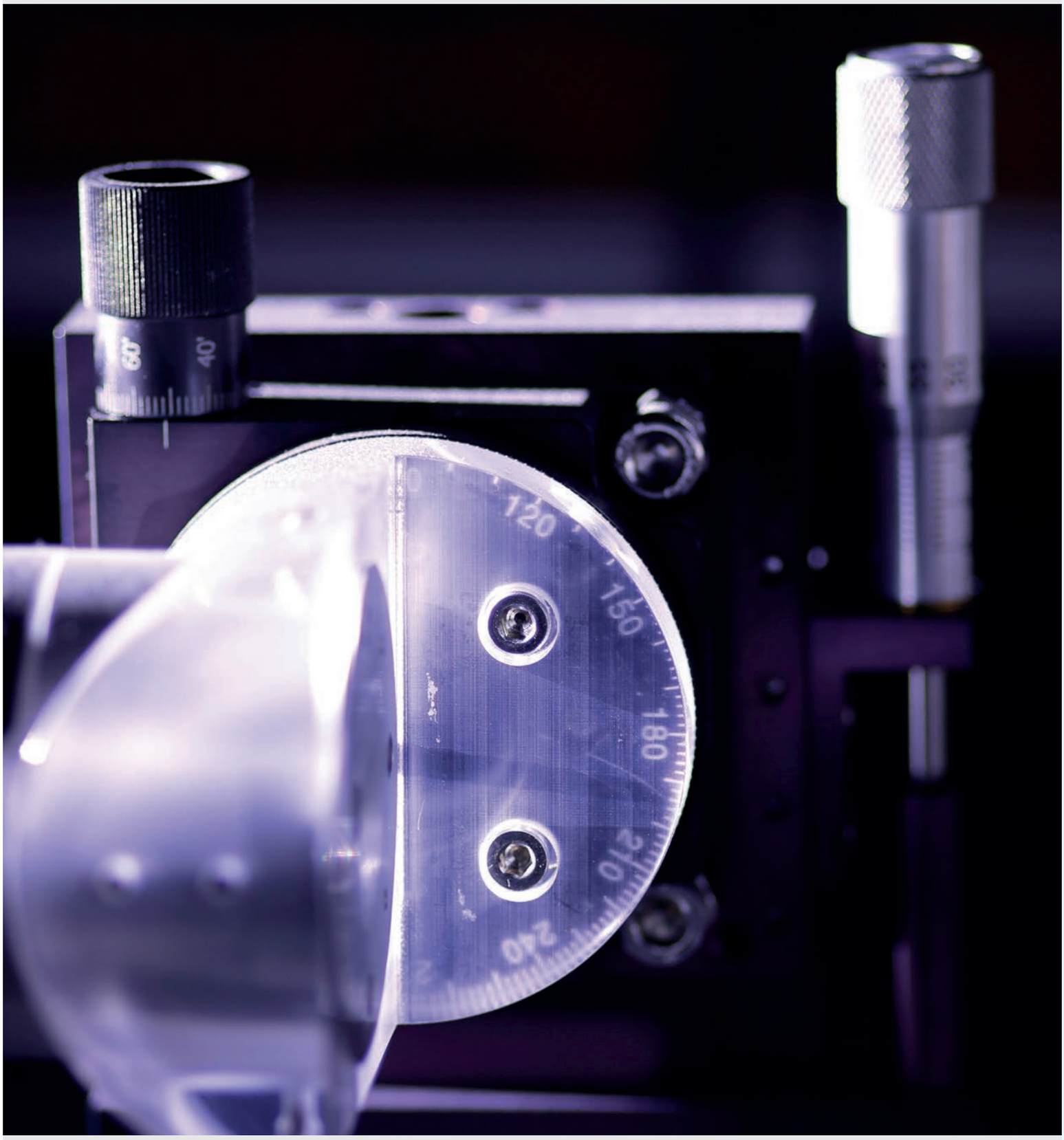
CENTRE FOR DIGITAL LIFE NORWAY

ANNUAL REPORT 2016

Founding a national research centre

Establishment and trust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FROM THE CENTER LEADER

Dear all!

Centre for Digital Life Norway (DLN) has been up and running for one year! DLN is a virtual center consisting of one umbrella network project together with many research projects and it represents a milestone and fundamentally new way of organizing biotechnological research not previously tested neither in Norway or internationally. The expected outcome of this organization is more synergies and added value out of the research projects and DLN sets a new standard for collaboration across the geographical distances.

As an enabling technology, biotechnology combines different knowledge areas and it relies heavily on interactions with other sciences and technologies. The intersection of life sciences and digital technologies will provide great opportunities for all four areas (blue, white, green and red) of biotechnology. Key features of biotechnology development as we see it today are big data, digitalization, and transdisciplinarity. In addition, there are huge expectations that biotechnological innovations will make major contributions to the rising bio economy. DLN aims to meet this rapid development and these high expectations and with this Centre we are rigging ourselves for the future. One main goal is more sharing and more collaboration. DLN also addresses relevant societal challenges and Responsible Research and Innovation is a crosscutting activity of entire Centre.

DLN is an invitation to engage! One key target group are the young scientists and DLN shall represent an important and well-functioning meeting arena for networking, exchange of knowledge and competence as well as for inspiration and career development. The first year of DLN has been dedicated to "establishment and trust"; establishing the foundation for the organization and time to map, orientate and find our place in the Norwegian Biotechnology landscape. It has been learning by doing, interactions and arrangements together with scientists and other stakeholders, and most of all it has been inspiring and meaningful. This report summarizes the main activities and achievements of this first year and we are looking very much forward towards the continued development of DLN together with the biotechnology society in Norway.

Sincerely,

Trygve Brautaset

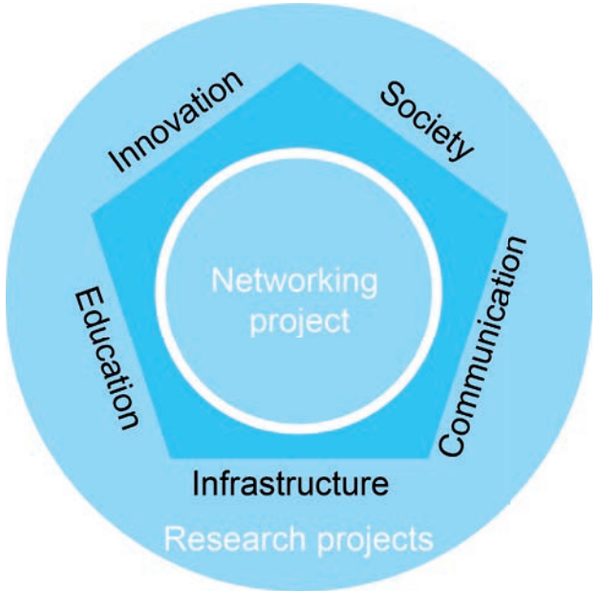
ABOUT DIGITAL LIFE NORWAY (DLN)

Centre for Digital Life Norway is a national center for biotechnology research, innovation and education. It is a unique milestone for transdisciplinary research, which develops new knowledge and new ways to create value and respond to the challenges of society.

The centre is managed by a networking project, and the management is distributed across the three universities NTNU, UiO and UiB. These universities constitutes the hub of the centre. Institutions that lead research projects within the centre become nodes, which in 2016 was SINTEF and NMBU.

2016 was the start-up year for the centre, and foundations for important internal structures were shaped. In addition, the centre arranged several events like the annual conference, meetings for innovation as well as competence and infrastructures, and finally workshops and lectures. An internal part of the centre is the DLN research school, open for all interested PhD students and post docs at Norwegian universities and schools.

Research and innovation projects, as well as the networking project are funded by directed calls in the Norwegian Research Council's program Biotechnology for Innovation (BIOTEK2021). In addition, other relevant projects are welcome to apply to join the centre. The projects combine digital technology and biotechnology, and they span the areas of health, aquaculture, agriculture, and industrial biotechnology. In 2016 the centre had six large research projects that are presented in this report.



DLN FOCUS AREAS

MANAGED BY THE NETWORKING PROJECT

EXECUTED BY THE RESEARCH PROJECTS

For further information, please visit our webpage at digitallifenorway.com or follow us on Facebook: Centre for Digital Life Norway.

DOUBLE INTRAPERITONEAL ARTIFICIAL PANCREAS

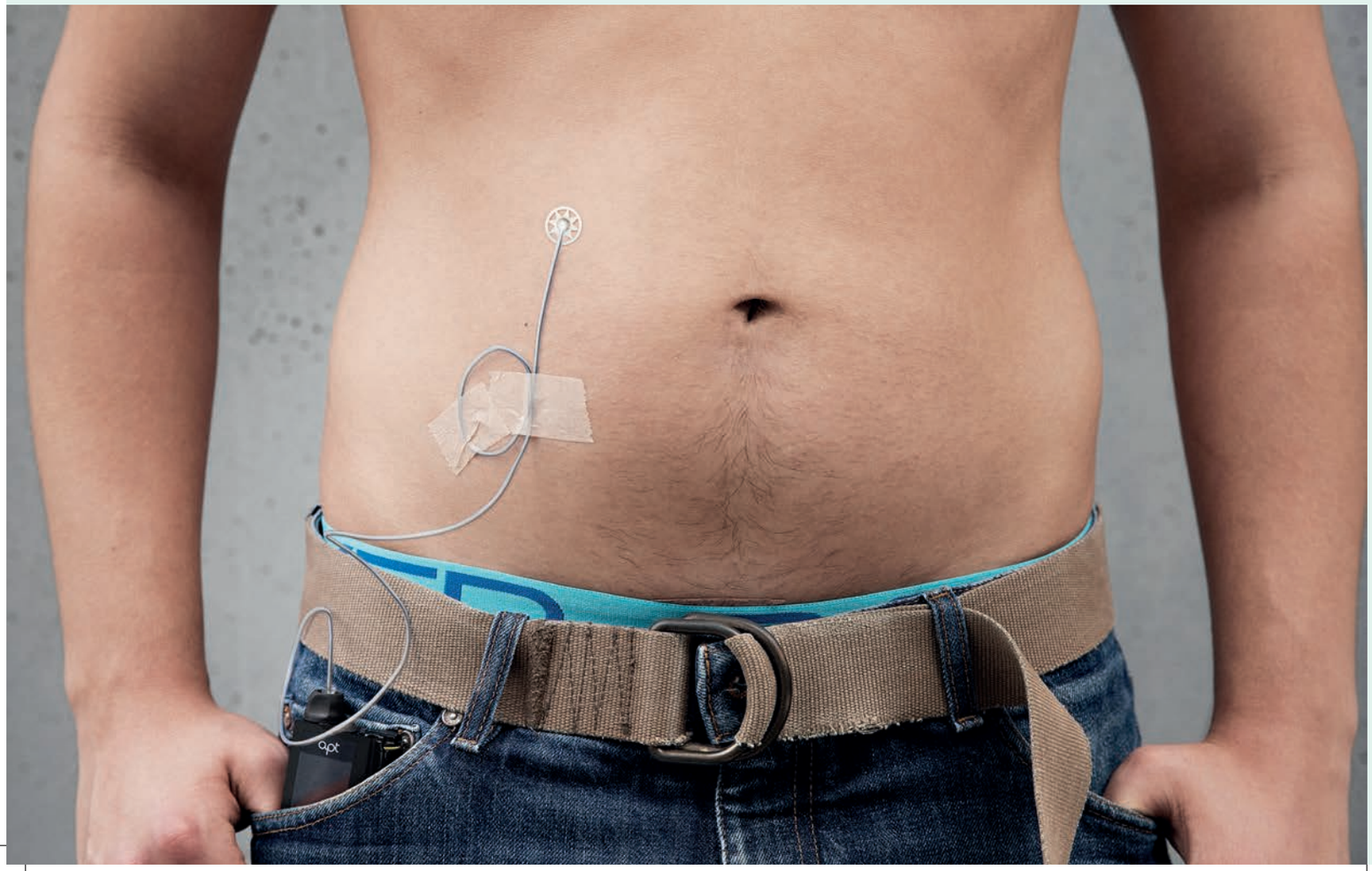
The Artificial Pancreas Trondheim (APT) research project is about continuous closed-loop control of glucose levels in people with diabetes type 1. These patients are fully dependent on correct insulin doses in order to normalize the glucose level, which is challenging for patients as well as health care professionals.

The final project goal is a fully automatic system for insulin dosing based on continuous glucose sensing. A major challenge for automatic insulin systems is the delay from injection of insulin under the skin until the main effect on glucose level. Continuous sensing of glucose levels is also challenging.

AMBITION

Our solution is to inject insulin and measure glucose in peritoneum; the space between the intestines, where insulin is absorbed much quicker than from under the skin. Computer simulations by APT show that since both insulin absorption and glucose sensing are much faster in the peritoneum, it should be possible to achieve almost the same glucose regulation as in people without diabetes.

In this project, 2–3 new glucose sensors will be developed for sensing in the peritoneum, we will design a "port" into the peritoneum for both sensing and infusion of insulin, and we will develop the rest of the system needed to test this in animals and later in humans.



ALL THIS WILL BE DONE TOWARDS OUR VISION:

- To eliminate the daily burden and long-term adverse effects of diabetes mellitus.
- Patients with diabetes mellitus should have the same life expectancy and quality of life as people without this disease.

The aim is to create a safe and robust artificial pancreas for patients with diabetes that makes it possible for patients to forget on a daily basis that they have diabetes type 1. To achieve this, we have to create an artificial pancreas that provides patients with normal or near-normal glucose levels throughout the day without risk of serious hypoglycemia.

ACTIVITIES

APT's activities in 2016 include:

- Hiring of 6-7 new employees, including PhD students, postdocs and researchers.
- Planning and initiating pilot animal studies for testing of intraperitoneal glucose sensors and intraperitoneal insulin infusion.
- Setting up a new lab for in-vitro development and testing of novel spectroscopic glucose sensors.
- Initial in-vitro tests of mid-infrared and Raman spectroscopy for glucose sensing in peritoneal fluid.
- Initial design and manufacturing of probes for glucose sensing in peritoneum.

ACHIEVEMENTS

At the IFAC DYCOPS-CAB conference in Trondheim in June 2016, Stavdahl presented our hypotheses and strategy, advocating the double intraperitoneal (IP) artificial pancreas.

We have also published a journal paper showing results of a prototype glucose sensor performing surprisingly well in peritoneum. IP measurement is faster than previously believed; sometimes almost as quick as intraarterial measurements. This confirms our hypothesis of very rapid dynamics between blood and peritoneum. 3-6 Feb 2016: Members of the APT research group attended the ATTD conference in Milan, Italy and presented two posters.

A new series of experiments in 2016, using a modified commercial glucose sensor shows promising results.

By Sven M. Carlsen

Projectleader APT

DCOD 1.0: DECODING SYSTEMS TOXICOLOGY OF COD (GADUS MORHUA)

The goal of the dCod-project is to combine the competencies in environmental toxicology, biology, bioinformatics and mathematics across the traditional department boundaries, to create a deeper understanding of cods' adaptations and reactions to stressors in the environment.

ACTIVITIES

dCod has had an active year, and some of our activities are described here. Much of the year was spent recruiting PhD and Postdocs at the different partner institutes and institutions. By November 1, all positions were filled. A Steering Group (SG) consisting of Anders Goksøyr, Guttorm Alendal, Dorothy Dankel (UiB), Bjørn Einar Grøsvik (IMR), Augustine Arukwe (NTNU), Ketil Hylland (UiO), Daniela Pampanin (IRIS), Jan Ludvig Lyche (NMBU), Malin Celander (GU, Sweden), and Nancy Denslow (UFL, USA) has also been appointed.

The dCod started off in April 2016 with a kick-off meeting in Bergen April 28-29 with participants from all partners attending in person or by skype. On December 15-16, 23 participants from almost all Norwegian partners of dCod met to discuss a common language across disciplines, data handling and management, RRI, as well as team building activities.

RESEARCH

Experiments throughout the years have included cod liver slice cultures, caging experiments close to the old dumping site for urban waste in the bay of Kollevåg, near Bergen, IMR sampling of wild cod from the North Sea and UiO collection of cod from Oslofjord. Further preparations for both wet lab and bioinformatics/modelling has been done for omics analyses, phenotypic anchoring, Topologival Data Analysis and Dynamical Modelling. The work to identify biomarkers for WP8 has been initiated.

The dCod project has had a strong focus on RRI perspectives. The Kollevågen caging study (see WP1) was designed in collaboration with the City of Bergen's Environment Office and the company Fishguard AS. We have produced a video describing the study, and we have made good local press coverage, as well as presentations at national and international meetings (see below).

PRESENTATIONS

The dCod 1.0 project has been presented at several meetings during 2016. The project was presented at the Digital Life Norway opening conference in Trondheim April 19, at the DLN workshops on Technologies for Digital Life (Bergen, October 20-21), and on Data Sharing and RRI (Trondheim, November 23-24). Several dCod members participated in the National Environmental Toxicology Symposium (NETS 2016) organized in Oslo by NMBU and NIVA October 26-27, both with oral presentations and posters. The project was also presented at Havforskermøtet (Marine Scientist Meeting, Bergen, November 14-16) with an oral presentation and a poster. dCod was also represented at two international meetings, 30th ESCPB and 17th ICSB, both in Barcelona, Spain, with both posters and oral resentations.

Post doc fellow Marta Eide (UiB, BIO)presenting her talk on the chemical defensome of Atlantic cod at 30th ESCPB, Barcelona.

ACHIEVEMENTS

2016 has been mostly devoted to getting activities started and setting up experiments. A number of samples have been generated and data have startet to accumulate from these samples. We also feel that we have developed a good cross-disciplinary working environment, with meeting places for biologists and mathematicians/

Sampling of cod after caging in Kolevåg, Askøy, near Bergen.

bioinformaticians, slowly establishing a common language across research groups in the project. The project has been well represented at national and international conferences, creating a good visibility of dCod 1.0 as well as the Digital Life Norway initiative through various presentations.

With regards to innovation, contact has been established between the Math group at UiB (Morten Brun) and BTO (Bergen Tech-Transfer Office) about a new method for topological data analysis.

AMBITIONS

Our ambitions are to continue this development. We foresee large data masses being produced in the first half of 2017, which will be fed into bioinformatical and mathematical workflows in WP6 and 7. We also foresee increased activities in RRI. We are planning two large in vivo aquaria exposures with cod, as well as new sampling campaigns of coastal and North Sea cod. We are also planning a research school in fish toxicogenomics in Kristineberg, Sweden in August.

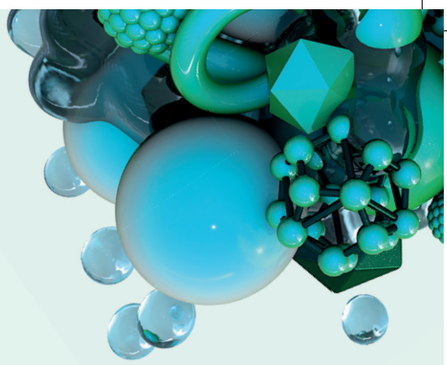
By Anders Goksøyr
Project Leader dCod

DIGIBRAIN: FROM GENES TO BRAIN FUNCTION IN HEALTH AND DISEASE

Brain-related disorders are some of the largest healthcare challenges in the world today and are projected to increase in aging populations. Unfortunately, the mechanisms underlying brain disorders are poorly understood, often leading to inefficient treatments with negative side effects.

In DigiBrain, we are approaching these problems from several angles, with the long-term goal of linking genes to behavior and ultimately finding alternative, patient-specific treatments. To achieve this, we have created a multi-disciplinary platform, bringing together experts and methods from experimental neuroscience, mathematical modeling, and clinical measurements.

Together with international collaborators, DigiBrain partners have used large genome-wide association studies to identify a few hundred gene variants that are associated with schizophrenia and/or bipolar disorders. Many of these genes are involved in neuron function and may impact the way in which neurons communicate with one another. By developing detailed mathematical models of neurons, we can perform high through-put screening on the possible effects of candidate risk genes. The most promising candidate genes will be brought to animal model systems and gene editing tools (e.g., CRISPR/Cas9) can be used to specify the links between specific gene variants and observable neuron function. The findings from these experiments will be compared to measurements of brain activity and studies of stem cells from the same human patients and controls. By uncovering the relationships between the risk gene variants and neuron function we hope to explain some of the underlying mechanisms of schizophrenia and bipolar disorders, which may in turn lead to novel drug targets or new applications for existing drugs.



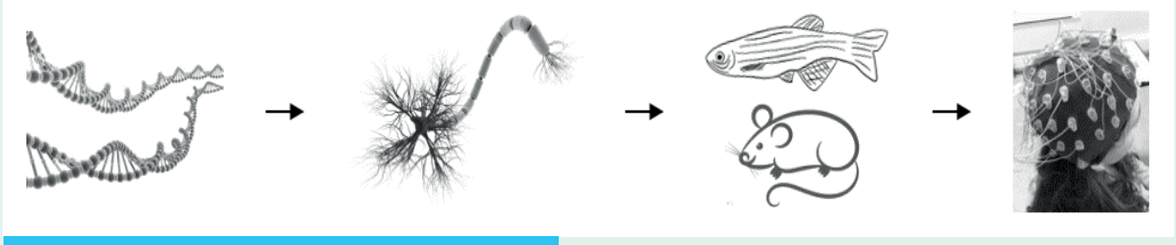
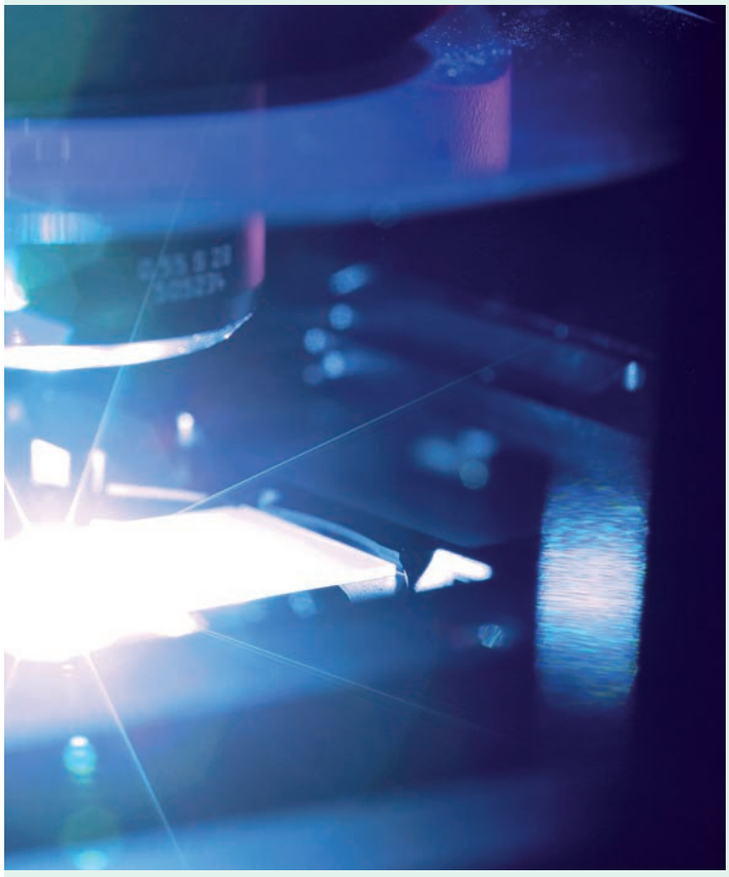


Figure 1: DigiBrain – investigating brain-related disorders on different levels, from genes to neuron models to animal models and humans

Since the kick-off meeting in January of 2016, DigiBrain has grown to include 20 people (hired in 2016: 1 researcher, 2 postdoctoral fellows, and 2 PhD students), and will expand further in the years to come. Though our interdisciplinary team already combines a wide variety of expertise, our participants take part in seminars, workshops and conferences to further expand their knowledge and skills, such as the 1st Meeting in the DLN Competence and Infrastructure Network (20-21 Oct, 2016, Bergen), the Workshop on Data Management and RRI (23-24 Nov, 2016, Trondheim), and the Society for Neuroscience 46th Annual conference (12-16 November, 2016, San Diego, USA).



By Marianne H. Fyhn
Project Leader DigiBrain

TOWARDS THE DIGITAL SALMON: FROM A REACTIVE TO A PRE-EMPTIVE RESEARCH STRATEGY IN AQUACULTURE (DIGISAL)

Systems biology will aid sustainability in salmon farming. Scarcity of fish oil has forced development of novel feedstuffs, challenging the salmon's metabolism as well as our understanding of it.

ACTIVITIES

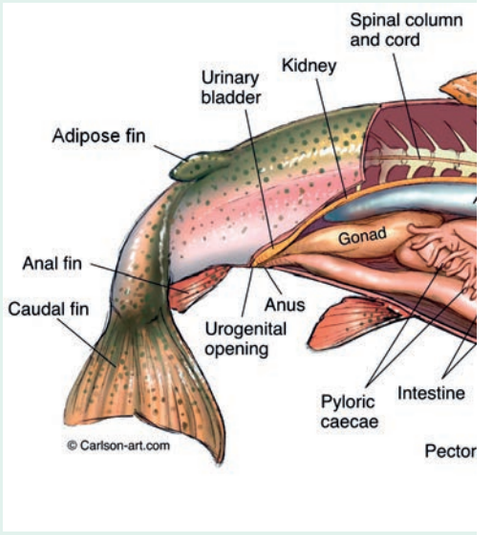
DigiSal's startup year has seen successful methods development, outreach to several audiences, and some challenges in recruiting specialists for some key transdisciplinary aspects of the project.

Our startup meeting in March 2016 established contact between partners that had not previously collaborated, with presentations of key tools and methods: mathematical modelling, wet-lab molecular biology, Crispr gene editing, and data and model management.

Experiment-wise, we have developed methods for liver-slice culture, metabolomics, and gene editing, using fish from collaborating projects. This has made us well prepared for 2017.

In August 2016, the Digital Salmon (the long-term initiative that DigiSal is part of) became an official partner in FAIRDOM, the multinational initiative for Findable, Accessible, Interoperable, and Reusable -- Data, Operations and Models. We featured as a "star use case" at the first FAIRDOM User Meeting in Barcelona, Sept 2016. We are also advising Digital Life Norway and the Research Council in facilitating and harmonizing data and model management.

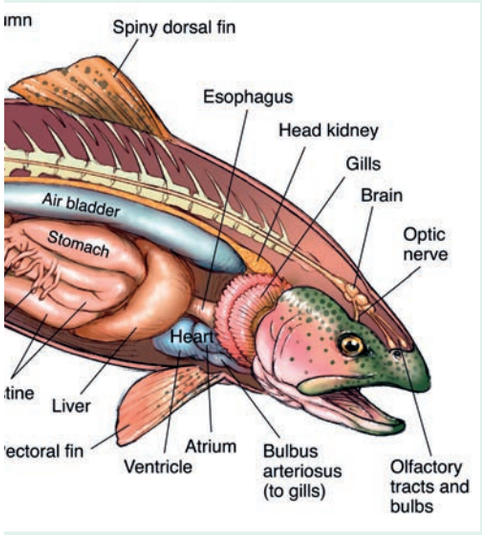
DigiSal is designed to be driven by mathematical modelling, because formulating biological knowledge in mathematical terms helps make it more explicit. This facilitates discussion between partners from different scientific disciplines, and helps confront theory with data. However, recruiting a mathematical modeller for this work proved frustratingly hard and has delayed progress on this front. Happily, the modelling team is now complete and we expect rapid development of a genome-scale metabolic reconstruction in 2017.



The other recruiment challenge has been in knowledge management. "Semantic web" information technologies make it possible to connect databases from disparate sources, including linking data to mathematical models. We expect this to become a mainstream career path for bioinformaticians over the next decade. Presently, however, we have learned that very few current candidates possess the combination of skills required for this task. Meanwhile, we have designated existing engineer/bioinformatician staff to ensure basic standards in data and model management.

ACHIEVEMENTS

DigiSal became a partner in the FAIRDOM multinational initiative for findable, accessible, interoperable and reusable (FAIR) knowledge.



We presented the vision of the Digital Salmon knowledge base in five invited talks to various audiences: innovators and biotech startups, research project developers.

Research activities are underway: Methods have been tested and tuned for liver-slice culture, metabolomics and gene editing. Pipelines for automatic annotation of gene function in salmon have been set up. We have gathered eggs of brown trout for a study of adaptation to shortage of essential fats, which may shed light on untapped genetic potential of salmon.

AMBITION

Salmon farming in the future must navigate conflicting and shifting demands of sustainability, shifting feed prices, disease, and product quality. The industry needs to develop a flexible, integrated basis of knowledge for rapid response to new challenges. Project DigiSal will lay the foundations for a Digital Salmon: an ensemble of mathematical descriptions of salmon physiology, combining mathematics, high-dimensional data analysis, computer science and measurement technology with genomics and experimental biology into a concerted whole.

DigiSal will focus on challenges of novel feedstuffs. Salmon are carnivores but today aquaculture provides more than half their fat and protein from plants, challenging the metabolic system and affecting fish health and nutritional value of salmon meat. The newly sequenced salmon genome and related resources will enable a tightly integrated theoretical-experimental study of mechanistic interactions among genetic and feed factors.

Systems-oriented mathematical and statistical modelling will be central, using existing and novel knowledge e.g. on metabolic reaction networks to guide design of experiments through multiple iterations. Metabolic function of fish will be characterized via multiple omics technologies in feeding trials and in vitro tissue-slice culture. Gut microbiota will receive particular attention. The resulting massive data will be summarized via multivariate models to deliver a predictive understanding of a whole range of possible diets, much more efficiently than by traditional feeding trials alone. Data and models will be annotated using bio-relevant ontologies, so that new knowledge automatically connects to that which already exists. Future challenges will be met by quickly reanalysing existing information and understanding of salmon biology, identifying knowledge gaps, acquiring new data and incorporating it into a unified whole. Thus, we begin a shift from a reactive to a pre-emptive R&D strategy in aquaculture.

By Jon Olav Vik
Project Leader DigiSal

INBIOPHARM - INTEGRATED NOVEL NATURAL PRODUCT DISCOVERY AND PRODUCTION PLATFORM FOR ACCELERATED BIOPHARMACEUTICAL INNOVATION FROM MICROBIAL BIODIVERSITY

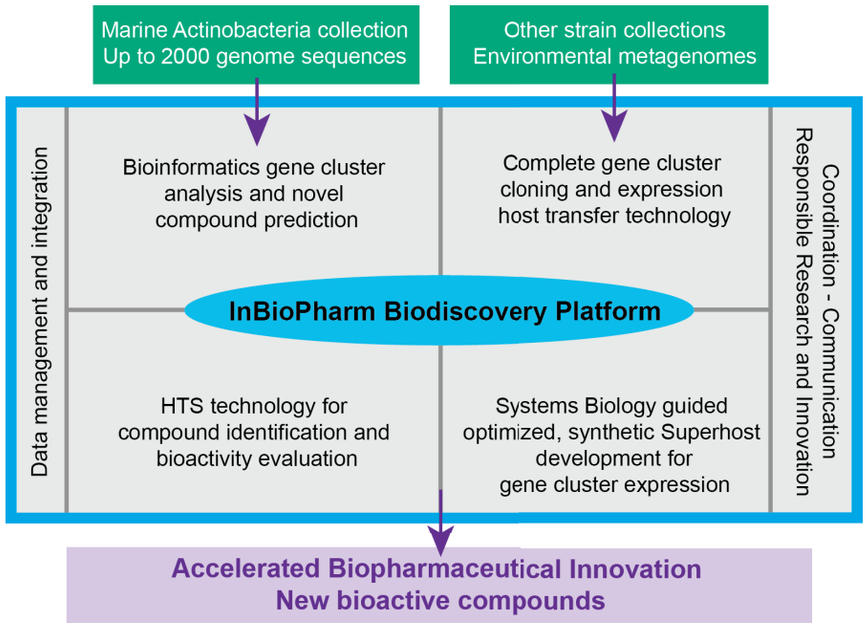
Spreading of antibiotic resistance among human pathogenic bacteria is a major global health concern, and new strategies for discovery and development of new medical products is needed. The INBioPharm project applies a multidisciplinary approach to develop a new technology platform that will solve key bottlenecks in bioprospecting for new bioactive compounds, with a main focus on new antibiotics from microbial biodiversity of the Trondheim fjord. The different modules of the INBioPharm biodiscovery platform are visualized in the figure below.

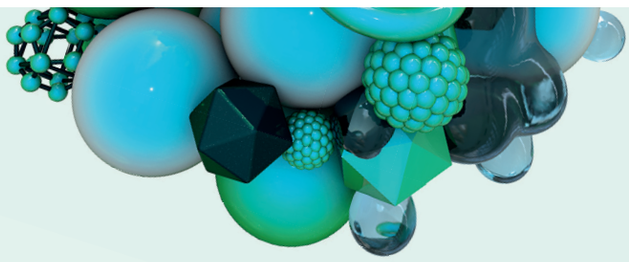
Actinobacteria are prolific, well-validated, and well-studied as a source of bioactive compounds with medical potential, delivering the majority of antibiotics in medical use today. However, Actinobacteria have a high number of silent gene clusters that can be expected to code for new antimicrobial and anticancer compounds.

ACTIVITIES, ACHIEVEMENTS AND AMBITIONS

Activities during the first ten months has mainly been establishing the administrative and experimental framework for the project. One PhD student and one Post-doc were employed at NTNU, as was one additional PhD student at SINTEF. The project's steering group was formed late in 2016, and the formal kick-off meeting of the project between

Modules of the INBioPharm biodiscovery platform, as well as its biodiversity inputs and envisioned main achievement.





SINTEF and NTNU held in October 2016. For competence building, a SINTEF researcher visited collaborators at Auburn University (USA) for three weeks in August 2016.

Dissemination included invited talks on five seminars and conferences in Trondheim and abroad, as well as a poster presentation at the international conference Functional Metagenomics 2016 on Inderøy, organized by SINTEF. Two more invited talks on international conferences and one more scientific poster are scheduled in the first half of 2017. The project contributed to two DLN reports and presentations of the project on the DLN and RCN website and was covered in popular scientific articles in NBSnytt, Gemini and Forskning.no. Project staff attended the Centre's opening conference in Trondheim in April 2016, as well as subsequent Volterra lectures and workshops organized by DLN.

All the NBioPharm research activities have started in parallel in all different project modules depicted in Figure 1. Development and application of dedicated bioinformatics workflows for integrated data analysis have also started. First analyses identified a large number of new species in our strain collection and predictions of new biosynthetic gene clusters (BGCs). For discovery of new bioactive compounds, BGCs need to be moved between, and expressed in different host bacteria. Hence, efficient cloning and transfer technology for large genomic DNA inserts in a suitable vector system is crucial. Pilot experiments are expected to be finalized early in 2017. Further optimisation, parallelization and automatization of this technique to comprehensive clone libraries is currently work in progress.

Within different host strains to be developed in the project, experimental monitoring of the intracellular status is important in bioactive compound production processes, as the microbial cells switch from a growth mode to production mode. New methods for such monitoring have been developed, complementing existing methods. Analytical strategies for advanced MS have been defined and are currently being evaluated for their detection sensitivity, identification of known and novel bioactive components, as well as high throughput capabilities.

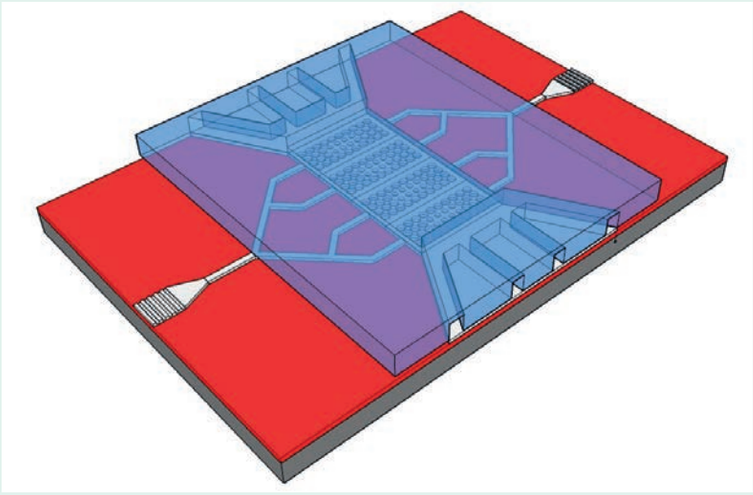
For initial exchange of comprehensive amounts of data within the INBioPharm consortium, an SFTP server has been set up. The possibility to integrate this with resources like NeLS (Norwegian e-Infrastructure for Life Sciences) is being assessed in connection with a local instance of SEEK at SINTEF for data management that is currently being tested.

In summary, the initial year 2016 of the INBioPharm project was characterized by efforts to generate a solid framework for a successful performance of the project. This included the necessary administrative tasks and initiating research activities on a broad basis in accordance with the work plan. INBioPharm is a highly ambitious project, in particular due to its integrated and interdisciplinary character, and by requiring simultaneous, coordinated technological advancements in the different modules of the novel biodiscovery platform. However, with the solid framework set in 2016, an efficient performance of project in 2017 and beyond is ensured, and the project team is confident to deliver according to the plans and expectations.

By Alexander Wentzel
Project Leader INBioPharm

LAB-ON-A-CHIP BIOPHOTONIC SENSOR PLATFORM (LOC)

The overall goal of the project is to develop a generic lab-on-a-chip (LOC) label-free biophotonic sensor platform capable of performing highly sensitive and selective multiplexed quantitative diagnostic tests with minute sample volumes. Laboratory functions will be realized on a chip at the size of a stamp with integrated components including biophotonic sensor elements, micro-/nanofluidic channels and read-out circuits. Micro-/nanofluidic channels will guide the transport of fluids containing target biomarkers to the multiplexed sensor elements. Surface functionalization of each sensor element with specific capture moieties mediates detection of their partner biomarker thus enabling numerous biomedical applications. To the right is a schematic illustration of a LOC sensor configuration with four sensors that are surface functionalized for different target biomarkers and a micro-/nanofluidic channel to transport the sample fluid.



ACTIVITIES

In 2016 there were three LOC project seminars, a kick-off seminar, and project seminars. In addition there were regular work package, Management Board, and student meetings. One post doc - and one PhD student were hired. In addition an NTNU financed PhD student and 3 master students worked on the LOC project.

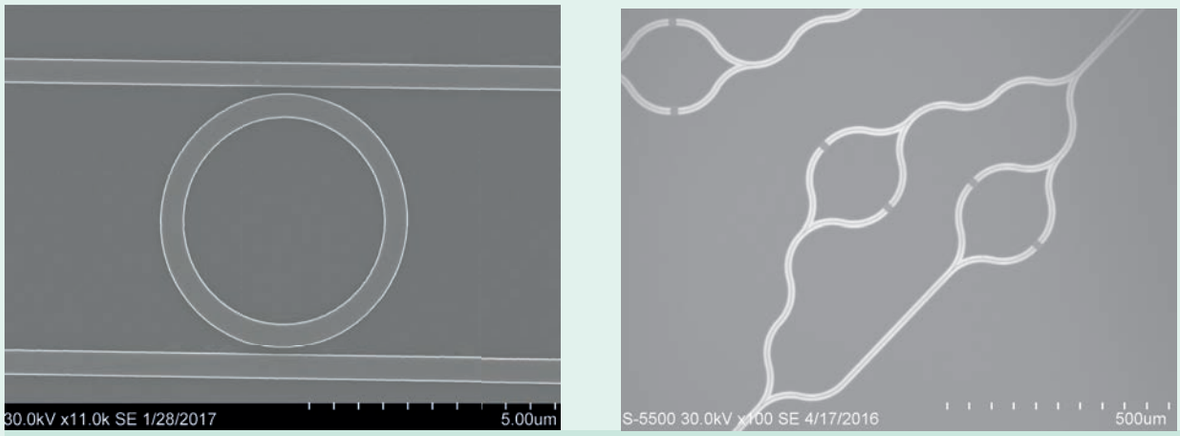
An Industrial Advisory Board (IAB) is being constituted to support the consortium with exploitation plans and know-how from the med-tech industry as well as medical user expertise i.e. from the field of oncology.

In 2016, the focus has been on overall planning of all aspects of the sensor concept including design, biomolecule immobilization, delivery of the sample to the detection sites of the photonic sensor, and signal readout. Different configurations of single channel sensors have been designed, simulated and fabricated on a silicon-on-insulator (SOI) platform using photolithography techniques. The first sensors have been optically characterized using a scanning electron microscope (SEM) and a specially designed optical transmission setup. Approaches for sensor surface modification and bioconjugation to enable controllable, stable, regiospecific biofunctionalization of the sensor compatible with photonics and microfluidics have been reviewed. Two chemistries have been selected. Finally workshops and work package meetings were held in 2016 to address micro- /nanofluidics issues.

ACHIEVEMENTS

Protocols for SOI processing have been developed. First generation single channel photonic sensors have been designed and fabricated on a SOI platform using photolithography techniques. A specially designed optical waveguide transmission setup with a tunable laser was built. Optical characterization has been performed using SEM and the optical waveguide transmission setup.

Different photonic sensor designs will be investigated before fabricating and assessing the most promising candidates. The ambition is to have adequate control over the critical parameters for biopatterning the sensor elements late 2017. From there we will explore the performance of the functionalized sensor, adjust patterning according to results and better integrate the biopatterning process with microfluidics and sensor fabrication.



Examples of SEM images showing an optical ring resonator sensor element (left) and a multiplexed configuration of four sensor elements (right).

A post doc has been hired who will have focus on surface functionalization. Protocols for use of the necessary instruments have been established. A specific strategy to advance the biopatterning has been implemented. An overall design of the photonic biosensor has been developed, including the first two generations of the micro-/nanofluidic system. A PhD candidate for the micro-/nanofluidics has been recruited.

A first generation of the nanofluidic prototype will be finalized in 2017, and together with the nanostructured sensor element, biofunctionalization protocols and readout optics/electronics developed in this project, the very first version of the nanophotonic biosensor will be tested on protein samples. The next generation LOC sensor will contain four multiplexed sensor channels with three different target biomarkers and a reference channel.

AMBITION

The LOC project will pursue to create awareness through communication activities of the project and its goals amongst the target stakeholder groups.

By Astrid Aksnes
Project leader LOC

INNOVATION AND INDUSTRY INVOLVEMENT

This initial year has been devoted to develop future strategies and the innovation platform of the Centre. Additionally, a survey identifying stakeholders and market opportunities within the field of digital biotechnology in Norway has been done. The report will be presented and discussed at our innovation day on the 21st of March 2017. Within the next year, we hope to make further valuable interactions with innovative researchers, TTOs and other prosecutors in the innovation ecosystem.

MAIN ACTIVITIES IN 2016

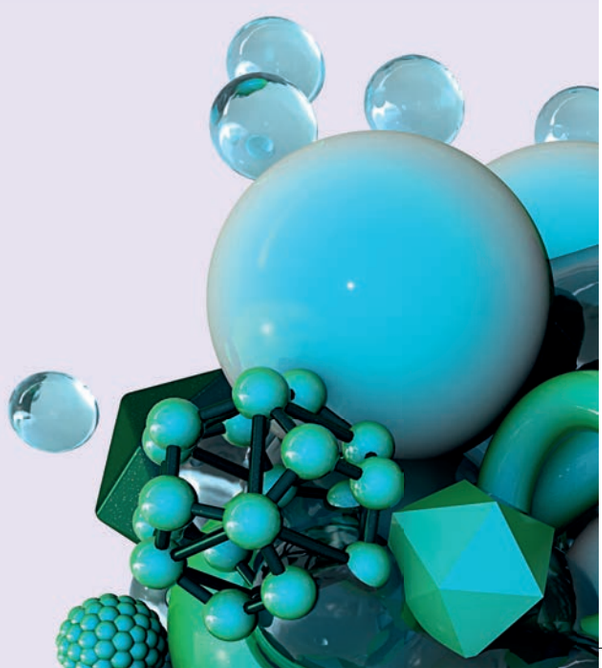
A major milestone was to identify stakeholders and to analyze market opportunities within the field of digital biotechnology in Norway. A task group of key personnel representing TTOs, innovation clusters and companies across Norway was recruited for giving input to the work and the future role of WG2. The task group was appointed at our first stakeholder meeting at Oslo Gardermoen on the 17th of June. At this meeting authorities and stakeholders from both industry and academia met to discuss how to obtain a strong and more innovative biotechnology sector in the digital era we are approaching.

Stakeholdermeeting in Oslo in June

During Autumn, the digital biotechnology survey was performed in collaboration with the consultancy Menon Economics. A questionnaire was sent out to nearly 500 different actors, and more that 30 stakeholders across Norway, representing industrial companies, SMEs, research institutions, TTOs among others, were interviewed on their use of digital and computational technologies and how they think such technologies may be of importance to address future challenges and stay competitive. The survey also questioned the status and needs related to competence and network, as well as challenges in the innovation value chain. A report describing the results will be published and presented at the DLN innovation day on the 21st of March 2017.

Another important milestone for 2016 has been to finalize strategies and future plans for WG2, and to develop the innovation platform of the Centre.

In this process, we have gained valuable input and tips from stakeholders and international experts. Some of the institutions we have visited are Innovation fund Denmark in Copenhagen, SystemsX and the industry relations team at ETH in Zürich, Switzerland.



MAJOR ACHIEVEMENTS IN 2016

- Established the DLN innovation platform.
- Established innovation strategies and future plans for WG2.
- Identified stakeholders and their fields of interests.
- Surveyed the digital biotechnology in Norway, and identified market opportunities and challenges.
- Established contact and interactions with different prosecutors in the innovation value chain, both nationally and internationally.

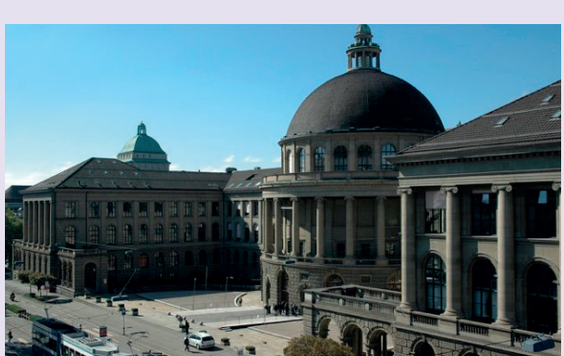
AMBITIONS FOR 2017

- Arrange an inspiring DLN-innovation day on the 21st of March, where the biotechnology survey will be presented and international experts will share their perspectives.
- Establish a future collaboration plan with the local TTOs in Norway.
- Establish a well-functioning interaction with the DLN research projects.
- Integrate innovative partner projects under the DLN umbrella.
- Establish industry marketing material from Digital Life research projects

INNOVATION IN RESEARCH PROJECTS

DCOD HAS ESTABLISHED CONTACT BETWEEN THE MATH GROUP AT UIB (MORTEN BRUN) AND BTO (BERGEN TECH-TRANSFER OFFICE) ABOUT A NEW METHOD FOR TOPOLOGICAL DATA ANALYSIS

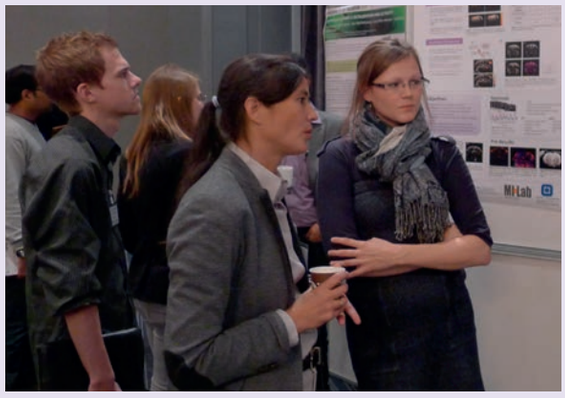
APT HAVE SUBMITTED TWO DOFI'S (DECLARATION OF INNOVATION) TO NTNU'S TECHNOLOGY TRANSFER OFFICE (TTO)



Visit to ETH, Zürich in December to discuss innovation culture and best practices regarding industry relations

TRAINING AND RECRUITMENT

The work group for Training and Recruitment shall promote recruitment of talented young researchers to the Digital Life mission; create an environment for excellent PhD training; and help further career development on the post-doctoral level. For all three goals, there will be a strong focus on recruitment, training and career development of female researchers.



DIGITAL LIFE NORWAY RESEARCH SCHOOL

The research school started up at the end of 2016, and its main goals are to promote transdisciplinary integration, build a culture for innovation, and create a new collective team spirit among all younger scientists who are connected to the Digital Life initiative. In order to reach these goals, the research school will focus on the following principles:

- Be broad and inclusive
- Hold a high degree of interdisciplinarity
- Establish a national curriculum of PhD courses in key Digital Life topics
- Facilitate networking
- Help build a culture for innovation
- Promote internationalization

2016 were mostly used for planning of future activities, and 2017 will see the results of this groundwork. The research school will offer an extensive curriculum of courses, award travel grants, and arrange our first annual meeting.

CAREER DEVELOPMENT ACTIVITY

The competition for senior-level academic positions is keen in most areas, and even though the primary objective of a post-doctoral fellowship is to qualify individuals for such positions, one post doc period is normally not sufficient to achieve this. In order to attract and retain the most talented individuals it is necessary to make research an attractive career option. Also, as there is a gender imbalance at the post doc and professor levels with a large male majority in biotechnology research, we will have a focus on helping female talents to pursue a successful scientific career. These goals will be achieved by the following:

- Establish and run the DLN excellence program
- Identify the most talented female PhD students and stimulate to that they continue with a scientific career after PhD level

The members of the Digital Life Norway Research School is the target population for the career development activity. So, due to the start up of the research school at the end of 2016, the career development activity will be initiated in 2017.

COMPETENCE AND INFRASTRUCTURE

Our activities throughout the year are in many ways linked to data. What technologies are available, nationally, to generate biological data of different modalities? How do we deal with the data after it has been generated - storing, documenting, complying with standards, and for sharing? How can we harvest synergies of ongoing method development in DLN – together pointing out best practices?

At the national network meeting "Technologies for Digital Life" we gathered about twenty different infrastructures, showing a great diversity and opportunity for doing cutting edge biotechnological research.

During 2017 a more thorough analysis of the national landscape of infrastructures will be finalized, focusing on the conditions of doing digital biotechnology and the possible role for DLN in the ecosystem. In 2017 we are also planning a national network meeting, this time focusing more on cutting-edge methods for doing digital biotechnology - "Methodologies for Digital Life".

October morning
Technologies for Digital Life

For a transdisciplinary centre building on RRI, open science and the FAIR-principles should be our ambition. Data management to support this ambition was the theme of a workshop held with the projects late autumn. Relevant available platforms were presented and the needs of the projects were discussed. We are now collaborating with ELIXIR.no and FAIRDOM on making solutions for improved data management in the research projects, using the Norwegian e-Infrastructure for Life Sciences (NeLS) and SEEK management platforms. This will ensure access to long term storage, good practices and ease for metadata documentation, as well as sharing and publishing of data and models. To improve training in the use of data management tools, we are organizing a hands-on workshop together with the DLN research school in 2017 on practical use these platforms.

The center has an exciting, but quite diverse set of research project. Still, in a recent report on the six first DLN projects we have identified areas for possible fruitful collaboration on methodologies for transdisciplinary research, both on the experimental side and on the computational side. Supporting collaborative development, such as methods for modeling, will be an important activity and we will work with the RRI group on aspects of this related to fundamental issues on (quantitative) modeling of biological systems.

During 2017 we will learn more about the new DLN projects and we are looking forward to yet an exciting and busy year!

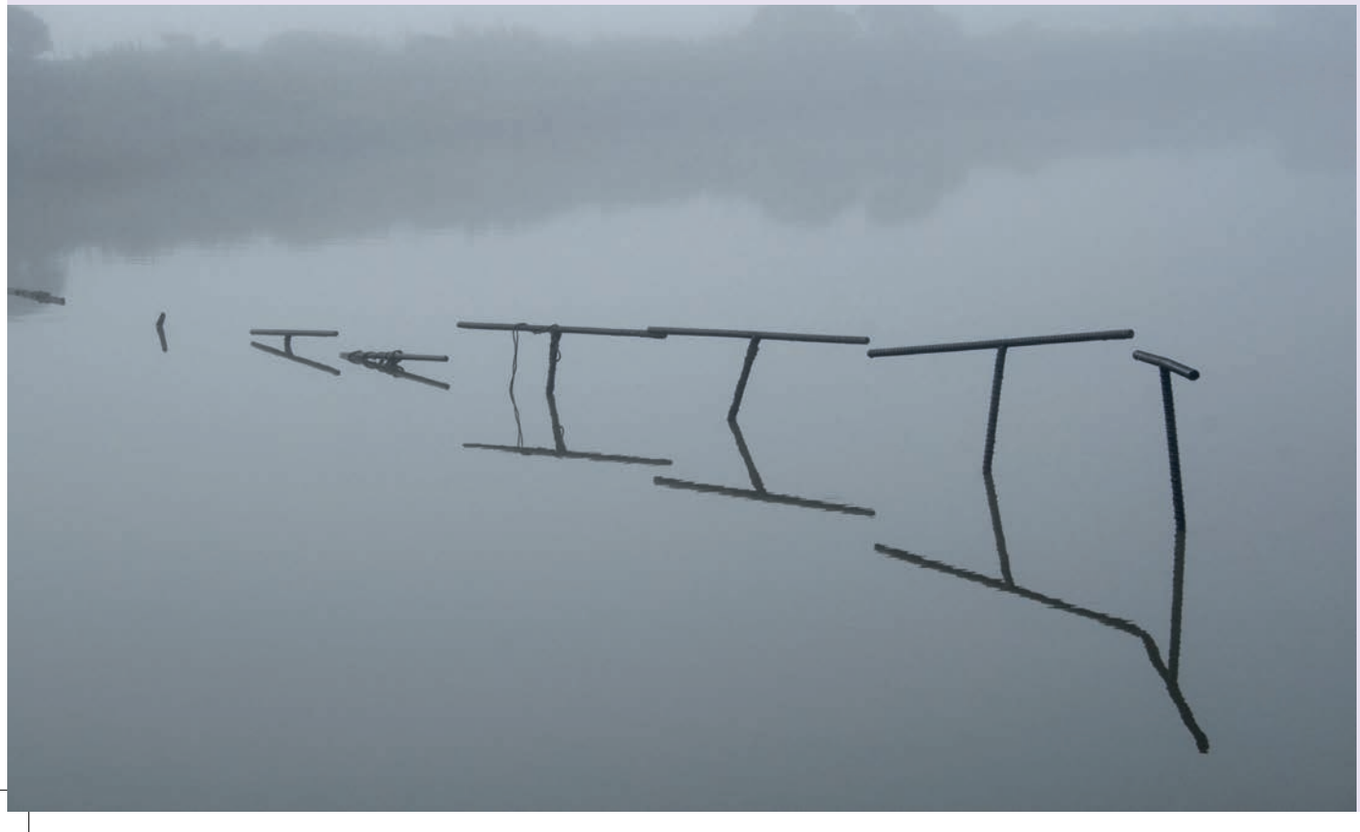
RESPONSIBLE RESEARCH AND INNOVATION

Responsible Research and Innovation (RRI) is a cross-cutting principle in European research (Horizon 2020) as well as Norwegian research. In Digital Life Norway (DLN), RRI plays a central role, meaning that all research and facilitating activities should be "mindful of its societal context and develop[...] anticipatory competence regarding its impacts". (Digital Life – Convergence for Innovation, p. 12). To this end, the RRI group at the DLN has been given the task to build and maintain a national biotechnology RRI research infrastructure and promote the RRI dimension throughout DLN research. This mandate has been implemented through internally and externally directed initiatives.

Internal to the DLN, the activities have been directed both towards the network project and towards the 2016 research projects (see above). With regard to the latter, the RRI group mapped the proposed RRI activity of all DLN research projects and formed a strategy on how to support them. Dialogue was then established through a string of meetings between projects and the RRI group, in which we explored the requirements of the research projects and the competencies on hand from the RRI group. The next item of the strategy was to organize a mini-course on RRI for all participants in the research projects. This was given in Trondheim in November 2016. All ongoing research projects were present at the course. On this background, the RRI group will have follow-up meetings with the research projects in 2017 in order to outline more concrete RRI plans.

The RRI group has also worked towards broadening awareness of RRI challenges in the network project. Above all, this work surfaces in the plans and strategies for DLN's next four years, where the RRI group articulated a number of measures for how to realize the overall goals of the Centre in manners that are grounded in societal values, needs and expectations.

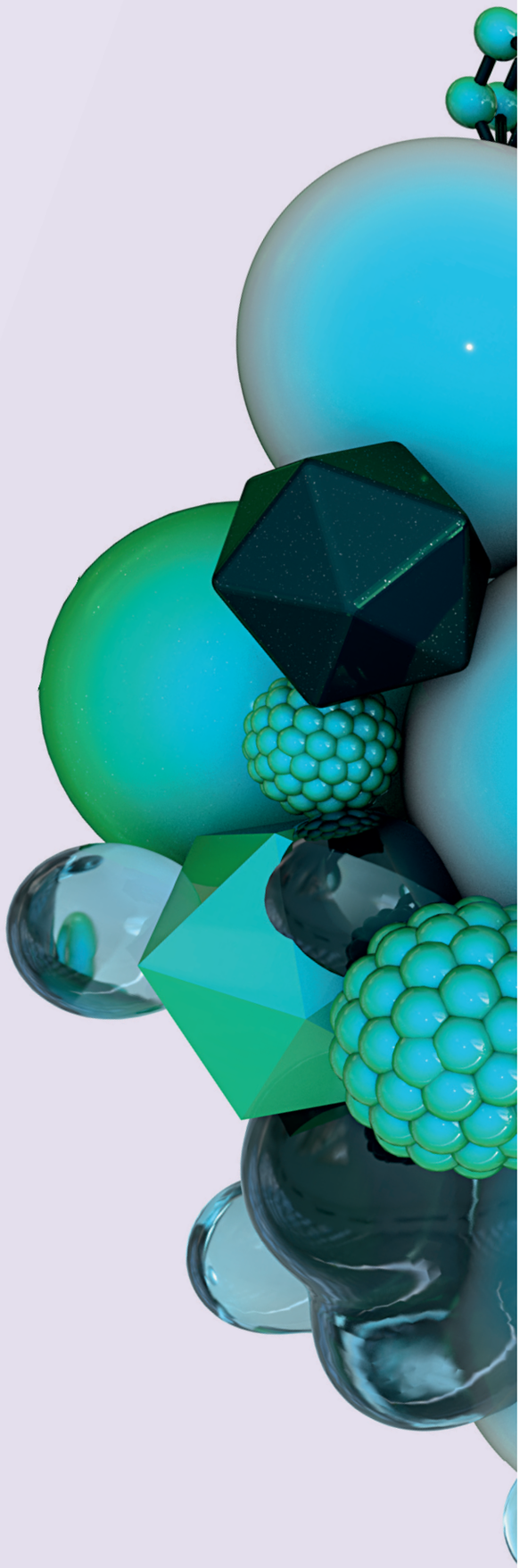
Outside the DLN, the RRI group has networked, primarily by reaching out to the Norwegian RRI community and presenting the specific manner in



which RRI has been implemented at the DLN. In addition, and importantly, the RRI group contributed to facilitate a thorough integration of RRI in the projects that answered last year's Digital Life call. In regards to networking – which is vital to the RRI group's continued development and grounding in the national and international RRI environment, one key event was the Digital Life workshop set up at the biannual ELSA Norway conference. The RRI group regards this workshop as the first of many events where the Norwegian RRI community is engaged towards questions concerning RRI and biotechnology. Also, the RRI-group has presented DLN's model for implementing RRI in various settings, such as meetings in Tekna and at the conference S.Net.

Among the activities, we would like to highlight the four so-called matchmaking meetings that were organised in Bergen, Trondheim, Tromsø and Oslo prior to the deadline of last year's Digital Life call. Here, the RRI group invited researchers from both the life sciences and from the social sciences and humanities. The ambition with these meetings was to facilitate the integration of RRI perspectives in the projects applying for funding in the Digital Life call by getting these two groups of researchers together, in order to discuss and exchange ideas for RRI. The meetings were partly an introduction to the concept and practice of RRI – with the RRI framework published by the Norwegian Research Council (RCN) last year as the nexus of the introduction, and partly a speed date session so that researchers in the life sciences were able to meet several researchers from the social sciences and humanities. The RRI-group plans similar events prior to all Digital Life calls.

Parallel to the work in the RRI group of the DLN Centre, a specific research project on the RRI dimension of DLN was recently funded by the Research Council of Norway. The project will begin in 2017, and we expect significant synergies between this project and the work inside the DLN Centre.



INREACH & OUTREACH

Forging the centre's visual identity and profile has been central in this initial year. Creating visibility and identity reflecting the centre's mission are essential tasks. In parallel, we have developed internal routines for cooperation and communication. Attention has been given to outreach activities from the very onset, starting with the Opening seminar, the Volterra Lectures series, attending Nordic Life Science Days, Cutting Edge Innovation Festival, and supporting the iGEM Teams at UiO and NTNU. The first year has also been devoted to strategy and planning for the years to come and road ahead.

MAIN ACTIVITIES

Establishing the Centre for Digital Life Norway has been the overall goal for DLN this first year. Forming a coherent organization of six major research projects under a leadership and network project all together is a challenge. Part of the activities has been operational by organizing internal meetings, establishing a functional group of coordinators, and engaging the research projects, in close collaboration with the centre leadership. This resulted in a successful Opening seminar in Trondheim, April 2016, where the centre presented itself, its research, and inaugurated the Volterra Lecture Series. A highly inspirational talk was given by Gene Myers, Director of Centre of Systems Biology Dresden.

Building on the centre's mission and values, the process of developing logo, graphical profile and visual profile was initiated. Together with the design bureau Miksmaster we have achieved a logo, visual design element, and graphical profile that reflect who we are and what we aim for. This is currently being implemented in print, on the web, and in social media, creating a common identity, brand and recognition of Centre for Digital Life Norway.

As communication is cross-cutting to the network and leadership project, we have interacted and supported all of the centre's outreach activity. Among these are encouraging researchers to apply to become part of the centre, support RRI-workshops, stakeholder meetings, and the infrastructure seminar "Technologies for Digital Life". An important task has been stakeholder mapping within industry and innovation together with the working group of industry and innovation involvement. Other activities mainly carried out by the inreach and outreach working group have been the Volterra Lectures together with the six research projects, sponsoring the iGEM teams and Cutting Edge Innovation Festival, and the development of the center's communication strategy.

Developing a well functioning centre that moves jointly forward, incorporating new research projects and organizations, truly transforming Norwegian biotechnology research and innovation, is the goal for the coming year and beyond.

AMBITIONS

- Annual conference
- Volterra Lectures 2017
- Stakeholder mapping
- Public engagement
- Digital Life Creative – public engagement & recruitment

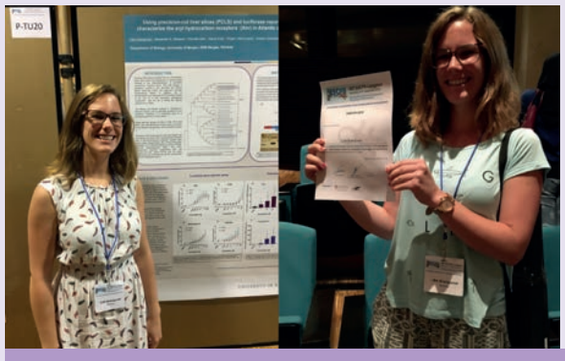
MAIN ACHIEVEMENTS

- Opening seminar
- Volterra Lectures
- Logo and graphical profile
- Web-site and social media
- Stakeholder mapping within industry and innovation
- Communication strategy

AWARDED FOR SCIENCE

Libe Aranguren won the award for best poster at the 30th ESCPB Congress in Barcelona, Spain on 4-7th September. The title of her poster was "Using precision-cut liver slices (pcls) and luciferase reporter gene assays for characterizing the aryl hydrocarbon receptor 2 (ahr2) pathway in atlantic cod (Gadus morhua)".

This work represent the first description of the aryl hydrocarbon receptors (AhR1b and AhR2) in Atlantic cod (Gadus morhua), and includes phylogeny and functional characterization (ligand activation) using both an in vitro luciferase gene reporter assay and ex vivo precision cut liver slices. The AhR plays a key-role in the chemical defense of Atlantic cod by sensing xenobiotic compounds, such as polycyclic aromatic hydrocarbons and dioxin-like PCBs, and controlling the expression of several enzymes in the biotransformation of these compounds.



Congratulations to Libe Aranguren who won the best poster award at the 30th ESCPB Congress

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DIGITALT LIV: Vil gjøre livet lettere for diabetes-pasienter

DIGITALT LIV: Lab-on-a-chip avslører sykdommer raskt

DIGITALT LIV: Bruker torskens genom til å måle stress og miljøpåvirkning

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Mette Langaas, NTNU

DLN BOARD

The Centre for Digital Life Norway is governed by a small and efficient Board. The DLN Board ensures alignment of DLN and institutional strategies and development. It secures a birds-eye perspective of the DLN Centre - pulling different work groups together. The DLN Board consists of one representative for each hub-partner, two representatives for the node partners, and two industry representatives. Presented here is the current DLN board. We thank Svein Stølen - UiO, Rein Åsland - UiB and Øystein Lie - NMBU for their work in 2016.

Finn-Eirik Johansen - UiO
Chairman of the board

Tor Grande - NTNU

Eyvind Rødahl - UiB

Eli Aamot - SINTEF

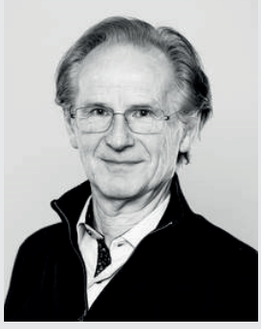
Ragnhild Solheim - NMBU

Silvija Seres
Industry representative

Gerd Nilsen
Industry representative

Svein Stølen - UiO
Retired from the Board

Rein Åsland - UiB
Retired from the Board

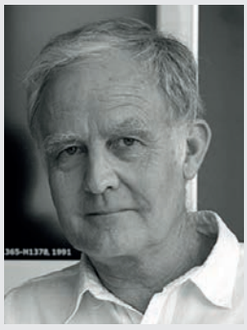


Øystein Lie, - NMBU
Retired from the Board

DLN SCIENTIFIC ADVISORY BOARD (SAB)

The Scientific Advisory Board (SAB) consist of internationally renowned experts in fields of high relevance to the DLN mission, and who have a proven track record in managing large and complex academic structures. The SAB will support DLN by providing independent, credible and impartial recommendations on academic matters, and matters concerning the internal operation of DLN as well as DLN's national network function responsibility.

Ulrike Felt
Universität Wien



Peter Hunter
The University of Aukland

Anne-Claude Gavin
EMBL

Rudi Balling
Université du Luxembourg

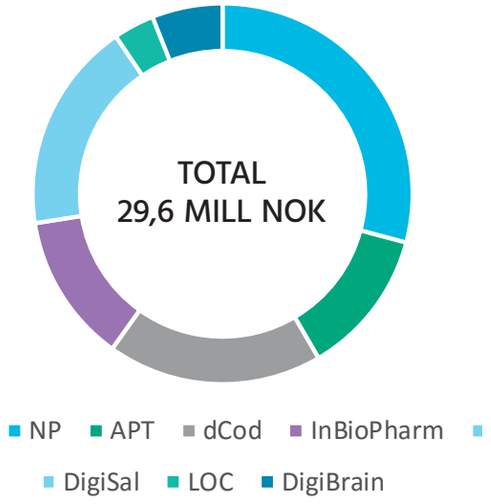
Vera van Noort
University of Leuven

Dominique Chu
University of Kent

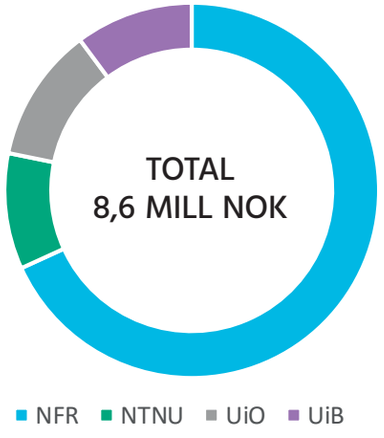
ECONOMY

The Digital Life program is the strategic initiative for biotechnology in the Norwegian Research Council. In the first call 250 mill. NOK were granted to six large research projects (total: 200 mill NOK) and one networking project (total 50 mill NOK) over five years.

In its first running year the centre has had a focus on recruitment, reflected in this first years spending of 12% of its total 250 mill NOK budget. Cost of running the centre will naturally increase as the projects progress and evolve. Total expenses for the six research projects and the networking project (NP) is displayed in the top figure.



The management of the centre is financed in a 7:1:1:1 ratio by the Norwegian Research Council, NTNU, UiO and UiB respectively. Financial accounts for 2016 shows that this ratio has been well maintained. Total expenses for the networking project (NP), divided into the four different contributors share is displayed in the bottom figure.



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END SLIDE SHOW
1.02.12
09.53
Centre for Digital Life Norway
Opening seminar
April 19th, Trondheim
Hotel Scandic Lerkendal, Klæbuveien 127, Trondheim
No Notes
Slide 1 of 1

CENTRE FOR
DIGITAL LIFE
NORWAY

DIGITAL LIFE NORWAY

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