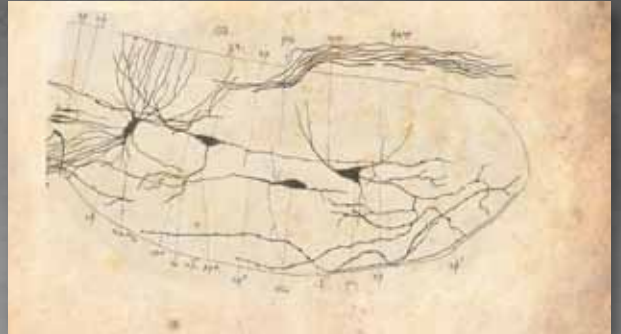
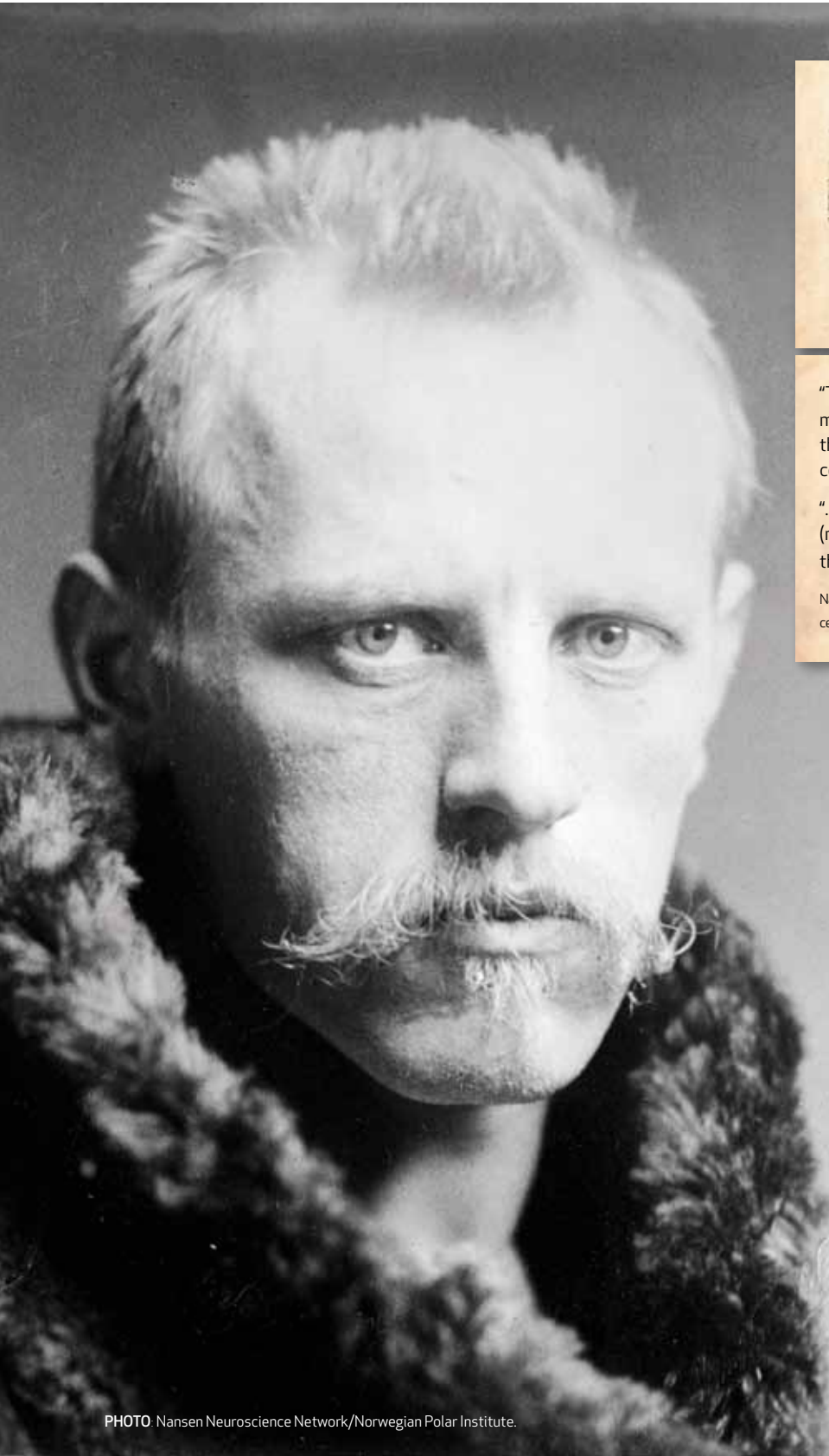


NATURALLY INSPIRED

Cancer, neuroscience, immunology, stem cells, biobanks and health registries,
diagnostics and tools, aquaculture, marine bioprospecting, industrial biotech

LIFE
SCIENCE
IN NORWAY



"The dotted substance, i.e. the interlacing of nervous fibrillæ, must be a principal seat of the nervous activity, through this substance or interlacing is the reflex-actions etc. communicated to the consciousness"

"..we can state, as a fact, that a plaiting or interlacing (not reticulation) of nervous fibrillæ extends through the whole central nervous system of all animals."

Nansen, F (1887) The structure and combination of the histological elements of the central nervous system. Bergen Museums Aarsberetning for 1886, pp 25 - 214, Pl I - XI.



EXPLORATION IS IN OUR GENES

One hundred and twenty years ago, Fridtjof Nansen earned the first Norwegian doctorate degree in neuroscience. It presented a revolutionary idea: that the brain consists of individual, separate nerve cells that communicate in the web of nerve fibres. Nansen's views were later confirmed and extended by others including Cajal who received the first Nobel Prize in neuroscience in 1906.

The Norwegian scientist and diplomat was perhaps more known for his famous explorations. Inspired by nature, he led the first crossing of Greenland on skis, and achieved great success with his Arctic expedition aboard the ship Fram.



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EMBRACING THE CENTURY OF LIFE SCIENCES

The Norwegian biotech industry is growing rapidly. There has been a 30 per cent increase in the number of companies over the last five years, with as many as 14 new companies in 2009 alone. And even more importantly, the growth is predominantly in the blue and green sectors, showing that biotech is increasingly becoming a ubiquitous enabling technology.

A real leader in Aquaculture

As described in this publication, biotechnology has been fundamental to Norway's position as a global leader in aquaculture. A success story with 30 years of systematic breeding for healthier fish, advances in feed development, novel vaccine programs providing a dramatic reduction in the use of antibiotics, is all dependent on biotechnology. Our marine traditions are now being taken one step further with the Government's ambitious plan for bioprospecting in the cold Arctic waters. This will involve searching for novel genes, enzymes and bioactive metabolites from rare species, as well as harvesting lipids and protein from the vast untapped blooms of algae and krill.

From Blue-Green to White Biotech

There are currently close to a million metric tons of marine byproducts from the Norwegian fish industry. In addition, our long coastline offers excellent potential for the cultivation of microalgae as feedstock for fine chemicals or biofuel. The Norwegian chemical industry, through companies such as Borregaard with its advanced biorefinery for wood and Statoil, our national oil company, are now looking at opportunities in the marine sector. On this basis Norway is well positioned to be a significant player in industrial biotechnology.

Cancer and Neuroscience

The Norwegian medical sector continues to flourish with examples of excellence particularly in cancer and neuroscience. Oslo Cancer Cluster offers a pipeline of 50 new product candidates in clinical or late preclinical development and two of its members, Clavis Pharma and Algeta, were the only European representatives in Biocentury's top 12 performers list at the end of 2009.

The neuroscience community is rapidly following its success, forming the Nansen Neuroscience Network.

The name draws inspiration from Norway's famous explorer and humanitarian Fridtjof Nansen, who was also a zoologist performing seminal studies on brain structure.

Biobanks

Both cancer and neuroscience will benefit from Norway's long traditions in epidemiology and population biobanks which have grown to comprise about 500, 000 donors or more than 10% of the population. This leading resource provides a unique opportunity to spearhead the era of personalized medicine in the context of the Scandinavian health care model.

I would like to acknowledge everybody contributing to this publication. On behalf of Innovation Norway it is a great pleasure to offer these glimpses into the Norwegian biotech landscape. The Norwegian population is increasingly embracing biotechnology as an essential remedy for some of the great challenges of our time; the sustainability of nature and a healthy life for an aging population. Norway is ready to make its contribution to the Century of Life Sciences.



Ole Jørgen Marvik
Sector Head,
Health and Life Sciences
Innovation Norway

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FROM STRENGTH TO STRENGTH

By Mike Ward, Senior Editor Biocentury

With its cushion of oil wealth, recession in Norway has been much less pronounced than in most of the developed world. It is currently the only in Europe running a budget surplus and given the turmoil in European currency markets, the Norwegian Krone is considered by investors and commentators alike to be one of the safest bets. In 2009, Norway's stock exchange was the only developed economy in the 10 best performing stock indices.

On any number of benchmarks, Norway emerges as one of the world's most prosperous countries. Indeed, it was ranked fifth, just behind Finland, Switzerland, Sweden and Denmark, according to the Prosperity Index, published last October by the Legatum Institute, a London-based think-tank, which measure not just material wealth but also takes into account the quality of democracy, healthcare provision, freedom, security and political governance among other factors.

World's 2nd largest sovereign fund

The biggest challenge facing Norway's politicians has been how best to invest the windfall from the country's oil and gas resources. The \$456 billion Norwegian Oil Fund, which is the vehicle by which Norway invests its oil wealth for future generations, is the world's second largest sovereign wealth fund, after the United Arab Emirates, and is Europe's biggest equity investor and is said to own about 1% of all the world's stocks.

Indeed, last year's Norwegian general election campaign focused on how Norway, which is the world's fifth largest oil exporter, should invest its natural resource riches. The fund is already about the size of the national economy and is expected to become more than double in size within the next decade.

Aligned with Europe

With a population estimated to be just 4.9 million in 2010, Norway has always had to look outwards with a fairly solid independent air. While it remains outside the

European Union, its regulatory environment is wholly aligned with the 27 member state grouping. The country is part of the European Economic Area (EEA) agreement between the European Free Trade Association (EFTA) and the European Union (EU), giving Norwegian and foreign-owned companies located in Norway full access to the internal market of the EU and the free movement of persons, goods, services and capital across European state borders. Consequently, access to the European market is relatively uncomplicated.

All of the major pharmaceutical companies are represented in Norway and in recent years, Norway has seen the emergence of its own biotech cluster. Despite not having an established indigenous venture capital network, usually a prerequisite for the development of a local biotech cluster, Norway has nurtured about 200 biotech companies, congregating around the country's six universities at Oslo, Tromsø, Bergen, Trondheim, Stavanger and Ås.



Naturally dominated by oil and gas, telecoms and shipping stocks, the Oslo Stock Exchange, is however starting to see increasing interest and support for Norway's biopharma companies.

PHOTO: John Hughes.

Since the start of 2006, Norway's emerging biotech sector has raised about \$330 million from the capital markets (1) - including four initial public offerings raising a total of \$196 million. Between 2001 and the end of 2005, Norwegian companies raised just \$42 million in equity.

Quick to act

Last year, this push was given an extra boost when the Norwegian government, as part of its \$2.9 billion stimulus package, made an explicit commitment for life sciences and innovation research. As part of that package, Innovation Norway, a state development agency, has been increasing the amount of loans it makes to research-intensive companies -- principally biotech and IT groups - from \$40 million to \$120 million. Moreover, Argentum, the Norwegian government fund which invests in private equity groups and had about \$650 million under management, received an additional \$280 million to invest in innovation-focused companies, including biotech.

While the country has had a reputation for so-called "blue" or marine biotechnology -- marine sciences are a specialty at the universities of Bergen and Tromsø -- Norway is now fast establishing itself as a new player in the oncology field, with Oslo as its focal point, with more than 70% of all cancer research in Norway conducted in the region.

Cancer a strength

Indeed, most of Norway's biotech industry is currently focused on cancer research and are based in and around Oslo and the Norwegian Radium Hospital. This growing pre-eminence has been underpinned by the Oslo Cancer Cluster which already has 60 members and continues to enhance local Norwegian research and early stage clinical trial efforts.

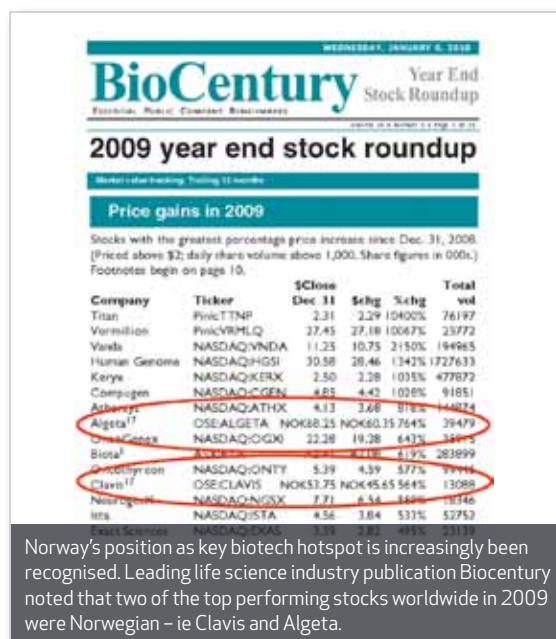
OCC has also rapidly established international links with centers of excellence worldwide working with both companies and cancer clusters in the U.S. and elsewhere

in Europe. Through these links, Norwegian companies have been able to establish collaborations with leading research centers including the MD Anderson Cancer Center in Houston, Texas, and the Memorial-Sloan Kettering Cancer Center, in New York.

Internationally connected

Earlier this year, the Oslo Cancer Cluster signed a memorandum of understanding with the Research Triangle Park, North Carolina-based not-for-profit Hamner Institutes to get access to its network of research collaborators as well as post-doctoral training in drug safety technologies, business training for entering the U.S. market, and regulatory training for compliance with FDA standards. The Norwegian member companies in Oslo Cancer Cluster has a large R&D pipeline with over 50 projects in preclinical and clinical phases.

Prominent Norwegian cancer therapy companies include Algeta ASA, Clavis Pharma ASA, and PCI Biotech Holding ASA.



SOURCE: BioCentury

Algeta starts

Algeta emerged as one of the best biotech investments anywhere in 2009. The Oslo-based company is developing Alpharadin, a radiopharmaceutical based on the alpha particle emitter radium-223, which is in Phase III trials to treat bone metastases in hormone-refractory prostate cancer, with data expected in 2012.

Last September, Algeta signed a partnership with Bayer AG which makes the German pharmaceutical major responsible for a majority of development costs and commercialization going forward. Algeta is responsible for manufacturing and product supply and retains the option to co-promote in the U.S., plus profit-sharing. Algeta received \$60 million upfront and is eligible for up to \$740 million in milestones, plus tiered double-digit royalties in territories where the product is not co-promoted.

PHOTO Algeta



Algeta emerged as one of the best biotech investments anywhere in 2009. The Oslo-based company is developing Alpharadin.

Clavis close behind

Clavis Pharma also closed 2009 with a significant partnership with Clovis Oncology Inc., a well-funded U.S. biotech start-up led by a team of highly experienced serial biotech entrepreneurs. Having been established with \$146 million in mid-2009, Clovis closed its first deal in November 2009 when it licensed from Clavis the development and commercialization rights to CP-4126

-- now designated CO-1.01 -- in the U.S., Europe, Canada and Central and South America, to treat a large subset of patients with pancreatic cancer and certain other solid tumors.

Under the terms of the deal, Clavis granted Clovis exclusive rights to develop and commercialize CP-4126, the lipid-conjugated form of gemcitabine, generated using Clavis' Lipid Vector Technology, with biomarker data which is in Phase II testing to treat pancreatic cancer. Clavis got \$15 million upfront and is eligible for up to \$365 million in milestones, plus tiered double-digit royalties.

Clavis has an option to co-develop and co-promote the compound in Europe. The companies also plan to develop a companion molecular diagnostic for the compound. The molecule has orphan designation from the U.S. Food and Drug Administration and in the European Union and is in Phase II testing to treat pancreatic cancer.

PCI next?

PCI Biotech hit the headlines earlier this year when the company reported that patients with inoperable head and neck cancer treated in a Phase I/II trial with intravenous Amphinex, a photosensitizer for photodynamic therapy, plus bleomycin saw complete clinical regression within a few weeks of administration. Although the trial was designed to test only the safety of Amphinex, which makes cancer cells sensitive to light and boosts the effects of chemotherapy, the researchers have decided the results were so impressive that they have been submitted to a leading journal for publication this year.

Research flourishes

A testament to the groundbreaking oncology research in Norway was the discovery by a group at the University of Bergen of the role of AXL receptor tyrosine kinase as a key regulator of metastasis and a strong predictor of poor overall survival in breast cancer patients. While AXL had been linked to many aspects of tumorigenesis its functional link to key processes in metastasis had remained unclear.



The number of Norwegian biotech companies has increased with 30% between 2004 (128) and 2009 (193)

In a paper in the Proceedings of the National Academy of Sciences, published in December 2009, the Bergen group reported that AXL is a key downstream effector of epithelial-to-mesenchymal transitions in breast cancer cells and is a useful biomarker for clinical outcomes -- AXL upregulation defines a subpopulation of about 40% of breast cancer patients where the clinical outcome is much worse.

However, AXL has potential beyond being a biomarker as the Bergen group has also shown that it is functionally required for the metastatic phenotype in breast cancer and so is an exciting therapeutic target for controlling the progression of metastatic breast cancer. The University of Bergen has filed for a patent covering the work and its diagnostic and therapeutic applications. Bergen-based biotech spin-out Bergen Bio A/S has licensed the intellectual property and is moving the work forward with target validation studies of AXL-targeting antibodies in cancer.

More than therapeutics

Beyond cancer therapeutics, Norwegian companies are also forging ahead in other therapeutic areas, as well as diagnostics, nutraceuticals and bioprocessing.

Pronova Biopharma ASA, and its partner *Takeda Pharmaceutical Co. Ltd.*, began an open label Phase III trial of its omega-3-acid-derived TAK-085, to treat hypertriglyceridemia. The compound is not novel as it is already on the market to in some countries to treat the same conditions. In the US it is marketed by partner *Glaxo SmithKline plc* as *Lovaza*. In other countries it is

marketed as *Omacor*. *Takeda* acquired exclusive Japanese rights to the compound from *Pronova* in 2005.

Nutraceuticals company *Nutri Pharma ASA* raised new funds at the start of 2010 to expand its coverage into infectious diseases through the all share acquisition of fellow Norwegian company *Bionor Immuno AS*. *Bionor's* lead candidate is *Vacc-4x*, a therapeutic peptide composed of four modified synthetic peptides that correspond to a conserved domain of the HIV p24 protein. *Vacc-4x* is in Phase IIb testing to treat HIV/AIDS, with data expected in October 2010.

A story worth following

So while much of Western Europe's biotech sector is in the doldrums, suffering from slow clinical progress of its programs and struggling to raise the necessary funds to advance their development, Norway's biopharmaceutical companies have fast established themselves as among the most promising new companies.

With a focused academic strength and support from the local investment community and government, Norway is well placed to establish itself as an emerging European biotech hotspot.

MEDICAL BIOTECH

PARTICULAR STRENGTHS WITHIN:

- Cancer treatment and diagnostics
- Neuroscience and functional imaging
- Biobanks and health registries

STRONGLY POSITIONED TO DELIVER TRANSLATIONAL MEDICINE

Norway is strongly positioned to deliver translational medicine in oncology and neuroscience through its unique combination of world leading research, biobank and health registry infrastructure, cluster organisation and commercialisation expertise.

Norway has always been well known for its magnificent scenery and its fishing, oil and gas industries, but its medical biotechnology is perhaps less well known. However following the success of companies such as Algeta, Clavis Pharma and Photocure, this is rapidly changing – and big pharma and investors alike are increasingly looking at the continuing flow of opportunities on offer. Perhaps the key to Norway's success is that translational medicine has long been practiced there. A steady stream of ideas are converted into new diagnostics and therapies from the world class research in cancer and neuroscience in particular performed at the universities and hospitals in the main centers of Oslo, Bergen, Trondheim and Tromsø,

A vibrant world-class science base

A number of international evaluations have highlighted the excellence of Norway's science and research, particularly in medical and environmental biotechnology and informatics. "Norway's research is of high quality with world-renowned

researchers producing excellent clinical work," says Steinar Aamdal, Professor of Clinical Cancer Research at the Oslo University Hospital.

This stems from the strategic approach taken by

the Norwegian Research Council to systematically create a range of results-orientated schemes to support and encourage research,

including Norwegian Centres of Excellence (SFF) and Centres for Research-based Innovation (SFI).

The Centres of Excellence scheme supports universities, university colleges or research institutes for a fixed term to encourage research in any discipline at an international level. The council set up the first 13 in 2001, adding a further eight in 2006. A third of these 21 centres are linked to life sciences."

The Norwegian government has put a lot of resources into the Centres of excellence, and these are already bearing fruit," says Ole Petter Ottersen, one of the founders of the CMBN and a prominent neuroscientist. Ottersen is a Professor in neuroanatomy and Rector of the University of Oslo.

In addition, Norway has 14 Centres for Research-based Innovation – 4 in life sciences or medicine, which are located in academic or research institutions. The aim of these centres is to fund long-term but industry driven research as public private partnerships. The Centres are open to and encourage participation from international companies.

Comprehensive Population Biobanks create unique infrastructure for translational medicine

Norway's strength in cancer, neuroscience and its other areas of medical biotechnology research stems partly from its wealth of in-depth information about its population.

Well in advance of others, Norway began prospective population screening in the 1970s to assess and improve the public health status of the nation. This screening was by

A steady stream of ideas are being translated from university and hospital research into new diagnostics and therapies in cancer and neuroscience in particular.

invitation in specific geographical regions, e.g. the Tromsø Study and the North Trøndelag (HUNT) Study. Oslo has also carried out a Mother and Child Cohort Study involving nearly 300.000 individuals. "This concept of screening was well received," says Per A Foss, PhD, CEO of HUNT Biosciences, which is now offering these assets on a commercial basis internationally. "In the HUNT Study, we found that 80% of the people invited turned up for screening, and then proceeded to provide both clinical samples and health/lifestyle information."

The biobanks are complemented by an efficient clinical records system. Created in 1951, the Cancer Registry of Norway, Institute of Population-based Cancer Research (Kreftregisteret) tracks all Norwegian cancer patients from suspected and confirmed diagnosis to remission or death. The law requires physicians to report cancer cases, including cancers discovered at autopsy. "The cancer registry is quite unique," says Aamdal. "Nowhere else has the same depth of data over so many years." Other linked national registries include the Medical Birth Registry, the Cause of Death Registry and the Norwegian Prescription Database.

Over 40 years, Norway's biobanks have grown to contain tissue samples from more than 500,000 people, which is around 10% of the total population. The data are linked using the 11-digit personal identification number that is issued to all Norwegians at birth.

This allows researchers and physicians to link population studies with disease diagnoses, to match controls and to compare pre-diagnosis, post-diagnosis and post-treatment tissue samples. "As well as benefitting the health service, this is of course a major tool for the diagnostics and pharmaceutical industry," claims Foss.

"For example, outside Norway, if you are interested in an early cancer marker, you would normally only have access to diagnostic samples. Because of the historic population screening initiatives, for many people we have tissue samples pre-diagnosis, which can be compared with post-cancer samples," says Foss. "Another example is our data on body mass index (BMI) and cardiovascular and metabolic disease – linking these could show how disease is a function of weight and who might be predisposed to these diseases. It's difficult to find a resource like this anywhere else in the world"



Norway continues to make significant life science infrastructure investments such as the HUNT Biobank specifically designed to help accelerate development and introduction of new treatments and therapeutics through biomarker discovery and validation.
PHOTO: HUNT.

Some idea of the “power” of the biobanks can be gleaned from looking at the HUNT Databank, which is the biobank from the HUNT study. This includes samples and phenotypic data from more than 120,000 people and has been used extensively for academic research and to inform national health strategies over the last 25 years. “The key point to remember as we now look to utilize this in biomarker discovery in particular is that we have samples from people prior to developing disease. We have also tackled the issue of consent. Any samples and data released for academic and industrial research are ‘de-identified’ and cannot be linked to individuals and all projects have to go through an ethical review board and are open to public scrutiny,” says Foss.

Cancer research a particular strength

The above infrastructure has enabled oncology research in particular to thrive. Indeed, Norway’s history in cancer

dates back to 1932, when the Radium Hospital opened in Oslo. This was created and funded by the people of Norway for the people of Norway, and is now part of the Oslo University Hospital.

“The Radium Hospital and the Oslo University Hospital carry out 80% of the cancer research in the Oslo region,” says Jónas Einarsson, MD, CEO of the Norwegian Radium Hospital Research Foundation and Chair of the Board, Oslo Cancer Cluster.

Norway also stepped into the field of what is now known as translational medicine as early as 1954, with the establishment of the Institute for Cancer Research at the Radium Hospital. “The Institute for Cancer Research was created to place researchers on the same site as the clinicians in order to create close connections and develop new technologies,” says Einarsson.



PHOTO Oslo Cancer Cluster.

The new Oslo Cancer Cluster Innovation Park is specifically designed to help accelerate development and introduction of new cancer treatments and therapeutics.

The proximity of the Radium Hospital and the Institute of Cancer Research makes translational research easier and it helps that many of the physicians have studied at the Institute of Cancer Research," adds Aamdal.

Recently an international panel evaluating Norwegian biomedical research on behalf of the Norwegian Research Council described the Institute of Cancer Research's research as, "very good, on the border of outstanding"

Particular strengths have been recognized in melanoma, breast cancer and gynecological cancers.

The Oslo Cancer Cluster provides a portal to oncology expertise

A key part of Norway's strength in cancer is the Oslo Cancer Cluster. In 2006, the Norwegian government set up a program to create Norwegian Centres of Expertise (NCE). The Oslo Cancer Cluster (OCC) gained this status in 2007 as a specialist centre for cancer.

"We already had a natural cluster of companies and institutions that had grown around the Radium Hospital and the Institute of Cancer Research, as well as the Norwegian Radium Hospital Research Foundation, which was created to commercialize products from the Radium Hospital. The Oslo Cancer Cluster created a forum for us to work together," says Einarsson. "The key aim is to develop the cancer drugs and diagnostics of the future and we are proud to say that we have 50 projects in late preclinical and clinical development.

"An important strength of the Oslo Cancer Cluster is that its focus is on only one therapeutic area," says Aamdal. "It provides small biotech companies with low-threshold access to patients for clinical trials and helps them attract attention early on from prospective partners."

The results have been impressive producing in recent years a conveyor belt of innovative companies developing oncology therapeutics and diagnostics including Photocure, Algeta, Clavis Pharma, Epitarget, PCI Biotech, DiaGenic, Affitech, and Lytix Biopharma.

Neuroscience the next frontier

Faced like many other countries with an ageing population, Norway has identified translational neuroscience as a

priority area. Again the biobanks and existing healthcare system provide an excellent starting point to exploit the country's long history of outstanding neuroscience research and equally importantly imaging technology development.

Oslo Cancer Cluster has created a unique collaborative forum. The key aim is to develop the cancer drugs and diagnostics of the future and we are proud to say that we have 50 projects in late preclinical and clinical development,"

Jonas Einarsson, Chairman OCC.

In fact already back in the 1800s, it was the Norwegian diplomat and zoologist Fridtjof Nansen, also known as an Arctic explorer, who first developed the neuron doctrine, one of the biggest discoveries in neuroscience. There were also many significant developments from the 1950s to the 1970s, including Alf Brodal and Jan Jansen at the University of Oslo mapping the actual "wiring" of the brain and Erling Seeberg, one of the founders of the key Oslo-based research centre, the CMBN, discovering the body's DNA repair pathways.

Further examples include seminal research on memory, for instance Per Andersen and Terje Lømo's pioneer work on "Long Term Potentiation" and Frode Fonnum and Jon Storm-Mathiesen's demonstration of glutamate's role as a key excitatory transmitter. More recently, groups at CMBN have been working closely with Nobel Laureate Peter Agre on the importance of aquaporins in brain water balance.

Other key CMBN areas of expertise are molecular biology and neuroscience, with applications in Alzheimer's and Parkinson's disease, epilepsy, brain oedema, meningitis and stroke. Their research into the balance of damage and repair in the normal aging process and neurodegeneration also has relevance in other disorders, including heart disease and cancer. "We have a holistic approach, trying to understand how the brain interacts with the body's other systems. This creates practical solutions as a valuable spin-off which hopefully can be translated into new treatments and therapies," says CMBN Director Professor, Tone Tønjum.

The CBM is based at the Norwegian University of Science and Technology in Trondheim (NTNU) and is part of the Kavli Institute for Systems Neuroscience. In comparison with other centres of excellence, most of which are quite broadly based, CBM concentrates on just one field of research – memory and the linked area of orientation and location.

Edvard Moser, Professor and Director of the CBM, sees this as a strength. "While we focus on basic research, there will still be many outcomes that have practical applications. For example, we are looking at Alzheimer's disease and we know that one of the mechanisms impaired is orientation. Elucidating the basic mechanisms could lead to better diagnostics and treatments," says Moser.

"Best of all, our status as a centre of excellence provides us with 10 years of funding, which will allow us to address higher-risk research questions than we could with shorter-term grants. In addition we have some interesting collaborations with industry."

The pattern is completed by another of Norway's Centres of Excellence, the MI Lab, also based at the NTNU. "This is the main technology university in Norway and has a reputation for excellent technology and research," says Olav Haraldseth, Professor and Research Centre Director at the MI Lab. "Trondheim became Norway's centre for

PHOTO: MI Lab



Modern medical imaging has its origins in Norway and the tradition of innovation continues through world leading centres of excellence such as the MI Lab in Trondheim, continuously in demand as a testbed by leading manufacturers.

imaging almost by accident – it had a good ultrasound imaging unit in the 1970s, which invented the techniques for cardiac ultrasound and its reputation has grown from this.” The MI Lab has close collaborative links with the University Hospital and access to researchers, physicians and postgraduate students.

MI Lab’s key areas of expertise are ultrasound, MRI and image-guided surgery, with a unit that Haraldseth describes as the ‘operating room of the future’ and is in great demand by leading international companies such as HP, Siemens and GE as a testbed for new technologies. “Advances in medical imaging technology are of increasing importance in promoting cost-efficient healthcare by improving diagnosis and making surgery more accurate and less traumatic, therefore reducing recovery time.”

“The new Nansen Neuroscience Network will create a portal to Norway’s world leading basic and applied research, including longstanding imaging expertise,”

Stein Lorentzen-Lund, Director,
Nansen Neuroscience Network

Since these groups already collaborate closely, and following the success of the Oslo Cancer Cluster model, they have received support from Innovation Norway to create a national network, the Nansen Neuroscience Network (NNN). Led by Stein Lorentzen-Lund and launching in May 2010, the NNN will focus on brain research, link science and industry in Norway stimulate international collaborations.

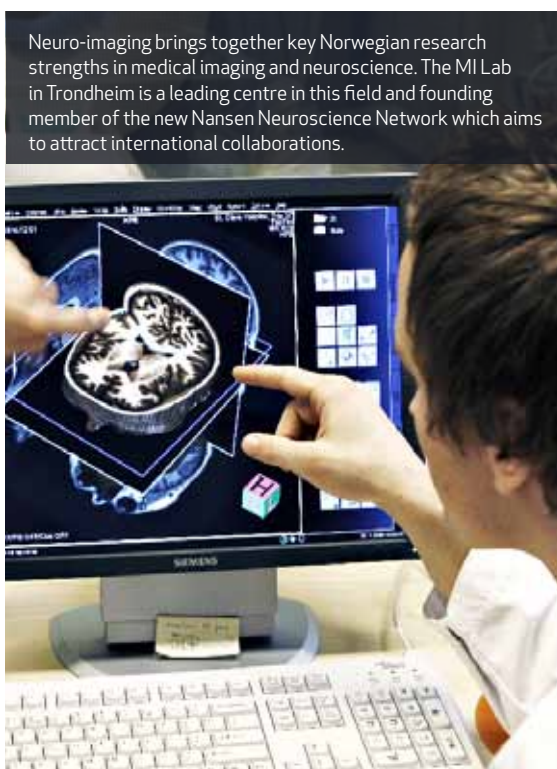


PHOTO: MI Lab.

Neuro-imaging brings together key Norwegian research strengths in medical imaging and neuroscience. The MI Lab in Trondheim is a leading centre in this field and founding member of the new Nansen Neuroscience Network which aims to attract international collaborations.

Government support drives sustainable growth

As relatively latecomers to the biotech party, Norway has been able to learn from the experiences of others and plan for a truly sustainable sector. The main support is channeled through the Norwegian Research Council and the state-owned Innovation Norway, which have programs to support start-ups and collaborations through funding and other resources.

“This is very important to help the small companies move from preclinical to phase I. Both can also help to evaluate the commercial feasibility of the science coming out of universities,” says Øyvind Bruland, Professor at the Norwegian Radium Hospital and founder of Algeta, one of the major success stories in recent years. “Collaborations between academia and industry are very important, but they are not always easy, as the participants come from two different worlds, with different standards and different expectations.”



Pioneered by Photocure, PDT therapy is increasingly been accepted and adopted worldwide for both medical and cosmetic applications. The company has also been extremely dynamic in its marketing approach securing deals with GE Healthcare and Galderma.

"The medical biotech industry is a small but growing segment, with most companies spinning out from hospitals, universities and research institutions, and as a sector is attracting increasing attention," says Erik Christensen, CEO, DiaGenic. "We find that good ideas are being supported by the technology transfer offices, and entrepreneurs can source grants and research awards from the government. However, the challenge is then to find ongoing

resources when the companies move from small to mid-size." Per Walday, CEO, PCI Biotech, agrees. "As a young industry, medical biotechnology needs ongoing support.

Walday's company is listed on the Oslo Axcess Exchange, which provides one model for securing such support. Others such as Clavis Pharma, Algeta and Affitech secured their futures through major collaboration deals, while Lytix Biopharma has been mostly funded through a new generation of local angel investors. Also during the recent recession Innovation Norway was quick to step in with an "emergency" fund to provide bridging finance. In turn this momentum has led to what looks like becoming sustained interest from the investment community. "Overall I believe that the biotechnology industry in Norway is less vulnerable than others that were affected by the 'biotech bubble,'" says Einarsson. "In addition to government support, this is because the companies tend to be more 'virtual,' with researchers remaining within academic institutions. This has the added benefit that it keeps the industry researchers close to the academic environment, the source of new ideas and cutting-edge research."

As an example Einarsson points to Photocure, one of the first of Norway's new generation of biotech companies which now has two products on the world market through agreements with Galderma and GE Healthcare.

"While drug development is reported to take 10 to 15 years and cost between \$800 million and \$1 billion, Photocure took a drug to market in about six years, on a much lower budget and only fifty employees. I strongly believe this was because of the close collaboration between clinicians, scientists and the industry," says Einarsson.

With investors willing to put money into high risk companies, even during the economic downturn, a solid economy and a highly educated and entrepreneurial workforce, Norway is the place to be for medical biotechs!"

Per Walday, CEO PCI-Biotech

What can Norway offer?

The international biotech “market” remains highly competitive. Nevertheless, Norway has a lot to offer and on the basis of recent success can now be considered a real player.

The science foundations are strong: “Norwegian research is globally positioned and highly cited, with strong international networks that provide an opportunity to learn from and support our scientists and influence the research,” says Tønjum. “It has a rich history of bold discovery and frontline science, particularly in neuro-anatomy, DNA repair, imaging and molecular biology – this is an area of high risk but large gains. We have also seen an increase in external funding, despite the current financial climate,” says Tønjum.”

Both Haraldseth and Ottersen agree. “The cutting-edge research in Norway attracts researchers from around the world, so that we can select the best,” says Haraldseth while Ottersen adds: “We have seen a steady increase in the resources going into research in Norway, building a very strong environment particularly in biotechnology. As well as having a high international reputation, Norway provides excellent salaries and working conditions, particularly for PhD students.”

Then there is the enviable pro- translational medicine environment: “Norway also has a high-quality healthcare system both inside and outside the hospitals and we have a patient population that is very willing to take part in clinical trials and has great confidence in the doctors,” adds Aamdal. “Norway is a small country, so we may not be always able to carry out the very large phase III trials, but are highly proficient in carrying out demanding smaller clinical studies. The availability of human resources and financial support complete the picture. One of Norway’s research strengths is its highly educated workforce, explains Christensen. “The workforce is loyal, with high ethical standards.”

“Norwegian investors are willing to put money into high risk companies, even during the economic downturn. Norway has a solid economy and a highly educated and entrepreneurial workforce,” says Walday, “as well as amazing natural resources and leisure opportunities.



PHOTO: Shutterstock.

Norway’s largest Tech Transfer Centre

The recent merger of Birkeland Innovation and Medinnova has resulted in the largest TTO in Norway and the country’s leading player in commercializing life science opportunities. From an international perspective the merger is also interesting because in addition to a clear single point of contact, the new company will be able to offer greater competence, a higher number of projects and closer contact to the market.

By covering Oslo University and Oslo University Hospital – and thus including all the commercial opportunities from National Centres of Excellence such as the Centre for Molecular Biology and Neuroscience (CMBN), Centre for Cancer Biomedicine (CCB), Centre for Immune Regulation (CIR) and Cancer Stem Cell Innovation Centre (CAST) - the company has access to a major research resource, comprising more than 3, 000 researchers in the Life Sciences with an annual research budget of approx. 5 billion NOK.

In a wider context, the new Technology Transfer Centre represents about 80% of all medical research activity in Norway and has a particular emphasis on opportunities in the fields of cancer, neurosciences, and immunology. The company has a steady stream of new life science inventions with close to 200 invention disclosures annually and has since 2006 established 17 start-up companies in the Life Sciences and more than 30 longer term collaborations between academics and national and international companies.

COMPANY PROFILES

■ Photocure

Focusing on oncology and dermatology markets, Oslo-based Photocure develops and sells drugs and devices based on its photodynamic therapy. This uses a locally applied photosensitiser that is activated using Photocure's proprietary light source. Photocure is developing light-activated therapeutics in late stage clinical trials for the treatment of cervical cancer and acne, and for the improvement of the appearance of the skin, as well as a diagnostic for the diagnosis of colon cancer. Photocure's lead product, Hexvix, a bladder cancer diagnostic, is approved for marketing in the EU. (www.photocure.com)

■ Algeta

Oslo company Algeta is developing radiotherapeutics for an area of unmet medical need – cancers that have metastasised to bone – as well as for disseminated tumours. The targeted alpha-emitting agents are based on radium-223 and thorium-227. Alpha emitters produce short-range, densely ionising radiation that can destroy cancer cells with minimal damage to normal tissue, and are well tolerated.

Alpharadin, the company's lead therapeutic, is targeted to bone and is in a phase III trial for bone metastases in hormone-refractory prostate cancer. It is also in clinical trials for bone metastases in breast cancer. (www.algeta.com)

■ Clavis Pharma

Clavis Pharma uses its Lipid Vector Technology (LVT) chemistry to link lipids to existing anticancer drugs to create new chemical entities, enhancing the efficacy and safety, improving dosing schedules, creating new indications and potentially allowing oral, transdermal and inhaled administration.

The Oslo-based company's lead, elacytarabine (a LVT derivative of cytarabine), is approaching phase III trials for the treatment of acute myeloid leukemia. Also in clinical development, the company is developing CP-4126 based on gemcitabine for the treatment of pancreatic cancer. (www.clavispharma.com)

■ PCI Biotech

PCI Biotech began in 2000 as a subsidiary of Photocure, and. It demerged from its parent company in 2008 and listed on the Oslo Stock Exchange, one of only a very few biotech IPOs that year. PCI Biotech uses light technology to allow lower-dose administration of existing, effective, but highly toxic drugs.

The light-directed drug delivery technology, using the company's proprietary photosensitiser Amphinex, triggers the release of biologically-active therapeutics at the disease site. The company has carried out a phase I/II trial of Amphonex with bleomycin in head and neck cancer, and is conducting preclinical studies of its photosensitiser technology in bladder cancer. (www.pcibiotech.no)

■ Lytix Biopharma

Based in Tromsø, Lytix Biopharma is developing synthetic peptide and peptidomimetic therapeutics for cancer and resistant bacterial and fungal infections. These are based on the ability of lytic peptides to lyse cell membranes, induce necrosis and trigger an immune response, but with better stability at a lower cost. The lead cancer drug candidate, Oncopore (LTX-315), has begun a phase I/II trial. In vivo, this injected peptide has both a local and systemic effect. A phase I/II study for their topical broad-spectrum antibiotic is also ongoing. (www.lytixbiopharma.com)

■ DiaGenic

DiaGenic, based in Oslo, is developing in vitro diagnostic tests based on the identification of disease-specific peripheral gene expression signatures from biological samples including blood. DiaGenic has received marketing approval for ADtect (early detection of Alzheimer's disease) and BCtect (early detection of breast cancer) in Europe. In its pipeline, DiaGenic has projects based on gene expression signatures for Parkinson's Disease and mild cognitive impairment, a precursor to Alzheimer's disease, and is working with a major pharmaceutical company on early disease detection for clinical trials. (www.diagenic.com)

■ Bionor Pharma

Bionor Pharma is in the vanguard of international biotech developing peptide-based therapeutic vaccines for infectious diseases and cancer. Located in Oslo, the company's lead product VACC-4X for HIV is currently in Phase IIA trials, which have demonstrated that patients' CD4 counts are raised and viral loads reduced. One major benefit of the vaccine is that patients are able to enjoy a drug-free of up to 18 months, which gives their immune systems time to recover and significantly improves quality of life. Other indications for Bionor's platform include influenza, HCV and HPV. (www.bionorimmuno.com)

■ Affitech

Affitech is a leading antibody therapeutics company developing products based on fully human antibodies. Founded by German and Norwegian scientists, the company merged with Danish listed company Pharmexa

in 2009 followed rapidly by major Research and Development Collaboration and Licensing Agreement with the Russian biotechnology company NTS Plus. The collaboration focuses on two potential therapeutic antibody products: AT001 (also known as r84), a novel, patented therapeutic antibody to vascular endothelial growth factor (VEGF) which is being developed as a potential competitor to bevacizumab (Avastin®) for the treatment of certain human cancers. AT008, a novel, patented therapeutic antibody directed against CCR4, an important G-protein coupled receptor ("GPCR") on the surface of many cancer cells and cells of the immune system. AT008 is expected to have clinical application in the treatment of cancer and certain other diseases. (www.affitech.com)

■ Santosolve

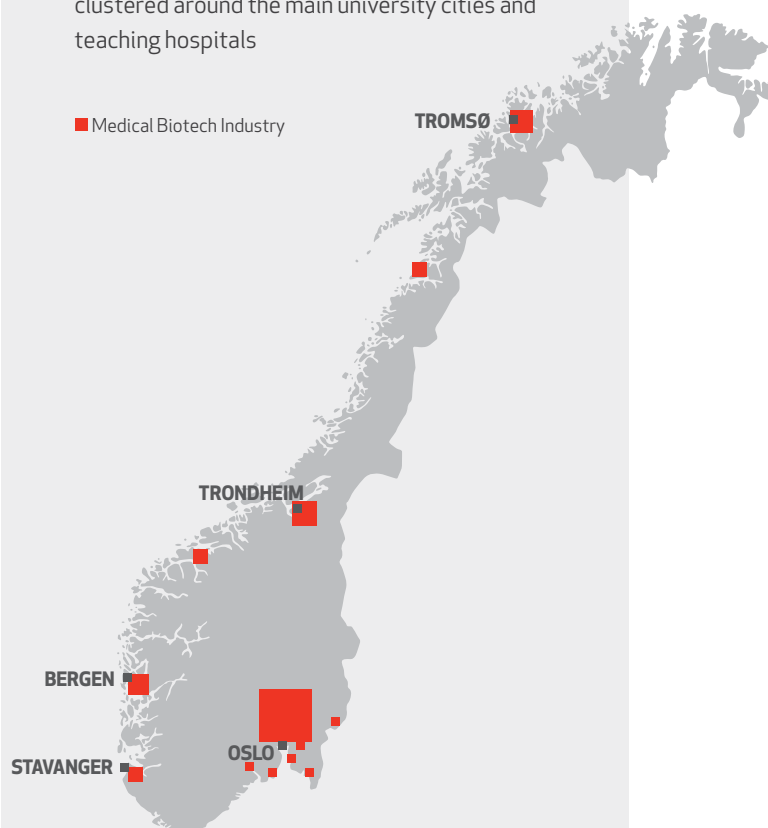
SantoSolve develops topical analgesic products based on strontium as the active agent. The Company's lead product, 2PX, is a low viscosity fluid administered topically at the site of pain. Preclinical and clinical studies have shown the product to have an excellent safety profile and strong analgesic effects in both nociceptive and neuropathic pain conditions. In 2009 the Company advanced 2PX into pivotal Phase III trials in both osteoarthritis of the knee and in chronic post-amputation pain. Both trials are expected to report results during 2010, and planning for confirmatory phase III trials are underway. The Company expects to be able to file an NDA during 2012. (www.santosolve.com)

■ BerGenBio

Based and the name suggests in Bergen, BerGenBio offers contract research and development services to pharmaceutical and biotechnology companies as well as seeking collaborations for pipeline development of novel drug targets and therapeutics, including small molecules, antibodies and RNAi drugs. Typical CRO Services include single or multiple simultaneous target validation studies. These either originate with client provided target sequences or shRNAs determined using the company's proprietary CellSelectRNAi platform technology. In addition, their role in disease state determined using proprietary in vitro models. In vivo models can be TET regulated and the progression of the disease can be visualized in real time using CellSelectImaging technology. Clients can utilize BerGenBio's cell lines and assay systems or they can provide tailored cell lines and disease modeling systems. Following target validation, compound and therapeutic screening services are offered to fast track lead compound selection for pre clinical development. (www.bergenbio.com)

MEDICAL BIOTECH INDUSTRY AND R&D

Distribution of the biomedical industry is clustered around the main university cities and teaching hospitals



TROMSØ

University of Tromsø
University Hospital Northern Norway

Mabcent – Centre of Marine Bioactives and Drug Discovery

TRONDHEIM

Norwegian University of Science and Technology
St.Olav University Hospital

Medical Imaging Laboratory (MI Lab)
Kavli Institute for Systems Neuroscience
Centre for the Biology of Memory (CBM)
Centre for Biomedical Computing (CBC)

BERGEN

University of Bergen
Haukeland University Hospital

STAVANGER

University of Stavanger

OSLO

University of Oslo
Norwegian University of Life Sciences
Akershus University Hospital
Oslo University Hospital

Biotechnology Centre of Oslo
NCE Oslo Cancer Cluster
Cancer Stem Cell Innovation Centre (CAST)
Centre for Biomedical Computing (CBC)
Centre for Cancer Biomedicine (CCB)
Centre for Immune Regulation (CIR)
Centre for Molecular Biology and Neuroscience (CMBN)
Interventional Centre (experimental medicine)
NCE Micro - and Nanotechnology
Norwegian Institute for Public Health



MARINE AND AGRO BIOTECH

PARTICULAR STRENGTHS WITHIN:

- Breeding programmes
- Vaccines
- Feed development
- Marine bioprospecting

FROM LAND TO SHINING SEA

Norway's recognised excellence in aquaculture is based on imaginatively applying life science techniques and technologies to develop guided breeding, extensively implemented vaccine programmes and advanced feed regimes. In addition, this expertise has helped Norway remain in the forefront of refining marine-based health products and supplements.

From specialist delicatessens to supermarkets world-wide, Norwegian salmon is firmly established as one of, if not the, leading brands. Success that depends not just on the skills of the fishermen. Since the 1980s, the application of life science expertise has been one of the drivers behind the steady increase in production and exports of Norwegian salmon and other farmed fish. Thus while fishing may have dwindled as an occupation over the past half a century, Norway is now home to more than 1,500 fish farms and a world leader in the aquaculture industry.

Norway's recent success in aquaculture is, undoubtedly, partly a result of transferring what it has learned in the agriculture sector into fisheries, combining traditional breeding knowledge with pioneering expertise in the life sciences – particularly in veterinary medicine and genomics.

Animal breeding provides a perfect starting point. Traditional breeding programmes are based on the century-old practice of selecting animals for breeding by certain pre-defined traits, such as productivity or calving ease. This is the way that the Norwegian Red, Norway's main dairy cattle breed, has been bred since it was established in 1935.

Nowadays, applying life science techniques makes the process a little easier. For instance, at Geno,

headquartered in Hamar, the rigorous process by which the best bull cows are chosen involves a DNA test to rule out those with genes for bitter tasting milk. There are plans in the next few years to move towards genomic selection – where a broader spectrum of traits are evaluated by DNA testing – as a way to reduce the number of test bulls purchased and increase the level of genetic improvement between one generation and the next.

Currently, however, Geno's R&D team is focusing on better artificial insemination techniques. Together with partners from academia, they have developed a method for preparing semen in a gel, helping it to survive for longer inside the cow and thus extending the window available for insemination.

“Norway's recent success in aquaculture stems from combining traditional breeding knowledge with pioneering expertise in the life sciences – particularly in veterinary medicine and genomics.”

Professor Øystein Lie, Executive Manager of Marelife

Even using current techniques, says CEO Sverre Bjørnstad, the breeding material is unique. Norwegian Red bulls undergo seven rounds of selection, during which more than 50 different traits are evaluated. “You will find cow breeds that have higher production potential, but not the combination of such high production potential and good health, fertility and easy calving,” he says. “What's unique about

breeding tradition in Norway, I think, is the way of organising the breeding work, where the farmers work together. And I think that goes also for aquaculture.”



Morten Rye, Scientific Director at Akvaforsk Genetics Centre, says Norway has successfully transferred knowledge in livestock breeding to applications in aquaculture. Akvaforsk applies the same basic selective breeding programs, using advanced statistical modelling to identify the very best parents and, through research and development, is starting to implement the use of genomic information much in the same way as cattle breeders.

The company currently works on a total of 14 different species, including Atlantic salmon, rainbow trout and turbot. But Akvaforsk works all over the world and one of its most pioneering projects to date involved transferring the knowledge gained from cold water species like salmon into tropical fish species, for the genetic improvement of farmed tilapia in the Philippines. "We looked into the genetic diversity of these populations in terms of production efficiency and eventually we initiated the same type of selection programme as we had been running for many other species before," he

"Norwegian transfer of genetics knowledge has had a major impact on the development of aquaculture production in tropical fish species in Asia,"

Morten Rye, Scientific Director, Akvaforsk Genetics Centre AS.

says. "They responded very nicely to selection – the same response that we have seen in other species."

The project was partly funded by the United Nations Development Programme and Asian Development Bank. The key point for those organisations, Rye notes, is that the work has a fundamental effect on the development of sustainable agricultural industries. "It's more than making certain companies very rich," he says. "That project and Norwegian transfer of knowledge has had a major impact on the development of aquaculture production in tropical fish species in Asia."

Tackling fish disease worldwide

More recently, Norwegian veterinary scientists have been using their considerable expertise in fish disease to tackle problems affecting other parts of the world. Researchers at the Norwegian School of Veterinary Science study infectious salmon anaemia (ISA) – the disease that recently wiped out the salmon industry in Chile – and have characterised genes and proteins belonging to the orthomyxovirus that causes it, as well as demonstrating a certain level of protection against the disease via a DNA vaccine incorporating one of the outer envelope proteins of the virus.

Much of Norway's veterinary research is conducted at the School and as Rector Lars Moe points out, the expertise of its scientists in veterinary health spans the whole spectrum, from agricultural to aquacultural species. "Many of the same problems that face chickens and pigs, they also face sea animals or fish farming, and so we have transferred that knowledge that we have from the land animals to the sea," says Moe.

PHOTO Yngve Ask/Innovation Norway



Norwegian scientists have spearheaded both national and international projects to sequence various salmonid and other fish species. The resulting information is being used to develop innovative fish breeding and health products.

The strategic position the School has taken in the last ten years is to try to cement its reputation as an international leader in fish disease research. But Moe says maintaining a broad area of competence is crucial to excelling in the field – for example, some of the same diagnostic methods that are used in larger animals can be applied in fish, as in heart disease and cataracts.

Meanwhile, work in larger animals continues to yield results in the field. One of the most important problems we have been tackling, explains Moe, is bovine viral diarrhoea virus (BVDV). Together with partners from industry and government ministries, researchers at the veterinary school have helped to reduce incidence of the disease – previously a significant cause of death and stillbirth in cattle – to nil in around 15 years, through the implementation of a screening and eradication programme that banned the sale of infected cattle.

Combining resources efficiently

Another key player is Nofima, established in 2008 as a merger between research institutes involved in agricultural food research, and aquaculture and fisheries research. The rationale behind the decision, says CEO Øyvind Fylling-Jensen, was that there are many technologies that can be used independent of the sector that the research is applied to. “If you look at measuring techniques, genetics and so forth, very much the same platforms are being used,” he says. “And Norway being a small country wants to utilise its resources in a more appropriate and more cost-efficient way than just having the institutes working independently.” The whole of aquaculture genetics, he says, has its roots in the agricultural sector. Equally, measuring techniques like infrared spectroscopy used in sorting of garbage are also used in the meat industry to measure fat content and have been transferred into measuring fat and colour in salmon fillets.

“Ongoing work includes applying diagnostic methods used in larger animals to fish – e.g. for heart disease and cataracts”

Lars Moe, Rector of the Norwegian School of Veterinary Science

Promoting sustainability

The broad spectrum approach is also one that the bio-marine network MareLife espouses. It works cross-sector to facilitate collaboration between partners in marine industries, including in fisheries, aquaculture, ingredients and marine biotech, and now even in the oil and gas, and energy sectors. “We facilitate collaboration between members,” explains Executive Manager Øystein Lie. “We don’t own the projects – we leave the members to own them. But we assist them in starting robust innovation and R&D projects, because they see new angles and new allies when they talk with us.”

Though its members are dominated by industry players, MareLife has tight links with academia and remains independent. It has influence at parliamentary level, for instance in budgetary and strategic decisions affecting

the development of the marine sector, and recently stepped in as peacemaker in a long-standing political debate about fish stocks – using the results of a genetic study it had initiated to broker an agreement.

As Lie explains, the EU and Norway had long been locked in a dispute

over quotas for mackerel fishing that prevented Norwegians from fishing their own stock once it had crossed into the EU zone. But the results of the study, which was in part carried out at the Norwegian School of Veterinary Science, showed that segregating stocks made genetic variability difficult to predict. The solution was to manage a common stock and thus ensure predictability for all parties.

This, says Lie, was a very practical result from genetics that could be applied in fisheries. He says it is not until recently that we could have considered using genetics as a means for negotiations between countries.



PHOTO: AkerBioMarine.



Photo: Aker BioMarine

Omega-3 is one of the major success stories of Norwegian nutraceuticals and leading the continuing search for new formulations and sources, Aker BioMarine has turned to krill, a more sustainable and higher yielding source than fish.

Marine bioprospecting – Norway's new treasure trove

Norway has already had several bounties from its coastal waters – a maritime industry, fisheries and most recently North Sea oil. Marine bioprospecting looks like being the next. Norwegian waters – the Arctic and sub-Arctic regions, the fjords and the coastline – are rich in species which could yield bioactives with applications in all sectors of the biotech industry. However, much of this marine biodiversity remains unexplored.

In 2003, researchers at The Norwegian University of Science and Technology (NTNU) and SINTEF (Foundation for Scientific and Industrial Research at the Norwegian Institute of Technology) began collecting bioactive extracts from sediments, sponges and water surfaces in the Trondheim fjord. Later, a collaboration with Stein Ove Døskeland at the University of Bergen was established and by 2008, a number of anti-cancer and anti-bacterial hits and leads had been identified.

“Norwegian research into the unique biodiversity of the Arctic waters is already leading to the discovery of many molecules, such as unique metabolites with pharmaceutical potential and cold-adapted enzymes with important industrial applications,”

Kjersti Gabrielsen, Head of Marbank

The SINTEF/NTNU consortium has established a network of partnerships at every stage of the drug development, to push toward commercialization of these compounds. An example of this is Biosergen AS, a company founded by Sergey Zotchev, Assistant Professor at the Department of Biotechnology NTNU. Going forward, Zotchev envisages a more genomic/metagenomic-led approach to marine bioprospecting, with a big influence from systems biology and synthetic biology.

Prioritised by government

Realising the potential of this work, the Norwegian government recently launched “Marine bioprospecting – a source of new and viable wealth creation” - a national strategy in marine bioprospecting. Over the next ten years, potential opportunities from Norway's marine genetic resources will be exploited by strengthening infrastructure and networking in this emerging sector.

The strategy is a key element of the government's High North policy, its general innovation policy, and the Strategy for the Marine Sector. ‘Our ambition is to exploit marine biological resources for industrial development,’ says Christina Abildgaard, Deputy Director General of the Ministry of Fisheries and Coastal Affairs.

The Norwegian Government is allocating an initial 50 million NOK for 2010 to implement the strategy and the Research Council of Norway's national FUGE (functional genomics) programme will be important in developing research and national infrastructure. ‘Our ambition is to exploit marine biological resources for industrial development,’ Christina Abildgaard, Deputy Director General of the Ministry of Fisheries and Coastal Affairs.

Under the marine bioprospecting strategy Marbank, the Tromsø-based marine biobank, is to be given formal national status. Marbank is a joint venture of the University of Tromsø, the Institute of Marine Research, the Norwegian Polar Institute and the Norwegian Institute of Fisheries and Aquaculture Research. Its mission is to provide a national repository of frozen marine genetic and biological samples collected and maintained under rigorously controlled conditions; this valuable archive of marine molecular diversity is then available to academia and industry for R & D.

‘We still have a long way to go but our overall goal is to collect as many species as possible, especially rare species that are not readily accessible,’ says Marbank's head, Kjersti Gabrielsen. The unique biodiversity of the Arctic waters will lead to the discovery of many molecules, such as unique metabolites with pharmaceutical potential and cold-adapted enzymes with important industrial applications.



The sub-arctic waters off the coast of Norway represent a new frontier in life science research with a treasure trove of new compounds ranging from unique enzymes to drug candidates waiting to be discovered.

Photo: UPhoto/Björn Guliksen.

Meanwhile, MABIT, the industrial research program for marine biotechnology in Northern Norway, will also be strengthened under the new strategy. MABIT supports R & D, innovation and commercialization in around 25 companies involved in extraction and purification of by-products from fisheries and aquaculture, including marine oils, food or feed ingredients, enzymes or fine chemicals.

Erling Sandsdalen, Leader of MABIT's Board, says they also want to develop marine biotech at a national level and in partnership with industry. Typically, 30-40 % of the funding for projects comes from industry.

Inspiration guaranteed

Medical biotechnology often grabs the headlines, but the applications of life sciences are far ranging. Norway provides a fascinating snapshot of just how far. From fish vaccines and DNA tracking to a potential treasure trove of new medical and industrial compounds in sub Arctic waters. All with international relevance. "You will find an unrivalled open spirit of collaboration here," says Lie. "We welcome new members to to Marelife since concerns for instance on fish stock sustainability are issues not just for Norway but for the international community at large."

COMPANY PROFILES

■ **AquaGen and GenoMar** both specialise in broodstock enhancement of aquatic and marine species with operations worldwide. AquaGen concentrates on Atlantic salmon and rainbow trout, while Genomar has already developed and commercialised superior tilapia seed which is emerging as one of the prime global white fish species. GenoMar is also pioneering GenTrack™, a patented DNA fingerprint based concept for secure verification of seafood origin literally from egg to plate. The system will increase consumer confidence by preventing frauds. (www.aquagen.no) (www.genomar.no)

■ **Aker BioMarine**

Aker BioMarine is a world leader when it comes to catching krill. Its patented trawling system allows krill, completely free from by-catch, to be brought onto the boat live. By the time it reaches the shore, it has already been turned into meal or paste and frozen. The vast majority of krill meal goes straight to fish farms, to be used in feed for salmon and other farmed species. The remaining less than 10 per cent is used to make krill oil (Superba™), which goes into dietary supplements for human consumption. Executive Vice President Hogne Vik has recruited a team from the pharmaceutical industry to test absorption and uptake of the active ingredients in krill oil. In head to head trials with fish oil, they have seen higher uptake from the gut to the serum and from serum to cells. "We're also studying anti-inflammatory effects and looking into inhibiting development of diseases," says Vik. "Because that is the aim for dietary supplements – it's not to feed, but to protect you from developing diseases." (www.akerbiomarine.com)

■ **Biotec Pharmacon**

Biotec Pharmacon develops pharmaceutical products based on beta glucans to boost human immunity. However, the company has marine origins since the founders originally discovered that disease resistance of Atlantic salmon was significantly enhanced by a special beta-1,3/1,6-glucan preparation. Later they showed this had

the same effect on piglets and other livestock animals, and moreover caused a commercially significant improvement of growth performance and feed utilization. Currently Biotec Pharmacon's lead product is the bioactive compound SBG (SBG, soluble beta-1,3/1,6-glucan). The company's clinical development program includes cancer immunotherapy where a combination treatment of SBG and monoclonal antibodies is currently in clinical phase I/II. Proof of concept trials with SBG in animals for treatment of Inflammatory Bowel Disease and treatment of Asthma have also started. Meanwhile, the subsidiary Biotec Marine Biochemicals AS develops and manufactures unique DNA/RNA-modifying marine enzymes for use in gene technology research and diagnostics. (www.biotec.no)

■ **Pronova BioPharma**

Pronova BioPharma is Norway's largest pharma company and a global leader in the research, development and manufacture of marine-originated omega-3 derived pharmaceutical products. Pronova BioPharma's first commercialized product, Omacor®/Lovaza™ is the first and only EU and FDA -approved omega-3 derived prescription drug and is prescribed as an adjunct to diet for the treatment of elevated levels of triglycerides in humans, a condition known as hypertriglyceridemia (HTG). Very high triglycerides have been linked to a number of cardiovascular diseases. Products containing Pronova BioPharma's API have also been approved in certain European and Asian markets for the secondary prevention of post-myocardial infarction (post-MI) in the period following the initial survival of a heart attack. Pronova BioPharma's global network of license and distribution partners includes: GlaxoSmithKline PLC (US), Takeda Pharmaceutical (Japan), Prospa (Italy) and Solvay (UK, Germany and others). IMS Health reports that global end-user sales of the product have increased from USD 144 million in 2005 to USD 1,063 million in 2009. The company estimates that approximately 1.3 million patients are currently on a prescription for Omacor/Lovaza. (www.pronova.com)

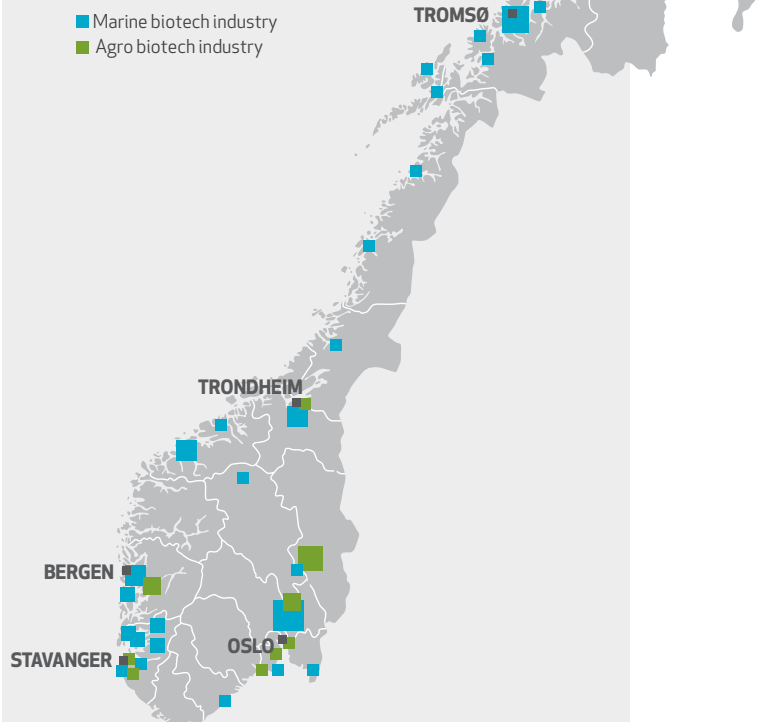
■ Biosergen

Biosergen AS was established in 2004 in order to exploit research at SINTEF and the Norwegian University of Science and Technology (NTNU) in Trondheim into “engineered biosynthesis”. This enables modification of the complex molecules such as polyketides and peptides found in natural antibiotics to produce drugs suitable for human use. Biosergen is currently running two development programs. The first is for systemic fungal infections where a candidate drug has been selected, BSG005G. The second is an anti cancer project currently in the lead optimization phase. (www.biosergen.com)

■ ■ Geno

As well as being experts in cattle breeding, Geno scientists are responsible for a recent breakthrough in cryopreservation of fish embryos, which could have a major impact on disease prevention in aquaculture. “Our scientists have been able to bring fish embryos down to -130 degrees and then bring them back to life,” says CEO Sverre Bjørnstad. The advance makes it possible to transfer genetic material between farms whilst limiting the spread of disease. Since an embryo could be stored and thawed to continue growing naturally at a much later date, the technique might also provide an option for conservation of species facing extinction. (www.geno.no)

MARINE AND BIOTECH INDUSTRY AND MAIN RESEARCH CENTRES



TROMSØ

University of Tromsø

Marine Bioactives & Drug Discovery (MABCENT)

Nofima

NORUT – Northern Research Institute

TRONDHEIM

Norwegian University of Science and Technology

SINTEF

BERGEN

University of Bergen

Institute of Marine Research

National Institute of Nutrition and Seafood Research (NIFES)

STAVANGER

University of Stavanger

International Research Institute of Stavanger

OSLO

University of Oslo

Norwegian University of Life Sciences

Norwegian School of Veterinary Science

Aquaculture Protein Center

Centre for Ecological and Evolutionary Synthesis (CEES)

Norwegian Food Safety Authority (NFSA) (Brumunddal)

National Veterinary Institute

Norwegian Agricultural Economics Research Institute (NILF)

Norwegian Institute for Water Research (NIVA)

INDUSTRIAL BIOTECH

PARTICULAR STRENGTHS WITHIN:

- Fermentation and biocatalytic tools
- Processing of marine biomass
- Leading wood biorefinery technology

FUELLING THE NEXT INDUSTRIAL REVOLUTION

Norway's wide ranging expertise in energy production is also being fuelled increasingly by biotech, with exciting new developments in biomass conversion and applying microbiology and advanced molecular biology tools for oil exploration, cleaner energy and biofuels.

Few countries are as blessed as Norway with energy resources. Of course everyone knows about the finite oil and gas, but there is another story to be told about renewables and the way they stimulating the emergence of an exciting industrial biotech sector.

As in other countries there is growing recognition that industrial biotechnology can feed into the demand for greener, cleaner, industrial processes. This could involve, for instance, enzymes replacing conventional chemistry and marine biomass used as renewable feedstock for production of both high end chemicals and biofuels. 'There is no national strategy for industrial biotechnology yet, so projects tend to come from general industrial R & D', observes Steinar Bergseth of the Norwegian Research Council! However, the last government R & D White Paper called for a 'greener' economy. This, together with the

national strategy on biotechnology, is likely to lead to opportunities for 'white' biotech projects.

Øystein Rønning, the Research Council's Industrial Biotechnology spokesman adds 'There is also a national strategy in blue biotechnology which could lead to developments in the white biotechnology area, through projects involving enzyme discovery and biocatalyses.

"Industrial biotech is increasingly on the agenda in Norway and can feed into the demand for cleaner greener processes,"

Steinar Bergseth, Norwegian Research Council



Borregard's world-leading biomass production plant is typical of the way in which Norwegian industry is looking to lead the new industrial biotech revolution.

Photo: Johnny Helgesen

Biofuels a growing interest

To this can be added a cross-departmental agreement in the Norwegian Parliament to develop alternative energy sources. While the main focus is on wind and solar, there is growing interest in biofuels – as evidenced by the establishment of the Center for Bioenergy Research at the Norwegian University of Life Sciences (UMB) and two research institutions in Ås.

A major contributor here is Professor Vincent Eijsink's Protein Engineering and Proteomics group (UMB), a world leader in chitin enzymology. They have characterized a broad range of enzymes for chitin bioprocessing, which can be tailored by enzyme engineering. 'We have built a competence in this area with the whole tool box needed to investigate the enzymes says Eijsink.

The tools range from advanced single molecule technologies, to reveal details of enzyme-substrate interactions, to large scale process equipment, including a steam explosion unit (a collabora-

tion with Cambi AS) for biomass pretreatment. Enzymes can therefore be tested in applied settings, and 75% of Eijsink's group is working on biomass conversion, addressing issues like optimizing biomass input streams, output product profiles, and processing conditions. 'We believe in taking a very integrated approach from research to large scale processing' explains Eijsink.

The efficiency of lignocellulosic biofuel production is limited by the ability of enzymes to break down crystalline cellulose into single polymer chain substrate. Eijsink's group has recently identified a group of accessory proteins in chitinolytic microorganisms that improve

substrate accessibility, suggesting that a search for the analogous cellulose proteins would be fruitful.

They also showed that the processive component of polysaccharide breakdown – where enzyme remains bound to polymer chain, thereby preventing its reassociation into insoluble form – actually slows down enzyme action. The UMB group obtained these findings through experiments on chitosans, which are soluble derivatives of chitin. Processive enzymes are present in current commercial preparations for biomass conversion. A more efficient approach could involve use of accessory proteins and/or novel enzymes to improve substrate accessibility.

The UMB group is also converting chitin into chito-oligosaccharides from which bioactives are being ex-

tracted, with a range of industrial applications such as plant pest management. Going forward, metagenomics will play a role in UMB's ongoing search for new industrial enzymes.

SINTEF is the largest independent research organization in Scandinavia. It generates new knowledge

and solutions for its customers based upon its research and development activities in technology, natural sciences and social sciences. As such, SINTEF is sure to play a major role in the development of industrial biotechnology in Norway. 'Our main focus is quantitative microbiology, going from strains to pilot scale,' explains Research Director Trond Ellingsen. The OECD has recently argued that industrial biotechnology will increase while the focus on health will decrease and SINTEF is ready to respond to this challenge. 'We are trained to work for industry,' SINTEF's Executive VP Torstein Haarberg adds. 'We are here for innovation and projects are becoming increasingly interdisciplinary and more international in focus.'

'We are trained to work for industry and our projects are becoming increasingly interdisciplinary and more international in focus,'

SINTEF Executive VP Torstein Haarberg

Open to collaboration

For a relatively small country, Norway has a long industrial tradition. It also has a history of companies able to reinvent themselves by embracing scientific progress. The case studies, Borregaard and Statoil, are just two examples of a growing trend to look at the opportunities offered by life sciences. Others are looking at a whole range of applications – from environmental clean-up to nanotechnology.

Value from every part of the tree

As with all the Nordic countries Norway has large forests, which have always been treated as renewable resources long before the idea became “fashionable”. Borregaard has become the world’s leading producers of chemicals from wood as an alternative to those derived from oil. Life cycle analysis shows that the use of wood as a raw material is sustainable and environmentally beneficial. For instance, carbon emissions from vanillin made from lignin are 90% less than for vanillin produced from petrochemicals.

Indeed lignin and its products already have applications in many industrial sectors. Borregaard looks for new applications all the time. Recently they have developed a plant growth enhancer through mimicking humic acid in soil, whose source is lignin, which is really taking off in the US. Another new lignin-derived product decreases the corrosion caused by strong acids used in the fish industry.

Borregaard’s speciality celluloses have applications in building, textiles, filters, plastics, glues and paints. Microfibrillar cellulose, which comes from degrading cellulose into microfibers, is particularly interesting. ‘This gives the cellulose totally different properties – it behaves more like a chemical and we have found a way to produce it large scale’, explained Gudbrand Rødsrud, Technology Director, Business Development. ‘There are many industrial applications and new areas. We don’t know what to expect because we keep finding unexpected properties in these microfibrillar celluloses. It is very exciting’.

Borregaard is interested in high value products for niche markets and has a lower focus on ethanol. However, they do produce 20 million litres of 2nd generation bioethanol

in their sidestream; it is used in solvents, car wash and also as a biofuel to power a number of Oslo city buses.

The company is involved in a number of biomass projects. In the Biomass2Products project partly funded by the Norwegian Research Council they are looking at obtaining products from wood, bagasse and straw through a new pretreatment process and in LignoRef at pretreatment of biomass for biorefineries. Borregaard is also participating in two EU biorefinery projects - one on biorefinery pretreatment with the ultimate product being aviation fuel (co-ordinated by the University of Lille), the other on microfibrillar cellulose (coordinated by the University of Oxford).

Putting oil-loving microbes to work

The state-owned Statoil, one of the world’s largest oil and gas companies, also continues in its endeavours to use microbiology and advanced molecular biology tools for oil exploration, cleaner energy and biofuels. The company already has a built a huge library of around microbial isolates and metagenomic extracts from oil deposits around the world which it is now looking to find applications for in both its own and potentially other sectors.

“However, our first priority is more efficient oil and gas production,” says Hans Kristian Kotlar, Senior Biotechnology Specialist. ‘We are using biotechnology through the whole value chain from exploration to extraction of energy,’

In this work Statoil are constructing DNA probes from microbial fingerprints associated with oil seepages, which will enable them to detect the presence of oil, without drilling, which is especially important in environmentally sensitive areas. Other oil-loving microbes are being used to degrade the otherwise intractable heavy grades of oil, thereby increasing recovery and yields.

Statoil is also interested in second generation biofuels, using raw materials like animal fats, fish oil and plant oil, using thermophilic enzymes to create viable feedstocks.

COMPANY PROFILES

○ Borregaard

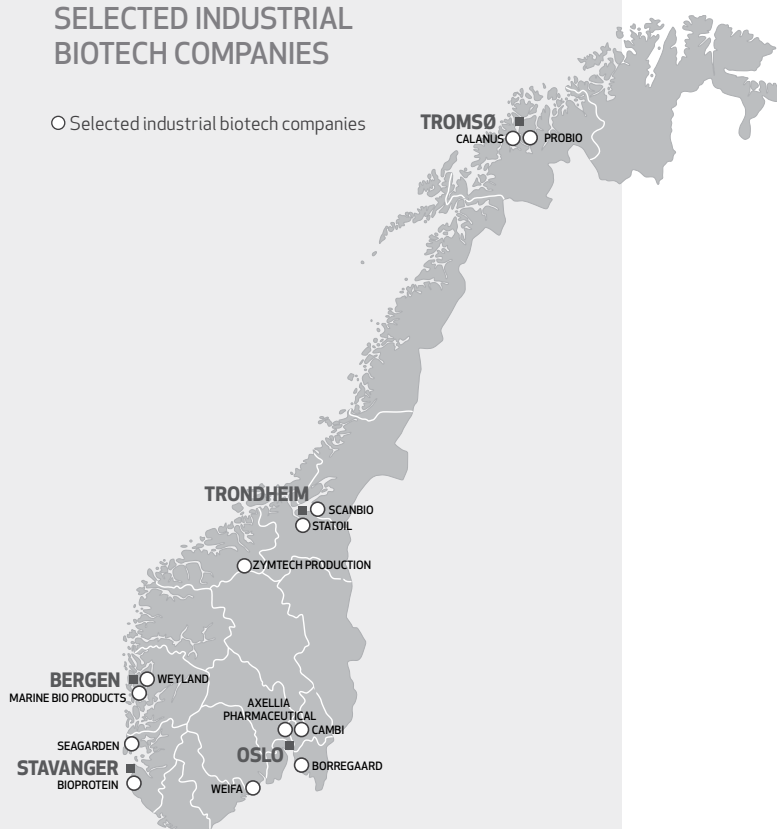
Borregaard, the world's leading producer of chemicals from wood, was founded in 1889 and is now part of the Orkla Group. The Borregaard biorefinery at Sarpsborg, south-east Norway, is the most advanced biorefinery for wood in the world. Here they process one million cubic meters of spruce from Norway and Sweden each year to obtain 160,000 tonnes of lignosulphonates and 160,000 tonnes of speciality cellulose – the aim being to make use of every molecule of a log of wood. Ninety percent of the wood log is converted to chemicals, the remainder to energy for internal use. Borregaard is the only company in the world making vanillin, one of the most widely flavoring and perfumery ingredients, from lignin. www.borregaard.com

○ Statoil

Statoil is an international energy company headquartered in Norway. It has more than 35 years of experience from oil and gas production on the Norwegian continental shelf and has currently operations in 40 countries. Statoil is among the world's largest offshore oil and gas operators and is seen as a leader in technology and resource management. Statoil has 29,000 employees worldwide, and is listed on the New York and Oslo stock exchanges with a market capitalisation of approximately USD 70 billion. Equity production in 2009 was 1,962 000 boepd and booked reserves of oil and gas is reported at 5.4 billion barrels. www.statoil.com.

SELECTED INDUSTRIAL BIOTECH COMPANIES

○ Selected industrial biotech companies



BIOENERGY:

Scanbio
Cambi
Statoil
Weyland

FINE CHEMICALS:

Borregaard
Zymtech Productions

FOOD AND FEED:

Calanus
Probio
Seagarden
Marine Bioproducts

PHARMA:

Axellia Pharmaceuticals
Weifa



THE LIFE SCIENCE LANDSCAPE IN NORWAY

Life sciences in Norway are clustered around 4 main centres – Tromsø, with the world's most northern university, Trondheim in the middle of the country with a strong tradition in engineering and applied sciences, the former Hanseatic port of Bergen and naturally the powerhouse and capital Oslo. All are open to inward investment and collaboration, encouraging life science companies to establish R&D or production units.

Tromsø, – the arctic hotspot

Well above the Arctic Circle and boasting the world's northernmost university, Tromsø, defies expectations. Home also to several polar-research centres, this bustling city has a strong innovation culture. The new Barrets Biocenter is the last addition to an already impressive research park located just outside the university campus.

Life science activities cluster round the University with its internationally renowned chemistry and biochemistry departments. Given Tromsø's role as a major arctic fishing port, it is no surprise that many of these activities are marine-focused and Tromsø has become one of the key centres for marine bioprospecting.

This has led to the founding of MabCent, an national innovation centre that aims to stimulate the development of high-value bioactive products by screening organisms from the arctic marine environment. Founded in 2007, MabCent is sponsored by The Research Council of Norway with NOK 76 million over eight years.

Linked to this is a major new resource, Marbank, a marine "biobank" to store the wide variety of genetic and biological material from marine, microorganisms, plankton, algae, invertebrates and vertebrates arising from marine bioprospecting activities.

Several leading companies have also sprung up in Tromsø based on applying life science research to the marine environment. These include Lytix Biopharma, Biotec Pharmacon, Pronova BioPharma and ProBio. The ambitious local TTO also has a strong pipeline of interesting future candidates.

Bergen - trading on history

The historic former Hanseatic port of Bergen also has a strong and growing life science community. Traditionally strong in medicine, Bergen University has spun out a promising portfolio of companies including Biosense Laboratories, UniTargetingResearch and Balter Medical. The latest is BerGenBio AS which has developed an innovative RNAi technology for drug target validation and high-throughput discovery. In addition, Bergen is home to one of Norway's main specialized life science venture capital funds Sarsia, which will spur future growth.

The Bergen region has a long tradition in marine sciences. For example, the Institute of Marine Research (IMR) conducts research on marine resources, marine environment and coastal zone management. The aquaculture program at IMR is one of the largest and most comprehensive of its kind in Europe and its knowledge base and molecular research on marine organisms are complemented by the UNI Sars Centre located at Marineholmen Technology

PHOTO: Henrik Romsaas



Well above the Arctic Circle, the world's most northerly university city Tromsø is also the vibrant home to a wide range of leading research institutes such as MabCent, the sub-arctic marine biobank Marbank and the Polar Research Centre.



Park. Marine research in Bergen has resulted in companies such as EWOS, Salmobreed, Intervet Norbio, Havbruksinstituttet AS, Blue Limit AS, Nutri Marin, and iLab.

In addition, the research institutions NIFES and Nofima Ingrediens are located in Bergen. The latter engages in national and international research, product development, analytical services and pilot production for ingredients, food, pharmaceutical and health food industries. Their primary areas of expertise cover marine bioprospecting, raw materials, by-product utilisation, feed and nutrition and the processing of marine sources.

Trondheim – engineering success

In the centre of Norway, Trondheim is a powerhouse of applied research in general and life sciences in particular. On the medical side, St. Olav's University Hospital and the Norwegian University of Science and Technology's Faculty of Medicine have a close cooperation on the development of the "Operating Theatre of the Future" which has attracted major international collaborators such as Siemens and Olympus. This work has also led to a number of spin-off companies developing instrumentation and reagents.

Biomedical companies would include Avexxin and Biosergen, the latter creating a pipeline of novel antibiotics from marine bioprospecting. A particularly strong resource is the comprehensive HUNT biobank which has formed a commercial arm HUNT Biosciences to exploit the growing biomarker discovery and validation market. Aquagen completes the picture as an internationally leading company on salmon breeding illustrating the fact that Trondheim is one of Norway's hotspots for aquaculture.

Trondheim is also becoming the home of white biotech in Norway thanks to the laboratories of SINTEF, the largest independent research organization in Scandinavia and the research centre of Statoil, the state oil company.

Oslo – capital gains

With a population of 1.3 million in the greater Oslo region, the capital dominates in terms of the resources needed for a life sciences hub. One out of four employees has successfully completed tertiary education in a science or technology field or is employed in a science and technology occupation. Layer on top of this an infrastructure of leading universities, research centres, and teaching hospitals and it is easy to see why the region has a strong tradition of biomedical and life science research. Oslo is paving the way for groundbreaking research and discoveries within cancer, neuroscience and marine biotechnology. Life sciences are also one of the areas prioritized as a future basis for growth by the local politicians.



PHOTO Bjørn Dufseth

Norway is a world-renowned centre for medical imaging and diagnostics. Oslo University Hospital and Ahus in Oslo, and St Olav's Hospital in Trondheim provide in-demand testbeds for new concepts and technologies.

Translating success

Among other key advantages in the region is the willingness to encourage industrial application of research. Translational medicine is a current hot topic, but has in fact long been practiced in the region. It started in the diagnostics, imaging and instrumentation field and led to the growth of several large industrial players such as Nycomed, Dynal and Axis-Shield. In addition international firms such as GE, HP, Siemens and Philips regularly use Oslo as a testbed for new technologies and ideas. Akershus University Hospital, which aims to be Europe's most hi-tech and innovative hospital being the latest example. Along with St. Olav's Hospital in Trondheim, Akershus is also one of the first fully digitalized hospitals in Norway.

More recently a number of biopharma companies such as Algeta, Clavis Pharma, PhotoCure and PCI Biotech have achieved success “translating” the fruits of local research into novel therapeutics, particularly in oncology. Progress has been encouraged and accelerated by the fact that Oslo is highly rated by pharmaceutical companies such as AstraZeneca, MSD, Roche, GSK and Pfizer for high quality clinical trials. Furthermore a talent pool is developing that should help perpetuate this sector.

Strong concentration

The Oslo University Hospital is the largest in Scandinavia forming a health trust that operates three university hospitals; Rikshospitalet including the Norwegian Radium Hospital, Ullevål and Aker. The recent merger of Birkeland Innovation and Medinnova resulted in the largest Technology Transfer Office (TTO) in Norway and the country's leading actor commercializing life science opportunities. By serving Oslo University and Oslo University Hospital, the new TTO represents about 80% of all Life Science research activity in Norway and has a particular emphasis on opportunities in the fields of cancer, neurosciences, and immunology.

Gaustadbekkdalen in Oslo contains one of the most concentrated physical campuses for bio-medical activity in the Nordic countries. The anchor at Gaustadbekkdalen is the close co-operation between Rikshospitalet, Norway's largest and most specialised hospital, and the neighbouring University of Oslo. The University is now planning a new cross-disciplinary research building within the life sciences. The Centre, if realised, will become one of the largest research and education investments in Norway this decade.

Also located at Gaustadbekkdalen are a large division of SINTEF, the Nordic countries' largest independent applied research organization, the Oslo Innovation Centre which – after a new expansion – will become one of the Nordic countries' largest research parks, and the Glaxo-SmithKline Innovation Center, a combined headquarters, incubator and conference center.

Not far from Gaustadbekkdalen, Montebello is home to the world famous Norwegian Radium Hospital which has spun out a multitude of cancer-related companies. This is also the site of the new Oslo Cancer Cluster Innovation Park, which will physically combine the Radium Hospital with a new incubator for cancer biotechs and a high school campus to create a unique infrastructure for translational oncology.

Further concentrations of life science and medtech companies are also beginning to appear further west in Lysaker and at the old airport in Fornebu.

Beyond medicine

In a beautiful countryside setting to the south-east of Oslo, the Ås campus is the focal point of green and blue biotech research. The campus includes the Norwegian University of Life Sciences, and the Norwegian institutes NOFIMA for Food, Fisheries and Aquaculture Research, and Bioforsk for Agricultural and Environmental Research. NOFIMA specialises in breeding programmes, fish feed, and product quality, along with the Aquaculture Protein Centre. Ås is also home to CIGENE, a FUGE centre providing integrated genetics research services to other institutes.



World class blue and green biotechnology research is clustered at the Norwegian University of Life sciences campus at Ås and has stimulated the creation of several new companies in the plant and animal genomics, vaccines and instrumentation fields.

PHOTO Håkon Sparre

Faster routes to access

Following the success of the Oslo Cancer Cluster, which has already attracted widespread international interest and collaborations, two other important networks have been formed. Norwegian medtech expertise is now showcased through the Oslo Medtech Cluster and neuroscience through the Nansen Neuroscience Network.

LIVE AND WORK IN NORWAY

Norway's profile as a life sciences hub has grown considerably in recent years. The success of companies such as Algeta and Clavis Pharma has caught the attention of investors and other stakeholders both at home and internationally. It has also led to an influx of talent from overseas. The key question now is whether success will breed success. So far the signs are good. With oil revenues enabling Norway to weather the recession, government support has been retained. And the talent pool is growing, with arrivals from overseas finding that Norway is as the surveys continue to say, one of the best places in the world to live and work.

Three case studies

Hanna Nemchenko from the Ukraine is among the first to enrol in special business-orientated courses promoted by Oslo Cancer Cluster and others to provide a new generation of bio-entrepreneurs:

PHOTO: Hanna Nemchenko



All researchers I meet in Norway work very efficiently in a result-oriented way. It is easy to be inspired by them. I now want to work with biotechnological commercialization and development of products based on biomedical innovations. I would consider Norway as the first-priority country for job searching because of its friendly work environment and efficient resource management.

Tz-Chiun Gou from Taiwan thrives on the respect she and her research are given in Norway. She is studying salmon virology, with a view to developing effective vaccines.

PHOTO: Tz-Chiun Gou



"The research resources are excellent and we network continuously with other labs worldwide. I recommend Norway whole-heartedly."

Oslo biotechs are increasingly attracting management from overseas. Jethro Holter from the UK is R&D director at Mole Genetics.

"For me Norway is the perfect location to combine a career with an adventurous lifestyle. The Norwegian science and technology sector is constantly seeking to expand its expertise with talented individuals with international experience and diverse backgrounds. I was happy to take advantage of just such an opportunity and lead an R&D department in a Norwegian-owned biotech company."

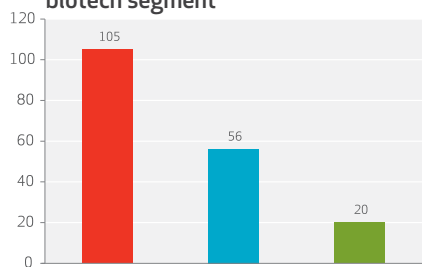
PHOTO: Jethro Holter



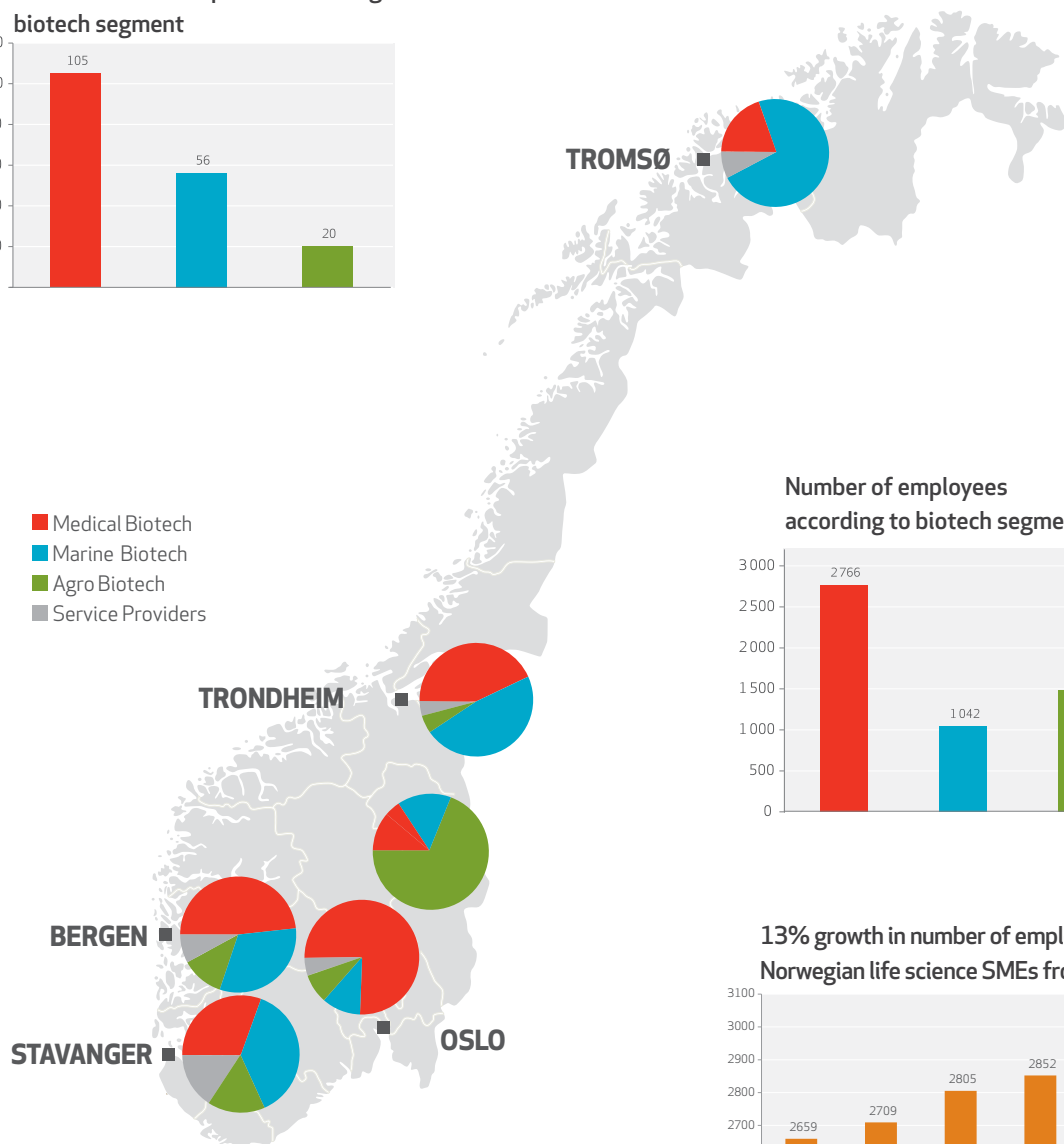
NORWEGIAN BIOTECH INDUSTRY

- FACTS AND FIGURES

Distribution of companies according to biotech segment

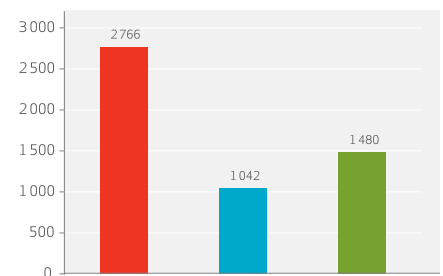


- Medical Biotech
- Marine Biotech
- Agro Biotech
- Service Providers

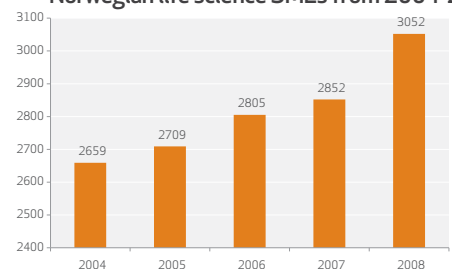


Regional distribution of biotech companies in Norway

Number of employees according to biotech segment



13% growth in number of employees in Norwegian life science SMEs from 2004-2008



COMPANIES

DRUG AND VACCINE DEVELOPMENT			COLIFAST AS	Lysaker	www.colifast.no
ACTAVIS NORWAY AS	Oslo	www.actavis.no	DALEN DIAGNOSTICS AS	Moss	www.dalendiagnosics.no
AFFITECH A/S	Oslo	www.affitech.com	DIAG NOR AS	Asker	no webpage
ALGETA ASA	Oslo	www.algeta.com	DIAGENIC ASA	Oslo	www.diagenic.com
ALGIPHARMA AS	Sandvika	www.algipharma.com	EUROFINS NORSK MATANALYSE AS	Oslo	www.matanalyse.no
AQUA BIO TECHNOLOGY AS	Sandefjord	www.aquabiotechnology.com	GE HEALTHCARE AS	Oslo	www.gehealthcare.com/nono
ARCTIC BIOLABS COMPANY AS	Tromsø	no webpage	GENA AS	Stavanger	www.gena.no
AVEXXIN AS	Trondheim	www.avexxin.no	GENETIC ANALYSIS AS	Ås	www.genet-analysis.com
A-VIRAL AS	Oslo	no webpage	GENTIAN AS	Moss	www.gentian.no
AXELLIA PHARMACEUTICAS AS	Oslo	www.axellia.com	ISENTIO AS	Bergen	www.isentio.com
BERGENBIO AS	Bergen	www.bergenbio.com	LABORA ANALYSELABORATORIUM OG FISKEHELSETJENESTE AS	Bodø	www.labora.no
BIONOR IMMUNO AS	Skien	www.bionorimmuno.com	NORCHIP AS	Klokkarstua	www.norchip.no
BIOSEGEN AS	Trondheim	www.biosegen.com	NORDIAG ASA	Oslo	www.nordiag.com
BIOTEC PHARMACON ASA	Tromsø	www.biotec.no	NOVEL DIAGNOSTICS ASA	Bergen	www.noveldiagnostics.com
C10 PHARMA AS	Oslo	www.c10pharma.com	ORTHOGENICS AS	Tromsø	www.orthogenics.no
CLAVIS PHARMA ASA	Oslo	www.clavispharma.com	PATOGEN ANALYSE AS	Ålesund	www.patogen.no
CORTICALIS AS	Nesoddangen	www.corticalis.com	PLASMACUTE AS	Bergen	www.plasmacute.com
CYTOVATION AS	Bergen	no webpage	SCREENCANCER	Bergen	www.screencancer.com
DNAACOS AS	Oslo	www.dnaacos.com	TIPOGEN AS	Bergen	www.tipogen.no
KILDA BIOLINK AS	Sandefjord	www.kilda.no	TOS LAB AS	Tromsø	www.toslab.no
LAURAS AS	Oslo	www.lauras.no	UNILABS TELELAB AS	Skien	www.telelab.no
LYTIX BIOPHARMA AS	Tromsø	www.lytixbiopharma.com	VITAS AS	Oslo	www.vitas.no
NAVAMEDIC ASA	Lysaker	www.navamedic.com	BIOMANUFACTURING AND CROs		
NORDIC NANOVECTOR AS	Oslo	no webpage	BIOPROTEIN AS	Stavanger	www.iris.no
NYCOMED PHARMA AS	Asker	www.nycomed.no	BIOSENTRUM AS	Stavanger	www.biosentrum.no
PHOTOCURE ASA	Oslo	www.photocure.com	DIA TEC MONOCLONALS AS	Oslo	www.diatec.no
PROPHYLIX PHARMA AS	Tromsø	www.prophylixpharma.com	NORWEGIAN ANTIBODIES AS	Ås	www.antibodies.no
REGENA MEDICAL AS	Oslo	no webpage	PLASTID AS	Stavanger	www.plastid.no
REGENICS AS	Oslo	www.regenics.no	PROMAR AS	Fornebu	www.intravision.no
RHEUMATECH AS	Oslo	no webpage	RPS RESEARCH NORWAY AS	Oslo	no webpage
SANTOSOLVE AS	Oslo	www.santosolve.com	SMERUD MEDICAL RESEARCH INTERNATIONAL AS	Oslo	www.smerud.com
SCANDINAVIAN BIOPHARMA AS	Oslo	ww.sarsiaseed.com	UNITARGETING RESEARCH AS	Bergen	www.unitargeting.com
SERODUS AS	Oslo	www.serodus.com	FOOD INGREDIENTS AND NUTRACEUTICALS		
SIRNASENSE AS	Oslo	www.sirnasense.com	ADVANCED BIOPOLYMERS AS	Trondheim	www.advancedbiopolymers.no
SPERMATECH AS	Oslo	www.spermatech.com	AKER BIOMARINE ASA	Oslo	www.akerbiomarine.com
THIA MEDICA AS	Paradis	no webpage	ARONIA JÆREN AS	Voll	www.aronia-saft.no
VACCIBODY AS	Oslo	www.vaccibody.com	AXELLUS AS	Oslo	www.axellus.no
WEIFA AS	Oslo	www.weifa.no	AYANDA AS	Tromsø	www.ayanda.com
DRUG DELIVERY TECHNOLOGY			BERG LIPIDTECH AS	Eidsnes	www.bl.no
EPITARGET AS	Oslo	www.epitarget.com	BIO SEA MANAGEMENT AS	Tromsø	www.probio.no
OMEGATRI	Oslo	www.omegatri.no	BIOFORM AS	Sørreisa	www.bioform.no
OPTINOSE AS	Oslo	www.optinose.com	BIOLINK GROUP AS	Sandnes	www.biolink.no
PCI BIOTECH AS	Oslo	www.pcibiotech.com	CALANUS AS	Tromsø	www.calanus.no
MEDICAL BIOBANKS			CHITINOR AS	Senjahopen	www.seagarden.no
GENOVA AS	Oslo	no webpage	DELANTE HEALTH AS	Bekkestua	www.delantehealth.com
HUNT BIOSCIENCES AS	Levanger	www.huntbiosciences.com	FIRMENICH BJØRGE BIOMARIN AS	Ellingsøy	www.firmenich.com
DIAGNOSTIC PRODUCTS AND SERVICES			FMC BIOPOLYMER AS	Sandvika	www.fmcbiopolymer.com
AXIS-SHIELD ASA	Oslo	www.axis-shield.com	GC RIEBER OILS AS	Kristiansund N	www.gcrieber-oils.no
AXIS-SHIELD POC AS	Oslo	www.axis-shield-poc.com	GLYCANOVA NORGE AS	Sarpsborg	www.glycanova.com
BEVITAL AS	Bergen	www.bevital.no	KAPPA BIOSCIENCE AS	Oslo	no webpage
BIOINDEX AS	Oslo	www.bioindex.no	MARINE BIOPRODUCTS AS	Storebø	www.marinebio.no
BIONOR TECHNOLOGIES AS	Skien	www.bionor.com	MED-EQ AS	Tønsberg	www.med-eq.no
BIOSENSE LABORATORIES AS	Bergen	www.biosense.com	MEDICMARINE AS	Kolbjørnsvik	www.medicmarine.no
BIOTA GUARD AS	Stavanger	www.biotaguard.no			
CALPRO AS	Lysaker	www.calprotectin.com			

COMPANIES

NAPRO PHARMA AS	Brattvåg	www.napro-pharma.no
NATTOPHARMA ASA	Lysaker	www.nattopharma.com
NOROMEGA AS	Tromsø	www.probio.no
NUTRI PHARMA ASA	Oslo	www.nutripharma.com
NUTRIMARINE LIFE SCIENCE AS	Bergen	www.nutrimarine.com
OLIVITA AS	Tromsø	www.olivita.no
PALM RESEARCH AS	Bergen	www.lectinect.no
PROBIO ASA	Tromsø	www.probio.no
Q-SHAPE AS	Asker	no webpage
SEAGARDEN AS	Haugesund	www.seagarden.no
SMARTFISH AS	Oslo	www.smartfish.no
VESTERÅLENS NATURPRODUKTER AS	Sortland	www.vnp.no
VIKHOLMEN BIOMARINE AS	Vikholmen	www.vikholmen.net
VITOMEGA AS	Heimdal	www.vitomega.no
ZYMTECH PRODUCTION AS	Lesja	www.aminotech.com
AGRO BIOTECH, PLANT/ANIMAL HEALTH AND BREEDING		
BIOBANK AS	Hamar	www.norsvin.no
BOVIBANK AS	Ås	www.geno.no
DR BADDACKY AS	Skotterud	www.draddack.no
GENINOVA AS	Hamar	www.norsvin.no
GENO	Hamar	www.geno.no
GRAMINOR AS	Ridabu	www.graminor.no
NORDOX AS	Oslo	www.nordox.com
NORSVIN	Hamar	www.norsvin.no
SPERMVITAL AS	Hamar	www.spermvital.no
STIFTELSEN DET NORSKE SKOGFRØVERK	Hamar	www.skogfroverket.no
AQUACULTURE, FEED, FISH HEALTH AND BREEDING		
AKVA REN AS	Furuflaten	www.akvaren.no
AKVAFORSK GENETICS CENTRE AS	Sunddalsøra	www.afgc.no
AQUA GEN AS	Trondheim	www.aquagen.no
AQUACULTURE ENGINEERING AS	Trondheim	www.aquaculture.com
AQUAPRO AS	Bergen	no webpage
BIOMAR AS	Myre	www.biomar.no
BLUE LIMIT AS	Bergen	www.avento.as/bluelimit
CRYOGENETICS AS	Hamar	www.cryogenetics.no
ECO ENERGY HOLDING AS	Bergen	www.eco.as
EWOS INNOVATION AS	Dirdal	www.ewos.com/no
EXIMO AS	Tromsø	www.trofico.no
GENDERGUIDE AS	Stavanger	www.genderguide.no
GENOMAR AS	Oslo	www.genomar.com
INTERVET NORBIO AS	Bergen	aqua.intervet.com
PHARMAQ AS	Overhalla	www.pharmaq.no
PROMAR AQUA AS	Bodø	www.intravision.no
SALMOBREED AS	Bergen	www.salmobreed.no
SCALPRO AS	Rong	no webpage
SCANBIO AS	Trondheim	www.scanbio.com
VITALITY INNOVATION AS	Larvik	www.vitalityinnovation.no
VIVID AS	Fagerstrand	www.vivid.no
INDUSTRIAL BIOTECH AND BIOFUEL		
AXELLIA PHARMACEUTICAS AS	Oslo	www.axellia.com
BIOPROTEIN AS	Stavanger	www.iris.no

BORREGAARD INDUSTRIES LIMITED, NORGE	Sarpsborg	www.borregaard.no
CALANUS AS	Tromsø	www.calanus.no
CAMBI AS	Asker	www.cambi.no
CHITINOR AS	Senjahopen	www.seagarden.no
DENOMEGA NUTRITIONAL OILS AS	Sarpsborg	www.denomega.com
MARINE BIOPRODUCTS AS	Storebø	www.marinebio.no
MARINE HARVEST INGREDI- ENTS	Hjelmeland	www.marineharvest.com
MARITEX AS	Sortland	www.tine.no
PAPIROGFIBERINSTITUTTET AS	Trondheim	www.pfi.no
PROBIO ASA	Tromsø	www.probio.no
SCANBIO AS	Trondheim	www.scanbio.com
WEIFA AS	Oslo	www.weifa.no
WEYLAND AS	Rådal	www.weyland.no
ZYMTECH PRODUCTION AS	Lesja	www.aminotech.com
BIOINFORMATICS		
INTERAGON AS	Trondheim	www.interagon.com
MOLMINE AS	Bergen	www.molmine.com
NORTHERN BIOLABS AS	Tverlandet	no webpage
PATTERN SOLUTIONS AS	Bergen	www.patternsolutions.no
PREDICHEM	Trondheim	www.predichem.no
PUBGENE AS	Oslo	www.pubgene.com
SENCEL BIOINFORMATICS AS	Oslo	www.sencel.com
RESEARCH TOOLS AND SERVICES		
CGENE AS	Oslo	www.cgene.com
DRUGDISCOVERYLABORATORY AS	Oslo	www.ddl.no
FLUENS SYNTHESIS AS	Bergen	www.fluenssynthesis.com
KINN THERAPEUTICS AS	Bergen	no webpage
LINGVITAE HOLDING AS	Oslo	www.lingvitae.com
MOLE GENETICS AS	Lysaker	www.molegenetics.com
SYNTHETICA AS	Oslo	www.synthetica.no
TOS LAB AS	Tromsø	www.toslab.no
UNILABS TELELAB AS	Skien	www.telelab.no
BIOMOLEX AS	Oslo	www.biomolex.com
BIOTEC MARINE BIOCHEMICALS AS	Tromsø	www.marinebiochem.com
CHEMLEX AS	Oslo	no webpage
DIABEADS AS	Oslo	no webpage
GENESEQUE	Trondheim	no webpage
GENOMICS SYSTEMS AS	Oslo	www.lingvitae.com
IC PARTICLES	Oslo	no webpage
INVITROGEN DYNAL AS	Oslo	www.invitrogen.com
NEXTERA	Oslo	www.nextera.no
QIAGEN AS	Oslo	www.qiagen.com
VECTRON BIOSOLUTIONS AS	Trondheim	www.vectronbiosolutions.com
REAGENTS & CHEMICALS		
BORREGAARD INDUSTRIES LIMITED, NORGE	Sarpsborg	www.borregaard.no
CHIRON AS	Trondheim	www.chiron.no
FAGERÅSEN AS	Oslo	www.eter.no
MARIMOL AS	Tromsø	no webpage
POLYPHENOLS AS	Sandnes	www.polyphenols.com
POLYPURE AS	Oslo	www.polypure.com
SERO AS	Billingstad	www.sero.no

USEFUL CONTACTS

SECTOR GATEWAYS NorBioBase Portal to Norwegian life science industry www.norbiobase.no	INDUSTRY ORGANISATIONS AND NETWORK continues Norwegian Bioindustry Association (NBA) Industry organisation within Federation of Norwegian Industries www.biotechforum.no	TECH TRANSFER OFFICES Inven2 AS (Univ. Oslo and Oslo University Hospital) www.inven2.com	National Institute of Nutrition and Seafood Research (NIFES) Research Institute providing advisory services to the government and food authorities concerning health and safety aspects of seafood www.nifes.no
Oslo Teknopol Non-profit development agency for the Oslo region - provides easy access to the local life science community. www.oslo.teknopol.no	Oslo Bio Collaborative network of stakeholders from the Oslo life science cluster www.oslobio.no	NTNU TTO (NTNU and St. Olavs Univ. Hospital) www.tto.ntnu.no	Norwegian Food Safety Authority (NFSA) Governmental body, research and competence centre. www.mattilsynet.no
GOVERNMENT OWNED ORGANISATIONS Innomed Network aiming to stimulate client-driven innovation in medicine www.innomed.org	Oslo Cancer Cluster (OCC) Norwegian Centre of Expertise (NCE) www.oslocancercluster.no	BTO AS (Univ. Bergen and Haukeland Univ. Hospital) www.bergento.no	SINTEF The largest independent research organisation in Scandinavia - multidisciplinary www.sintef.no
Innovation Norway Provides loan and grants for industry and business advice for young companies through a network of international offices www.innovationnorway.no	Oslo Medtech Member association and innovation network www.oslomedtech.no	TTONord (Univ. Tromsø, Univ. Hospital Northern Norway) www.ttonord.no	Interventional Centre (IVS) Research and development centre for medical imaging and image guided intervention at the Oslo University Hospital www.ivs.no
Norwegian Biotechnology Advisory Board Main advisory body for bioethics and research policies www.bion.no	UNIVERSITIES & RESEARCH HOSPITALS Akershus University Hospital www.ahus.no	Prekubator AS (Univ. Stavanger) www.ipark.no	Centre for Biomedical Computing (CBC) www.simula.no
Research Council of Norway Responsible for the national research policy and provider of basic and applied research grants within all disciplines www.rcn.no	Norwegian School of Veterinary Science www.veths.no	Sinvent AS (SINTEF) www.sintef.no	CENTRES OF RESEARCH-BASED INNOVATION (SFI) Cancer Stem Cell Innovation Centre (CAST) www.cancerstemcell.no
SIVA - Industrial Development Corporation of Norway Develops and supports research parks, innovation incubators and technical infrastructure www.siva.no	Norwegian University of Life Sciences (UMB) www.umb.no	Bioparken AS (Norw. Univ. Life Sciences) www.bioparken.no	Marine Bioactives & Drug Discovery (MABCENT) www.mabcent.no
INDUSTRY ORGANISATIONS AND NETWORK MABIT Research program for marine biotechnology www.mabit.no	Norwegian University of Science and Technology (NTNU) www.ntnu.no	OTHER RESEARCH INSTITUTIONS Bioforsk Norwegian Institute for Agricultural and Environmental Research www.bioforsk.no	Medical Imaging Laboratory (MI Lab) www.ntnu.no/milab
MareLife Innovation Network for fisheries, aquaculture and marine compounds www.marelife.no	Haukeland University Hospital www.helse-bergen.no	Institute of Marine Research Norway's largest marine research centre and an authority on management of marine resources www.imr.no	Tromsø Telemedicine Laboratory (TTL) www.telemed.no
Medcoast Scandinavia Norwegian-Swedish life science network www.medcoast.org	Oslo University Hospital (OUS), Includes four university hospitals: Rikshospitalet, the Norwegian Radium Hospital, Ullevål and Aker. www.ous-research.no , www.rikshospitalet.no , www.ahus.no , www.ullevaal.no	International Research Institute of Stavanger (IRIS) www.iris.no	ACADEMIC CENTRES OF EXCELLENCE (CoE) Centre for Cancer Biomedicine (CCB) www.cancerbiomed.net
Rubin Special interest group for marine by-products www.rubin.no	St. Olav University Hospital www.stolav.no	National Veterinary Institute Research in the fields of fish health, animal health and welfare, feed and food safety www.vetinst.no	Centre for Ecological and Evolutionary Synthesis (CEES) www.cees.uio.no
Association of the Pharmaceutical Industry in Norway (LMI) Industry organisation within the Federation of Norwegian Industries www.lmi.no	University Hospital Northern Norway (UNN) www.unn.no	NORUT - Northern Research Institute Multidisciplinary research group with marine biotechnology as one of their specialities	Centre for Immune Regulation (CIR) www.cir.uio.no
FHL Maring Industry organisation within the Federation of Norwegian Fish and Aquaculture Industries www.fhl.no/maring	University of Bergen (UIB) www.uib.no	Nofima The Norwegian Institute of Food, Fisheries and Aquaculture Research www.nofima.no	Centre for Molecular Biology and Neuroscience (CMBN) www.cmbn.no
MedITNor Member association and innovation network www.meditnor.net	University of Oslo (UIO) www.uio.no	Norwegian Agricultural Economics Research Institute (NILF) Research and advisory body for agricultural economics and rural development www.nilf.no	Centre for the Biology of Memory (CBM) www.ntnu.no/cbm
Nansen Neuroscience Network (NNN) Member association and innovation network www.nansenneuro.net	University of Tromsø (UIT) www.uit.no	Norwegian Institute for Air Research Research within climate change and environmental pollution www.nilu.no	Aquaculture Protein Centre (APC) www.apc-coe.no
Norwegian Biochemical Society (NBS) Academic research society www.biokjemisk.com	INCUBATORS AND PROJECT DEVELOPMENT Bio-Medisinsk Innovation AS (BMI) Seed investor and project development organisation www.bmioslo.no	Norwegian Institute for Public Health National centre for research in epidemiology, mental health, control of infectious diseases, environmental medicine, forensic toxicology and drug abuse www.folkehelsa.no	Kavli Institute for Systems Neuroscience www.ntnu.no/cbm
	Norinnova Seed investor and project development organisation in the Tromsø region www.norinnova.no	Biotechnology Centre of Oslo Research satellite under the auspice of University of Oslo www.biotech.uio.no	MEDICAL BIOBANKS HUNT Biobank and Cohort of State of the art biobank hosting regional health surveys from 200.000 donors organised under the auspices of NTNU Norway www.hunt.no , www.huntbiosciences.com
	Norwegian Radium Hospital Research Foundation Seed investor and project development organisation focused on cancer www.radforsk.no	Norwegian Institute for Water Research (NIVA) Research on the use and protection of fresh and marine water bodies and water quality www.niva.no	Norwegian Mother and Child Cohort Study and biobank with samples from about 300.000 individuals hosted by the Norwegian Institute for Public Health www.fhi.no
	Oslo Innovation Center Incubator and centre for innovation and industrial development www.forskningsparken.no		Norwegian Cancer Registry A complete registry of clinical data and samples from all Norwegian cancer patients. www.kreftregisteret.no



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Innovation Norway

- we give local ideas global opportunities

Innovation Norway promotes nationwide industrial development profitable to both the business economy and Norway's national economy, and helps release the potential of different districts and regions by contributing towards innovation, internationalisation and promotion. Innovation Norway has offices in all the Norwegian counties and in more than 30 countries worldwide. The head office is in Oslo.

Oslo Teknopol

- your key to the Oslo region

Oslo Teknopol is a regional development agency owned by the City of Oslo and Akershus County Council. Our aim is to stimulate innovation and attract foreign investments and talent to Norway's capital region. We can help you access the Oslo region's unique knowledge base and connect with its innovative players.

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