

# Cancer Research



## Content and applications

Greater Copenhagen is home to a wide range of strong research environments within oncology (cancer research). The region has a leading international research environment focusing on fundamental understanding of disease, cancer diagnostics and environments focusing on testing and developing new therapeutic methods.

Cancer research is widely anchored at the University of Copenhagen, the Technical University of Denmark (DTU), Copenhagen University Hospital and various of the region's other hospitals.



## Key environments and star researchers.

Basic cancer research is mainly done at the University of Copenhagen where BRIC and the new Stem Cell Center together provide the framework for a large number of leading international teams of researchers. Prof. Kristian Helin, who is the head of BRIC, is one of the leading researchers. DTU has world-class environments in immunotherapy and bioinformatics using advanced super computers to focus on cancer.

Copenhagen University Hospital has leading international teams in cancer diagnostics using PET scanning and advanced imaging diagnostics. Copenhagen University Hospital is also a Phase 1 Unit and is a leading international unit for early stage clinical testing for new types of cancer treatment.



## Potential for attracting investment

- There are strong environments throughout the innovation-chain, from basic medical research, clinical research and cancer diagnostics to leading environments working with clinical testing of new forms of treatment.
- Globally speaking, oncology is one of the areas to attract most private corporate investment by biotech companies in R&D.
- There is a great deal of openness about commercial collaborations in many of the leading environments.
- There is a very large pool of talented young researchers that can help companies undertake the latest research and translate the results of research into new types of treatment.

## Characteristics of the research area

Cancer research (oncology) in Greater Copenhagen is anchored at the health science departments at the University of Copenhagen and DTU as well as other clinical research environments in the region's hospitals.

Greater Copenhagen provides international research from basic understanding of disease ranging from the way cancer arises and spreads, to top research in advanced methods for effective diagnostics, and leading environments with expertise in testing and trial of new therapies.

### International top quality niches

In the field of basic oncological research, Greater Copenhagen has leading research environments in epigenetics, cancer stem cells and research into cancer's signalling pathways and biomarkers. The research draws on research in bioinformatics and advanced methods for identifying patterns and identifying new biomarkers based on large volumes of biological data.

Greater Copenhagen also has leading environments in cancer diagnostics and testing. Copenhagen University Hospital's Department of Physiology and nuclear medicine is one of the largest in Europe and a leader when it comes to molecular imaging and researching new tracers for diagnostic purposes (PET-scanning). This department also works closely with researchers at the Department of Biomedical Sciences at the University of Copenhagen and DTU.

Another important stronghold in the whole area of cancer is Copenhagen University Hospital's Phase I unit which is one of the leading units in Europe for early stage clinical testing of new treatments for cancer. In recent years, there has been a significant increase in the number of foreign companies deciding to have new types of treatment tested by the Copenhagen University Hospital unit. 30 tests were expected to be done in 2016. Such rapid progress is due, among other things, to the Phase I Unit which is the only one in Europe to offer full gene sequencing for all patients. Just recently,

they have established a broad collaboration with all the country's oncology departments on patient recruitment. This means that foreign companies can have more specially designed tests designed for their new drugs and therapeutic solutions.

### Bibliometric key figures

The bibliometric indicators for research production and quality demonstrate that Greater Copenhagen is a clear leader in Europe when it comes to oncology and cancer-related research, cf. Table 1.

All in all, over the past 10 years, researchers at the University of Copenhagen and DTU have published almost 3700 scientific articles in internationally recognised journals. However, the total number of publications is lower than some of the regions of comparison, with Greater Copenhagen only taking a fifth place in terms of numbers of publications compared to the other European cities. Relatively speaking, cancer research accounts for a smaller proportion of all research in Greater Copenhagen than in the regions of comparison.

On the other hand, the quality of research is high. In terms of the proportion of scientific articles amongst the 10% most cited in the field, Greater Copenhagen comes second. And in terms of proportion of research jointly published with private companies, Greater Copenhagen is first amongst the regions of comparison.



Key bibliometric indicators				
	Specialisation	Output ranking (No.)	Highly cited article ranking (%)	Co-publication ranking (%)
Oncology	0.83	5 (2080)	2 (19.4%)	1.5
Theoretical Computer Science	0.78	5 (1603)	2 (18%)	1.7

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 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

Every year, around 14 million people are diagnosed with cancer worldwide. The whole area of cancer is one of the areas of medical research to receive most investment in R&D.

A large number of global pharma companies make cross-border investments to gain access to new knowledge, access to talent and to develop and test new, more effective treatments for cancer.

Greater Copenhagen is strong on research throughout the entire value chain, from basic medical research, clinical research and diagnostics and has particularly good conditions for testing and trialling new cancer drugs and new ways of treating cancer.

### Star researchers and major scientific breakthroughs

The region has a number of star researchers in a range of areas relating to cancer research. There are strong research teams at BRIC and the Stem Cell Centre at the University of Copenhagen and at DTU Bioinformatics. Prof. Kristian Helin, who heads BRIC is an example of one of the region's star researchers. He works together with his research group, the "Helin Group", to understand the fundamental mechanisms underlying the development and growth of cancer cells. Kristian Helin also heads a Centre for Epigenetics, funded by the Danish National Research Foundation, and received an ERC Advanced Grant in 2012.

Recent years have seen a series of research breakthroughs that are important steps along the way to more targeted treatment of cancer and an actual cure.

Among other things, Prof. Ali Salanti of the Department of Immunology and Microbiology at the University of Copenhagen and an international team of researchers, developed a new method for targeting toxins at cancer cells.

Provisional trials show that the method can kill up to 95% of all types of cancer cell. The team is aiming to develop and test the technology in order to create an effective cure for cancer for testing in humans within a few years.

Prof. Henrik Clausen, at the Department of Cellular and Molecular Medicine, runs the Basic Research Centre for Glycomics. The centre has also developed "5E5", an antibody that has been shown to be extremely promising in experimental treatment of tumours and is expected to be used in immunotherapy in clinical trials within the next couple of years. Similarly, at the Department of Cellular and Molecular Medicine, Ian Hickson and his Center for Chromosome Stability have had very promising results in inhibition of DNA repairs in tumour cells.

### **Large talent pool**

There is a large pool of talented postdocs and PhDs and Masters graduates specialising in a range of disciplines relating to cancer in this area. Greater Copenhagen provides access to highly qualified graduates with experience of collaborating with the many bright, internationally acclaimed researchers in the region.

At the University of Copenhagen alone, over the past five years more than 500 PhDs have been admitted to departments with a strong profile in cancer research, among other things at the Department of Biomedical Sciences, the Department of Drug Design and Pharmacology and the Department of Cellular and Molecular Medicine (CMM).

DTU also trains a significant number of PhDs and Masters graduates every year in important disciplines relating to the field of cancer, also in bioinformatics, etc. Many have become experts in 'big data' analysis of biological data using powerful supercomputers.

### **Unique research facilities**

The hospitals, universities etc. in the region have access to advanced, state-of-the-art research infrastructure, including:

- The Phase 1 Unit at Copenhagen University Hospital which provides a state-of-the-art clinical testing service with effective patient recruitment and complete patient gene sequencing. The unit is a European leader in trials targeting new drugs to treat cancer. The Phase 1 Unit has established effective collaboration in recruiting cancer patients for clinical trials for the NEXT national alliance that involves oncological departments throughout Denmark.
- DTU Bioinformatics has one of the world's 100 most powerful supercomputers that can process enormous volumes of biological data as a precursor to developing new drugs. The supercomputer is part of the ELEXIR European research infrastructure.
- The Danish National Biobank has more than 16 million biological samples, making it possible to link biological samples to individually-based health data, etc.
- State-of-the-art equipment for diagnostics and medical imaging. Around DKK 250m has been invested in advanced equipment for PET/CT scanning at Copenhagen University Hospital. At the Cluster for Molecular Imaging, researchers operate a core facility for molecular imaging in animal testing.

### **Strong collaboration with leading international research environments**

Globally speaking, the leading research environments in oncology and cancer research are mainly to be found in USA, at Harvard University, John Hopkins and also at Oxford University in England. The strong cancer research environments in Greater Copenhagen have collaborations with an extensive range of leading environments worldwide and the University of Copenhagen also ranks in the Top 50 of the strongest cancer research environments.

Copenhagen University Hospital has well-developed ties to leading research centres abroad. Their Phase I Unit also works closely with the strongest phase I units in Europe, and is also responsible for a series of major clinical trials involving patients from the phase I units of other countries.

### **Extensive corporate collaborations**

These strong cancer research environments interact closely with the business sector. Greater Copenhagen tops the ranking among the regions of comparison in terms of joint publication with the corporate sector, in both oncology and cancer research (see Table p. 2).

There are also several good examples of cancer research having formed the basis for new patents and spin-out companies. Over the past five years, DTU has announced seven new discoveries in cancer and at the University of Copenhagen, research has led to several successful spin-out companies.

One of the most successful examples is EpiTherapeutics, a company based on researching epigenetics from BRIC. EpiTherapeutics was sold in 2015 to a large American company for almost DKK 500m (see box).

Relations with internationally leading pharmaceutical companies in the field of cancer are also highly developed at the Phase 1 Unit at Copenhagen University Hospital. Over the past three years, the number of early stage clinical trials done for foreign pharmaceutical companies has risen sharply. In 2015, there were around 20 clinical trials on new cancer drugs. In 2016 around 30 companies were expected to trial new treatments for cancer via the Phase 1 Unit. It is the only Phase I Unit to offer complete gene sequencing for patients.

### **Spin out-company sold for almost DKK 500m.**

EpiTherapeutics was established in 2008 by Kristian Helin in conjunction with several Danish venture capitalists - NOVO Seeds, SEED Capital.

The company was based on the groundbreaking research in epigenetics and cancer, led by Kristian Helin and his group at BRIC at the University of Copenhagen. Their research was patented and subsequently licensed to EpiTherapeutics on the basis of an agreement with the University of Copenhagen.

Epigenetics are about understanding the reasons underlying cellular change that is not due to heritable conditions associated with cellular DNA. BRIC's research led to the discovery of a new family of proteins which provided a new understanding of core mechanisms that can influence and restrict the development and growth of cancer cells.

EpiTherapeutics worked on developing and translating discoveries from research relating to the key role of specific proteins and enzymes for the development of different types of cancer cell for new forms of treatment and new cancer drugs.

EpiTherapeutics also worked on a series of development programmes aimed at taking innovative new ways of treating cancer up to the early stages of pre-clinical testing.

EpiTherapeutics was sold in 2015 for a total of USD 65m to an American pharma company, Gilead Sciences.