Metabolism and diabetes

Content and applications

Greater Copenhagen is home to one of the leading research clusters in the world in metabolism and metabolic/lifestyle disease such as diabetes and obesity.

Diabetes and obesity is growing rapidly worldwide and could have an income potential in the billions for companies that successfully translate research into improved, more effective therapies and prevention by way of healthy new foods, dietary regulation, etc.

Key environments and star researchers.

The region has a strong functional ecosystem covering medical and clinical top level research in cellular biology and molecular pharmacology. Copenhagen is also home to top level research relating to nutrition and exercise, including research into how physical activity and diet affects bodily function and helps prevent and alleviate lifestyle disease.

Researchers from the University of Copenhagen are responsible for the GLP-1 technology) that is one of the cornerstones for the treatment of diabetes and obesity. Research across several departments at the University of Copenhagen and DTU has been significantly helped along in recent years by a very large grant from the Novo Nordisk Foundation for establishing the Center for Basic Metabolic Research. Interaction between the research teams is good, and there is strong interaction between researchers working on the basic understanding of metabolic mechanisms and researchers specialising in nutrition, exercise and health.

Potential for attracting investment

- A tradition for strong relations between researchers and the corporate sector in metabolism, diabetes and obesity research.
- Significant production of PhDs, postdocs and attractive graduates that foreign companies can easily approach.
- World-leading ecosystem for diabetes research, with investments made throughout the chain from basic medical research to super modern centres for effective treatment of diabetes at hospitals in the region.

Characteristics of the research area

Strong research in metabolism and diabetes is anchored in the departments of the University of Copenhagen and the Technical University of Denmark (DTU) as well as in clinical research at the region's hospitals. Greater Copenhagen has top level research throughout the entire spectrum, right from basic medical research, via understanding the role of physical activity, hormones and enzymes, and clinical research into the treatment, diagnostics and prevention of diabetes and obesity.

Research is mainly concentrated at the centres around the University of Copenhagen's Nørre Campus, which is home to the majority of the Faculty of Health and Medical Sciences, including the Biotech Research and Innovation Center (BRIC) and the Center for Basic Metabolic Research funded by the Novo Nordisk Foundation. Department of Nutrition, Exercise and Sports, Faculty of Science is also located at North Campus.

International top quality niches

Research in Greater Copenhagen also includes international top level research into the significance of hormones for regulating appetite. This has provided the basis for a range of new cancer treatment and drugs for treating type 2 diabetes. Regarding basic research into endocrinology and metabolism as well as research in the role played by nutrition and exercise in prevention and treatment of diabetes and obesity, Greater Copenhagen's researchers are clearly among the international elite (cf. section on bibliometric key figures).

One of Greater Copenhagen's key strengths lie in the good interaction between strong niches. Researchers in nutrition concurrently address how to translate the results of basic endocrinological research into new insights into dietary composition, exercise as well as methods for preventing and alleviating lifestyle diseases.

This research is also used by food companies to develop new products with special properties that reduce the risk of type 2 diabetes, obesity, etc. There is nowadays already considerable interaction between international food producers and nutritional and dietetics researchers.

Bibliometric key figures

The bibliometric indicators for research production and quality show that Greater Copenhagen is a clear leader in Europe when it comes to research into metabolism, endocrinology, physical activity and nutrition/dietetics, cf. Table 1.

All in all, over the past 10 years, researchers at the University of Copenhagen and DTU have published almost 3500 scientific articles in internationally recognised journals. This puts Greater Copenhagen into first place amongst the regions of comparison in terms of research output.

Further, Greater Copenhagen is highly specialised which means that metabolic and nutritional research accounts for a significantly larger proportion of research production in Greater Copenhagen than in the relevant European regions of comparison.

Finally, Greater Copenhagen also leads the regions of comparison with respect to quality of research, in terms of the numbers of publications amongst the most globally most cited 10% in this field of research.

Key bibliometric indicators

	Specialisation	Output ranking (No.)	Highly cited article ranking (%).	Co-publication ranking (%)
Endocrinology, metabolism, diabetes	1.7	1 (2436)	2 (21.9%)	1 (26%)
Nutritional and dietetics	1.7	1 (926)	1 (19.7%)	1 (8.5%)

Period: 2005 -2015. Regions of comparison: Amsterdam, Berlin, Dublin, Geneva-Lausanne, Hamburg, Helsinki, Munich, Oslo and Stockholm/Uppsala.

Specialisation is an expression of the size of a field of research compared to all research production at University of Copenhagen, DTU and Copenhagen Business School (CBS) compared with its size in the regions of comparison. A specialisation level 1 indicates that Greater Copenhagen is on level with the regions of comparison. Specialisation of >1 indicates that Greater Copenhagen is more specialised in the field of research than the regions of comparison.

Output ranking measures Greater Copenhagen's position in the field concerned among the regions of comparison in terms of article production (with the absolute numbers of articles in brackets).

Highly cited article ranking indicates Greater Copenhagen's placing in the regions of comparison for the proportion of articles in the field of research in Copenhagen that are among the 10% most cited worldwide (percentage in brackets).

Finally, co-publication ranking indicates Greater Copenhagen's rank among the regions of comparison for the proportion of articles in the field published jointly with the business sector (percentage of overall article production in Greater Copenhagen in brackets).

Key arguments for the research area's potential to attract investment

Across the world, metabolic disease is on the rise, both in the west and in the major growth economies like India, China, Brazil and the Middle East.

Already now, around 390m people worldwide have type 2 diabetes and this figure is expected to be close to 600m by 2035. There is a very considerable, rapidly growing market for new pharmaceutical products, therapies and new healthy foods that can prevent and alleviate obesity, type 2 diabetes and other lifestyle diseases.

Greater Copenhagen has a clear research stronghold in the area, which is reflected in the parameters important for attracting investment. Research into lifestyle disease is interesting for a very broad range of foreign companies, such as those working to develop new drugs or diabetes and obesity, food producers that are developing healthy new products and companies working with treatment and prevention, such as those developing new personalised medical devices.

Star researchers and major scientific breakthroughs

Prof. J. J. Holst of the University of Copenhagen is internationally recognized as one of the top researchers behind the discovery of GLP-1 technology, which also forms the basis of Novo Nordisk's latest blockbuster product "Victoza" for treating type 2 diabetes and severe obesity. In the spring of 2016, J.J. Holst won a DKK 20m ERC grant. In 2013, he was awarded the "Mini Nobel Prize" in the form of the Anders Jahre Prize and the Fernström Prize. He is now Research Director of the Metabolism Center (funded by the Novo Nordisk Foundation) and Deputy Head of the Department of Biomedical Sciences.

Another star researcher in the field is Prof. Oluf Borbye Pedersen, who does research on intestinal bacteria and their significance for insulin resistance and obesity. Oluf Borbye Pedersen and his fellow researchers have analysed

large volumes of biological data to demonstrate that insulin resistance is especially closely associated with the spread of two types of intestinal bacteria. This discovery paves the way for entirely new ways of understanding and treating obesity and type 2 diabetes by influencing the intestinal flora, for example by targeting diet etc.

Various internationally recognized researchers also work at the Department of Nutrition, Exercise and Sports, including Prof. Arne Astrup, who has led several internationally acclaimed research projects on nutrition, exercise and obesity. He has also demonstrated how proteins, fats and carbohydrates have different effects on appetite, partly through GLP-1 and PYY, thus showing the way to more effective treatments for overweight patients and pre-diabetics.

Another profile in the same department is Prof. Erik A. Richter, who explores molecular physiology, focusing on the interaction between exercise, muscle-building and the importance of exercise for metabolic processes, including the significance of increased insulin sensitivity in healthily individuals and type 2 diabetics.

The work done by these researchers has resulted in a large number of highly cited scientific articles, while also forming the basis for stronger collaboration with Danish researchers and international companies in the food industry.

Large talent pool

Every year, scores of PhD students enter the field of metabolism and diabetes and get the opportunity to develop their talents under the guidance of the region's many star researchers. Since 2011, 43 PhD students have been admitted to the Center for Basic Metabolic Research at the University of Copenhagen.

Similar numbers of PhD students specializing in metabolic and lifestyle disease are also being admitted to the Department of Biomedical Sciences. About 115 PhD Students are employed at the Department of Nutrition, Exercise and Sports.

There is extensive, close interaction between universities and major companies in many PhD projects. Every year Novo Nordisk herself funds 30 PhD bursaries for young scientists, wishing to train as researchers in fields relating to Novo's areas of interest.

There is an annual intake of new Masters and PhD students specialising in biotechnology at CBS. In conjunction with the University of Copenhagen and DTU, CBS runs the Bio Business Innovation Platform (BBIP), which focuses on strengthening entrepreneurial skills in life science. The platform also provides specialized processes in Innovation and Strategy in Biobusiness, Finance, Accounting and Valuation in Bio Business, etc. CBS also offers the world's first Master's course in Business Administration and Innovation in Health Care, which addresses innovation and business development in the healthcare sector.

Unique research facilities

The region's universities, hospitals, etc., have advanced, state-of-the-art research infrastructure and the DKK 850m invested in the Metabolism Center has also helped create the best possible framework for research. Research infrastructure includes:

- Unique biobanks with biological material and the option of cross-batching data from electronic patient records, etc.
- Unique personal data registers and extensive expertise in undertaking large scale randomised studies.

Agreements have also been made with the Capital Region and the Novo Nordisk Foundation to establish regional supercentres for treating diabetes. There has also been an agreement to establish a world-leading centre for diabetes treatment at Herlev Hospital aimed at integrating leading treatment offerings and research. The Novo Nordisk Foundation has agreed to

invest DKK 2.8bn in the new centre which will be operational in 2020.

Strong collaboration with leading international research environments
There is close collaboration between research at the Metabolism Center and other relevant research environments, including the Department of Biomedical Sciences, the Department for Nutrition, Exercise and Sports and relevant environments at DTU in bioinformatics and drug delivery. There is also extensive collaboration with leading environments in USA (including the University of Massachusetts and Harvard), the Karolinska in Sweden and leading environments in China and Australia.

In the field of endocrinology research, the University of Copenhagen takes second place worldwide in terms of overall research output, and quality of research in terms of numbers of scientific articles among the 10% most cited. The University of Copenhagen is only surpassed by Harvard University in Boston, USA.

Extensive corporate collaborations
There is a long tradition of close collaboration between researchers and the corporate sector in the field of metabolic research with scientists employed by the university making the fundamental discoveries whilst the task of translating them into new drugs and therapies is done in close interaction between university researchers and scientists in companies such as Zealand Pharma, Novo Nordisk, etc.

Greater Copenhagen ranks as No 1 amongst the European regions of comparison in terms of the proportion of published scientific articles resulting from collaboration with private sector corporate researchers. Teams of researchers at the Metabolism Center, for example, all focus sharply on ensuring that their research has practical applications and leads to new effective treatments. There is close interaction with a whole range of international pharma companies such as Merck, Sanofi, etc.

Center for Basic Metabolic Research, University of Copenhagen
"We collaborate with a extensive range of the major global pharma companies. Novo is naturally a key collaborative partner but we also have many other collaborations, and for example we work closely with Merck Sharp & Dohme. We endeavour to reduce our research to practice in many ways. For example, we have two new spin-out companies going in this field and it all looks very promising."

Prof. Jens Juul Holst, Center for Basic Metabolic Research

Novo Nordisk
"I should remind you that the fundamental discoveries from which we have become amazingly rich were made at the universities. We translate and discover drugs on the basis of those discoveries.
I have bright inventors in my laboratories but we have never had anything to do with the original discovery. We often get masses of accolades and glory in the media but the real accolades and glory should usually go to the universities and collaborations between the universities and us."

Mads Krogsgaard Thomsen, Director of Research at Novo Nordisk in Berlingske Tidende 1 May 2016.

Zealand Pharma:
"Back in 1998, Zealand was a start-up company working in rented laboratories at the School of Agriculture in Copenhagen. It was here that ZP10, now called Lixisenatid, was discovered purely by chance. Today it is an approved drug produced and marketed globally by Zealand's partner Sanofi."

Source: Zealand Pharma, Annual Report 2012.