all recruited by or selected through a transparent and open process:

- Research teams within the selected thematic areas.
- Areas allocated to 1–2 Centres of Excellence / Centres for Research-based Innovation / ERC winners in the field of life sciences, in particular within the selected thematic areas.
- Areas reserved for shorter research stays (1–12 months) for individuals and small groups
- Other prioritised research activities, primarily supporting core facilities in the building

6. Conclusions and recommendations

Societal challenges, **free basic research** and **innovation** are proposed as overarching premises for allocation of space in the free life science research area of the life science building, with *convergence*, *synergy* and *excellence* as basic elements of all activities. Under these criteria, we suggest the following thematic areas:

- ANTIMICROBIAL RESISTANCE
- A SUSTAINABLE LIFE SPAN
- NEUROSCIENCE
- PERSONALISED MEDICINE
- ENABLING HEALTH TECHNOLOGIES
- OPEN LIFE SCIENCES

Any group who has been awarded substantial external funding, including Centres of Excellence, a Centres of Research-based innovation or ERC grants, may be supported in OPEN LIFE SCIENCES.

The suggested thematic areas will share the life science building with the Department of Chemistry and the Department of Pharmacy from the Faculty of Mathematics and Natural Sciences as well as NCMM, OCBE and Centre for Bioinformatics. Together, these units directly or indirectly cover most life science-related research fields suggested by the external players to have high potential for innovation and business development.[10] The strong emphasis on excellence in all regards, and the creation of broad and highly competent user bases for advanced core facilities are furthermore what the external players point out as key elements for developing the life science building into a centre of gravity for life science research in the Oslo region and nationwide.

All suggested activities should be carried out within the frame of the established departments and faculties.

Time aspects need to be discussed in a separate, dedicated process. These include onset, duration, periodic evaluation of internally funded projects (i.e. not within OPEN LIFE SCIENCES) and termination of the proposed thematic areas, the frequency of funding calls, as well as concrete number of associates assigned to each of the proposed themes in the free areas of the life science building. Whereas project plans and milestones for some initiatives may be determined ahead, others will depend on the outcome of ongoing processes that are not finalised at this point, and should therefore not be determined prematurely.

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