

STATE OF MEDICON VALLEY 2019

An Analysis of Life Science
in Greater Copenhagen

medicon valley **alliance**

Creating Opportunities

STATE OF MEDICON VALLEY 2019

An Analysis of Life Science in Greater Copenhagen

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PREFACE

The winds of change continue to blow through Medicon Valley and the Danish and Swedish life science industry. The region's life science industry is still expanding, and new products are being launched, although turnover in the region's largest pharmaceutical companies has temporarily plateaued. Novo Nordisk Foundation's endeavour to establish a world-class innovation environment at COBIS in Copenhagen is progressing with the BioInnovation Institute. Medeon Science Park in Malmö is expanding with the new structure Forskaren 1, and Lund's Medicon Village just inaugurated its newly constructed building The Spark.

Pharmaceutical exports are still rising. Between 2017 and 2018, Swedish life science exports increased by 10.6%; in the same period, Danish life science exports increased by 7.7%. According to Statistics Denmark, the Danish pharmaceutical industry grew over 20% between November 2017 and June 2019, and the sector now makes up one-fifth of Denmark's industrial production. As the life science sector has grown more important for both the Danish and Swedish national economies, and with the increasing pressure on public healthcare systems in both countries, political interest has also grown. Denmark now has an internationalisation strategy for health and the life sciences, and the Swedish government presented an eight-point programme that forms the backbone for the upcoming Swedish life science strategy. While there are many common points of interest in the two countries' ambitions and their choice of strategical areas, there are also certain important differences. In Denmark, the focus is clearly set on generating growth, and internationalisation and exports are keywords. The Swedish debate centres more on co-operation, and partnerships between private, public and academic actors are among the principal elements. Nordic collaboration has no prominent role as yet, although the countries share many of the challenges that face the sector in general.

There is also more potential for collaboration in academia. In a comparison with nine other leading European life science clusters, it was concluded that Medicon Valley's researchers are cited more often than average in 15 of the region's 20 largest research areas. The conclusion is part of a bibliometric analysis conducted by the Dutch research centre CWTS at Leiden University on behalf of Medicon Valley Alliance. While the result should certainly be considered a success for Medicon Valley, it also shows that there is still great potential for continued development in which trans-Øresund collaboration is an important element.

With its 250 members, the Danish-Swedish network organization Medicon Valley Alliance has a unique opportunity to build bridges between national and regional initiatives, as well as to create stronger links between the industry, academia and public healthcare providers in the region. In the years to come, Medicon Valley Alliance will place a strong emphasis on strengthening the organisation's role as a facilitator of increased collaboration between our members, for the benefit of life science in Sweden and Denmark.

Copenhagen and Malmö
4 November 2019

Petter Hartman
CEO Medicon Valley Alliance



106 billion DKK

2018 was a record year for the Danish life science industry's exports. In 2018, the export of medical products and devices was responsible for 15.4% of Denmark's total exports; that share has doubled since 2008. Exports were valued at nearly 106 billion DKK – more than double what they were ten years ago. Life science exports were also record-high in Sweden in 2018, having risen 10.6% compared to 2017.

Increase in tax contribution in both countries

The life science sector in Denmark contributed 19.6 billion DKK in revenue in 2017, which is a 20% increase from 2016. Tax contributions from Swedish life science companies were 12.7 billion SEK in 2017; this is a 5.2% increase from 2016.



PHOTO: NEWS ØRESUND

GREAT POTENTIAL. "Government funding for specific collaborations between institutions in the Øresund Region would spark a lot of collaborations, because funding is usually what controls how researchers organise their work", says Anna Blom, Professor of Medical Protein Chemistry at Lund University, in an interview on page 38.

699

Danish life science patent applications to the EPO in 2018. The number of Swedish patent requests was 373.

The region's researchers are cited more frequently than average in 15 of the 20 largest subject areas for life science research in Medicon Valley. This was shown in CWTS' survey of scientific publications and citations in the life sciences from 2006-2017. The 20 largest fields of research were responsible for more than 50% of the total number of scientific publications in the life sciences in Medicon Valley during the period examined.

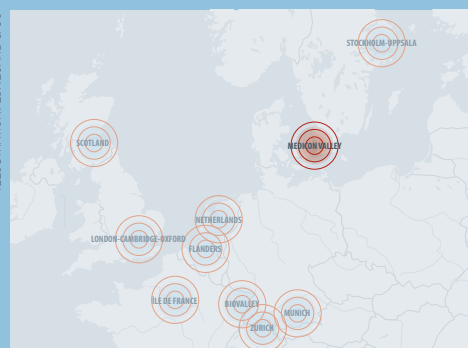


ILLUSTRATION: LÖNGBÄRD & CO

Beacons growing bigger

In 2018, the turnover of Medicon Valley's four largest life science companies (Novo Nordisk, Lundbeck, Ferring Pharmaceuticals and LEO Pharma) remained stable at 154 billion DKK. If the region's largest medtech company (Coloplast) is included, it increased to 171 billion DKK.



PHOTO: NEWS ØRESUND

44 000

Medicon Valley's life science sector employs 44 000 people.

STABLE DEVELOPMENT IN MEDICON VALLEY

Higher employment numbers, large acquisitions and hopes for a new blockbuster drug in oral-tablet form from Novo Nordisk for the treatment of type-2 diabetes are all indications of stable and positive developments in the continued renewal of Medicon Valley's life science companies.

Employment rate on the rise

44 000 people are employed at Medicon Valley's companies according to the latest statistics from 2017 – a 3.4% increase in one year. If consultants and subcontractors are included, the cluster's importance is greater still. Last year, the largest employer, Novo Nordisk, had 16 300 employees in Denmark, and provided employment for another 7 900 people brought in via external companies. The majority of them work at the company's facilities in Zealand and in the Capital Region of Denmark.

Acquisitions and new drugs bring growth

In the shift from older to new pharmaceuticals, the global turnover for Medicon Valley's four largest life science companies (Novo Nordisk, Lundbeck, Ferring Pharmaceuticals and LEO Pharma) plateaued; the companies' total turnover increased half a per cent last year, to 154 billion DKK. With the help of new drugs and acquisitions, turnover is expected to rise again. In 2019 so far, there have been six major acquisitions in Medicon Valley, worth more than 28 billion DKK. Of these, five concern sales in which the acquiring company is based in Medicon Valley. In addition, Widex, which manufactures hearing aids, has merged with Sivantos and become the new, larger company WS Audiology. An important new drug just won FDA approval in the USA: Novo Nordisk's Rybelsus (Semaglutide) will give patients with type-2 diabetes the option of an oral tablet instead of injections.

Rising Danish and Swedish life science exports

Positive development is also apparent on a national level in both Denmark and Sweden. Danish life science exports rose by 7.7% last year to 106 billion DKK. Swedish life science exports rose 10.6% to the equivalent of 65 billion DKK. The number of patent applications submitted in the life sciences to the European Patent Office (EPO) last year increased ten per cent in Denmark and four per cent in Sweden.

PHOTO: LUNDBECK

Increased tax contributions from the life science sector

In Denmark, the life science sector's total tax contributions in 2017 increased 20% to 19.6 billion DKK; in Sweden, tax contributions from the life science sector rose 5.2% to 12.7 billion SEK. Read more on page 13.

Competitive research

Measured in terms of scientific publications, research in Medicon Valley is in a good place, as a cluster ranking performed by the Dutch research centre CWTS at Leiden University on behalf of Medicon Valley Alliance shows.

Medicon Valley's research in the life sciences is cited significantly more frequently than the international average in 15 of the region's 20 largest areas of research. When it comes to the seven largest of these subject areas, the region places around midway or just below in a comparison with nine other outstanding European life science clusters, according to CWTS' analysis.

Biochemistry – a strong area

The four fields of research to generate the largest number of scientific publications in the life sciences in Medicon Valley from 2006-2016 were Biochemistry & Molecular Biology, Endocrinology & Metabolism, Oncology, and Neuroscience.

– Biochemistry is a strong area for us – in Copenhagen as well as here in Lund, says Bo Ahrén, Pro Vice-Chancellor of Lund University in an interview on pages 23-26 of this report.

An example to which Lund University is happy to give prominence is the new Wallenberg Centre for Molecular Medicine at Lund University, where the focus is on research in regenerative medicine.

Of these four areas of research, the first three place relatively well in the European cluster comparison – near the median. In the global comparison, they are distinctly above average. Neuroscience, which is often used to exemplify the region's areas of strength, placed rather poorly however, with the lowest citation frequency compared to the other nine leading European life science clusters. A subject area with a citation frequency well above the international average is Medicine, General & Internal. Read more on pages 28-33.

The subject areas in which development is strongest is clearly linked to where the research resources are, according to several of the people interviewed for this report. In part, this is because of political investments; in recent years, the Swedish

and Danish governments have prioritised e.g. antimicrobial resistance and personalised medicine. The industry also exerts influence, particularly in Denmark, where companies have a tradition of creating research foundations with a great deal of resources to distribute.

ESS and MAX IV will affect life science

Another important factor that has yet to make a mark in the bibliometric analyses is the growth expected to accompany the materials research facilities ESS and MAX IV, which will also affect the life sciences. Whilst the synchrotron radiation facility MAX IV in Lund is still in its start-up phase, the pan-European neutron research facility ESS in Lund is currently being constructed. The new research infrastructure is expected to create new opportunities in everything from biochemistry and molecular biology to microbiology, biotechnology and pharmacology; in extension, these can also be applied to many more areas in the life sciences.

Similar biobanks in Denmark and Sweden

Situated in a venerable white building just outside of central Copenhagen is Denmark's State Serum Institute (SSI). SSI's collaboration with Swedish universities is so intensive that the computer-generated network analysis performed by the research institution CWTS at Leiden University identified it as a Swedish actor. The close collaboration is largely because Sweden and Denmark have similar biobanks and registers, giving researchers the opportunity to carry out significantly larger register-based studies through collaboration between the countries.

– Collaboration with Sweden is clearly something we seek out – or that the Swedes seek out; it goes both ways. We've accrued know-how, and we co-publish many articles with Swedes every year. We know whom to contact, says Mads Melbye, Director of the State Serum Institute in Denmark. Read more on page 42.

Trans-Øresund cooperation

In addition to biobank collaboration, there are a number of other contiguous areas spanning the Øresund. This report is published by Medicon Valley Alliance, a network organisation for companies, universities and society across the Øresund. Denmark is very involved in the new materials research organisations MAX IV (operational) and European Spallation Source (operational in 2023)

in Lund. Together with regional governments and universities, the Danish government has funded a beamline at MAX IV. When it comes to European Spallation Source, Denmark and Sweden are both host nations, and the facility's data management and software centre (DMSC) is situated at COBIS in Copenhagen.

At Novo Nordisk Foundation's major investment BioInnovation Institute at COBIS, the vice chairman is a Swede: Bo Ahrén, pro vice-chancellor of Lund University.

Many researchers collaborate at Swedish and Danish universities. But as Professor of Medical Protein Chemistry at Lund University Anna Blom says in an interview on page 38, there's more work

to be done to increase university collaboration across the Øresund.

– Government funding for specific collaborations between institutions in the Øresund Region would spark a lot of collaborations; funding is usually what controls how researchers organise their work.

Politicians in Region Skåne and the Capital Region of Denmark recently decided to increase collaboration across the Øresund. They are exploring new possibilities for a shared Danish-Swedish ambulance helicopter and collaboration within e.g. paediatrics and exchange of knowledge about the large hospital constructions underway in both countries.

LIFE SCIENCE DEFINITION

Life science can be defined as the study of living organisms (including microorganisms, plants, animals and human beings), but when describing

a life science cluster, life science is seen in a broader context. It includes the pharmaceutical, biotechnology and medical technology

industries, as well as the academic institutions conducting research within life science and hospitals treating patients in the clinic.



Bo Ahrén, Pro Vice-Chancellor of Lund University.



MAX IV in Lund.



Katrine Krogh Andersen, Dean of Research at the Technical University of Denmark.



Copenhagen Bio Science Park, Cobis.



The Spark, Medicon Village in Lund.



Thue Schwartz, Professor at the University of Copenhagen.

FACTS AND FIGURES: Positive development for Danish and Swedish life science

PHOTO: NOVOZYMES

According to the latest statistics, the number of employees is on the rise in the life science sector in Medicon Valley and in Denmark and Sweden in general; patent applications are up; exports are increasing, and the sector's contributions to the state coffers are growing in both countries. In Denmark, tax contributions from the life science sector grew 20% in 2017 compared to the previous year, and Danish exports have more than doubled over the past ten years.

- Life science exports from Denmark and Sweden have hit an all-time high. Danish life science exports are now worth close to 106 billion DKK, having more than doubled over the past ten years. Swedish life science exports have also reached a record high after rising 10.6% in 2018.
- In 2017, Danish life science sector contributed 19.6 billion DKK in tax revenue; this is 20% more than the preceding year. In total, income- and corporation tax contributions from Swedish life science companies were 12.7 billion SEK in 2017; this is a 5.2% increase from 2016.
- In 2018, Danish companies submitted 699 patent requests in the life sciences to the EPO; this is a 10% increase from 2017. In Sweden the increase was a more modest 4%.
- There were 44 000 employees in Medicon Valley in 2017 – the most recent year for which statistics are available. Compared with 2016, this represents a 3.4% increase.
- Medicon Valley's main life science municipality is Gladsaxe (Bagsværd) outside Copenhagen; there are 8 600 employees in the life sciences in that Danish district. Among the companies there are Novo Nordisk's headquarters and large facilities, as well as the sister company Novozymes.
- The second-largest municipality is Copenhagen, where there are 6 400 employees. Closely following Copenhagen with 6 000 employees is Ballerup. In Skåne, Malmö is the principal municipality for the life sciences with its 2 000 employees.

RECORD-HIGH TAX CONTRIBUTIONS FROM DANISH LIFE SCIENCE IN 2018

In Denmark as in Sweden, in 2017 the life science industry contributed more in taxes than in the preceding year. In Denmark, the rise has been substantial with a 20% increase in total tax revenue. Life science exports from Denmark and Sweden have hit an all-time high. Danish life science exports are now worth close to 106 billion DKK, having more than doubled over the past ten years. Swedish life science exports have also reached a record high after rising 10.6% in 2018.

The rise in the Danish life science industry's tax contribution was substantial in 2017. The increase has been due to record high corporation tax. In total, the companies paid 10.4 billion DKK in corporation tax; this is 42% more than the preceding year. In Sweden, contributions from corporation tax on life science companies is at its highest since 2011.

When it comes to patent applications to the EPO in the life sciences, the number of requests

from Denmark increased 10% in 2018 compared to the previous year. In Sweden, there was a 4% increase in the same period. Danish life science exports have doubled in the past ten years, although the increase from 2016 to 2017 was greater in Sweden (10.6%).

The number of employees in Medicon Valley was 44 000 in 2017 – a 3.4% increase compared to the previous year. At 6.2%, the increase in the region was greatest in Skåne.

RISING EMPLOYMENT IN MEDICON VALLEY

There were 44 000 employees in Medicon Valley in 2017 – the most recent year for which statistics are available. Compared with 2016, this represents a 3.4% increase. Within the region, the Capital Region of Denmark saw a 3.9% increase; Region Zealand had a 1.1% decrease, and Skåne experienced a 6.2% upswing between the two years. This is shown by figures from Statistics Sweden and Statistics Denmark.

In 2017, the number of people employed in the life science sector rose in Denmark as well as Sweden compared to the previous year. In Denmark, there was a 2.3% increase; in Sweden that number was 6.2%. Looking at the total period 2008-2017, Denmark saw an annual increase of 1.8%, while Sweden saw a 1.3% decrease.

Västra Götaland County is the Swedish region in which the greatest increase – 7% – occurred between 2016 and 2017; Skåne (6.2%) and Stockholm-Uppsala (5.8%) were not far behind. In Denmark, the greatest increase took place in the Capital Region of Denmark (3.9%), and there was a 1.1% decrease in Region Zealand.

These figures are based on statistics from Statistics Sweden and Statistics Denmark and are not directly comparably with figures from earlier reports; the reason is that the methodological definition of biotech companies has been broadened for this report.

In numbers: Medicon Valley's life science sector employs 44 000 people. Of these, 32 700 are in the Capital Region of Denmark, 6 300 are in Region Zealand, and 5 000 are in Skåne. In Sweden on the whole, the sector employs 33 500 people; in Denmark that number is 43 200.

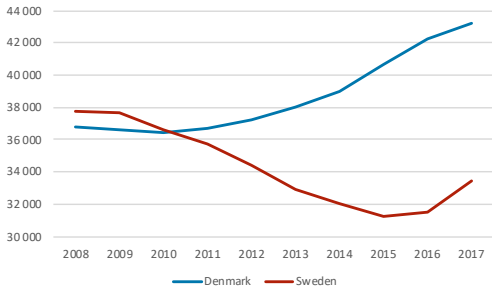
The Capital Region of Denmark is responsible for 74% of employment in the life science sector in Medicon Valley and nearly 76% of total employment in the Danish cluster. Stock-

holm-Uppsala is responsible for about 50% of Swedish employment in the life sciences. Medicon Valley's part of the total employment in the life science sector in Denmark and Sweden is 57%.

Medicon Valley's main life science municipality is Gladsaxe (Bagsværd); there are 8 600 employees in the life sciences in that Danish district. Among the companies there are Novo Nordisk's headquarters and large facilities, as well as the sister company Novozymes. The graphic showing the five largest municipalities in Denmark and the three largest in Sweden is based on data from Statistics Sweden and Statistics Denmark, as well as information provided by the largest companies and Øresundsinstitutter's own research. The second-largest municipality is Copenhagen, where there are 6 400 employees and companies such as H. Lundbeck, Ferring Pharmaceuticals and Genmab. Closely following Copenhagen with 6 000 employees is Ballerup, where e.g. Leo Pharma's headquarters and facilities for Novo Nordisk are located.

In Skåne, Malmö is the principal municipality for the life sciences with its 2 000 employees. Among the companies there are Novo Nordisk's Swedish office, Lundbeck, Leo Pharma and Ferring, as well as the headquarters for Atos Medical, Arjo and PolyPeptide. Helsingborg and Lund have the same number of employees in the life sciences – 1 100 – and include e.g. McNeil (Helsingborg) and Baxter (Lund).

LIFE SCIENCE EMPLOYMENT

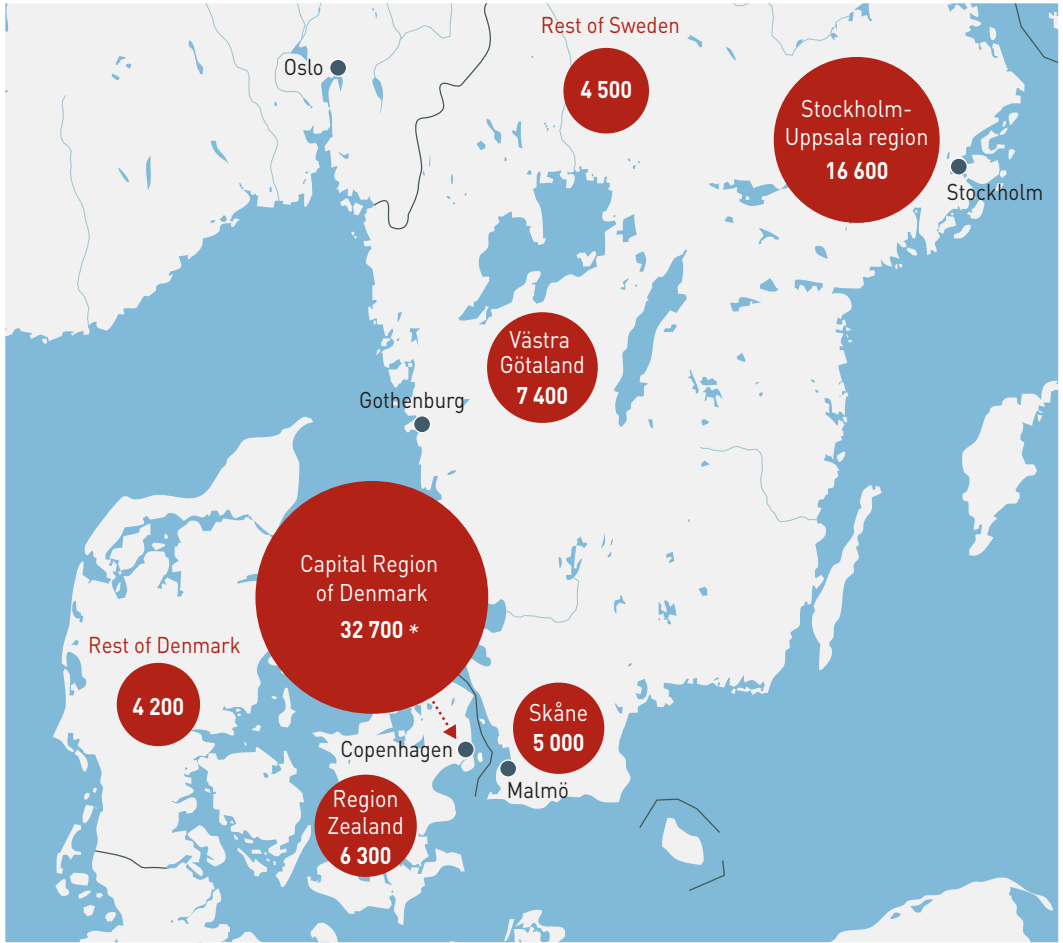


Source: Statistics Sweden, Statistics Denmark and information from the biggest life science companies



PHOTO: NEWS ØRESUND

EMPLOYMENT IN LIFE SCIENCE BY REGION IN DENMARK AND SWEDEN



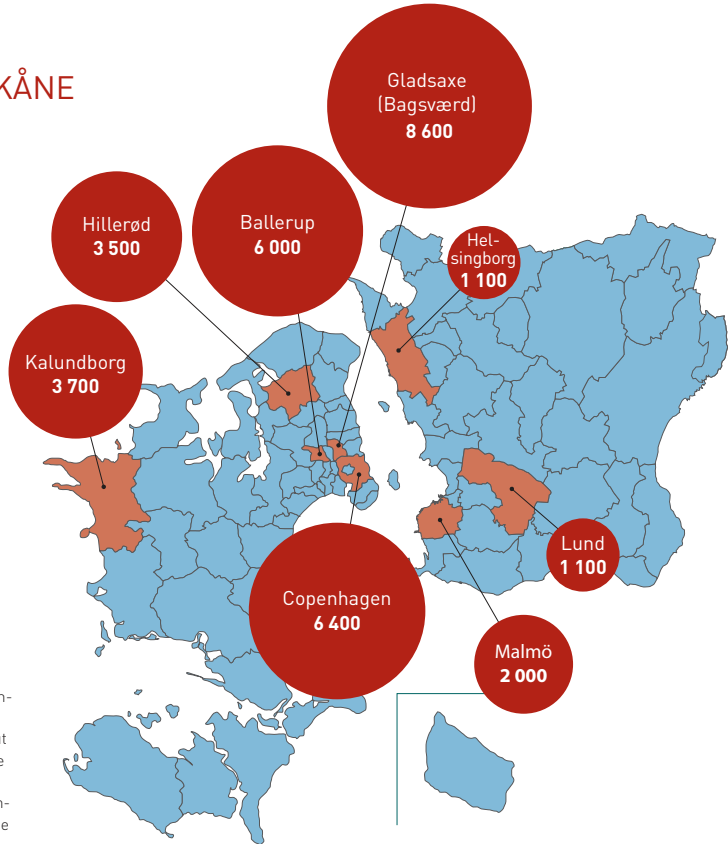
Source: Statistics Denmark, Statistics Sweden and information from the biggest life science companies in Denmark.

EMPLOYMENT AND CHANGE OVER TIME*

	2017	Change 2016-17	Annual change 2008-17
Denmark	43 200	2.3%	1.8%
Capital Region of Denmark	32 700	3.9%	2.3%
Region Zealand	6 300	-1.1%	0.8%
Denmark, rest of	4 200	-3.9%	-0.3%
Sweden	33 500	6.2%	-1.3%
Skåne	5 000	6.2%	-3.5%
Stockholm-Uppsala region	16 600	5.8%	-1.5%
Västra Götaland	7 400	7.0%	1.2%
Sweden, rest of	4 500	6.6%	-1.6%
Medicon Valley	44 000	3.4%	1.3%

Source: Statistics Sweden, Statistics Denmark and information from the biggest life science companies. * The figures from Statistics Denmark have been adjusted due to a systematic review of the employment figures for all of the Danish municipalities in Medicon Valley. Read more about the methods used on pages 60-65, in the Appendix.

EMPLOYMENT IN
LIFE SCIENCE IN SKÅNE
AND ZEALAND BY
MUNICIPALITY*



Some examples of companies in the largest life science municipalities

Gladsaxe: 8 600 employees

Headquarters and large facilities for Novo Nordisk and Novozymes.

Ballerup: 6 000 employees

Novo Nordisk, LEO Pharma (headquarters, research and production site), GN Hearing, Symphogen and Pfizer are all based in Ballerup Municipality.

Copenhagen: 6 400 employees

H. Lundbeck (headquarters and factory), Ferring Pharmaceuticals (research facility). The Danish capital is also the location of Xelia Pharmaceuticals, Genmab and several foreign life science companies such as Novartis, Boehringer Ingelheim, Stryker and AstraZeneca.

Kalundborg: 3 700 employees

Production sites for Novo Nordisk and Novozymes.

Hillerød: 3 500 employees

Novo Nordisk, Fujifilm - formerly Biogen (production

site), PolyPeptide and Zymenex.

Malmö: 2 000 employees

Atos Medical (headquarters), Arjo (headquarters), Rechon Life Science, PolyPeptide Group, Nordic Drugs, Qpharma and numerous national and regional headquarters from the life science sector, e.g. Lundbeck, LEO Pharma and Novo Nordisk.

Lund: 1 100 employees

Lund's life science environments are dominated by the medtech company Baxter (Gambro Lundia), Alligator Bioscience, Camurus and several smaller biotech companies at the science parks Medicin Village and Ideon.

Helsingborg: 1 100 employees

McNeil, which develops and manufactures quit smoking products, is the largest life science company in Helsingborg.

INCREASE IN THE LIFE SCIENCE INDUSTRY'S
CONTRIBUTION TO DANISH AND SWEDISH ECONOMY
– DANISH CORPORATION TAX AT A RECORD HIGH

In Denmark as in Sweden, in 2017 the life science industry contributed more in taxes than in the preceding year. For Danish life science companies, the rise has been substantial. The increase has been due to corporation tax, which is at a record high. In Sweden, contributions from corporation tax on life science companies is at the highest level since 2011.

In 2017, Danish life science companies paid 10.4 billion DKK in corporation tax; this is 42% more than the preceding year. 2017 was a record year for Denmark in general when it comes to the total contributions from corporation tax – on the whole, it brought 72 billion DKK to the state coffers. Although corporation tax has been lowered in recent years, an analysis by the Danish Ministry of Taxation has shown that revenue from corporation tax has never been higher. This is in part because there are more companies paying corporation tax, and in part because Danish companies' taxable surplus has returned to the same level as in the years before the financial crisis. According to the Ministry of Taxation's report, production companies are responsible for one third of corporation tax. It may be assumed that this development is particularly strong in the life science sector, which contributed 42% more in 2017 than in the previous year.

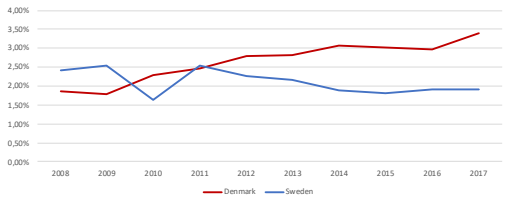
Income tax revenue from employees in the life science sector also increased 2.6%. On the whole, the life science sector contributed 19.6 billion DKK in tax revenue for a 20% increase in one year. Compared to 2008, the contributions from the sector more than doubled in 2017, and the annual percentual growth was 9.7%.

The life science sector's share of the total revenue from income and corporation tax in Denmark was 3.4% in 2017. That share has grown significantly since 2008, when it was 1.9%. Furthermore, compared to 2016, it has increased 0.4 percentage units.

19.6 billion DKK (+20%)

On the whole, the life science sector contributed 19.6 billion DKK in revenue in 2017, which is a 20% increase from 2016.

THE LIFE SCIENCE SECTOR'S
SHARE OF THE TOTAL INCOME-
AND CORPORATION TAXES



Source: Statistics Denmark, the Swedish Tax Agency and Statistics Sweden

While the development in Sweden has not been quite as pronounced, the life science sector's tax revenue contributions also rose from 2016 to 2017. In total, income- and corporation tax contributions from Swedish life science companies were 12.7 billion SEK in 2017; this is a 5.2% increase from 2016. In Sweden as well, corporation tax has risen most – 8.9% – while income tax from the sector's employees has increased two per cent, like in Den-

TAX CONTRIBUTIONS IN LIFE SCIENCE 2017

	Denmark (billion DKK)	Euro (million)	Sweden (billion SEK)	Euro (million)
Income tax	9,2	1 239	7.0	732
Corporation tax	10,4	1 391	5.7	591
Income and corporation tax	19,6	2 631	12.7	1 323

Source: Sveriges Riksbank and Danmarks Nationalbank. Converted to Euros using the average Euro exchange rate for 2017 (9.6326 SEK for 1 Euro and 7.4386 DKK for 1 Euro). Because of differences in the Danish and Swedish tax systems, the tax figures are not directly comparable. Read more about the sources and differenced in the Appendix on pages 60-65.

mark. In a more long-term perspective however, the amount contributed via corporation tax has not grown; instead, the total revenue from life science companies' corporation tax has dropped 12% since 2008, which corresponds to 788 million SEK. In Sweden, companies in the life science sector

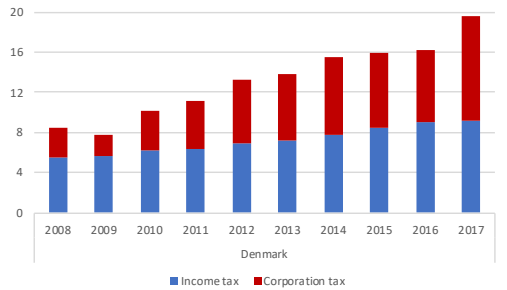
THE LIFE SCIENCE SECTOR'S TOTAL CONTRIBUTIONS FROM INCOME- AND CORPORATION TAX IN SWEDEN (IN BILLIONS OF SEK)



Source: Statistics Denmark, the Swedish Tax Agency and Statistics Sweden

are responsible for 1.9% of the total contributions from corporation- and income tax. The share has maintained the same level since 2014, but was previously higher. It reached a peak in 2009, when 2.5% of the total tax revenue came from companies in the life science sector.

THE LIFE SCIENCE SECTOR'S TOTAL CONTRIBUTIONS FROM INCOME- AND CORPORATION TAX IN DENMARK (IN BILLIONS OF DKK)



PATENTS – SHARP RISE IN THE NUMBER OF APPLICATIONS IN DANISH PHARMACEUTICALS

The number of Danish patent applications in the life sciences to the European Patent Office (EPO) rose 10% last year. The greatest increase was in pharmaceuticals, although most patents are still sought for biotechnology. Swedish patent applications rose by 4% – most were in biotech – but medical technology continues to dominate.

In 2018, Danish companies submitted 699 patent requests in the life sciences to the EPO; this is a 10% increase from 2017 and the highest entry in the years for which statistics are available; i.e. since 2009. When it comes to subject matter, the greatest increase in patent requests in Denmark was in pharmaceuticals – from 123 applications in 2017 to 194 in 2018; this represents a 58% increase. Despite a slight – four per cent – decrease in 2018 compared with the previous year, most patent applications in Denmark are still submitted in biotechnology (271).

When it comes to patent applications from Swedish life science companies, the rise in numbers from 2017 to 2018 was somewhat more modest:

four per cent, from 358 to 373. Whilst development has been consistently positive since 2014, it has not yet returned to the 2010 peak, when the number of patent requests was 521. In 2018, Swedish applications to the EPO were predominantly in medical technology (200). The sharpest

699

Danish life science patent applications to the EPO in 2018. The number of Swedish patent requests was 373.

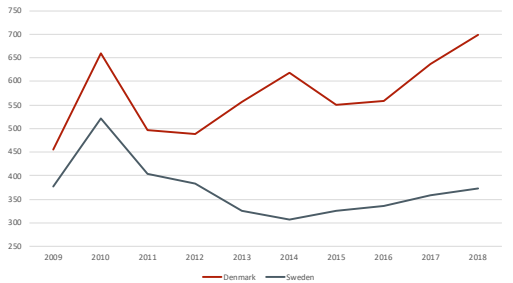
increase of 2018 compared to the previous year was in biotechnology – 29%. Applications for pharmaceuticals patents on the other hand decreased 13%, going from 96 in 2017 to 84 in 2018.

Among the Danish and Swedish companies on the EPO's list of last year's 25 top applicants are Novo Nordisk in medical technology (15th with

80 applications), pharmaceuticals (14th with 25 applications), and in biotechnology (16th with 29 applications). In addition, Danish Novozymes is in 3rd place for biotechnology with its 115 applications. AstraZeneca, whose roots are in Sweden and the UK, came 21st in pharmaceuticals with 22 applications.



NUMBER OF LIFE SCIENCE PATENT APPLICATIONS TO EPO FROM SWEDEN AND DENMARK



Source: EPO

TOP TEN TECHNOLOGICAL FIELDS REPRESENTED IN DANISH AND SWEDISH PATENT APPLICATIONS FOR THE PERIOD 2009–2018 AND 2018 (IN PARENTHESES)

SWEDEN			DENMARK	
Place	Technological field	Number of applications	Technological field	Number of applications
1	Digital communication	9 366 (1 192)	Biotechnology	2 458 (271)
2	Telecommunications	2 915 (228)	Medical technology	1 928 (234)
3	Transport	2 880 (294)	Engines, pumps, turbines	1 522 (298)
4	Medical technology	2 532 (200)	Pharmaceuticals	1 335 (194)
5	Computer technology	1 956 (212)	Civil engineering	1 241 (126)
6	Mechanical elements	1 535 (117)	Audio-visual technology	1 090 (168)
7	Measurement	1 385 (120)	Other special machines	839 (125)
8	Civil engineering	1 382 (123)	Food chemistry	793 (92)
9	Machine tools	1 143 (86)	Electrical machinery, apparatus, energy	757 (112)
10	Other special machines	1 062 (103)	Measurement	677 (89)
...				
16	Pharmaceuticals	893 (84)		
20	Biotechnology	688 (89)		

Source: EPO. Understanding this table: The first figure denotes the number of patent applications for the entire period of 2009–2018 within the respective technological fields. The figure for the number of patent applications in 2018 is in parentheses. The year indicates the publication date, which is 18 months after the filing of the national application.

RECORD-HIGH LIFE SCIENCE EXPORTS

Life science exports from Denmark and Sweden have hit an all-time high. Danish life science exports are now worth close to 106 billion DKK, having more than doubled over the past ten years. Swedish life science exports have also reached a record high after rising 10.6% in 2018. China took over Germany's place as Sweden's largest export market. While China is also a growing market for the Danish life science industry, the US remains Denmark's largest export market.

After a rather weak 2017 with little growth, Danish life science exports rose significantly in 2018. Total exports are nearly 106 billion DKK for a 7.7% increase compared to 2017; looking at the past decade, this represents more than a doubling of exports. Danish life science exports are responsible for more than 15% of Denmark's total exportation of goods; that is the highest share recorded between 2008-2018.

The US is Denmark's largest export market. In 2018 it grew still more, and life science exports to the USA were valued at 28 billion DKK – a 21% increase compared to 2017. After the US, China is the Danish life science industry's largest export market. Medical products and devices worth 8.7 billion DKK were exported to the Chinese market, but the increase from 2017 – one per cent – was minimal. Seen in a long-term perspective however, exports to China have risen substantially. The average annual growth between 2008-2018 was 23%.

Danish exports to Germany, Sweden, the UK and Italy decreased in 2018. The four countries are among the top-ten export markets for the Danish life science industry. Exports to France and Canada rose however, and the two countries are now 6th and 10th respectively on the top-ten list. In a long-term perspective, exports rose to all of the Danish life science industry's ten largest markets between 2008-2018.

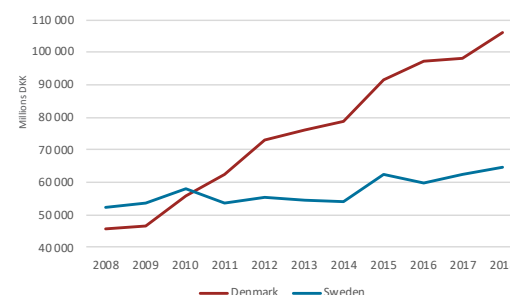
China overtook Germany and became Sweden's largest export market for life science products last year. In 2018, exports to China were valued at 12 billion SEK – a 21% increase compared to 2017. As in Denmark, Swedish life science exports to the Chinese market have risen markedly in the past decade. From 2008 to 2018, the average annual growth was 29%. Germany is the second-largest export market for the Swedish life science industry, followed by the US. The annual growth to these two markets has been somewhat more modest but nonetheless positive. Ex-

ports to France, Belgium and the UK have fallen in the past decade, however. There was growth in all of the export markets on the top-ten list in 2018 with the exception of the UK; exports to Britain decreased five per cent compared to 2017.

The Swedish life science industry's exports in 2018 were worth a total of 89 billion SEK (equivalent to nearly 65 billion DKK); that is a 10.6% rise compared to 2017, and a record high for the decade. The life science industry is responsible for 6.2% of Sweden's total exportation of goods – a share that has been quite stable in recent years.

Sweden and Denmark are both important export countries for medical products and devices; in relation to the population, Denmark holds 4th and Sweden 10th place on the list of countries with the most life science exports per capita. The country with the highest exports in the life science sector is Germany, which is responsible for 15.2% of global sales. Following Germany are Switzerland and the US; Ireland is the largest exporter in terms of population size, followed by Switzerland, Belgium and Denmark.

VALUE OF EXPORTS IN LIFE SCIENCE, IN MILLIONS (DKK)



Figures are for medical and pharmaceutical products and medical instruments, apparatuses etc.
Source: Statistics Denmark and SCB/Statistics Sweden and Riksbanken.

LIFE SCIENCE EXPORTS IN DENMARK AND SWEDEN IN 2018

	Millions DKK	Export share 2018	Growth (one year)	Annual growth 2008-2018
Denmark	105 876	15.4%	7.7%	8.7%
Sverige	64 786	6.2%	10.6%	2.9%

Source: Statistics Denmark and SCB/Statistics Sweden and Riksbanken. Figures are for medical and pharmaceutical products and medical instruments, apparatuses etc. Annual growth is calculated on figures in national currency



PHOTO: NOVOZYMES

THE PRINCIPAL EXPORT MARKETS FOR DANISH LIFE SCIENCE

	Exports in millions (DKK) 2018	Annual growth 08-18
USA	27 899	15%
China	8 689	23%
Germany	5 786	3%
Japan	4 992	6%
Sweden	4 802	2%
France and Monaco	3 642	2%
Great Britain	3 581	6%
Norway	2 915	10%
Italy	2 684	6%
Canada	2 632	11%

Source: Statistics Denmark

THE PRINCIPAL EXPORT MARKETS FOR SWEDISH LIFE SCIENCE

	Exports in millions (DKK) 2018	Annual growth 08-18
China	9 010	29%
Germany	8 347	4%
USA	8 174	1%
Japan	4 484	22%
Norway	3 865	4%
France	3 080	-4%
Australia	2 795	3%
Belgium	2 620	-3%
Great Britain and Northern Ireland	1 917	-3%
Netherlands	1 714	10%

Source: SCB/Statistics Sweden and Riksbanken.
* Annual growth is calculated on figures in national currency.

THE TOP 20 COUNTRIES WITH THE MOST LIFE SCIENCE EXPORTS PER CAPITA

Denmark is the world's fourth largest exporter of pharmaceuticals and medtech measured in export per capita during 2018, while Sweden holds tenth place on the global list.

Country	Export per capita, USD	Percentage of global life science export	Country	Export per capita, USD	Percentage of global life science export
Ireland	12 578	8.3%	Malta	877	0.1%
Switzerland	9 769	11.3%	Israel	798	1.0%
Belgium	4 944	7.7%	Hungary	708	0.9%
Denmark	2 895	2.3%	France	566	5.1%
Singapore	2 362	1.8%	Italy	523	4.3%
Netherlands	2 303	5.4%	United Kingdom	507	4.6%
Slovenia	1 894	0.5%	Lithuania	414	0.2%
Germany	1 354	15.2%	Finland	395	0.3%
Austria	1 301	1.6%	Czech Republic	360	0.5%
Sweden	999	1.4%	Hong Kong SAR, China	354	0.4%

Source: UN Comtrade Database, World Bank and Danmarks Nationalbank.

THE BEACONS OF MEDICON VALLEY: New strategies, directors and products



Medicon Valley is still in transformation. New chief executives have taken the helms of the region's four major pharmaceutical companies since 2017. The companies' sales have plateaued, but new products are being launched. Some of the region's biotech companies have entered a strong growth phase, and several deals worth billions of crowns have been presented this year. New investments are a keyword when it comes to the region's life science parks.

- The Novo Nordisk Foundation, The Lundbeck Foundation, Dr Frederik Paulsen Foundation and the LEO Foundation control the ownership of Medicon Valley's largest companies: Novo Nordisk, H. Lundbeck, Ferring Pharmaceuticals and LEO Pharma. Foundation ownership prevents acquisition and thus secures the companies' continued presence in the region in the future. Foundation ownership also means that company management can act with a long-term perspective. Some of the foundations invest in new biotech companies and make large donations to universities in the region.

Medicon Valley is also home to a globally leading cluster of hearing aid manufacturers: Oticon, GN Hearing and WS Audiology.

- Medicon Valley's biotech companies are thriving. Since 2014, New York-based Bristol-Myers-Squibb has invested 13 billion DKK in Danish biotech companies. Bavarian Nordic, Zealand Pharma and Genmab are just a few examples of Danish companies making strong headway. And there are more and more biotech companies sprouting forth from Lund's science parks Medicon Village and Ideon.

- There are also many medtech companies in the region, such as Coloplast, Baxter (formerly Gambro), Arjo, Nolato Medical and Atos Medical.

- Medicon Valley's academic spectrum in the life sciences is broad, with nine learning institutions that do research in the field. Globally leading diabetes research and neuroscientific research take place at the University of Copenhagen, as well as at Lund University. DTU and Malmö University are both highly advanced in areas such as bioengineering and biological surfaces.

THE WINDS OF CHANGE ARE STILL SWEEPING THROUGH MEDICON VALLEY

The region's major pharmaceutical and biotech companies are not the only ones making strong progress. The beacons of research and innovation are shining brighter; the materials research facility MAX IV in Lund is operational and European Spallation Source in Lund, whose data centre is in Copenhagen, will open the doors to its first researchers in 2023. The BioInnovation Institute is moving along at Copenhagen Bio Science Park, and Medicon Village in Lund and Medeon Science Park in Malmö are adding on. Ideon Science park in Lund is also growing.

The new materials research facilities MAX IV and European Spallation Source are expected to have an important impact on the life science industry. We can also see thriving science parks like Medicon Valley in Lund, Medeon in Malmö, and COBIS in Copenhagen – where the Novo Nordisk Foundation is funding the new BioInnovation Institute with the aim to create a leading innovation environment for the life sciences. Together, this means an even stronger foundation for life science research.

Change is also afoot for the big pharmaceutical companies; there are new chief executives for the four largest of them (Novo Nordisk 2017, Lundbeck 2018 and Ferring and LEO Pharma 2019). Strategies are being modernised and research investments are starting to make their marks as new products. The region's largest pharmaceutical company, Novo Nordisk, received FDA-approval for its new diabetes products Ozempic and Rybelsus, which are expected to be blockbusters.

THE BEACONS OF MEDICON VALLEY

THE NOVO NORDISK FOUNDATION GROUP

Novo Nordisk Foundation is an industrial foundation whose objective is to act as majority shareholder in the publicly traded Novo Nordisk and Novozymes, as well as to support scientific, humanitarian and social causes.

Novo Holdings is the Foundation's wholly owned subsidiary. It manages the Foundation's endowment and its controlling interests in the publicly traded companies Novo Nordisk and Novozymes. Via the platforms Seeds, Ventures and Principal Investments, investments are made in external biotech companies at various stages of development. Novo Holding also has 13 large, more long-term investments, including investments in five Danish companies: Chr. Hansen, Sonion, Symphogen, Veloxis Pharmaceuticals and Xellia Pharmaceuticals.

Novo Nordisk is the original company behind the group, and today it is Denmark's largest pharmaceutical company and a globally leading insulin manufacturer. The company also makes drugs for obesity, haemophilia and growth disorders.

Turnover 2018: 111.8 billion DKK

Number of employees 2018: 43 202, of whom 16 300 in Denmark and 85 in Sweden.

Facilities in Medicon Valley: Headquarters in Bagsværd outside Copenhagen and offices in Ørestad and Malmö. Research facilities in Måløv and Hillerød. Production facilities in Værløse, Søborg, Måløv, Gentofte, Køge, Kalundborg and Hillerød.

Novozymes was founded in 2000 as a demerger from Novo Nordisk. Novozymes is a publicly traded biotechnology company and a globally leading manufacturer of industrial enzymes as well as a major producer of microorganisms.

Turnover 2018: 14.4 billion DKK.

Number of employees 2018: 6 427, of whom 2 687 in Denmark.

Facilities in Medicon Valley: Headquarters and R&D in Bagsværd and production facilities in Kalundborg and Copenhagen. Research facility in Lyngby.

THE LUNDBECK FOUNDATION

Is an industrial foundation whose objective is to maintain and expand the activities of H. Lundbeck and to provide funding for scientific research. The Foundation is the largest shareholder in the publicly traded companies H. Lundbeck and ALK-Abelló, as well as in Falck A/S. The Foundation also invests in life science companies.

H. Lundbeck is a global pharmaceutical company specialising in drugs for psychiatric and neurological disorders.

Turnover 2018: 18.1 billion DKK

Number of employees 2018: 5 389, of whom 1 769 in

Denmark and 75 in Sweden.

Facilities in Medicon Valley: Headquarters and production in Valby/Copenhagen and production in Odsherred. Office in Malmö.

FERRING PHARMACEUTICALS

Is a wholly privately owned pharmaceutical company with its roots around the Øresund. Ferring is run by Frederik Paulsen through the Dr Frederik Paulsen Foundation. There are also a number of pharmaceutical companies in Malmö with a historic link to Ferring: PolyPeptide Group, Qpharma, Nordic Drugs and Euro Diagnostica.

Turnover 2018: 1.89 billion EUR

Number of employees 2018: 6 500, of whom 575 in Denmark and 19 in Sweden

Facilities in Medicon Valley: Ferring Pharmaceuticals A/S, also called Ferring International Pharma Science Centre, and Ferring Lægemedler A/S in Ørestad (Copenhagen), and a sales office in Malmö and API-manufacturer Syntese in Hvidovre Municipality outside Copenhagen. Headquarters in Switzerland.

LEO FOUNDATION

Was established in 1984 to secure LEO Pharma's future as an independent, research-based Danish pharmaceutical company. The foundation also supports international research with focus on dermatology.

LEO Pharma is an entirely privately/foundation-owned pharmaceutical company with focus on the development and production of medicines for dermatology and thrombosis.

Turnover 2018: 10.4 billion DKK

Number of employees 2018: 5 847 of whom 2 119 in Denmark and 35 in Sweden.

Facilities in Medicon Valley: Headquarters, R&D and production in Ballerup outside Copenhagen. Office in Malmö.

GLOBALLY LEADING HEARING AID MANUFACTURERS

Around Copenhagen there is a globally leading cluster of hearing aid manufacturers: Oticon, GN Hearing and WS Audiology (merger of Widex and Sivantos).

MEDTECH MORE COMMON IN SKÅNE

Coloplast is the largest medtech company in Zealand. Other large medtech companies in Skåne are Baxter (formerly Gambro), Arjo, Nolato Medical and Atos Medical.

BIOTECH BUSINESS BOOM

There are thriving biotech companies on both the Swedish and Danish sides of Medicon Valley, such as Bavarian Nordic, Genmab, Zealand Pharma, Symphogen, Alligator Bioscience and Camurus.

Figures for companies' turnover and number of employees have been supplied by the companies themselves.

THE BEACONS OF MEDICON VALLEY

SUCCESS STORY. Pharmaceutical and biotech companies in Greater Copenhagen are a success story characterised by several large pharmaceutical companies complemented by successful biotechnology companies. But Medicon Valley is more than just pharmaceuticals and biotech. The region also has successful medtech companies, a globally leading cluster of hearing aid manufacturers, growing science parks and the two large materials research facilities MAX IV and European Spallation Source, the latter of which is currently under construction in Lund, and ESS data management centre DMSC in Copenhagen.

4 PHARMACEUTICAL COMPANIES with headquarters or former headquarters in the Capital Region of Denmark dominate Medicon Valley's largest groups in pharmaceuticals and biotechnology. The four large groups Novo Nordisk, Lundbeck, Ferring and LEO Pharma and the foundations that own them have also acted as a venture capital investor and a nursery for many of the researchers in Greater Copenhagen. A number of biotechnology companies have emerged since the late 1990s, such as Genmab, Zealand Pharma, Bavarian Nordic and Symphogen in Denmark and Alligator Bioscience and Camurus in Skåne.



Novo Nordisk



Ferring



Lundbeck



LEO Pharma



University of Copenhagen

9 UNIVERSITIES. Greater Copenhagen's academic spectrum in the life sciences is broad, with nine learning institutions conducting research in the field. Globally leading diabetes research and neuroscientific research take place at the University of Copenhagen, as well as at Lund University. The learning institutions also have other strong life science research, for example on metabolic diseases and plant biology. In addition, DTU and Malmö University are both highly advanced in areas such as bioengineering and biological surfaces.



Medicon Village, Lund

CLUSTER RANKING: A unique comparison of ten European life science clusters: fields of research



PHOTO: LUNDBECK

Medicon Valley research in the life sciences is cited significantly more often than the international average in 15 of the region's 20 major areas of research. When it comes to the seven largest of these subject areas, the region places around midway or just below in a comparison with nine other outstanding European life science clusters, according to an analysis by the Dutch research centre CWTS.

- The five subject areas in which Medicon Valley's research institutions produced the greatest number of scientific publications from 2006-2016 were Biochemistry & Molecular Biology (4.7% of total publications), Endocrinology & Metabolism (3.9%), Oncology (3.7%), Neuroscience (3.5%) and Medicine, General & Internal (3.2%). This was shown by a bibliometric analysis performed by the Dutch research institution CWTS at Leiden University on behalf of Medicon Valley Alliance.
- Together, the 20 largest research areas in Medicon Valley are responsible for more than 50% of the scientific publications in the period studied.
- In 15 of those areas, publications by Medicon Valley researchers were cited significantly more often than the international average for their respective fields of research from 2006-2017. The remaining five are just above or below the average in the international comparison.
- Compared with nine other leading European life science clusters, Medicon Valley places around midway in the seven largest subject areas in the region.
- The Swedish government has taken initiatives to get more researchers and students from abroad to stay in the country, and the Danish government is also seeking to make it easier to recruit qualified experts from abroad.

THE CITATION FREQUENCY OF MEDICON VALLEY IS SIGNIFICANTLY ABOVE AVERAGE IN 15 OF THE REGION'S 20 LARGEST SUBJECT AREAS

The three fields of research to generate the largest number of scientific publications in the life sciences in Medicon Valley from 2006-2016 were Biochemistry & Molecular Biology, Endocrinology & Metabolism, and Oncology, as shown in a bibliometric analysis performed by the Dutch research institution CWTS at Leiden University on behalf of Medicon Valley Alliance. The analysis also shows that the citation frequency for publications in 15 of the region's 20 largest fields of research was significantly above the international average. Compared with nine other European life science clusters, Medicon Valley places around midway.

Life science researchers in Medicon Valley produced scientific publications in a very large number of subject areas from 2006-2016. More than half of those publications can be attributed to the 20 largest fields of research however, as shown in the graphic on page 28. Unsurprisingly, the largest field of research is Biochemistry & Molecular Biology, which is one of the broadest categories in CWTS' subject classification.

– Biochemistry is a strong area for us – in

Copenhagen as well as here in Lund, says Bo Åhrén, Pro Vice-Chancellor of Lund University.

An example to which Lund University is happy to give prominence is the new Wallenberg Centre for Molecular Medicine at Lund University, where the focus is on research in regenerative medicine.

The Dean of Research at the Technical University of Denmark (DTU), Katrine Krogh Andersen, calls attention to her university's strength and aptitude in biochemistry and microbiology – this

Oft cited: Medicon Valley's researchers

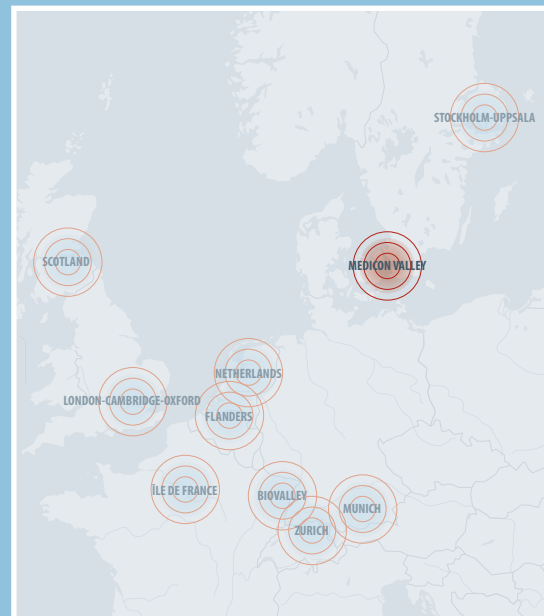
The region's researchers are cited significantly more often than average in 15 of the 20 largest subject areas for life science research in Medicon Valley. This was shown in CWTS' survey of scientific publications and citations in the life sciences from 2006-2017.

Close to the middle in a European comparison

Medicon Valley is above the median when it comes to the number of citations per scientific publication from an international perspective. But in a comparison with nine other leading European life science clusters, the Swedish-Danish region comes in at just about in the middle, as a review of the seven largest topics in Medicon Valley showed. The study was performed by the Dutch research institute CWTS at Leiden University.

"It is very, very important that we perform good basic research, because one can never predict what will turn out to be exciting. But at the end of the day, the most important thing is that the results we produce can be used."

Thue Schwartz, professor at Novo Nordisk Center for Basic Metabolic Research at the University of Copenhagen, believes that getting his research results out there is important, so he developed a number of spin-off companies. Read more in the interview on page 40.



The ten largest areas of research in the life sciences in Medicon Valley

Based on scientific publications from 2006-2016.

1. Biochemistry & molecular biology
2. Endocrinology & metabolism
3. Oncology
4. Neurosciences
5. Medicine, general & internal
6. Public, environmental & occupational health
7. Pharmacology & pharmacy
8. Cardiac & cardiovascular systems
9. Immunology
10. Surgery

20

MAJOR FIELDS OF RESEARCH.

The 20 largest fields of research were responsible for more than 50% of the total number of scientific publications in the life sciences in Medicon Valley during the period examined.

"Government funding for specific collaborations between institutions in the Øresund Region would spark a lot of collaborations, because funding is usually what controls how researchers organise their work."

Anna Blom, professor of Medical Protein Chemistry at Lund University, in an interview about funding, research conditions in the region, and Øresund collaboration, in which she sees great potential for development. Read more on page 38.



BIOBANKS BRINGING SCANDINAVIANS TOGETHER.

Swedish and Danish biobanks are comprehensive and similarly structured. That has been giving researchers at e.g. the State Serum Institute and Lund University a reason to work transnationally in order to access more material. The Danish government's State Serum Institute collaborates so frequently with Sweden that a data-generated network analysis located it in Sweden. See page 42 for more.

A unique comparison of ten European clusters

On behalf of Medicon Valley Alliance, the Dutch research institute CWTS at Leiden University performed a bibliometric

comparison of ten leading European life science clusters based on their total influence in the research world.

Most quoted

Based on the international average in the respective fields, the five topics in the life sciences within which Medicon Valley's researchers' scientific publications were most frequently cited from 2006-2017 are:

- Medicine, general & internal (MNCS: 1.71)
- Cell biology (MNCS: 1.61)
- Genetics & heredity (MNCS: 1.46)
- Plant sciences (MNCS: 1.40)
- Sport sciences (MNCS: 1.39)

An MNCS score of 1 entails that a publication has been cited as frequently as the international average in its field of research. This list is based on the 40 main research areas in the life sciences in Medicon Valley.



is also substantiated in the university's internal analysis, which foregrounds e.g. DTU's research in medical protein chemistry.

Biochemistry and molecular biology are also an area in which smaller universities in Medicon Valley perform research. Among others, the universities in Roskilde and Malmö perform research that can be fully or partially categorised in that field.

According to Anna Blom, Professor of Medical Protein Chemistry at Lund University and head of the Swedish Research Council's Scientific Council for Medicine and Health, the biochemistry groups in the region – and in Skåne specifically – maintain a strong international level, but they can hardly be called globally-leading.

– In my opinion, this is due in part to underfunding and an excessive administrative burden placed on researchers, as well as lacking infrastructure. Contemporary research requires extremely advanced methods – not least animal models and expensive equipment. That's not something that can be maintained by individual research groups; it needs to be created by the universities, and the extent to which that is being done isn't sufficient, she says.

Read more about Anna Blom's research on the complementary system of the immune system in an interview on page 38.

Linking research and industry

Endocrinology & Metabolism follow Biochemistry & Molecular Biology in size order and have long since been an important research subject in the region, particularly at the larger universities and university hospitals. The subject area concerns research on hormones and metabolism and includes e.g. diabetes. It can be linked to the region's successful life science industry.

– Endocrinology is high on the list, which is not strange – there's a strong tradition in the field, built on the foundation cast by Novo Nordisk, says Bo Ahrén from Lund University.

Research and industry have gradually developed a relationship of mutual exchange, and each contributes to the other.

– It's also related to the Novo Nordisk Foundation's strategic investments in that area. Endocrinology and metabolism have been an important part of the pharmaceuticals industry in the Copenhagen area. We consider that particular subject area a strong one for us, and there are also implications for the industry, where we've for example trained employees, says Mogens Holst Nissen, Vice Dean



Bo Ahrén, Pro
Vice-Chancellor of
Lund University.

PHOTO: NEWS ØRESUND

FACTS: DEFINITION OF SUBJECT CATEGORIES

- The publications were categorised according to the scientific journals in which they were published. Each journal was attributed to one or more subject categories using fractional counting; by the same principle, a publication that appeared in that journal was seen as belonging to these subject categories.

- The subject categories were defined by aggregating Web of Science's journal subject categories. This was done according to the fixed classification system called the NOWT system (Netherlands Observatory for Science and Technology). NOWT is a formal cooperation between the Centre for Science and Technology Studies (CWTS) linked to Leiden University and the Maastricht Economic Research Institute on Innovation and Technology (MERIT) of Maastricht University, and is funded by the Dutch Ministry of Education, Culture and Science, Directorate Research and Science Policy.

- The subject categories encompass areas of varying size; for example, Biochemistry & Molecular Biology covers a broad field with many scientific journals, whilst other subject areas may include significantly fewer scientific journals.

MEDICON VALLEY MIDWAY BETWEEN EUROPEAN LIFE SCIENCE CLUSTERS FOR SCIENTIFIC PUBLICATIONS AND CITATION FREQUENCY

In a comparison with nine other outstanding European life science clusters, the percentage increase in the number of scientific publications from 2006-2016 was greatest in Medicon Valley. The Danish-Swedish region took sixth place in the comprehensive comparison, both for articles produced and citation frequency, as an analysis performed by the research institute CWTS on behalf of Medicon Valley Alliance shows. The analysis results were presented in detail in last year's annual report "State of Medicon Valley 2018 – An Analysis of Life Science in Greater Copenhagen". The following is a summary of the report.

- Medicon Valley's researchers produced 32 027 scientific publications in the life sciences during the period studied, 2006-2016. From 2006-2017, 13% of those publications were among the 10% most frequently cited in their respective fields.

- The number of scientific publications in Medicon Valley increased 23% from the period 2006-2009 to the period 2013-2016; the increase was percentageally greater than in any other cluster in the study.

- The study comprised a bibliometric comparison of ten European life science clusters, one of which is Medicon Valley. It was carried out by the Dutch research institute CWTS at Leiden University on behalf of Medicon Valley Alliance. The study included the following clusters:

- London-Cambridge-Oxford
- The Netherlands
- Île de France/Paris
- Flanders
- Stockholm-Uppsala
- Scotland
- Medicon Valley
- Zurich
- BioValley (a German-French-Swiss cluster that includes Basel, Alsace, Freiburg, Karlsruhe, Mulhouse and Strasbourg)
- Munich

- The European life science clusters in the comparison that produced the greatest number of scientific publications during the period studied were London-Cambridge-Oxford (116 263), the Netherlands (90 779), and French-German-Swiss BioValley (49 925). The clusters with the largest proportion of scientific publications among the

ten per cent most frequently cited internationally in their respective fields were London-Cambridge-Oxford (17%), Zurich (16%), and Scotland (15%).

- The clusters in the comparison that resemble Medicon Valley most closely are Stockholm-Uppsala, Flanders, and to a degree, Munich.

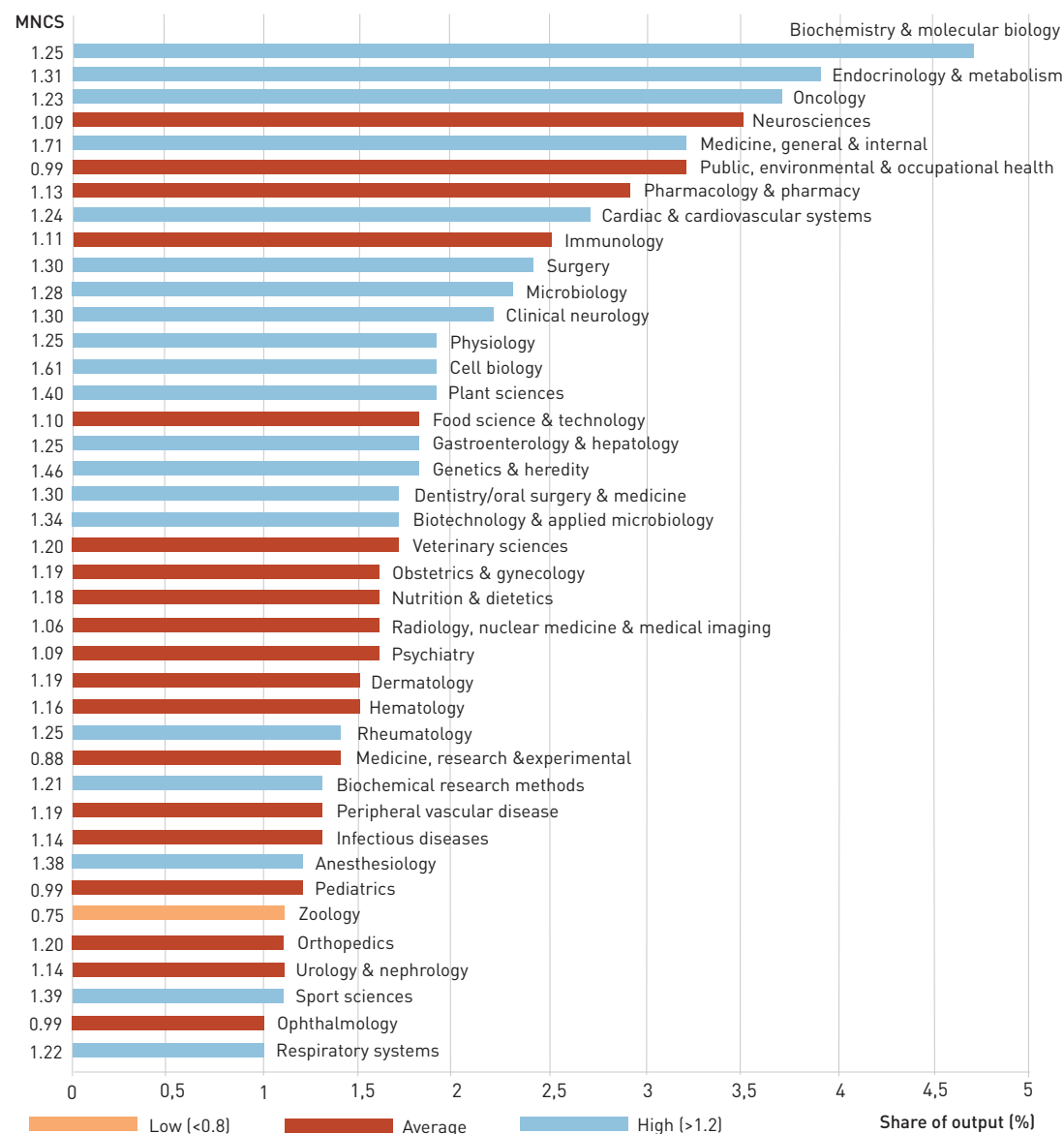
- International collaboration was a part of 54% of Medicon Valley's scientific publications and led to significantly more citations than publications that were the result of national collaboration or the work of individual research groups. The research networks in the transborder region are however predominantly national.

- Internal research networks in Sweden and Denmark are markedly stronger than research networks that cross the Øresund Strait, as shown by CWTS' network analysis of the Swedish and Danish research institutions with which actors in Medicon Valley collaborate in the life sciences. Although practical issues and border obstacles throw a spanner in the works, universities in Medicon Valley believe that more trans-Øresund cooperation could strengthen research. The research facilities ESS and MAX IV, as well as a coordinated strategy for diabetes research, are highlighted as ways to bring the region closer together.

- Life science research is performed in several hospitals on the Danish side of the strait, whilst on the Swedish side it is concentrated primarily in Skåne University Hospital.

MAIN FIELDS OF RESEARCH AND THEIR IMPACT

The diagram shows the 40 subject areas in which research institutions in Medicon Valley produced the greatest number of scientific publications from 2006–2016, as well as the citation degree of these publications in relation to the international average in each respective research area (MNCS) from 2006–2017. 1 indicates that a publication has been cited as frequently as the calculated average for its field of research. In the diagram, the colour blue indicates an MNCS score over 1.2 (above average), red an MNCS score of 0.8–1.2 (average), and orange an MNCS score below 0.8 (below average).



Source: CWTS B.V.

• The five subject areas in which Medicon Valley's research institutions produced the greatest number of scientific publications from 2006–2016 were Biochemistry & Molecular Biology (4.7% of total publications), Endocrinology & Metabolism (3.9%), Oncology (3.7%), Neuroscience (3.5%) and Medicine, General & Internal (3.2%).

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for Research at the Faculty of Health and Medical Sciences at the University of Copenhagen.

Thue Schwartz, Professor at the University of Copenhagen's Novo Nordisk Foundation Center for Basic Metabolic Research, points to the importance of research hospitals that have been linked to diabetes research and industry for a long time: Hvidovre Hospital and Gentofte Hospital, as well as Steno Diabetes Center.

– They are very important. Both clinical research and basic research in endocrinology have flourished in research hospitals, he says.

He also points out that the University of Copenhagen and Lund University have collaborated closely in the field, though in his opinion, the collaboration was more comprehensive several decades ago than it is today.

Read more about Thue Schwartz' research on how metabolites – the metabolic substance made when the body breaks down food – affect receptors in the adipose tissue of the body in an interview on page 40.

Research performed at university hospitals and research institutions

In descending size order according to CWTS' bibliometric comparison, the major fields Biochemistry & Molecular Biology and Endocrinology & Metabolism are followed by Oncology, then Neuroscience, which is also linked to the region's life science industry. Cancer research is distributed throughout many of the region's learning institutions, and is among other things the primary focus of the Danish organisation the Danish Cancer Society. Neuroscience has long since been an important field of research, with multiple centres and operations at

Lund University, where research on e.g. Parkinson's and Alzheimer's has been internationally acclaimed. The University of Copenhagen has also made active investments in the area, particularly in recent years.

Following Neuroscience is Medicine, General & Internal, which primarily includes clinical research and care for widespread diseases such as lung- and heart disease, diabetes, and neurological disorders, particularly in combination. Research is primarily performed at the university hospitals in Copenhagen and elsewhere in Zealand and in Skåne.

The subject area is followed by Public, Environmental and Occupational Health, a transdisciplinary field concerned with improving a nation's health and investigating the effect of surroundings and work environments on health. The Danish National Institute of Public Health should be mentioned in relation to the latter area. It is located in Copenhagen, although it is officially part of Aarhus University. The institute's research focuses



Thue Schwartz,
Professor at the
University of
Copenhagen.

PHOTO: NEWS ØRESUND



• Fifteen of Medicon Valley's 20 largest areas of research are on a level that the research institute CWTS classifies as high with regard to the publications' citation degree in relation to the international average within each respective subject field (MNCS) from 2006–2017. That entails that their MNCS score is over 1.2 on a scale in which 1 indicates that a publication has been cited as frequently as the calculated average for its respective field of research. The remaining five research areas in the top 20 range from 0.99 and 1.13, i.e. approximately or slightly above average.

• Based on the 40 research areas in which the most research is performed in Medicon Valley – which are represented in this diagram – the most frequently cited publications by Medicon Valley researchers in relation to the average for their respective fields of research were from Medicine, General & Internal (MNCS: 1.71), Cell Biology (1.61), Genetics & Heredity (1.46), Plant Sciences (1.40) and Sports Science (1.39).

• Of the 40 research areas in the diagram, there is only one – Zoology – whose citation frequency is lower than 0.8.

TEN LIFE SCIENCE CLUSTERS IN COMPARISON

• On behalf of Medicon Valley Alliance, the research institute CWTS at Leiden University conducted a comparison of the bibliometric performance of ten life science clusters in Europe, one of which is Medicon Valley:

- London-Cambridge-Oxford
- Netherlands
- Île de France/Paris
- Flanders
- Stockholm-Uppsala
- Scotland
- Medicon Valley
- Zurich
- BioValley (a German-French-Swiss cluster that includes Basel, Alsace, Freiburg, Karlsruhe, Mulhouse and Strasbourg)
- Munich

• In the report, clusters are defined as areas in which universities and other research institutions are fairly densely located in a specific geographic area, where internal collaboration is customary or habitual, and where there is an established cluster organisation of some kind.

• Based on these criteria, we compiled a list of 15 European life science clusters. To do this, we identified the geographic areas that are home to the first 25 universities on the European list of the greatest number of published articles in the field "Biomedical and Health Sciences" in the Leiden Ranking 2012-2015, as well as studying the selection in a number of earlier reports on life science clusters

to avoid overlooking clusters where e.g. there is no single, large university, or no transborder clusters.

• We then reduced these 15 clusters to ten by analysing how many articles were published by universities in the 15 European life science clusters, and the frequency with which they were cited. The comparison was done in Leiden Ranking "Biomedical and Health Sciences" 2012-2015.

• The clusters differ in terms of size and the number of research institutions. Some clusters are larger, more well positioned and conduct more research than others. The objective has been to represent the clusters' significance and research positions in relation to one another, and not to show how each cluster performs according to its own unique conditions – a project that would require a significantly larger scope than the present one.

• The comparison has been done for the years 2006-2016. Citations have also been counted through 2017.

• The source was the research database Web of Science, and the publications selected for these regions were limited to those designated to the higher-level category of "Medical and Life Sciences".

• All of the scientific publications in the relevant categories and journals from each region were counted, regardless of whether the research was conducted at e.g. a university, university hospital, other research institutions, or at a commercial enterprise.

on e.g. equality in healthcare and the health effects of lifestyles, and an important area that has begun to emerge is mental health. Malmö University also carries out research in that area – like the National Institute of Public Health, the focus is on e.g. equality in healthcare and health.

The seventh largest field of research with regard to the number of scientific publications in CWTS' comparison is Pharmacology and Pharmacy, which concerns how substances such as pharmaceuticals interact with the human body or other living organisms. Research in the field is performed at e.g. the University of Copenhagen, Lund University, and DTU, where the Dean of Research Katrine

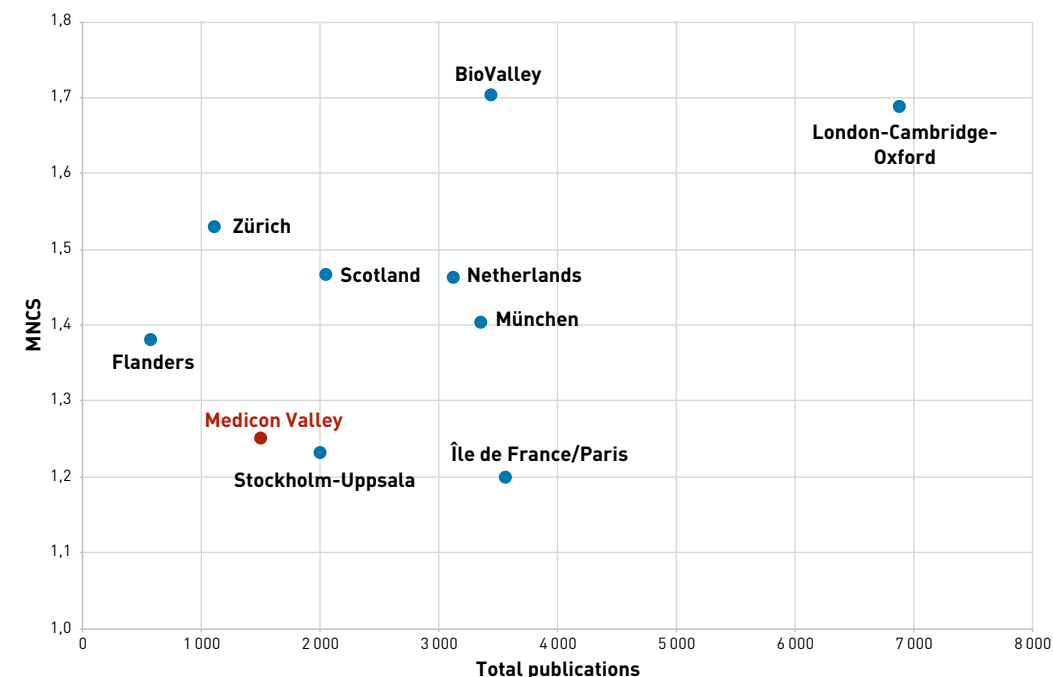
Krogh Andersen foregrounds Pharmacology as one of the university's more important subject areas.

Many citations from an international perspective

Together, the 20 largest research areas in Medicon Valley are responsible for more than 50% of the scientific publications in the period studied. In 15 of those areas, publications by Medicon Valley researchers were cited significantly more frequently than the international average for their respective fields of research from 2006-2017. The remaining five are just above or below the average in an international comparison.

BIOCHEMISTRY AND MOLECULAR BIOLOGY

The diagram shows the number of scientific publications (total publications) in the respective subject area from 2006-2016, as well as the citation degree of these publications in relation to the international average in the respective research areas (MNCS) from 2006-2017. 1 indicates that a publication has been cited as frequently as the average for its respective field of research.



Source: CWTS B.V.

- Compared with the other life science clusters in the analysis, Medicon Valley places eighth for both the number of publications and for the citation frequency of the publications in relation to the international average in each respective field of research.

If the perspective is broadened to encompass the 40 largest research areas in Medicon Valley from 2006-2017, only one subject – Zoology – was cited significantly less frequently than the international average for its respective field of research.

The representation of these results is further modulated by CWTS' comparison with nine other successful life science clusters in Europe, specifically French-German-Swiss BioValley, Flanders, Île de France, London-Cambridge-Oxford, Munich, the Netherlands, Scotland, Stockholm-Uppsala and Zurich. In this group of clusters, Medicon Valley's placement was in the middle in most cases, both in terms of the number of scientific publications

produced and the citation frequency of those publications – see the diagrams on pages 31-34.

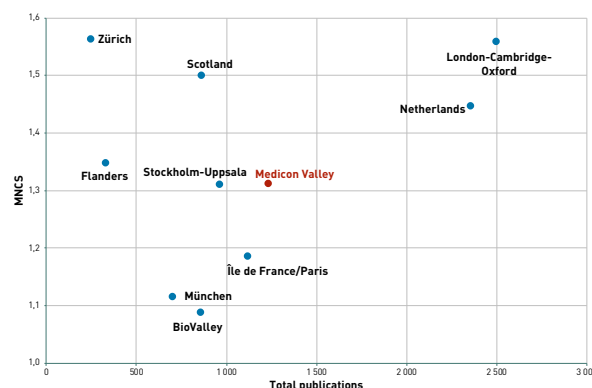
Neuroscience places lowest

One subject area that falls out of line is Neuroscience; whilst Medicon Valley researchers' publications were cited slightly more often than the global average, in terms of citations, the region clearly performed more poorly in the European comparison. This came as a surprise to Bo Åhrén, Pro Vice-Chancellor at Lund University.

– Neuroscience is one of the very strongest areas in Lund when it comes to medicine; that has been the case for decades, and the tradition is strong.

The diagrams below show the number of scientific publications (total publications) in the respective subject area from 2006-2016, as well as the citation degree of these publications in relation to the international average in the respective research areas (MNCS) from 2006-2017. 1 indicates that a publication has been cited as frequently as the average for its respective field of research.

ENDOCRINOLOGY & METABOLISM



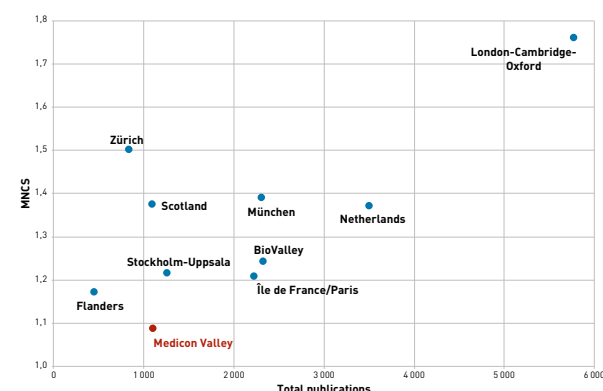
- Medicon Valley places third compared to the other life science clusters in the analysis. Only London-Cambridge-Oxford and the Netherlands produced a greater number of scientific publications than Medicon Valley during the period in question.
- In terms of the number of citations with regard to the international average in each respective field of research, Medicon Valley is at the middle and shares sixth place with Stockholm-Uppsala.

ONCOLOGY



- Medicon Valley is just below the average compared to the other life science clusters in terms of both the number of citations (seventh place) and citation frequency (sixth place).

NEUROSCIENCES



- Medicon Valley's citation frequency is the lowest of all ten clusters in the comparison, and it places seventh for the number of publications.



Kerstin Tham, Vice Chancellor at Malmö University.



Katrine Krogh Andersen, Dean of Research at DTU, the Technical University of Denmark.

The same goes for Denmark, where Lundbeck is the driving force. The results were low all the same. I had expected different results, considering the excellent researchers we have here, many of whom are absolutely at the forefront globally, he says.

None of the people interviewed had a clear understanding of or explanation for the low results. Mogens Holst Nissen, Vice Dean for Research at the University of Copenhagen's Faculty of Health and Medical Sciences, believes that could be about to change, however. Neuroscience, as mentioned, is one of the areas in which the University of Copenhagen has made growth investments, e.g. by recruiting researchers and pooling strength in a common institution.

– Neuroscience in particular is in a phase that we expect to mean continued development and a reinforcement for the region. We expect that it will be discernible in the future, in the years to come, he says.

Remarkably high number of citations in Medicine, General & Internal

A very successful subject area in terms of the citation frequency of Medicon Valley researchers' scientific publications is Medicine, General & Internal. During the period studied (2006-2017), the MNCS score for the area was 1.71 (a score of 1 entails that a publication was cited as frequently as the international average for its field of research). The score is comparatively a very high one. Medicine, General & Internal comprises clinical research and care for widespread diseases such as COPD, heart failure, diabetes, neurological

disorders, or infections. In other words, there is no sharp divide between Medicine, General & Internal and the other major fields of research.

Bo Ahrén reasons that the comparatively poorer result for Neuroscience could be related to the way the research has been classified.

– There are of course sources of error in bibliometry. However, the other subject areas have the placement one would expect them to, he says.

Despite the high citation frequency for research in Medicine, General & Internal in Medicon Valley, the region still remains close to the median in relation to the other nine European clusters studied.

There are other such examples in which Medicon Valley maintains its place in the middle in the European comparison, e.g. Public, Environmental & Occupational Health. This is true although Medicon Valley researchers' citation frequency in that particular area is unusually low compared to the international average: the MNCS score is 0.99 and thus lower than the international average.

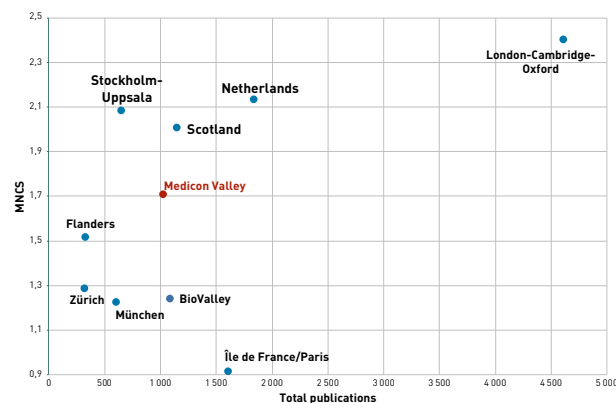
However, according to the Dutch research institution CWTS, which performed the bibliometric analysis, based on the material no general conclusions can be drawn regarding whether a European trend can be discerned concerning the areas in which research is performed and how frequently the scientific publications are cited.

Private foundations make major investments in the life sciences

The subject areas in which development is strongest is clearly linked to where the research resources are,

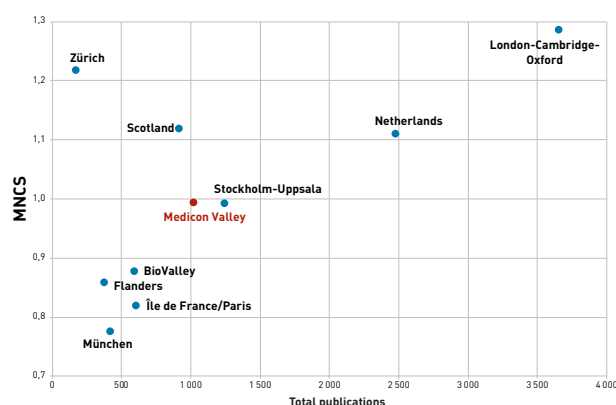
The diagrams below show the number of scientific publications (total publications) in the respective subject area from 2006-2016, as well as the citation degree of these publications in relation to the international average in the respective research areas (MNCS) from 2006-2017. 1 indicates that a publication has been cited as frequently as the average for its respective field of research.

MEDICINE, GENERAL & INTERNAL



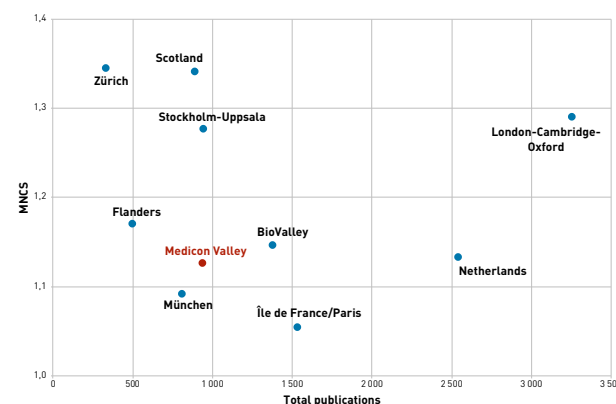
- Medicon Valley is close to the median compared to the other life science clusters, despite the high MNCS score of 1.71. Medicon Valley places fourth for citation frequency and sixth for the number of publications.

PUBLIC, ENVIRONMENTAL & OCCUPATIONAL HEALTH



- Medicon Valley is close to the middle compared to the other selected life science clusters, despite the relatively low MNCS score. Medicon Valley places fourth for the number of publications and fifth for citation frequency.

PHARMACOLOGY & PHARMACY



- With an MNCS score of 1.13, the region shares seventh place in a comparison of the life science clusters' citation frequency. Medicon Valley comes in sixth for the number of scientific publications.



A student at Mærsk Tårnet, University of Copenhagen.

PHOTO: NEWS ØRESUND

according to several of the people interviewed for this report. In part, this is because of political investments; in recent years, the Swedish and Danish governments have prioritised e.g. antimicrobial resistance and personalised medicine. The industry also exerts influence, particularly in Denmark, where companies have a tradition of creating research foundations with a great deal of resources to distribute. In the life sciences, two such foundations are the Novo Nordisk Foundation and the Lundbeck Foundation. The practice is less common in Sweden, although the Wallenberg Foundations are one example that they do exist there as well.

– Private foundations are distributing more and more funds; there has been an enormous increase in the past ten years, so that there are more resources for research in private foundations than in the public ones. The life sciences are an area in which the majority of resources are clearly in private foundations, so we can reinforce those environments, says Katrine Krogh Andersen, who was Dean of Research at the Technical University of Denmark (DTU) at the time of the interview.

In January 2020, she will take over her new position as Dean of the Faculty of Science at the University of Copenhagen.

As an example, she mentions the multiple research centres started by the Novo Nordisk Foundation, such as the Novo Nordisk Foundation Center for Biosustainability at DTU, as well as the

Novo Nordisk Foundation's so-called Challenge Programme, with investments of 60 million DKK.

– It's thus a question of some very large investments made by these foundations, which target excellent researchers – both Danish and international researchers that they'd like to bring to Denmark. I think that within a few years that will mean a real fortification of research in the life sciences, she says.

Katrine Krogh Andersen also points out that since this development just started around ten years ago, only the first phase is visible in the bibliometric analyses being performed now.

– Since research funds are predominantly distributed by actors external to the universities, the learning institutions themselves have a difficult time influencing the direction of the research being performed, says Anna Blom from Lund University.

Lund University is also involved with the distribution of research grants from the Swedish Research Council, and it is part of numerous Swedish research committees and foundations.

– The university has extremely limited possibilities to steer my research – because all of my funding is external and in part from the government, but above all from private financiers such as the Wallenberg Foundations or the Swedish Cancer Society. That being so, it's important to invest in individuals and develop them. Ideally both women and men, she says.



PHOTO: SIMON SKIPPER

Erik Bisgaard Madsen, Trine Winterø and Mogens Holst Nissen, three of the vice deans at the University of Copenhagen.

Anna Blom emphasises the importance of individual researchers who construct a successful environment in a particular area and in doing so lay the foundation for a strong field of research at their university or in their region.

– When I came here in 1993, diabetes was not yet the very largest research area at Lund University. The successful environment that we have today was built up by Professor Leif Groop, who was recruited from Finland and was a wonderful leader for many years. He was a brilliant researcher himself, but he was also able to recruit a whole pool of researchers. Now that he's retired, there's a whole group of younger professors in the field of diabetes with a variety of competencies, and together they're creating a fantastic environment, she says.

According to Blom, the case is similar in e.g. neuroscience.

Thue Schwartz, Professor at the Novo Nordisk Center for Basic Metabolic Research at the University of Copenhagen, is also convinced that individual researchers can play a vital role in the emergence of a successful field of research.

Schwartz also strongly emphasises the funding opportunities that the Novo Nordisk Foundation and others provide within the life sciences, specifically in metabolism and endocrinology.

Effects of ESS and MAX IV not yet apparent in the analysis

Another important factor that has yet to make a mark in the bibliometric analyses is the growth expected to accompany the materials research facilities ESS and MAX IV, which will also affect the life sciences. Whilst the synchrotron radiation facility MAX IV in Lund is still in its start-up pha-

se, the pan-European neutron research facility ESS in Lund is currently being constructed. ESS' data centre is located in Copenhagen. The new research infrastructure is expected to create new opportunities in everything from biochemistry and molecular biology to microbiology, biotechnology and pharmacology; in extension, these can also be applied to many more areas in the life sciences.

In addition, the research facilities are expected to have a broader influence on the research community.

– Building up MAX IV and ESS will attract Danish researchers and lead to increased internationalisation, as well as more collaboration with Denmark within those fields, says Bo Åhrén from Lund University.

International collaboration generally leads to an increase in the citation impact of scientific publications, Åhrén points out, and other rectors and deans foreground the importance of working together – not only in Medicon Valley, but in a broader international perspective.

Prioritisation and profiling as strategies

According to Kerstin Tham, Vice Chancellor at Malmö University, an investment with the potential to strengthen the region would be a more clearly defined prioritisation according to subject area. She recommends for example a research strategy in diabetes to give the region a stronger profile in relation to e.g. Stockholm-Uppsala.

– Comparisons like these are valuable and allow us to see the strengths we have and could perhaps reinforce further. One such area of strength is endocrinology. It would be incredibly valuable if the region created an even more defined image compa-

red with other regions, perhaps by focusing more on prediabetes and preventative measures. I believe in defining a profile rather than competing for the same research funds and researchers, she says.

Mogens Holst Nissen from the University of Copenhagen thinks along similar lines; he believes that prioritisation of subject areas is important.

– In terms of continued growth for the region, one might ask whether one should aspire for broad research coverage. Perhaps broad coverage is important in education, but in research? If we compare fields, what are the clinical areas in which we're particularly strong? Which basic research areas? he says, and continues:

– Not for the sake of finding differences, but rather in order to be able to say: Are there any areas where we can find synergies, or fields for which we need to make sure we secure funding? Resources need to be available for an area in order to maintain research within that area.

Bibliometrics need a context

The rectors and deans interviewed for this report all emphasise that there are many factors besides the number of scientific publications and citations that define a successful life science cluster.

– What's missing from bibliometric analyses is the ecosystem: how it's measured and on what it's based. What does it entail that Novo and Lund-

beck are here, and GSK and Pfizer are in London? There are some fundamental differences, says Trine Winterø, Vice Dean for Innovation and External Relations at the Faculty of Health and Medical Sciences at the University of Copenhagen.

Erik Bisgaard Madsen, Vice Dean for Public and Private Sector Services at the Faculty of Science at the University of Copenhagen, points out that bibliometric delineations are always somewhat random.

– The Faculty of Science contributes quite positively to the publication rates in Medicon Valley. Science is actually strong. But the bibliometric analysis overlooks areas such as biostatistics; it usually isn't counted as part of the life sciences. Hence, there are certain biases here, and because of them the analysis needs to be taken with a grain of salt, he says.

On the other hand, there is a point to analyses like these, because they render visible strong areas, and in extension, they can attract investments in industry, says Mogens Holst Nissen, Vice Dean for Research at the Faculty of Health and Medical Sciences at the University of Copenhagen.

– Pharmaceutical- and biomedicine companies can locate areas in which they know they can invest, and they can be certain of finding educated researchers, such as doctoral students, to make contributions in the field of research they've chosen, he says.



PHOTO: NEWS ØRESUND

SEEKING INTERNATIONAL EMPLOYEES – BUT NOT FINDING COLLABORATION WITH DENMARK

Anna Blom is Professor of Medical Protein Chemistry at Lund University and the head of a research group that focuses on a part of the immune system called the complement system. She believes that research in Sweden would benefit from more long-term research grants – and suggests specially designated funds for trans-Øresund collaboration. In Blom's opinion, the current research exchange between the Swedish and Danish parts of the region is far too meagre.

Earlier this year, Anna Blom was appointed "Wallenberg Scholar", receiving a five-year grant of 18 million SEK for free basic research from the Knut and Alice Wallenberg Foundation. Blom heads a group of 20 researchers whose research work focuses on the complement system, which forms a part of

the innate immune system in all organisms from humans to sea cucumbers. The work of the research group – which, according to Anna Blom, can be counted among the top five globally in its field – has come to expand: the research ranges from studying how bacteria defend themselves against the complement system in the hopes of finding alternatives to antibiotics to investigating complement's role in rheumatological illnesses related to the immune system to find new kinds of therapy or improve diagnostics. In addition, Anna Blom and her colleagues study the complementary system's role in diabetes. The group is also continuing work with their discovery that people with breast cancer whose cancer cells produce a larger amount of the protein COMP have poorer prognoses, a much higher number of metastases, respond worse to treatment, and succumb much more quickly to the disease.

– In part, it can be used as a diagnostic tool – if a woman who gets breast cancer has indications of that protein, the treatment should presumably be significantly more offensive, since the prognosis is worse. And of course, we also try to figure out: Can we use this knowledge to develop a treatment? says Anna Blom.

Her path to Lund University began in her hometown Krakow, where she studied molecular biology, and continued through Uppsala University, where she wrote her master's thesis and prepared her defence in medicinal and physiological chemistry.

Anna Blom then got a position at Lund University, located at the Wallenberg Laboratory in Malmö. She started out there as a post-doc, but today she is a professor and the head of a large research group. She is also chair of the Swedish Research Council's Scientific Council for Medicine and Health, has a

part-time position in clinical chemistry at the clinic at Skåne University Hospital, and is assistant prefect for strategic issues at her institute.

– I have a lot of other tasks on top of those, as female professors typically do. For better or worse – it takes time away from doing research, but on the other

hand, someone has to help create an environment that works well, she says.

Loyalty to her academic institution is one of the reasons Anna Blom chose to stay at Lund University. She also sees many advantages to working in Skåne and the Øresund Region – from Sweden being a country with fairly good gender equality and one in which, in Anna Blom's experience, meritocracy is alive and well and corruption is practically non-existent – to the area's good communications, which make it relatively easy to recruit new employees.

Of the 20 researchers in Anna Blom's group, only two are Swedes – the rest are from e.g. Greece, Germany, Turkey, Italy, and England. The choice was a conscious one made by Anna Blom, who seeks the exchange of ideas and experience that occurs when people with different backgrounds meet. She has practically never worked with Danes, however, and finds that a more extensive collaboration with the Danish part of Medicon Valley is lacking.

– There are no natural meeting places; at any rate I've never been invited to any or seen any relevant occasions. I have a small collaboration with Copenhagen, but that's because there is someone there in exactly my research field. He could just as well be

"I have a small collaboration with Copenhagen, but that's because there is someone there in exactly my research field."



Anna Blom heads an immunology research group at Lund University.

in Brussels; I would be working with him just the same.

As Anna Blom sees it, there is a lack of interest in the Øresund Region in Stockholm, both when it comes to regional development as well as in terms of research.

– Government funding for specific collaborations between institutions in the Øresund Region would spark a lot of collaborations; funding is usually what controls how researchers organise their work.

She'd also like to see transborder conferences, for example in her own field of immunology. Or more meeting places and networks where researchers can meet and get to know each other.

– Occasionally I'm invited to Copenhagen as an opponent for a PhD defence, and looking at that fantastic, new research building Mærsk Tower – yes, well, there must be a whole lot of research being done there. That's exciting, but I have no idea who the researchers are, she says.

Even if she prefers to recruit internationally and work with researchers around the globe, Anna Blom sees a lot of benefits to local collaborations across the Øresund Strait. A major advantage is that the proximity makes it easier to perform experiments together, and that the universities can share expensive equipment and facilities. On top of that, Anna Blom sees a climate-friendly aspect to choosing collaboration partners who are nearby.

– I just went to San Diego to give a lecture; flying 24 hours back and forth for that purpose is crazy. It isn't sustainable, and I don't think it can continue. A lot of people want to meet in person – and that can really be necessary when the discus-

sions are complicated – and in those cases it's so much easier to go to Denmark, she says.

Through her position at the Swedish Research Council and other research foundations, Anna Blom has insight into how research funding works from the perspective of the government as well as from that of the researcher. She believes that the potential is there for improvements that would benefit research in the region and give it more of a competitive edge.

– There is a definite need for more stability and long-term funding so researchers can dedicate themselves to somewhat more risky research endeavours that might not produce results for a long time, because that is a precondition for finding real breakthroughs, she says.

She also points out the size of grants; a typical grant from the Swedish Research Council lasts for three years and the length of a post-doc position.

– When you apply for a grant in for example the USA, you can receive full funding for the project at hand. Here, the grant covers maybe ten or twenty per cent of what is needed. I write around 20 applications a year just to be able to maintain a group, because my university doesn't give me any funding other than my own salary. That is the case for most of the people in my department, she says.

In the long term, Anna Blom hopes to be able to contribute to increased knowledge and improved diagnostics or treatments for illnesses.

– Personally, I enjoy simply understanding things, seeing how they work. And discovering something that no one has ever seen before. That's the driving force, it's really the best, she says.

BRINGING RESEARCH RESULTS TO THE PEOPLE WITH SPIN-OFF COMPANIES

Thue Schwartz divides his time between basic research on how the building blocks created when the body breaks down food affect receptors in adipose tissue and bringing the results of his research to the public via the companies he starts up. He is a professor at the Novo Nordisk Foundation Center for Basic Metabolic Research at the University of Copenhagen, and collaborations with Sweden have been extremely important throughout long stretches of his career thus far.

Collaboration with Swedish research colleagues already took off at the start of Thue Schwartz' career. Though he trained as a doctor, he chose to begin re-researching gastrointestinal hormones. At the time – in the 1970s and 80s – there was an excellent research group at Lund University that focused on the very same subject as Thue Schwartz' group at the University of Copenhagen, just using a different approach.

– Lund – with Rolf Håkansson in pharmacology and Frank Sundler in anatomy – was our most important collaboration partner and we worked together very closely, he says.

Little by little, Thue Schwartz' research came to be more about how hormones affect receptors in the body. He worked at Novo Nordisk for a while in the 1990s, but chose to return to the university. A few years later, he started his own biotech company, 7TM Pharma. His research grew more specifically oriented toward endocrinology and metabolism around ten years ago, when he was part of a funding application for the centre that is now the Novo Nordisk Center for Basic Metabolic Research, where he is now professor.

– I was still involved with receptors, but this time I was working with receptors for metabolites, he says, referring to the metabolic substance created when the body breaks down food, or in fatty tissue.

They're generally considered the building blocks of the body, or seen as small units of energy, Thue Schwartz explains.

– But from our perspective, many also function as extracellular signal molecules, so the way they work is that they're created in one cell and send a signal to the adjacent cell, or to the cell that creates the metabolite. When we started ten years ago it was an entirely new field of research, he says.

Thue Schwartz and the research group of 12-15 people he leads are trying to understand how

metabolites function as both units of energy and neurotransmitters, e.g. in adipose tissue. In the work they do, they collaborate closely with other colleagues at the Novo Nordisk Center for Basic Metabolic Research, but also with a research group from the Wallenberg Laboratory at the Sahlgrenska Academy at the University of Gothenburg that

specialises in the importance of gut flora for health.

– I invested in equipment at Sahlgrenska with Professor Fredrik Bäckhed, who is based there, and I employed him part-time in my division of the centre (Novo Nordisk Foundation Center for Basic Metabolic Research). After we

had been sharing knowledge and resources for a few years we received a large research grant together with Jens Nielsen from Chalmers, says Thue Schwartz.

At the moment, he isn't involved in any collaborations in what is traditionally classified as Medicon Valley or the Øresund Region.

– But if you expand the Øresund Region to include Gothenburg, I am. After all, it's the same train line, he says.

Parallel to his research, Thue Schwartz has started up a number of companies as a way to bring his research out into the world. He was also involved in starting up Denmark's first biotech venture fund, BankInvest BBU.

The youngest company in which he is part-owner is Embark Biotech, whose goal is to develop new treatment methods for obesity. It's based on the group's research into new ways to stimulate adipose tissue to use fat, rather than store it.

– In November of 2018 we signed an extensive collaboration-, research- and development contract with Novo Nordisk, says Thue Schwartz, but he doesn't want to say much more about it.

He points out that the contract with Novo



Parallel to his research work, Thue Schwartz has started up several companies.

Nordisk was signed at a very early stage, the reason being that the parties involved knew each other well and trusted each other.

– We were confident that they would receive it well – and vice versa – and the development has been insanely good. It's great to see that basic research can be put to good use, he says.

Thue Schwartz believes that the conditions for performing life science research in Medicon Valley are extraordinarily good because of the good funding opportunities in Denmark. As he sees it though, that's mostly due to resources from large research foundations like the Novo Nordisk Foundation and the Lundbeck Foundation.

– There is clearly too little public funding. It's a bit of a shame that we're so dependent on the private foundations, he says.

At the same time, he considers the research funding from the Novo Nordisk Foundation very positive, particularly because of its broad scope; there are possibilities to apply for funding for everything from large research centres to specific research projects to the recruitment of new researchers or for giving young researchers opportunities abroad.

– You can basically apply for funds to do anything. That's extremely important. And it isn't limited to endocrinology and metabolic research, even if they do welcome those; it covers biomedical research and other areas as well, says Thue Schwartz.

In addition, he highlights that the Novo Nordisk Foundation often grants long-term funding with relatively few partners involved, which leaves more in the coffers for each research group and

allows for more focused collaboration.

Thue Schwartz points out that he believes there are good opportunities to fund newly established companies as well, since there are funds available for many different phases of development. The Novo Nordisk Foundation is also very active via Novo Holdings in that respect, he says.

Personally, Thue Schwartz finds the combination of research and entrepreneurship important.

– It is very, very important that we perform good basic research, because one can never predict what will turn out to be exciting. But at the end of the day, the most important thing is that the results we produce can be used. Basic research is what motivates me, for us to understand what's going on – but one great and important thing is that we can utilise that basic research for patient treatment, he says.

He believes that research in endocrinology and metabolism will continue to be a strong area for Medicon Valley in the future. The factors that strengthen the region in that area right now – like the interplay of research and industry, funding opportunities and the existing tradition in endocrinology and metabolism – should endure, says Thue Schwartz.

– There will of course be changes to the areas of focus, but that's just variations on a theme. While gut hormones were the most important thing last century, I think that the focus will shift more and more to fatty tissue. Another thing is that our understanding of the central nervous system's importance in endocrinology has been a very good field of research, but I think in the future it's going to be really, really big, he says.

SCANDINAVIAN BIOBANKS INSTRUMENTAL IN EXTENSIVE TRANSBORDER COLLABORATION

Denmark's State Serum Institute (SSI) collaborates extensively with Swedish universities – so much so that a computer-generated network analysis located the Danish research institute as part of Sweden. This is largely because Sweden and Denmark have similar biobanks and registers, giving researchers the opportunity to carry out significantly larger register-based studies through collaboration between the countries.

– Collaboration with Sweden is clearly something we seek out – or that the Swedes seek out; it goes both ways. We've accrued know-how, and we co-publish many articles with Swedes every year. We know whom to contact, says Mads Melbye, Director of the State Serum Institute.

There are four main themes for research at the institute: epidemiologic research, vaccine research, research on infectious disease preparedness – e.g. antibiotic resistance and the development and implementations of new diagnostic methods – and research on congenital disease. In addition, SSI runs the Danish National Biobank. Of the ca 700 employees at the state-run research institute, which operates under the auspices of the Danish Ministry of Health, around 150 work primarily in research.

SSI is currently working to build up a large

centre for antimicrobial resistance with the World Bank and others.

– We are very actively involved in antimicrobial resistance and collaborate internationally. But we also have large-scale projects in other areas, such as e.g. a vaccine development project and a large genetic project, says Mads Melbye.

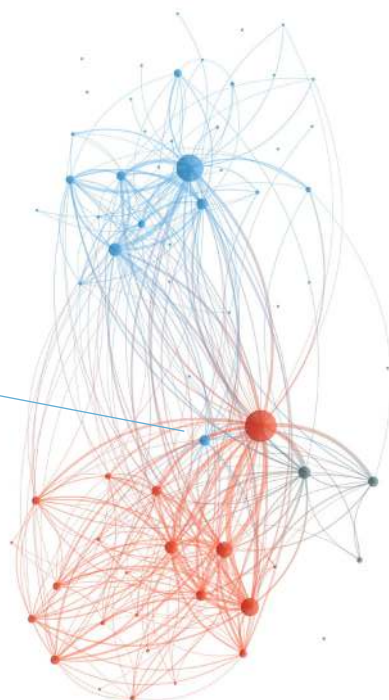
He is unsurprised by the results of the computer-generated network analysis performed by the research centre CWTS at Leiden University. Collaboration between different research institutions is shown in different colours, so actors who produce scientific publications together frequently are automatically assigned the same colour. In the specific network analysis that shows collaboration between research institutions in Medicon Valley – both internally and with other research institu-

FACTS

Denmark's State Serum Institute (SSI) is located as part of Sweden in the network analysis. This is largely because Sweden and Denmark have similar biobanks and registers, giving researchers the opportunity to carry out significantly larger register-based studies through collaboration between the countries.

State Serum Institute (SSI) in the network analysis which shows Swedish and Danish collaborative partners in the life sciences (2006-2016).

To read more of the network analysis prepared by the research institution CWTS at Leiden University to which this article refers, see Medicon Valley Alliance's 2018 annual report: State of Medicon Valley 2018 – An Analysis of Life Science in Greater Copenhagen.



tions throughout Sweden and Denmark – SSI is conspicuous; it is the only actor that the computer program VOSviewer does not place in its own country's network.

– We try to work on a Scandinavian level with our register-based studies. We use large population groups, and in many of our projects we include the Swedish population as well. In such cases, all of Sweden is included. But in many of the projects, there are researchers in Malmö or Lund whom we've met who present the Swedish data set, says Mads Melbye.

In Scandinavia and Sweden in particular, the registers are organised in such a similar manner that extensive collaboration is motivated, he explains.

In addition to register-based studies, SSI also collaborates occasionally with universities in Lund, Malmö and the rest of Sweden on specific research projects.

Within Medicon Valley, for example, there have been collaborations focusing on infectious diseases, oncology and blood disorders.

– At the moment however, there is no specific project tying together the Øresund Region per se. It's more that many of our employees live on the other side of the Øresund Strait, and we recruit a

lot of people from Sweden, says Mads Melbye.

He admits that he is astonished by how little contact there is between the universities in Malmö and Lund and the large research institutions in Copenhagen.

– The contact is more specific to individuals – we don't take part in any special events. I find that there is unbelievably little being done on an organisational level to pull the region together. I don't know of any specially designated facilities or research funds, or common infrastructures. The only thing that comes to mind are the big materials research facilities; besides them I don't know of any other projects, he says.

An opportunity to which Mads Melbye – who is also a professor at Stanford University in the USA – calls attention is a post doc-programme in Silicon Valley where 30 post docs receive assistance commercialising their research results, meeting every fortnight with industry representatives, advisers and other start-up companies.

– Something similar would be conceivable for the Øresund Region. Thirty students could be taken on, regardless of whether they live in Sweden or Denmark. It would also be a way to bring together industry and academia, he says.

"I find that there is unbelievably little being done on an organisational level to pull the region together."

THREE CURRENT RESEARCH ENDEAVOURS IN THE LIFE SCIENCES

- The International Centre for Interdisciplinary Solutions on AMR is the name of the knowledge and research centre on antimicrobial resistance that the State Serum Institute is currently building up with World Bank and the collaborative organisation Consultative Group on International Agricultural Research (CGIAR), which works to secure the future food supply. Last November, Denmark's then-Minister of Health Ellen Trane Nørby signed a memorandum of understanding with the ambition to construct the centre and eventually generate 400-500 jobs in Denmark. Two Danish ministries are involved in the project: the Ministry of Health (formerly the Ministry of Health and the Aged), which is behind the State Serum Institute, and the Ministry of the Environment and Food.
- Genomic Medicine Sweden is a project that aims

to make practical use of genomic innovation in health care and implement a sustainable precision medicine infrastructure in Sweden. Region Skåne is coordinating the work, which involves all of the Swedish regions and brings together clinics, researchers, companies and patient organisations.

- The Capital Region of Denmark, Region Zealand, the University of Copenhagen, and the Technical University of Denmark (DTU) are also working collaboratively on a shared data infrastructure project to be used by clinicians and researchers in their work with precision medicine. In addition, a genome centre is being created to assist clinics and researchers with analyses, as well as a biobank centre that will support researchers whose studies are based on biological samples and genetics.

UNIVERSITIES, REGIONS AND RESEARCH INSTITUTIONS

PHOTO: NEWS ØRESUND



1. REGION ZEALAND*

Life science researchers: 550
of which professors: 30
of which doctoral students: 140
Life science students: -

PHOTO: NEWS ØRESUND



2. ROSKILDE UNIVERSITY

Life science researchers: 55
of which professors: 6
of which doctoral students: 19
Life science students: 459

PHOTO: NEWS ØRESUND



3. TECHNICAL UNIVERSITY OF DENMARK (DTU)

Life science researchers: 1170
of which professors: 82
of which doctoral students: 442
Life science students: 4 024

PHOTO: NEWS ØRESUND



4. UNIVERSITY OF COPENHAGEN

Life science researchers: 6 809
of which professors: 682
of which doctoral students: 2 673
Life science students: 15 283

PHOTO: NEWS ØRESUND



5. THE NATIONAL INSTITUTE OF PUBLIC HEALTH (NIPH), UNIVERSITY OF SOUTHERN DENMARK

Life science researchers: 97
of which professors: 6
of which doctoral students: 15
Life science students: -

PHOTO: NEWS ØRESUND



6. REGION HØVEDSTADEN*

Life science researchers: 3 748
of which professors: 231
of which doctoral students: 813
Life science students: -



Source: The universities and research institutions own numbers.

Life science researchers includes professors, associate professors, lecturers, post docs, doctoral students, etc. See footnotes in the Appendix for more information about the figures.

* Researchers at the hospitals in the region often conduct research part-time. Some of the researchers at the hospitals and at the Danish Cancer Society also have part-time positions at the universities in the region.

**The numbers for Lund University are not complete.

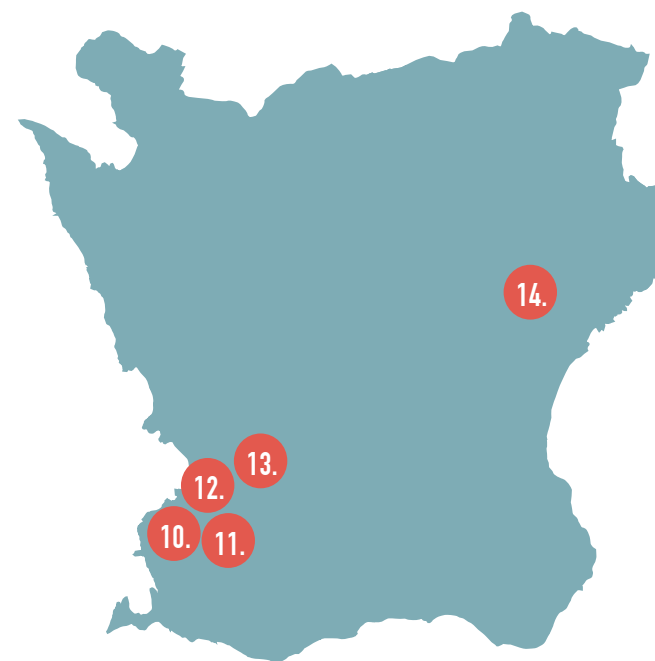


PHOTO: NEWS ØRESUND



7. AALBORG UNIVERSITY IN COPENHAGEN

Life science researchers: 22
of which professors: 3
of which doctoral students: 4
Life science students: n.a.

PHOTO: NEWS ØRESUND



8. STATE SERUM INSTITUTE

Life science researchers: 150
of which professors: n.a.
of which doctoral students: n.a.
Life science students: -



9. DANISH CANCER SOCIETY*

Life science researchers: 162
of which professors: 9
of which doctoral students: 52
Life science students: -

Other learning institutions:

Copenhagen Business School (CBS) does not conduct life science research in the traditional sense, but it is touched upon, for example through research in organisation and public management.

The vocational school the Copenhagen School of Design and Technology conducts a small amount of research on optometry.

PHOTO: NEWS ØRESUND



11. REGION SKÅNE*

Life science researchers: ca 1 800
of which professors: 107
of which doctoral students: 736
Life science students: -

PHOTO: NEWS ØRESUND



12. THE SWEDISH UNIVERSITY OF AGRICULTURAL SCIENCE IN ALNARP

Life science researchers: 189
of which professors: 21
of which doctoral students: 60
Life science students: 564

PHOTO: NEWS ØRESUND



13. LUND UNIVERSITY**

Life science researchers: 3 533
of which professors: 189
of which doctoral students: 1 122
Life science students: ca 2 780

PHOTO: NEWS ØRESUND



14. KRISTIANSTAD UNIVERSITY

Life science researchers: 50
of which professors: 8
of which doctoral students: 10
Life science students: ca 800

PHOTO: KRISTIANSTAD UNIVERSITY

25th best in the world in medicine and the life sciences

...is how the University of Copenhagen placed in the QS World Ranking Life Sciences & Medicine in 2019.

Greatest number of scientific publications: University of Copenhagen

Of Medicon Valley's centres of learning, the University of Copenhagen produced the greatest number of scientific publications in the period 2014-2017, which is the most recent period studied in the official Leiden Ranking (i.e., not the special report prepared for Medicon Valley Alliance). The same goes for the field Biomedical and Health Sciences. Leiden Ranking is based solely on the number of scientific publications and the frequency with which they have been cited as compared to averages in their respective subject areas.

LUND UNIVERSITY ON TOP IN THE TIMES HIGHER EDUCATION RANKING. The University of Copenhagen tends to be the region's highest ranked centre of learning, but Lund University topped the list of Medicon Valley's learning institutions in the Times Higher Education Ranking list.



PHOTO: NEWS ØRESUND

American universities top the list

Seen globally, the ranking lists are dominated by American universities. In Europe, the highest placing universities are primarily British, as well as Swiss.

... but it's difficult to see a trend

Looking back on recent years, there are no clearly discernible trends for the region as a whole – neither positive nor negative. There is no ranking list in which all of the region's centres of learning have placed higher – or lower – over time; their placements vary from list to list.

One university whose ranking has improved significantly however is Aalborg University, which has a small-scale life science research division in Medicon Valley. The University of Copenhagen is also ranked increasingly higher on most of the ranking lists.



Improved placement...

The University of Copenhagen has improved its position in the Shanghai Ranking, moving from number 43 in 2009 to number 26 in 2019.

Three influential ranking lists

UNIVERSITY	TIMES HIGHER EDUCATION RANKING 2020 (2019)	SHANGHAI RANKING 2019 (2018)	QS WORLD RANKING 2020 (2019)
University of Copenhagen	101 (116)	26 (29)	81 (79)
Lund University	96 (98)	101-150 (101-150)	92 (92)
Technical University of Denmark (DTU)	184 (163)	101-150 (151-200)	112 (112)
Aalborg University	201-250 (194)	201-300 (201-300)	324 (343)
University of Southern Denmark	251-300 (251-300)	301-400 (301-400)	372 (376)
Swedish University of Agricultural Sciences	301-350 (251-300)	301-400 (201-300)	-
Roskilde University	601-800 (601-800)	-	-

The placement of the region's universities varies significantly between ranking lists. They are also based on different criteria: Times Higher Education Ranking, Shanghai Ranking and QS World Ranking all take into account scientific publications and citations, but other than that, their parameters are rather diverse. Shanghai Ranking for example takes into consideration the number of Nobel Prize winners and other distinctions, as well as scientific publications in the journals Nature and Science. For QS World University Ranking, the university's academic reputation comprises 40% of the assessment, whilst Times Higher Education considers e.g. instruction, which comprises 30% of the criteria.

TECHNICAL UNIVERSITY OF DENMARK CITED MOST FREQUENTLY. The Technical University of Denmark (DTU) is the seat of learning in Medicon Valley whose articles were most often among the ten per cent most frequently cited in their respective subject areas, according to the Leiden Ranking for 2014-2017. If looking exclusively at research in Biomedical and Health Sciences, the University of Copenhagen was highest on the list, followed by DTU and Lund University.

Roskilde and Malmö Universities – to each its own list

The universities that feature on more or less all of the larger ranking lists are: University of Copenhagen, Lund University, DTU, Aalborg University, the Swedish University of Agricultural Sciences and the University of Southern Denmark – the three lattermost of which have branches in Medicon Valley, whilst their primary operations are outside of the region. In addition, Roskilde University is on the Times Higher Education's list (placement 601-800), and Malmö University ranks 401-450 on QS' special list for the Life Sciences & Medicine.



PHOTO: NEWS ØRESUND

Footnote: Shanghai Ranking is published by the independent organisation ShanghaiRanking Consultancy. Times Higher Education is published by the eponymous journal and reviewed by PricewaterhouseCoopers (PwC). QS World University Rankings is published by the British student guidance company Quacquarelli Symonds (QS).

GOVERNMENT INITIATIVES FAVOUR MORE INTERNATIONAL RESEARCHERS IN MEDICON VALLEY

The Danish government wants to make it easier to recruit qualified personnel from abroad, and more and more researchers on both sides of the Øresund Strait are being employed by the materials research centres ESS and MAX IV. The Swedish government has proposed a bill that will make things easier for international students and researchers and let them stay in Sweden after their time at a university or college. The number of international talents who took advantage of tax relief schemes in Sweden and Denmark also rose in 2018 and 2016; the latter is the most recent year for which relevant Danish statistics are available. The number of international students in the region rose slightly between the scholastic year 2016-17 and 2017-18 due to increases in the Danish part of Medicon Valley.

Already in 2018, changes were made to make the Danish tax relief scheme more attractive, with the maximum period for which it could be used extended from five to seven years. At the same time, the fixed tax rate rose one percentage unit, from 26% to 27%.

An agreement between the new Danish government and the parties that support it made following the 2019 elections stipulates that employers with a concrete shortage of qualified personnel should be able to recruit qualified workers from abroad more easily. Precisely which services this will encompass and the ways in which the process will become easier will be determined by the Minister of Employment, according to an announcement made by the Danish government this June.

In response to a new EU-directive on the topic, the Swedish government is planning to introduce

new rules for residency permits given to international researchers and students as of 1 January 2020. Researchers and students at higher learning institutions will be able to e.g. remain in Sweden for up to one year after completing their studies or research in order to seek employment or start a company of their own. In addition, in some cases, those with residency permits that allow them to study or do research in another EU-country may be able to study or do research in Sweden.

Recruitment of researchers to the neutron research facility ESS, located in Lund and with a data centre in Copenhagen, is also underway, as is the taking on of new employees for the synchrotron radiation facility MAX IV – which is also in Lund and already operational. At ESS, which is co-owned by 13 European nations, there are already

researchers from 50 countries. The facility will be opened to users in 2023.

Together with both governments' initiatives in the area, it is probable that this will affect the number of international researchers who come to Medicon Valley for employment continuing to rise in the coming years.

In 2018, the number of international researchers who were approved for the Swedish tax relief scheme increased slightly, going from 740 in 2017 to 786 in 2018. In 2018, 1 042 applications to participate in the scheme were submitted. These figures are all for Sweden, not Medicon Valley specifically.

In Denmark, the most recent figures available are for 2016 and were published in the beginning of 2018. Statistics show a steady increase in the number of international researchers who participated in the Danish tax relief scheme for researchers and key employees almost every year since 2001. Between 2001-2016, there was an increase from 647 to 2 645 participants, and only in 2011 did the number decrease slightly.

International students

In eastern Denmark, the number of international students in the life sciences who were enrolled in a programme on 1 October increased six per cent from 2016 to 2017, according to data from Statistics Denmark. Statistics show that the number continued to rise in 2018 as well, albeit slightly more slowly. That means that the trend is continuing: the number of international students in the life sciences in eastern Denmark has increased steadily every year since 2007.

In the rest of Denmark however, the number of students in the life sciences decreased four per cent

in 2017 compared to 2016, and the decrease grew in 2018.

Thus, while the number of international students in life science programmes in eastern Denmark increased, the corresponding figure in Skåne decreased by five per cent between the scholastic year 2016-17 and 2017-18, according to statistics from Statistics Sweden. More recent statistics are not yet available for Sweden. The decrease in Skåne goes against the trend elsewhere in Sweden for the period in question.

When looking at the past five years however, the number of international students in the life sciences in Skåne appears to be relatively stable, whilst the number of research students has decreased slightly over the same period in the Swedish part of Medicon Valley.

On the whole, the number of international students enrolled in life science programmes in Medicon Valley increased two per cent in the scholastic year 2017-2018, to 3 497; this is due to the greater number of international students in eastern Denmark, which offsets the decrease in Skåne.

The number of international research students in the region rose four per cent in the same period; this is also due to increases on the Danish side of the Øresund Strait. The number remained essentially unchanged in Skåne.



NUMBER OF INTERNATIONAL STUDENTS IN THE STUDY YEAR 2017/18

	Number of students	of whom in research programmes	Change 2008/09 - 2017/18
Skåne	1 048	309	14%
Stockholm-Uppsala region	3 952	1 592	37%
Västra Götaland	1004	237	28%
Sweden, rest of	2 022	261	35%
Sweden	8 026	2 399	32%
Eastern Denmark	2 449	925	124%
Denmark, rest of	1 525	339	60%
Denmark	3 974	1 264	94%
Medicon Valley	3 497	1 234	93%

Source: Statistics Sweden and Statistics Denmark

FACTS: IMPROVED TAX RELIEF SCHEME IN DENMARK

- Both Denmark and Sweden offer special tax schemes for foreign employees to make it easier for companies and universities to attract talent from other countries.
- The Danish system is distinctly more advantageous. While a key employee in the Danish scheme needs to earn a minimum of 65 100 DKK per month including employee benefits, a foreign expert in Sweden needs a monthly salary of 91 001 SEK to be approved.
- When comparing the minimum level for the salary

in Denmark and Sweden, it is important to note that the salary on a Swedish payslip is generally lower than its Danish counterpart due to differences in the way the social security systems are financed. In Sweden, employers have to pay employer contributions for the employee in addition to their salary, whilst in Denmark, the social security system is financed via income taxes.

- In Sweden, tax relief can be received for a period of maximum three years; in Denmark, the tax relief period was extended from five to seven years in 2018.

ANALYSIS: Acquisitions and product launches



PHOTO: BAVARIAN NORDIC

The businesses of Medicon Valley are transforming. Among other things, there are fresh strategies, new products and company acquisitions. On the macro level, development is stable: exports and employment numbers are up, and the number of patent applications has increased.

- Things are going well for the life science industry in Denmark, Sweden and Medicon Valley. Danish pharmaceutical exports rose 7.7% in 2018, and Swedish exports rose 10.6%. In 2017 there were 44 000 people employed in the life sciences in Medicon Valley – a 3.4% increase in one year. But the sector's importance for the region reaches far wider. On top of Novo Nordisk's 16 300 employees in Denmark at the end of 2018, 7 900 people were brought in as consultants from external companies; employment via subcontractors should be added to this.
- One indication of the strong revivification of Medicon Valley's companies are six large company acquisitions made in 2019, which were worth over 28 billion DKK. The acquiring companies were Lundbeck, LEO Pharma, Bavarian Nordic, Zealand Pharma and Fujifilm. Furthermore, one of the region's major hearing aid manufacturers, Widex, merged with Sivantos; today, the new company is called WS Audiology. For Medicon Valley's larger life science companies, the transition also means renewed strategies.
- This September, Novo Nordisk received approval from the American FDA for Rybelsus (semaglutide), its new type-2 diabetes drug in oral tablet form. Some analysts believe that it will prove a new blockbuster drug. It won't necessarily generate as many new Danish jobs in Medicon Valley as previous Novo Nordisk best-sellers however, as the company made large investments in a manufacturing plant for the tablets in the US.
- For several years now, the innovation- and support system for the life science sector has been in a development phase that includes national life science offices and strategies, new materials research facilities, and flourishing science parks. Research is also an area of strength. According to an analysis performed by the Dutch research centre CWTS at Leiden University, the region's researchers are cited with above average frequency in 15 of Medicon Valley's 20 principal subject areas.

MEDICON VALLEY'S TRANSITION: THE NEXT STEP

The reorganisation and renewal of companies in Medicon Valley's is continuing at a high pace: there have been new strategies, technologies and pharmaceuticals, as well several large company acquisitions. According to the latest statistics available, employee numbers are on the rise in Medicon Valley's life science sector – and in Denmark and Sweden in general. There are more patent applications, exports are increasing, and the sector's contribution to the state coffers is growing in both countries. Conditions are improving for the life science cluster to be able to have a stabilising effect – even in the next recession – as support grows with new national life science offices, new materials research facilities and thriving science parks.

Restructuring and growth set the tone for Danish and Swedish life science, particularly in the trans-border Medicon Valley region. In recent years, the supporting structure for the life sciences, which is both innovative and promotes exportation, has undergone important developments. On the whole, the conditions have improved for the life sciences to become a sector with a stabilising effect

in the next recession, at least on the Danish side of Medicon Valley. In Skåne, there are no life science companies giving local employment to more than 1 000 employees.

On the Danish side of Medicon Valley, the four largest life science companies and the region's major medtech company employ a total of 22 200 people locally. But life science is also growing in Skåne – there

are new biotech companies, thriving science parks, and two materials research facilities.

In 2018, the turnover of the region's four major life science companies (Novo Nordisk, Lundbeck, Ferring Pharmaceuticals and LEO Pharma) and Medicon Valley's largest medtech company (Coloplast) grew one per cent to 171 billion DKK. The differences between the companies are many, however. Coloplast and Lundbeck are bringing both profit and turnover to new heights, whilst the other three companies are in a transitional phase that has temporarily slowed growth.

Changing external factors have made the transition a necessity; pricing pressure has increased on the crucial American market, affecting Novo Nordisk in particular. The companies also need to adapt to new technologies with biopharmaceuticals, personalized treatments and the sector's drift toward food and ICT. It's not a given, however, that the new initiatives will generate as many new Danish jobs as before. Novo Nordisk for example already decided in 2015 to invest 13.6 billion DKK in new facilities to produce a future treatment for type-2 diabetes in tablet form. Of the 800 new positions this would generate, 700 were expected to be in the US. The American pharmaceuticals market remains the most important market for Danish companies.

New strategies

LEO Pharma for example is in a major transformational phase and on the way to becoming a global enterprise with new biopharmaceuticals in dermatology and skin disorder analysis aided by AI technology that uses smartphone cameras. Major acquisitions, sales and partnerships have helped transform the company – including the acquisition of Japanese Astellas' dermatology business for €675 million in late 2015.

In an interview in 2018, Ferring's owner and chairperson Frederik Paulsen described his aim to completely transform the company, whose headquarters are in Switzerland, but whose roots are around the Øresund. The acquisition of Reebotix strengthened the company's microbiota platform, and Ferring Holding has acquired a platform for the treatment of bladder cancer.

Novo Nordisk has been going through a rough patch with pricing pressure on the important American market, but has also been renewing its diabetes treatment products. This September, Novo Nordisk received FDA-approval for Rybelsus, its new semaglutide-based drug in tablet form for type-2 diabetes. The drug Ozempic was approved in 2017 and is a treatment in semaglutide injection form that only needs to be taken once a week. Semaglutide also has a weight-reducing effect, and many analysts believe that

it will be a blockbuster drug. Novo Nordisk is currently expanding the world's largest insulin manufacturing plant in Kalundborg for 650 million DKK and has also made major investments in the US.

Acquisitions worth billions

Another indication that the life science cluster in Medicon Valley is in a transitional phase are the large acquisitions made in 2019.

- October 2019: **Bavarian Nordic** acquires two vaccines from GlaxoSmithKline – against rabies and tick-borne encephalitis – for up to 6 billion DKK. **Zealand Pharma** acquires Encycle Therapeutics in Canada for 540 million DKK.
- September 2019: **Lundbeck's** new CEO Deborah Dunsire acquires the American biotech company Alder Biopharmaceuticals for USD 1.95 billion.
- August 2019: **Fujifilm** completes the acquisition of Biogens large-scale biologics manufacturing site located in Hillerød near Copenhagen (with almost 800 employees) for USD 890 million.
- July 2019: **LEO Pharma** completes the acquisition of German Bayer's prescription dermatology drug. The companies have not disclosed the acquisition amount.
- May 2019: **Lundbeck** acquires American Abide Therapeutics for up to 2.65 billion DKK.
- March 2019: The Danish hearing aid manufacturer **Widex** merges with Sivantos. Operating under the new name WS Audiology, the company opens its headquarters in Lyngby, Denmark, and in Singapore.

National focus on the life sciences

In recent years, the life sciences have increasingly become a focal point for the Danish as well as the Swedish government. Both countries have establis-

RECORD-BREAKING DANISH EXPORTS

2018 was a record year for the Danish life science industry's exports. In 2018, the export of medical products and devices was responsible for 15.4% of Denmark's total exports; that share has doubled since 2008. Exports were valued at nearly 106 billion DKK – more than double what they were ten years ago. Life science exports were also record-high in Sweden in 2018, having risen 10.6% compared to 2017.

hed national offices for the life sciences. In February 2019, Denmark launched an internationalisation strategy with seven key areas that will help realise the government's vision of making Denmark one of Europe's leading life science nations. Sweden's national coordinator for the life sciences, Jenni Nordborg, has been tasked with creating a national life science strategy aimed at making Sweden a leading nation in the field. Eight prioritised areas have already been selected.

Major investments are being made in the two materials research facilities on the Swedish side of Medicon Valley, in Lund. MAX IV and the upcoming European Spallation Source, ESS, are both expected to have an important impact on life science research. Both are being co-funded by Denmark. ESS, for which Sweden and Denmark are host nations, will be operational in Lund in 2023, but ESS' Data Management and Software Centre (DMSC) at COBIS in Copenhagen was already inaugurated on 29 October 2019.

Collaborating biobanks

Another concrete national collaboration effort is the data exchange between the national biobanks, which are a unique research resource. Swedish and Danish biobanks are comprehensive and similarly structured. Read more on page 42.

A Danish strength in the life sciences is the fact that the country's major pharma companies are steered by industrial foundations, which prevents the companies from being acquired whilst also ensuring the donation of profits to research. The largest of them is the Novo Nordisk Foundation, which also makes its mark on the Swedish side of Medicon Valley. The Novo Nordisk Foundation's latest major endeavour is the BioInnovation Institute, BII, at COBIS in Copenhagen. The ambition with BII is to create an outstanding innovation environment that leads to more research results from the life sciences being developed into new companies. On the Swedish side of the Øresund, the foundation-owned Medicon Village Science Park in Lund did some adding on, whilst Medicon Science Park in Malmö is currently expanding its premises.

National life science offices, collaborating Danish-Swedish biobanks and universities, new materials research facilities and expanding science parks all mean that the support and innovations systems in the life sciences have gained greater power, both nationally and in Medicon Valley.

Research in Medicon Valley is also competitive in a global context. It can be seen clearly that Medicon Valley researchers are cited with significant above-average frequency internationally in 15 of the region's



MEDICON VALLEY is the bi-national life science cluster spanning the island of Zealand in Eastern Denmark and the Skåne region of Southern Sweden. Today, the Danish-Swedish region is marketed internationally with the name 'Greater Copenhagen', and its increasing population has reached four million residents. In Sweden, the same geographical area is often called the 'Øresund Region'.

20 most important subject areas. The conclusion is part of a bibliometric analysis conducted by the Dutch research centre CWTS at Leiden University on behalf of Medicon Valley Alliance. The four areas of research that generated the greatest number of scientific publications in the life sciences in Medicon Valley from 2006-2016 are biochemistry and molecular biology, endocrinology and metabolism, and oncology.

In a comparison of publication volume and citation frequency in the region's seven largest subject areas, Medicon Valley places in the middle or slightly below compared with nine other European life science clusters. Read more about the cluster ranking of research on page 22.

On the macro level, the latest statistics show there have been continued notable successes in Denmark and Sweden and within Medicon Valley. Pharmaceutical exports are increasing dramatically in both countries and the number of patent applications in the life sciences is growing, as is the number of employees. In 2017 there were 44 000 people employed in the life sciences in Medicon Valley. But the importance for the region's labour market is greater still. At the end of 2018, just Novo Nordisk had 16 300 employees in Denmark (converted to full-time). If personnel hired via consultant companies are included, 24 800 people were employed by Novo Nordisk. Today, Novo Nordisk is the Danish company with the highest profits, and its turnover has increased from 29 billion DKK in 2004 to 112 billion DKK in 2018.

APPENDIX: Facts and definitions

LARGER MEETINGS AND CONFERENCES

Below are some of the larger meetings and conferences being arranged in the Greater Copenhagen Region in the coming year, as well as a selection of international meeting places in which representatives from organizations and companies from the region's life science cluster will be participating.

- 7 November 2019, Stockholm
Bioscience 2019
- 11 November 2019, Rome
European Statistical Forum
- 11-13 November 2019, Hamburg
BIO-Europe
- 13-14 November 2019, London
European Microbiome Congress
- 18-19 November 2019, Berlin
Synbio Markets
- 18-21 November 2019, Düsseldorf
Medica
- 19 November 2019, Copenhagen
Healthtech Nordic Investor Forum 2019
- 20 November 2019, Boston
Drug Development Boot Camp 2019
- 27 November 2019, Copenhagen
NOME Annual Meeting
- 4-5 December 2019, New York
The Nordic-American Life Science Conference
- 10-11 December 2019, Marseille
BioFIT 2019
- 11 December 2019, London
Genesis 2019
- 27-30 January 2020, Dubai
Arab Health
- 31 January 2020, Copenhagen
Medicon Valley Alliance New Year's Reception
- 7 February 2020, Zurich
Swiss Nordic Bio 2020
- 13 February 2020, Rotterdam
Innovation for Health
- 20-24 March 2020, Amsterdam
EAU20
- 23-25 March 2020, Paris
BIO-Europe Spring
- 8 April 2020, Lund
The Future of Swedish and Danish Life Science
- 8-12 April 2020, Tokyo
A Gateway to Japanese Healthcare Market
- 28-30 April 2020, Copenhagen
Int. Forum on Quality & Safety in Healthcare
- 24 June 2020, London
Anglonordic Life Science Conference
- 5-9 September 2020, Copenhagen
EuroTox 2020
- 8-10 September 2020, Malmö
Nordic Life Science Days 2020
- November 2020, Copenhagen
Medicon Valley Alliance Annual Meeting

NORDIC LIFE SCIENCE DAYS RETURNS TO MALMÖ

The annual Nordic Life Science Days was held in Malmö from 10-12 of September this year. It was the third time the conference was held in Sweden's third largest city, and this year there was a record number of companies and organisations participating from 40 different countries. Around 60% of the 1 300 delegates were from the Nordic countries, but there was a significant increase in Chinese, German, and American

participants, according to managing director Olivier Duchamp, who spoke to News Øresund. Moreover, there was an increased investor presence this year. Sweden-BIO was the event's main organiser, and holding the event in Malmö was a chance to showcase their logistic-and professional expertise. Nordic Life Science Days will return to MalmöMässan next year from September 8-10 .

REPORTS AND FACTS

The following is a selection of recent reports from the life sciences in Sweden, Denmark and Greater Copenhagen.

Before the change of government in Denmark this June, the parting administration released two reports. The first is called **Internationaliseringsstrategi for sundhed og life science** (Internationalisation strategy for health and the life sciences; in Danish), published by the Ministry of Health in February. Via seven central areas of focus, the report describes how Denmark can become one of Europe's leading life science nations by increasing exports and attracting greater knowledge and more investments in the health- and life science sectors.

A second report entitled **Danske styrker inden for forskning, teknologi og uddannelse** (Danish strength in research, technology and education; in Danish), prepared by IRIS Group for the Danish Business Authority in June of 2019, describes a series of research and technology strengths in Denmark and highlights healthtech, food science, biotech and pharmaceuticals as areas of strength. According to the report, life science research is strong both in terms of scientific production, research quality and industry collaboration.

Earlier this year, Region Skåne released a report called **Skånska Styrkeområden – ett underlag till regionalt tillväxt- och innovationsarbete i Skåne** (Scanian areas of strength – a basis for regional growth and innovation in Skåne; in Swedish). The report puts the spotlight on the life science industry as one of seven areas of strength and a highly productive sector, and medical and physiological research as the region's most outstanding research.

Rambøll also did an investigation of the life science industry, publishing the report **Innovationsframtid Skåne – analys av branschområden** (Innovation future Skåne – sector area analysis; in Swedish) in April of 2019. The report highlights three sectors in which “smart specialisation” is underway: precision medicine; construction, supply and renovation; and material innovation and production. In addition, the report points out that there are 50 medicine- and pharmaceuticals businesses in the region, and a total of 301 companies in personalized medicine.

Invest in Skåne brought out a report in a joint effort with Invest in Stockholm, Business Region Göteborg and SwedenBio called **Bridging the Gap – a survey-based report on financing activities in the Life Science sector** in May, 2019. The report underscores that the most common source of funding for life science companies is private equity financing. Public fund programmes and public equity offers are the second most frequently used funding sources.

Funding details were also an issue touched on in **Lägesrapport 2019: investeringar och kvalitet, fokus life science** (Progress report: investments and quality, focus life science; in Swedish), released by Forska!Sverige. Among other things, the results indicate that around 25% of the total state-sponsored funding goes to medical research and development in Sweden.

Forska!Sverige was also responsible for an opinion survey about medical research in August, 2019. 80% of Swedes believe that investments in medical research can and should be increased. 87% believe that Sweden should be a leading nation when it comes to medical research, since according to the population Sweden is involved in the development of new medical products and health care treatments.

The report **Omvärldsanalys – styrkeområden gynnsamma för utvecklingen av life science i Sverige** (Competitive Intelligence – Favorable Areas of Strength for Life Science Development in Sweden; English presentation available) from February 2019 was prepared for Sweden's Innovation Agency Vinnova. Regarding research, the report highlights Region Skåne's research environments as a position of strength, as well as its research infrastructure and innovation that supports innovation structures. The region is also foregrounded as specialised in personalised medicine. However, according to respondents to the report's survey, procuring funds for mid-sized (30-100 million SEK) life science innovation projects is difficult.

In the Danish Association of the Pharmaceutical Industry's annual report **Lægemedelindustriens nøgletal** (The pharmaceutical industry: key figures; in Danish) from February 2019 mentions e.g. that the life science industry comprises just one-third of all private research and development work in Denmark.

In September, the Confederation of Danish Industry (DI) released the analysis **Sundhedsindustrien er afgørende for Danmark** (The healthcare industry is vital for Denmark; in Danish), which notes that every second company and over 80% of employment in the healthcare industry is in the capital region. It also highlights that the pharmaceutical industry was responsible for 28% of the Danish economy's value growth between 2007-2017, taking into consideration that the sector comprises just one per cent of Denmark's total employment.

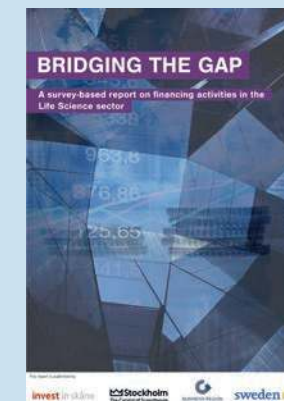
Health data is another central area of the life science industry to come under the lens in the report **Værdien af bedre adgang til sundhedsdata** (The value of improved access to health data; in Danish), prepared by Deloitte this June. According to the pharmaceuticals industry, increased use of and access to data would facilitate fulfilling the need for new pharmaceuticals, recruiting patients for clinical trials, and evaluating effects – and side effects – for the authorities, so new pharmaceuticals could be used to help patients more quickly.

In an international context, Deloitte released the report **Global Life Science Outlook**, which describes big data as the new rapid growth currency of the medical sector in the effort to deliver more personalised products. The report mentions that the increased use of data and digital solutions can ensure improved patient involvement, provide better insight for the evaluation of clinical trials, and make the product development process faster.

The annual report **Pulse of the Industry** from Ernst & Young came out in September of 2019. It highlights that data-driven business models and -solutions are crucial for continued growth in the sector – which saw rising profits around the globe for the third consecutive year. Digital solutions and artificial intelligence are also in the spotlight as particular areas for increased innovation in the medtech industry; the American federal agency for food and drugs (FDA) has already approved at least 33 algorithms.

The European Federation of Pharmaceutical Industries and Associations published the annual report **The Pharmaceutical Industry in Figures in June**. It notes e.g. that research and development for the pharmaceutical market is experiencing strong growth in Brazil (11.4%), China (7.3%) and India (11.2%), whilst the five largest European markets have grown an average of five per cent.

Finally, in September the report **Achieving a Healthier and More Sustainable Future for All** was released by the International Federation of Pharmaceutical Manufacturers and Associations (IFPMA). In it, the organisation highlights three general strategies that are necessary to ensure universal health care. Among other things they include disease surveillance and appropriate response systems, investments that are both sufficient and innovative, and improved access to medicine and vaccines at lower costs.



This report, “**State of Medicon Valley 2019**”, is an annual report, published for the first time in November 2019. The report has been prepared by the Danish-Swedish knowledge centre Øresundsinstituttet and commissioned by the network organisation Medicon Valley Alliance.

ORGANISATIONS

TRADE AND NETWORKING ORGANISATIONS:

- **ASCRO** – Swedish association focused on clinical research and clinical trials
- **BioPeople** – a publicly-funded catalyst for collaboration between companies and public research
- **Cluster Excellence Denmark** – a support function for clusters and innovative networks in Denmark co-funded by the Danish Agency for Institutions and Educational Grants and the regions
- **CHC**, Copenhagen Healthtech Cluster – Danish organisation that aims to create growth opportunities within healthcare
- **CHI**, Copenhagen Health Innovation – Danish organisation focused on developing new educational and development activities within healthcare
- **Dansk Biotek** – Danish trade organisation for companies in biotechnology
- **EuropaBio**, the European Association for Bioindustries – European trade organisation for the biotechnology industry
- **EFPIA**, European Federation of Pharmaceuticals Industries and Associations – European trade association for the pharmaceutical industry in Europe
- **FOIN**, the Association of Innovative Settings in Denmark – Danish trade association for science parks and innovative settings, formerly Forskerparkforeningen/The Science Park Organisation
- **Healthcare Denmark** – Danish organisation with political mandate to market the Danish health care sector
- **IFPMA**, International Federation of Pharmaceutical Manufacturers & Associations – international trade association for pharmaceutical companies and associations
- **Kemi & Life Science** – Danish trade community and network for distributors and manufacturers of chemicals
- **Lif Danmark** – Trade association for the pharmaceutical industry
- **Lif Sverige** (researching pharmaceutical companies) – Trade association for manufacturers of pharmaceuticals
- **Life Science Law DK** – an independent society that aims to improve legal conditions for the Danish life science industry
- **Medicoindustrien** – Danish trade association for companies that produce, sell, or have an interest in medical equipment
- **MVA**, Medicon Valley Alliance – Networking and member organisation in the Danish-Swedish life science cluster Medicon Valley in Greater Copenhagen
- **Pharma Danmark** – trade union for academics employed in the Danish life science industry
- **Swecare** – Swedish member organisation that works for broad collaboration with the health and healthcare sectors
- **SwedenBIO** – Swedish trade association for the life science sector

- **Swedish Labtech** – Swedish trade association for companies working in diagnostics, laboratory equipment, analysis and biotechnology
- **Swedish Medtech** – Swedish trade association for medical technology
- **SISP**, Swedish Incubators & Science Parks – Swedish trade association for incubators and science parks
- **Synapse Life Science Connect** – a student-driven, non-profit organisation that strives to link the academic bioscience community and the life science industries
- In addition, there are the broader trade organisations **Dansk Industri** (Confederation of Danish Industry) and **Dansk Erhverv** (Danish Chamber of Commerce) and **Handelskammaren** (Sweden's Chamber of Commerce) and **Svenskt Näringsliv** (Confederation of Swedish Enterprise).

PUBLIC ACTORS:

- **Copenhagen Capacity** – A public initiative to promote investments and economic development in Greater Copenhagen
- **Erhvervsfremmebestyrelse** (The Danish Executive Board for Business Development and Growth) – a part of the Danish Business Authority that promotes and funds decentralized business approaches
- **Erhvervsstyrelsen** – Danish business authority that works to improve companies' competitive strength
- **Innovationsfonden** – Fund from the Danish Ministry of Higher Education and Science that invests in new knowledge initiatives
- **Invest in Skåne** – A public initiative to attract foreign investments to the region, promote exports and internationalisation for companies in the Skåne region
- **Läkemedelsverket/Medical Products Agency** – Swedish authority that tests and approves pharmaceuticals
- **Lægemiddelstyrelsen /Danish Medicines Agency** – Danish authority that tests and approves pharmaceuticals
- **Patent- och registreringsverket/Swedish Patent and Registration Office** – Swedish authority for intellectual property rights
- **Danish Patent and Trademark Office/Patent- og Varemærkestyrelsen** – Danish authority for intellectual property rights
- **Styrelsen for Forskning og Innovation** – Danish authority that works to strengthen research and innovation
- **The Government Offices of Sweden's coordinating Office for Life Science** – was established in 2018 and is working among other things with a new life science strategy.
- **The Life Science Office at Denmark's Ministry of Industry, Business and Financial Affairs** – the government office responsible for the implementation of the Danish national strategy for life science.
- **Tillväxtverket** – Swedish authority to promote companies' competitive strength

- **Tillväxtanalys** – Swedish authority with tasks such as analysing and evaluating Swedish growth policies
- **Vetenskapsrådet** – Swedish authority that works to promote Swedish research
- **Vinnova** – Swedish authority that works to improve opportunities for innovation and research
- **Wonderful Copenhagen** – Danish organization working to attract e.g. life science conferences to the Medicon Valley region

MEDIA:

- **Dagens medicin** – Swedish journal about the healthcare sector
- **Dagens medicin, Dagens Pharma, Kommunal Sundhed and Praktisk medicin** – Danish journals about the healthcare sector
- **European Biotechnology News** – European journal about life science
- **Greater Copenhagen Life Science Magazine** – Scandinavian life science magazine published by the Danish marketing and advertising agency Nem Media
- **Kemivärlden Biotech** – Scandinavian journal for chemistry, chemical engineering and biotechnology
- **Labitech.eu** – European news site on the biotechnology industry
- **Life Science Sweden** – Journal on the Swedish biotechnology, medical technology and pharmaceutical industries
- **Medwatch** – Danish news site on the medical and pharmaceutical industries
- **Nordic Life Science News** – journal and news site on the Nordic life science industry
- **Pharma Industry** – Swedish trade journal for the pharmaceutical industry

SCIENCE PARKS IN MEDICON VILLAGE THAT COMPLETELY OR SIGNIFICANTLY FOCUS ON THE LIFE SCIENCES:

- **DTU Science Park** – focus on deep tech. Located in Hørsholm and Lyngby. Formerly known as Scion DTU.
- **Cobis** – focus on life science. Located in Copenhagen. Owned by DTU Science Park and Symbion.
- **Symbion** – focus on life science, foodtech, edtech, hardware/makerspace and SaaS. Located in Copenhagen.
- **Ideon** – focus on future transportations, smart cities, smart materials and health tech. Located in Lund.
- **Krinova** – focus on food, the environment and health. Located in Kristianstad.
- **Medeon** – focus on life science. Located in Malmö.
- **Medicon Village** – focus on life science. Located in Lund.

LEARNING AND RESEARCH INSTITUTIONS IN MEDICON VALLEY WITH ACTIVITY IN THE LIFE SCIENCES:

- **University of Copenhagen** – A large university with departments for health and medical sciences, science, humanities, law, social sciences and theology.
- **Technical University of Denmark (DTU)** – A technical university in Kongens Lyngby, just north of Copenhagen.
- **Roskilde University** – A university in the middle of Zealand with emphasis on transdisciplinarity.
- **Aalborg University in Copenhagen** – A campus of Aalborg University in Jutland with a broad range of departments.
- **The National Institute of Public Health (NIPH), University of Southern Denmark** – A research institution that is part of the University of Southern Denmark, but also serves the Danish authorities, supporting them with research and counsel on public health.
- **CBS** – A university in Copenhagen with focus on economics, as well as educational training in Business Administration and Bioentrepreneurship.
- **Copenhagen School of Design and Technology** – An institute of higher education in Copenhagen with some research in optometry.
- **Capital Region of Denmark** – The region encompasses a large number of hospitals, predominantly in Copenhagen and northern Zealand. The largest of them is Rigshospitalet.
- **Region Zealand** – The region encompasses a number of hospitals, primarily in Zealand and Lolland. The most important of them is Zealand University Hospital in Roskilde and Køge.
- **The State Serum Institute, Copenhagen** – A research institution of the Danish Ministry of Health. Its focus is on diagnostics, epidemiological monitoring and vaccination research.
- **The Danish Cancer Society, Copenhagen** – A patient organisation to fight cancer. With a research centre in Copenhagen.
- **Lund University** – A large university with departments for medicine, science, technology, the humanities, law, economics, theology, art, music and theatre.
- **Malmö University** – A new university with a transdisciplinary focus.
- **The Swedish University of Agricultural Sciences in Alnarp** – One of the largest campuses of the Swedish University of Agricultural Sciences, which has campuses throughout Sweden. Its main areas are landscape architecture, horticulture and plant production.
- **Kristianstad University** – A college in north-eastern Skåne with a strong focus on education.
- **Region Skåne** – The region encompasses a number of hospitals in Skåne, the largest of which is Skåne University Hospital in Lund and Malmö.

Statistics and method

Describing the life science sector with statistics is a challenge. The sector is far from homogenous, and it shifts over time. There are only five sub-areas designated in the national statistics as exclusively life science sectors; the remainder are spread out over a long string of sector codes. The same is true for universities where life science is not a clearly defined research area. Therefore, the exclusive use of statistics from the national statistics offices cannot provide a sufficiently complete and comprehensive representation. We have thus also chosen to complement the statistics with facts from the Nordic Business Key, as well as information provided by the companies and universities themselves.

The macro-level numbers in this report and certain special figures, such as for example domestic and international students, have been specially requested from Statistics Denmark and Statistics Sweden. We have used the following statistic divisions to define the life science sector and export of life science products:

SN1 and DB07-sector codes are exclusive to life science sectors, used for figures regarding employment:

21 Manufacture of basic pharmaceutical products and pharmaceutical preparations
26.60.10 Manufacture of hearing aids and supplies
26.60.90 Manufacture of irradiation, electromedical and electrotherapeutic equipment
32.5 Manufacture of medical and dental instruments and supplies
46.46.10 Wholesale trade of medical goods and nursing supplies.

The following codes are used for the description of scientific research and employment:

72.11 Research and experimental development in biotechnology
72.19 Other research and experimental development in natural sciences and engineering.
These two industries encompass companies whose primary purpose is research in natural sciences and not life science production companies.

Some of these are life science companies; however, since the sectors also contain research within other areas than life science, the sectors are not included in the figures for employment in the life sciences, but are instead presented separately.

The commodity groupings (SITC) in trade statistics utilised to describe exports:

54 – Medical and pharmaceutical products
872 - Medical Instruments and appliances and similar

ABOUT THE FIGURES

TAXATION, PAGES 8-17

Defining the Danish life science sector to calculate taxes

In the statistics for the number of employees in the life science sector, the sector is defined according to the

sector of the workplaces. This definition cannot be used in the calculation of the sector's tax contributions, since corporation tax is paid on the company/concern level, and the main sector of a workplace does not necessarily correspond to the company's main sector. The following method has thus been used:

1. For each year, the number of full-time employees who work at a workplace whose main sector is life science is tallied.
 2. Information is retrieved for the companies/concerns to which these workplaces belong. The number of employees who work in life science branches at these workplaces is tallied, as well as the number of employees on the company/concern level.
 3. For a given year, a company/concern in the life science sector is included if:
 - a. The company/concern has employed more than 50% of its employees at workplaces in the life science sector during the year in question; or
 - b. The company/concern meets criterion a) throughout the entire period 2008-2017 for the majority of its active period.
- It has been necessary to include criterion b) in order to encompass companies/concerns that pay taxes via a holding company certain years, and in others via the producing company.

The source for the Swedish figures of income and corporation tax is the FRIDA database. FRIDA is a combined individual database and firm register for all Swedish companies. The life science sector has been defined according to the sector of the company's headquarters.

Corporation tax

Corporation tax for Danish life science companies is defined as the corporation tax paid by companies/concerns that fulfil the above criteria. For Sweden corporation tax is the company's final tax, which consists of state tax (bodelagsskatt) on the year's result (22% of reported surplus) plus other taxes that may be applicable, e.g. yield tax.

Income tax

Income tax for people employed in the life science sector is defined for people employed in the companies/con-

cerns that fulfil the criteria described in 'Defining the Life Science Sector'. Income tax is determined geographically according to where the income is earned, and not where the employee resides. Thus, border commuters from Sweden are included in the analysis of Danish income tax. Residents of Denmark who work abroad are in turn not included in the analysis of Danish income tax.

Income tax is calculated from the total personal income; i.e. it includes income from salary and self-employment, as well as any transfers of income that are subject to taxation.

In Denmark, income tax is equivalent to the total personal final tax on income, including labour market contributions. The total personal final tax includes state tax, health care tax, municipal tax, preliminary corporation tax, tax on stock dividends and stock profit, and labour market contributions. Final tax is determined after the deductions have been made and various tax additions have been included.

The amount of labour market contributions paid for employees in the life science sector is calculated by inferring that the labour market contributions comprise the same share of the total income tax, including labour market contributions, for the life science sector in its entirety as for the economy as a whole. The income tax, excluding labour market contributions, for employees in the life science sector is divided by the share of the total income tax including labour market contributions, comprised by the labour market contributions for the economy as a whole, to calculate the income tax including labour market contributions for employees in the life science sector.

In Sweden, income tax is equal to the total income tax on gainful employment. The source for this data is the Swedish income register for the period 2008-2017. Income from gainful employment includes income from a position of staff employment including benefits, surplus from business operations, sickness benefits, unemployment benefits and pension income after general deductions. These may be social security duties to another country, alimony or social contributions.

Income and corporation tax comprise only part of the amount contributed to the treasury through taxes and duties; of which value-added tax is the absolute largest in both countries. In Sweden, duties and other taxes include e.g. a municipal property tax, burial tax, duties to religious communities, vehicle tax and a series of excise duties on

e.g. alcohol and tobacco. In Denmark there are a large number of taxes and duties in addition to corporation tax and income tax, for example municipal property tax, which is calculated based on value, registration duties on cars and a number of excise duties on other products such as tobacco, wine, spirits, chocolate and sugar.

EXPORT, PAGES 8-17

The figures for the global pharmaceuticals market are the amounts invoiced to pharmacies and hospitals by distributors. Those amounts are not equivalent to the amounts that manufacturers of pharmaceuticals receive for their products; discounts and other price agreements are not included.

The source for the information on the global market is IQVIA. The source for the global market export is the UN Comtrade database and figures for the Danish and Swedish life science export are retrieved from Statistics Denmark and Statistics Sweden, respectively.

The Danish and Swedish life science sectors' exports are calculated as the export of Medicinal and pharmaceutical products (SITC 54), as well as Instruments and appliances, n.e.s., for medical, surgical, dental or veterinary purposes (SITC 87.2). The SITC classification is the UN's classification system for goods (Standard International Trade Classification). The sources are the foreign trade statistics from Statistics Denmark and Statistics Sweden, respectively.

EMPLOYMENT, PAGES 8-17

The employment figures cover the manufacturing sectors: 21 Pharmaceuticals, 26.60.10 Manufacture of hearing aids and supplies, 26.60.90 Manufacture of irradiation, electromedical and electrotherapeutic equipment, 32.50.00 Manufacture of medical and dental instruments and supplies and 46.46.10 Wholesale of pharmaceutical and nursing goods. The sources are the register-based Labour Force Statistics in Denmark (RAS) and in Sweden (RAMS). Statistics Denmark and Statistics Sweden utilise national industry classification (DB07) and (SNI2007), both of which are based on and correspond to the European industry classification NACE. A company can perform business that is within more than one sector classification. In such cases, the company has a main sector and one or more additional sectors. In the register-based Labour Force Statistics, all of a company's employees are registered under the company's primary sector.

Note that it is also possible that branch codes are assigned to companies differently in Denmark and Sweden.

Other industry subdivisions of the life science sector cannot be extracted, as they are placed within service sectors such as business services, which covers a significantly broader area than life science. The advantage of using the narrow definition of the sector is that it becomes possible to trace the industry's development over time, as well as to draw European and international comparisons. The disadvantage is that the life science industry is not shown in its entirety. Therefore, the figures are supplied

SECTOR CLASSIFICATION

The definition of life science often includes:

- BIOTECHNOLOGY COMPANIES
- PHARMACEUTICAL COMPANIES
- MEDICAL TECHNOLOGY COMPANIES

mented by figures for employees at life science companies not covered by the national statistical figures from Statistics Denmark and Statistics Sweden; an example of a company that we have supplemented with employee figures is Novozymes. The supplementary information has been collected from the relevant companies either via email, telephone or via the company website; from Nordic Business Key; www.allabolag.se; or from news articles.

PATENTS, PAGES 8–17

For patent applications figures from the European Patent Office (EPO) are used. Normally, a patent application to EPO is preceded by an application to the national patent office. The filing date for the application to the national patent office is the priority date for the subsequent application to EPO. The publishing date for a patent application to EPO is usually 18 months after the priority date. Patent information from United States Patent and Trademark Office (USPTO) is rather old at the time of publishing, and for that reason it has been chosen primarily to present data for EPO, even though the interest in patent applications at USPTO has grown as a consequence of the growth of the American medical market.

UNIVERSITIES, RESEARCH INSTITUTIONS AND REGIONS, PAGES 44–45

Figures for the number of researchers and students have been provided by the universities, regions and research institutions themselves. All figures are from 2018 unless otherwise noted.

University of Copenhagen. Life science researchers: head count. Number of doctoral students at departments and centres with life science activities.

Lund University. The numbers apply to the total number of researchers at the Faculty of Medicine and the number of researchers at the following departments at the Faculty of Engineering: The Department of Biomedical Engineering, and Chemical Engineering. There are also researchers in the life sciences at the Department of Computer Science and the Department of Technology and Society at Lund University's Faculty of Engineering, and at the Faculty of Science, from which information could not be obtained. Of the doctoral students, 397 are employed at Lund University, so only this number has been counted in the total number of life science researchers. The others are part-time doctoral students employed by Region Skåne.

Technical University of Denmark (DTU). The information is for the total number of researchers at the following departments: DTU Food, DTU Vet and Centre for Diagnostics, DTU Aqua, DTU Biosustain, DTU Bioinformatics, DTU Bioengineering, DTU Chemical Engineering, DTU Environment and DTU Nutech, and an equivalent selection of students. Research in the life sciences was also performed at DTU Chemistry, DTU Electrical Engineering, DTU Nanotech, DTU Mechanical Engineering, and DTU Compute.

The Swedish University of Agricultural Sciences in Alnarp. Information regarding the number of researchers

and professors is for June 2019; the number of doctoral students pertains to all of 2018. The number of students includes those from Horticultural Science, Landscape Engineering, Agronomics, Plant Biology for Sustainable Production, Agroecology, and Outdoor Environments for Health and Well-being.

Malmö University. Life science students: full-time equivalents.

Roskilde University. Figures from the turn of the year 2016/17.

Aalborg University in Copenhagen. Figures from 2019.

The Capital Region of Denmark. Figures from 2017. The number of researchers indicates people who dedicate at least 10% of their working hours to research – often, but not always – in the life sciences. A number of researchers also have part-time positions at the University of Copenhagen. Doctoral students also include research fellows.

Region Skåne. All professors also have part-time positions at Lund University. Head count for researchers – many conduct research part-time.

Region Zealand. Head count for researchers – many conduct research part-time.

The Danish Cancer Society. There are also twelve professors with part-time positions at universities in the region.

The State Serum Institute. Head count.

INTERNATIONAL RESEARCHERS AND STUDENTS, PAGE 48–49

International students

The figures for the number of students and their connection to the job market are retrieved from customised analyses by Statistics Denmark and Statistics Sweden. The selection of educational programmes was made from the programme classifications in Denmark and Sweden, and programmes have been chosen within which work in the sector is usually found after education is completed.

The figures for Denmark and Sweden are not directly comparable due to differences in the educational systems and the available data material.

The Danish and Swedish educational systems are structured differently. In Denmark, students – apart from exchange students – register for an entire programme at the bachelor or graduate level. In Sweden, it is possible to register for individual courses, and it is also possible to complete a master's degree by combining individual courses from different programmes. The criterion is that one must earn 120 ECTS points to complete a master's degree. A student who has registered for two courses in the same semester will thus be accounted for two times in the statistics. An attempt has been made to account for this in the extracts from the Swedish data. Students registered for more than one course at the same institution are only counted as one student; however, if that student is registered for courses at two separate institutions, s/he will be accounted for twice in the data material. The figures for the number of students are thus not directly comparable between Denmark and Sweden.

The definition of an international student depends on national definitions and the possibilities offered in the dataset at hand. Therefore, the definition differs in Danish and Swedish data extractions. In Sweden, an international student is defined as 1) a person from a country outside of the EU/EEA, who upon moving to Sweden reported that the move was motivated by studies, and where a residency permit has been issued for less than two years before the commencement of studies; 2) students who have moved to Sweden less than six months prior to the commencement of studies; and 3) other individuals lacking a Swedish personal identification number in the educational institutions' study administration systems. In Danish data, an international student is defined as such if s/he came to Denmark within a period from one year prior and three months after commencement of studies, and does not have a Danish secondary education.

International researchers

Data for foreigners who have not completed their education in the country are incomplete in the national statistics office's register of the population's education. Because of the poor data quality on the education of workers who have come to Denmark from abroad it has been necessary to use additional sources such as the utilisation of the tax relief schemes, and the Danish Agency for Labour Market and Recruitment's database Jobindsats.dk.

It is not possible to extract specific data material for the life science sectors in Medicon Valley from the data sources used here; however, by the use of the available complementary Danish sources, the Danish life science sector's need for highly qualified workers from abroad becomes clearly visible. The Danish Ministry of Taxation and the Forskarskattenämnden websites offer statistics about the utilisation of the tax relief scheme.

CLUSTER RANKING:, PAGES 23–65

Selection of life science clusters

Medicon Valley Alliance has chosen to commission an analysis from the Centre for Science and Technology Studies (CWTS) of Leiden University.

For technical reasons, CWTS recommended a comparison of European clusters rather than of clusters around the globe. CWTS uses NUTS-coding to identify European clusters, and would not be able to work with the same precision for clusters around the world. The result is also a more consistent range of clusters with which to compare Medicon Valley. To identify relevant life science clusters in Europe, Øresundsregionen, which has prepared the report for Medicon Valley Alliance, compiled a number of sources. The selection process was based on the Leiden Ranking from 2012–2015 (which was the most recent available ranking at the time of the selection), which is independent of the consultant report later produced by CWTS. It investigated the locations or geographic areas in which the first 25 universities on the European list of the greatest number of scientific articles in the field "Biomedical and Health Sciences" are situated. While "Biomedical and Health Sciences" does not encompass the area identified as life science in CWTS' analysis completely, it is decisively the category that corresponds most closely. Earlier reports were then consulted with the aim of identifying additional locations or geographic areas with life science clusters. The following reports were consulted:

- "The Leading Life Sciences Clusters in Europe", prepared by SANOFI on behalf of Science Business 2015.
- "Evaluation of Future Opportunities in Medicon Valley", prepared by The Boston Consulting Group on behalf of Medicon Valley Alliance 2012.
- "New Home for the European Medicines Agency", prepared by KPMG on behalf of Novo Nordisk 2017.

Using these reports, we identified cluster areas that were not linked to a university on the top-25 list in Leiden's Ranking of "Biomedical and Health Sciences", or that are transborder, but have strong research in the

THE EFFECT OF SECTOR DRIFT AND SECTOR CHANGE

Statistics for the number of employees in the life science sector are based on figures from the register-based Labour Force Statistics in Denmark (RAS) and in Sweden (RAMS). The employment figures cover the manufacturing sectors: 21 Pharmaceuticals, 26.60.10 Manufacture of hearing aids and supplies, 26.60.90 Manufacture of irradiation, electromedical and electrotherapeutic equipment, 32.50.00 Manufacture of medical and dental instruments and supplies and 46.46.10 Wholesale of pharmaceutical and nursing goods. Sector drift and sector changes for individual companies can affect

the figures to a greater or lesser degree. The more detailed statistics are for individual sectors and smaller geographic areas, the more visible sector drift and change of sector become. A sector drift is a slow change in a company's product portfolio that eventually leads to it belonging to a different sector than it did originally. A change of sector is the switch to another sector code without changes to the company's product portfolio.

State of Medicon Valley 2017 contains an example (Coloplast) of how sector code can change over time.

life sciences on the whole.
For each cluster, we conducted online research to ensure the existence of a cluster organisation or confirm that the area or location in question is locally recognised as a cluster. As there is no simple definition of a cluster, some clusters have a larger scope than others. A crystal clear definition in this area is almost impossible.

Departing from the above parameters, we compiled the following list of clusters in Europe whose universities published the greatest number of scientific articles in “Biomedical and Health Sciences” from 2012-2015 (currently the most recent available period). Arranged according to the number of articles in the ten per cent most frequently cited articles, the clusters are:

- London-Cambridge-Oxford
- The Netherlands
- Paris / Île de France
- Flanders
- Stockholm-Uppsala
- Scotland
- Medicon Valley
- Zurich
- BioValley (a German-French-Swiss cluster including Basel, Alsace, Freiburg, Karlsruhe, Mulhouse, Strasbourg)
- Munich
- Rome
- Berlin
- Heidelberg
- Barcelona
- Milan

Of these, we have chosen to compare the first ten clusters on the list, which CWTS identified according to the following NUTS code definitions:

- London-Cambridge-Oxford: UKH1, UKH2, UKH3, UKI and UKJ1
- The Netherlands: the entire country
- Paris/Île de France: FR10
- Flanders: BE21, BE22, BE23, BE24, BE25 and BE10
- Stockholm-Uppsala: SE11 and SE12, except Linköping University, Örebro University and Mälardalen University College
- Scotland: the entire country
- Medicon Valley: SE22, DK01 and DK02, except Blekinge Institute of Technology
- Zurich: CH04
- BioValley: CH03, FR42, DE11, DE12, DE13 and DE14
- Munich: DE21 and DE27, except Neu-Ulm University of Applied Sciences and Kempten University of Applied Sciences

All scientific publications in the relevant categories from every region have been included, regardless of whether the research was performed at e.g. a university, a university hospital, or other research institutions or commercial enterprises.

Selection of the bibliometric database
CWTS conducted its analysis in an in-house version of Web of Science:
“Our CWTS Citation Index (CI) system will be used for these analyses. The core of this system is comprised of an enhanced version of Clarivate’s citation indexes: Web of Science (WoS) version of the Science Citation Index, SCI (indexed); Social Science Citation Index, SSCI and Arts & Humanities Citation Index, AHCI.
We therefore calculate our indicators based on our in-house version of the WoS database. WoS is a bibliographic database that covers the publications of about 12 000 journals in the sciences, the social sciences, and the arts and humanities.”

Definition of life science
CWTS has limited its bibliometric analysis to encompass only publications within the category life sciences. They define this category as follows:
“... all the publications selected for these regions were limited to those that are designated to the higher level category of ‘Medical and Life Sciences’. This category is a derivative of those Web of Science categories that adhere to the moniker that was defined for this higher level field of science. This is to some extent an arbitrary process in which choices are made on the basis of best practice and educated assumption.”
The complete list of categories is as follows:
For a more detailed description of the methodology, please refer to the report “CWTS Bibliometric Report: Benchmark Life Science Regions Research for Øresund Institute 2006-2016/17” by Erik van Wijk, 2018.
*van Wijk, Erik (2018): “CWTS Bibliometric Report: Benchmark Life Science Regions Research for Øresund Institute 2006-2016/17”

MISCELLANEOUS
We have also collected information from personal interviews, telephone interviews and in e-mail contact with experts and companies. This applies, among others, to the chapter on beacons. Data for the reviews of companies has been retrieved from Bisnode, through contact with the companies and from their websites, as well as from media reports. We have also utilised the public investigations from within life science, as well as other reports from public actors and trade and networking organisations.

Web of Science Categories in ‘Medical and Life Sciences’		
Agricultural engineering	Engineering, biomedical	Ophthalmology
Agricultural experiment station reports	Entomology	Ornithology
Agriculture, dairy & animal science	Evolutionary biology	Orthopedics
Agriculture, multidisciplinary	Fisheries	Otorhinolaryngology
Agronomy	Food science & technology	Parasitology
Allergy	Gastroenterology & hepatology	Pathology
Anatomy & morphology	Genetics & heredity	Pediatrics
Andrology	Geriatrics & gerontology	Peripheral vascular disease
Anesthesiology	Gerontology	Pharmacology & pharmacy
Audiology & speech-language pathology	Health care sciences & services	Physiology
Behavioral sciences	Health policy & services	Plant sciences
Biochemical research methods	Hematology	Primary health care
Biochemistry & molecular biology	Horticulture	Psychiatry
Biology	Immunology	Public, environmental & occupational health
Biophysics	Infectious diseases	Radiology, nuclear medicine & medical imaging
Biotechnology & applied microbiology	Integrative & complementary medicine	Rehabilitation
Cardiac & cardiovascular systems	Marine & freshwater biology	Reproductive biology
Cell & tissue engineering	Materials science, biomaterials	Respiratory system
Cell biology	Mathematical & computational biology	Rheumatology
Chemistry, medicinal	Medical informatics	Social work
Clinical neurology	Medical laboratory technology	Soil science
Critical care medicine	Medicine, general & internal	Sport sciences
Dentistry/oral surgery & medicine	Medicine, research & experimental	Substance abuse
Dermatology	Microbiology	Surgery
Developmental biology	Mycology	Toxicology
Emergency medicine	Neuroimaging	Transplantation
Endocrinology & metabolism	Neurosciences	Tropical medicine
	Nursing	Urology & nephrology
	Nutrition & dietetics	Veterinary sciences
	Obstetrics & gynecology	Virology
	Oncology	Zoology

INTERVIEW LIST

- **Bo Åhrén**, Pro Vice-Chancellor, Lund University, meeting, 7 Sept. 2018
- **Erik Bisgaard Madsen**, Dean, Associate dean for Trade and Government Collaboration, Faculty of Science – University of Copenhagen, telephone, 24 Aug. 2018
- **Anna Blom**, professor of Medical Protein Chemistry, Lund University, meeting, 14 May 2019
- **Mogens Holst Nissen**, Vice Dean for Research, Faculty of Health and Medical Sciences – University of Copenhagen, telephone, 20 Aug. 2018
- **Katrine Krogh Andersen**, Dean of Research, DTU, meeting, 4 Sept. 2018
- **Mads Melbye**, Director, State Serum Institute, telephone, 25 June 2019
- **Thue Schwartz**, professor at the Novo Nordisk Foundation Center for Basic Metabolic Research – University of Copenhagen, meeting, 11 June 2019
- **Kerstin Tham**, Vice-Chancellor, Malmö University, meeting, 17 Sept. 2018
- **Trine Winterø**, Vice Dean of Innovation & External relations, Faculty of Health and Medical Sciences – University of Copenhagen, telephone, 20 Aug. 2018

REFERENCE LIST

The exact sources are provided with the statistics in the respective chapters and on pages 60-65.

PRIMARY STATISTICAL SOURCES:

- SCB/Statistics Sweden, including customised analyses
- Statistics Denmark, including customised analyses
- UN Comtrade
- World Bank

OTHER SOURCES:

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- Times Higher Education – World University Rankings 2018
- Ministry of Foreign Affairs of Denmark and The Ministry of Health, Internationaliseringsstrategi for sundhed og life science, 2019 (Internalisation Strategy for Health and Life Science)
- QS World University Rankings 2019
- Press releases and annual reports from respective companies.
- In addition, we received data via email from companies, municipalities, trade organisations, universities and other players.

Behind the report:

MEDICON VALLEY ALLIANCE AND ØRESUNDSINSTITUTTET

ØresundsInstitutttet and Medicon Valley Alliance have a long-term analysis collaboration. State of the Region is an annual analysis of the developments in Medicon Valley. Medicon Valley Alliance and ØresundsInstitutttet are both member-based, and a selection of the member-actors are represented in the board of directors.

Board of directors:



MEDICON VALLEY ALLIANCE (MVA) is a non-profit membership organization in the Danish-Swedish life science cluster Medicon Valley, which is a part of Greater Copenhagen. Our 250 members, who together employ approximately 140 000 people, represents the region's triple-helix and include universities, hospitals, human life science businesses, regional governments and service providers.



Board of directors:



ØRESUNDSINSTITUTTET is an independent Danish-Swedish centre for analytics and information that brings together more than 100 actors from the industry, the public sector and academic institutions with the aim of strengthening knowledge about societal developments on both sides of the Øresund Strait. As a member of ØresundsInstitutttet, you become part of our strong Danish-Swedish network – and gain access to network meetings, facts, analyses and news about developments in the Greater Copenhagen region.



The analysis "State of Medicon Valley" is prepared by ØresundsInstitutttet and commissioned by Medicon Valley Alliance.

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MEDICON VALLEY ALLIANCE

MVA is a Gold Label-certified, non-profit member organisation in the Danish-Swedish life science cluster Medicon Valley. Its 250 members include universities, hospitals, human life science businesses, regional governments and service providers that employ approximately 140 000 people and represent the Region's 'double triple-helix'. The activities in MVA focus on strengthening collaborations for a vibrant life science ecosystem in Medicon Valley through networking events and increased collaboration across borders and sectors.

THE VISION

The vision is to be a well-known and respected member-driven contributor to the realisation and positioning of Medicon Valley as the most competitive and vital life science cluster in Northern Europe.

THE MISSION

MVA is committed to realising Medicon Valley's potential by facilitating networking, knowledge-sharing, and collaboration, analysing challenges and potentials, and mobilising support from key opinion leaders.

CALL TO ACTION

Read more about the Danish-Swedish life science cluster organisation Medicon Valley Alliance's events and activities on www.mva.org, where you can also find more information about how YOUR company can benefit from a membership.

