

Bacteriology



Content and applications

In the field of bacteriology, Greater Copenhagen is an international leader in two vital areas:

- Research into antibiotic resistant bacteria and ways of preventing bacteria from developing antibiotic resistance.
- Methods for preventing bacteria from creating biofilms, which are a major challenge for industry and for humans and can lead to life-threatening inflammatory conditions.



Key environments and star researchers.

Research is broadly anchored in a range of institutions in Greater Copenhagen. There are strong research environments at the Department of Immunology and Microbiology and the Department of Drug Design and Pharmacology at the University of Copenhagen, at Statens Serum Institute and at DTU Vet, DTU Food and DTU Bioengineering and DTU Biosustain at the Technical University of Denmark (DTU).

Star researchers include Prof. Michael Sommer and his team who have developed a new resistance principle that can cut the risk of antibiotic treatment leading to the development of resistant bacteria.



Potential for attracting investment

Antibiotic resistance is a global challenge. In Europe alone, every year about 25,000 people die as a result of infection with bacteria that have developed resistance. In domestic livestock and food production, biofilms and antibiotic resistance lead to enormous production losses. Researchers in Greater Copenhagen are amongst the world leaders in these areas which are very broadly anchored in the academic environment. Greater Copenhagen also offers unique research infrastructure, including facilities at Statens Serum Institute, Biosustain at DTU and from an international point of view, there are very special competencies at the Biofilm Test Facility at the Department of Immunology and Microbiology, University of Copenhagen.

Characteristics of the research area

Bacteriological research is strongly interrelated with a number of Greater Copenhagen's other research strengths, such as food and fermentation, bio-energy and protein research. This entails that the environment has a great deal of critical mass and has a strong presence at both the University of Copenhagen and DTU.

Special strengths include understanding the mechanisms that lead to bacteria developing resistance and research into methods for disrupting biofilms. Both fields address key socioeconomic challenges with global perspectives.

International top quality niches

Research in Greater Copenhagen into antibiotic resistant bacteria involves the medical and veterinary fields. Research focuses on understanding the microbiological changes that lead to resistance and how the risk of resistance can be reduced by changing the way agriculture, hospitals and general practitioners use antibiotics.

Research into biofilms seeks to understand the mechanisms that lead to the creation of biofilms in which bacteria clump together to form a biological film that makes it very difficult to fight the presence of bacteria. There are strong research environments at the Costerton Biofilm Center, which is an interdisciplinary research facility at the University of Copenhagen, and at the Biofilm Test Facility, also at the University of Copenhagen, which works closely with the commercial sector.

The presence of biofilms creates major problems in humans since they exacerbate wound-healing and can lead to chronic, life-threatening inflammation.

Biofilms are also a challenge in many places in the industry where bacteria form biofilms that make it difficult to comply with hygiene requirements. But biofilms can also have a positive impact, e.g. in effluent treatment.

Bibliometric key figures

Greater Copenhagen's research strengths in antibiotic resistance and biofilms are only partially reflected in the bibliometric analysis. This is due to microbiology and immunology being a relatively broad field of research, covering many different types of research. Applied Microbiology and Biotechnology are in the category of research that is closest to reflecting Greater Copenhagen's areas of strength, cf. Table 1.

This shows that over the past decade, researchers at the University of Copenhagen and DTU published around 1054 articles in recognized international scientific journals.

Greater Copenhagen has the greatest overall output amongst the comparator regions. The bibliometric indicators furthermore reveal that Greater Copenhagen is highly specialised in this field. A specialisation rate of 1.92 indicates that research accounts for almost twice the proportion of overall research in Greater Copenhagen than in the comparator regions.

Greater Copenhagen comes out on top for quality research, and the region comes third in terms of numbers of globally most cited articles. Amsterdam and Geneva-Lausanne are better ranked but their strengths lie in other areas of microbiology.

Greater Copenhagen is placed first in the regions of comparison in terms of percentage of research articles published jointly with private companies.

Key bibliometric indicators				
	Specialisation	Output ranking (No. articles)	Highly cited article ranking (%)	Co-publication ranking (%)
Applied Microbiology and Biotechnology	1.92	1 (1054)	3 (18.6%)	1 (12%)

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 prospects for attracting investments

Bacteria that develop resistance to known antibiotics are a serious global problem. WHO has demonstrated that multi-resistant bacteria have spread all over the world.

Bacterial resistance results in treatment processes being lengthy or more expensive and could in time lead to more people dying from simple infections. A UK report suggests that up to 10,000,000 humans globally could die from resistant bacteria if new breakthroughs and measures are not made in coming years.

The challenges arising from biofilms are also serious. The increasing use of artificial 'spare parts', e.g. hip prostheses, implants and implanted medical devices also means that an increasing number of people get infections in which the bacteria form biofilms that are drug resistant and lead to chronic inflammation in the body.

Star researchers and major scientific breakthroughs

Greater Copenhagen is home to various internationally acclaimed researchers specialising in bacteriology and resistance. At DTU one of them is Prof. Morten Sommer, who was recruited in 2010 from Harvard. He was employed as the youngest professor in Denmark at DTU Bioengineering with responsibility for creating a strong team to research bacteria, and also to focus on resistance.

At DTU Food, Prof. Frank Aarestrup's team investigates the connection between the use of antibiotics for livestock in agriculture and the implications for human health. Their research has contributed to the development of international practices for surveillance and detection of food-borne antibiotic-resistant bacteria. This unique knowledge has also helped make the National Food Institute (DTU Food) a reference laboratory for WHO and EU.

The University of Copenhagen has supported a EuroStars programme, focusing on resistance and has established a leading international center to study biofilms, the Costerton Biofilm Center. The centre is interdisciplinary and aims both to understand the fundamental mechanisms underlying the creation of biofilms and to develop new therapies to disrupt them, with a focus on preventing and treating chronic inflammation. The centre's internationally acclaimed researchers include Prof. Niels Høiby, who formerly headed up the clinical microbiology department at Copenhagen University Hospital and Prof. Michael Givskov, the Director of the Center.

Large talent pool

Greater Copenhagen has a great deal of research talent by way of PhDs and postdocs who are highly knowledgeable about the microbiological processes underlying multiresistant bacteria and biofilm development. Many departments at both DTU and the University of Copenhagen are engaged in medical and veterinary research in this area.

At the University of Copenhagen alone, over the past five years about 500 PhD students have been admitted to relevant departments such as the Department of Biomedical Sciences, Department of Immunology and Microbiology, Department of Drug Design and Pharmacology and the Department of Veterinary Disease Biology.

Many of these have been educated and trained under the leadership of the many international top researchers in the region in the field of microbiological and structural biological research.

Unique research facilities

Research into antibiotic resistance is based among other things on advanced mass spectroscopy to study the function of proteins in bacteria. At the national level, the Research and Innovation Agency decided to provide DKK 40m in funding to support the establishment of the national PRO-MS Platform, the Danish National Mass Spectrometry Platform for Functional Proteomics.

This effort will also enable DTU and the University of Copenhagen to purchase and use the most advanced mass spectrometers to study the chemical make-up of proteins.

In international biofilm research, the Biofilm Test Facility at the University of Copenhagen provides unique research infrastructure. The test facility has also established strong competencies in producing biomaterials for the use of researchers at universities and a whole range of pharmaceutical companies that see biofilms as a new business area.

Strong collaboration with leading international research environments

The global leading research institutions in this field include such top American universities as Harvard and MIT, and leading agricultural universities such as INRA in France. DTU and the University of Copenhagen are in the world's Top 25 in this field.

International research collaborations have been established between environments in Greater Copenhagen and top environments in USA, including Harvard University. There is also close collaboration with the leading veterinary research environments, including researchers at Lund University which is also strong in this field. The Biofilm Center Works closely with the Singapore Centre of Environmental Life Sciences Engineering.

Extensive corporate collaborations

Extensive commercial collaborations have been established in this field and there has been corporate veterinary collaboration for years. Nowadays, there is extensive interaction amongst other things on developing methods for limiting the use of antibiotics in livestock production.

The Biofilm Test Facility collaborates with various pharmaceutical companies.