Health Innovation West

Strengthening life science cluster collaboration in West Sweden

MAY 2021

Health Innovation West is a cluster organisation aiming to put West Sweden on the global map when it comes to life science and health innovation.

Stronger together!

HEALTHCARE

Region Västra Götaland is the principal organisation for all main healthcare operators - and test bed providers - in the region, with prominent private market operators in the mix.

ACADEMIA

Five universities in the region form a backbone of scientific excellence. Internationally-acclaimed academia have generated ground-breaking research, and Nobel-prize winners.

INVESTMENT & FUNDING

Governmental funding, private capital and International investors are active in West Sweden and appreciate the wide range of companies, in combination with cutting edge innovation.

INNOVATION SUPPORT

West Sweden has a wide spread of support systems for bringing new ideas to life. Expertise, openness and willingness to collaborate are distinct and significant factors.

INDUSTRY

The life science industry in West Sweden is a mix of large international companies and over 400 SME and startups. The strong heritage of automotive and ICE industry presents excellent conditions for sector convergence.

*"**Imagine** if West Sweden was known as the region where evidence is generated and where innovation is adopted"*

Mobility. Artificial intelligence. Next generation sequencing. The ongoing transition to personalised healthcare is forcing us to reimagine how we collect, connect and analyse huge amounts of high-quality data so we can better understand, diagnose, treat and prevent diseases.

In a rapidly changing world where knowledge and technologies are advancing and converging at high speed at the same time, building new structures for collaboration within and between sectors has never been so important.

West Sweden has a proud tradition of developing groundbreaking innovation within life science. With its strategic location and trading heritage, the region has traditionally brought people together.

Today, West Sweden is characterized by a strong life science industry. Multinational, leading companies are based in the region. Academic strongholds include internationally eminent research teams. And high-quality clinical research and test beds are a feature of the region. Life science in West Sweden also benefits from close proximity to the automotive industry and a growing ICT sector. Several prominent life science infrastructure projects and initiatives are currently under development in West Sweden.

The challenge we have is to bring it all together and to harness the power of a currently underutilized life science ecosystem. The need is there. The building blocks are there. The can-do attitude is there. Momentum and expectation exist.

Let's work together to unlock the potential in the region's life science ecosystem, to make it happen to ensure future competitiveness. We have a fantastic opportunity to create something unique that has a positive impact within the region and beyond.

Contributing **stakeholders**

During 2019 and 2020, a cross –functional group of public and private actors in West Sweden met to discuss increased collaboration within life science with the purpose of strengthening West Sweden's attractiveness and competitiveness. Through a series of workshops, study trips and meetings, the group agreed on a number of common objectives and a way forward.

INDUSTRY

- AstraZeneca
- AZ BioVentureHub
- Getinge
- GoCo & Next Step Group
- Mölnycke Healthcare
- Vitrolife
- Vitartes
- Wellspect
- Abigo
- Antaros Medical
- Cellink
- Monocl
- Doberman

PUBLIC ORGANISATIONS

- Business Region Göteborg
- Region Västra Götaland (VGR)
- Chalmers University of Technology
- Gothenburg University
- Mölndals Stad
- Göteborg & Co
- Swedish Government Office for Life Sciences

BENCHMARKING

- Medicon Valley Alliance
- Medicon Village
- Uppsala BIO
- Lindholmen Science Park
- The West Swedish Chemistry & Materials Cluster
- Life Sciences in West Holland
- Norway Life Science Cluster
- MASS Bio (Boston)

INDUSTRY TRADE ORGANISATIONS

- West Sweden Chamber of Commerce
- Sweden BIO

Health Innovation West

Why we're creating a **life science cluster?**

To increase the attractiveness and competitiveness of life science in West Sweden with the focus on:

- Attracting international skills and expertise
- Catalysing innovations connected to the transformation of healthcare
- Attracting new investments and establishments in the region

Health Innovation West

How we're creating a **life science cluster?**

- Catalyse more collaboration across the region
- Create an attractive portal to a collective arena for life science in West Sweden.
- Showcase and build on our strengths
- Harness the unifying forces and expertise in common issues and areas of interest

Together, we can create the destination:
Health Innovation West

Health Innovation West

Who did the work?

The work with the market analysis was led by a small working group, supported by a steering group with representatives from the private and public sectors. Back office support was provided by Sahlgrenska Science Park.

WORKING GROUP

• Mia Ekdahl, *Project Manager*	Sahlgrenska Science Park
• Jenny Almkvist	Region Västra Götaland
• Jonas Qvillberg	Triathlon Group
• Jamie Smith	AZ BioVentureHub/Sahlgrenska SP
• Iris Öhrn	Business Region Göteborg

STEERING GROUP

• Magnus Björsne, *Chairperson*	AZ BioVentureHub
• Matti Ahlqvist	AstraZeneca
• Eva-Lena Albihn	Business Region Göteborg
• Anders Carlberg	Region Västra Götaland
• Charlotta Gummeson	Sahlgrenska Science park
• Jeanette Hedén Carlsson	Getinge
• Anders Hyltander	Sahlgrenska University Hospital
• Mattias Goksör (*prev Göran Landberg*)	University of Gothenburg
• Bo Norrman	Chalmers University of Technology
• Marie Uddenmyr (*prev Peder Wahlgren*)	GoCo
• *Carina Kloek-Malmsten (until Jan-21)*	*City of Mölndal*

REPORT FUNDING

- AstraZeneca
- Getinge
- GoCo
- Sahlgrenska Science Park
- Region Västra Götaland
- Monocl *(database access)*

IN KIND FUNDING VIA SAHLGRENSKA SCIENCE PARK (0.7 FTE)

- Region Västra Götaland
- Business Region Göteborg
- Mölndals Stad
- Chalmers University of Technology
- University of Gothenburg

Health Innovation West

So, **where did we start?**

- Anchored in industry needs and strategic focus areas, we commissioned a market analysis report with a multi-faceted purpose:
- **Identify potential** areas of excellence where Health Innovation West has the potential to become world-class by leveraging regional strongholds and opportunities.
- Create a **fact-based, updated overview** of the life science cluster in West Sweden by consolidating **easily accessible data**. This helps to prioritise investments and design an action plan for Health Innovation West.
- Identify experienced **challenges** and **improvement potential.**

The consultancy company, Triathlon, carried out the market analysis with project management from Sahlgrenska Science Park. The analysis was supervised by the Steering Group for Health Innovation West.

Health Innovation West

What methodology was used for the report?

Qualitative interviews:

Interviews with stakeholders representing both private and public organizations

In total 37 individuals have been interviewed; 18 represent industry and 19 from the public sector (e.g. academia, healthcare, support functions)

Representatives from major life science companies with presence in the region

Quantitative data

(Examples)

Mapping of life science companies present in region

Bibliometric data

Research funding

Review of existing publications of regional strongholds

Expert search (Monocl)

University ranking

Collaborative data (e.g. co-publications)

- Potential areas of excellence were identified utilizing **a dual approach combining both quantitative analysis with qualitative data** obtained via interviews with stakeholders representing both private and public organizations
- Particular emphasis was given to the qualitative input regarding industrial priorities and areas of interest to ensure an industrial perspective in this initial analysis
- Evaluations for each area have been conducted in three main dimensions:
  - Industry stronghold and relevance
  - Scientific and academic stronghold
  - Existing infrastructure and collaborative initiatives

Health Innovation West

HEALTH INNOVATION WEST

Market analysis of cluster strongholds and opportunities

September 2020, Gothenburg

triathlon
triathlon group

Foreword

Cross-sector collaboration more important than ever

The importance of cross-sector collaboration has never been as important as today. The ongoing COVID-19 pandemic has had profound impact on the whole world and represents a global challenge not seen for decades. At the same time, the pandemic has also showed the immense ability of healthcare, researchers, industry and regulators to quickly find unprecedented ways of working together across sectors around the world.

West Sweden has a strong history of developing groundbreaking innovation within life science in close collaboration between academia, healthcare and industry. However, in a rapidly changing world where knowledge and technology are advancing at high speed, it is even more important to ensure an efficient public/private collaborative environment necessary to build future competitiveness of the Nordic life science sector.

This report has been developed as part of the ongoing cluster initiative Health Innovation West with aim to establish the region as an internationally competitive and renowned life science cluster. The purpose of the report is to identify areas in which the region has the potential to become world class by leveraging regional strongholds and opportunities utilizing a fact-driven approach. The work was carried out during June-August by Triathlon Group and affiliated ISEA in collaboration with Sahlgrenska Science Park.

It is evident that Health Innovation West possess elements necessary to become a world-class cluster. A particularly encouraging key take-away is the perceived true openness to strengthen the cross-sector collaboration and opportunity to leverage the momentum that has been built-up. Even more importantly, there is a strong urge and expectation for execution. The importance of choosing where to focus is now of critical importance to drive execution and show short-term success. However, in the end of the day, execution is down to people that are given opportunities and mandate to drive the work forward. Without an operative and dedicated team to drive this, there is an imminent risk that the ambition will remain as an ambition, and the built-up momentum is lost. It is therefore our sincere hope that this report will provide the necessary foundation to select initial focus and contribute in driving towards execution.

Finally, we would also like to thank all persons who have contributed with their time and valuable input during the work. Thank you.

Mia Ekdahl
Sahlgrenska Science Park
Head of Communications /
Project Manager Health Innovation West

Jonas Qvillberg
Triathlon Group
Partner Life Science

Contents

About the report

Background: Health Innovation West

- A cluster initiative initiated during the autumn 2019 with the objective to establish Health Innovation West as an internationally competitive and renowned life science cluster with focus on:
  - Internationally competitive supply of talent
  - Collaborative innovation leveraging cross-sector strongholds
  - Attracting national and international investments and establishments
- The ambition is to establish a cluster membership organization for the life science sector in West Sweden to provide a united platform and support in driving innovation and growth
- The work related to Health Innovation West is carried out by a cross-sector constellation involving both public and industrial actors, coordinated by Sahlgrenska Science Park during the initial phase

Report purpose

The report is intended to fulfill a somewhat multifaceted purpose but with the overall aim to provide fact-based information to support the ongoing work. The report should be seen as an initial effort to consolidate information with focus in three main areas:

1. Create a fact-based updated overview of the life science cluster in West Sweden by consolidating easily accessible data
2. Based on industrial needs and priorities, identify potential areas of excellence where Health Innovation West has the potential to become world class by leveraging regional strongholds and opportunities
3. Identify experienced challenges and improvement potential

Methodology

A dual approach combining quantitative and qualitative analysis

Qualitative interviews

Interviews with stakeholders representing both private and public organizations

In total 37 individuals have been interviewed; 18 represent industry and 19 from the public sector (e.g. academia, healthcare, support functions)

Representatives from major life science companies with presence in the region

Quantitative data

(Examples)

Mapping of life science companies present in region

Bibliometric data

Research funding

Review of existing publications of regional strongholds

Expert search

University ranking

Collaborative data

- Potential areas of excellence have been identified utilizing a dual approach combining both quantitative analysis with qualitative data obtained via interviews with stakeholders representing both private and public organizations
- Particular emphasis has been given to the qualitative input regarding industrial prioritizes and areas of interest to ensure an industrial perspective in this initial analysis
- Evaluation for each area have been conducted in three main dimensions:
  1. Industry stronghold and relevance
  2. Scientific and academic stronghold
  3. Existing infrastructure and collaborative initiatives
- The intention is that the identified areas of excellence will serve as input in the future work in finding specific areas of mutual interest and forming concrete projects and initiatives

For full description of methodology, interviewees etc. please refer to appendix

Methodology: Interviews

Qualitative interviews have been conducted with stakeholders representing both private and public organizations

Qualitative interviews

Interviews with stakeholders representing both private and public organizations

In total 37 individuals have been interviewed; 18 represent industry and 19 from the public sector (e.g. academia, healthcare, support functions)

Representatives from major life science companies with presence in the region

Quantitative data

(Examples)

Mapping of life science companies present in region

Bibliometric data

Research funding

Review of existing publications of regional strongholds

Expert search

University ranking

Collaborative data

Interviewee organizations

Industry

- Abigo
- Antaros Medical
- AstraZenca
- AstraZeneca BioVentureHub
- Cellink
- Dentsply Sirona Implants
- Essity
- Getinge
- Mölnlycke Health Care
- Vitrolife
- Wellspect

Academia, public sector and other

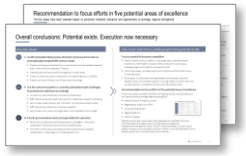
- Business Region Gothenburg
- Chalmers University of Technology
- Gothia Forum
- GU Ventures
- Innovationsplattformen VGR
- Medicon Valley Alliance
- RISE
- Sahlgrenska Academy (GU)
- Sahlgrenska University Hospital
- University of Gothenburg

Structure of the report

This report is structured into seven chapters. Due to the multifaceted scope, the report has turned out relatively comprehensive. A short description of each chapter is presented here as a guidance to the reader.

1. Introduction

The introduction chapter provides a short background to the cluster initiative and describes the multifaceted purpose of this report.



2. Executive summary

Executive summary of the main findings and conclusions focused on areas of excellence and high-level recommendations

3. Health Innovation West Cluster Overview

This chapter intends to present a fact-based updated overview of the life science cluster in West Sweden, including:

- Industry overview
- Review of the scientific excellence in the region
- Infrastructures and ongoing initatives

4. Prioritized areas of excellence

Presentation of the prioritized candidates for areas of excellence, including a description of the methodology used to identify and prioritize the areas.

5. The need for execution – Improvement potential

Chapter 4 presents a summary of the challenges and barriers highlighted during interviews with key stakeholders, in some cases with supporting data from quantitative review.

6. Conclusions and recommendations

Presentation of the conclusions and a recommended high-level roadmap for future work, including enabling factors.

7. Detailed evaluation: Areas of excellence

For each of the five prioritized areas, this chapter presents area specific bibliometric data, and examples of highlighted initiatives and infrastructures, as well as an area outlook

8. Appendix

The appendix includes a more detailed description of the methodology used for specific data gathering as well as complemetary data not presented in the main parts of the report.

Contents

Overall conclusions: Potential exists. Execution now necessary

Key take-aways:

1 Health Innovation West possess elements necessary to become an internationally renowned life science cluster

- Presence of strong industrial anchor companies and commercialization capacity both in life science and adjacent ICT sector
- Internationally eminent scientific strongholds in certain areas
- History of close cross-sector collaboration and “get-things-done” mentality
- Presence of major initiatives and infrastructure to leverage

2 The life science ecosystem is currently underutilized with challenges that need to be addressed accordingly

- Limited and underutilized real cross-sector collaboration
- Difficulties to access the healthcare system for collaborative research and testing
- Lack of clear cluster overview and “front-door” for Life Science West Sweden
- Difficulties to recruit talent and necessary expertise
- Lack of clear vision, action and organization with mandate to drive change

3 A built-up momentum exists and expectation for execution

- Perceived true openness and the expectation to strengthen cross-sector collaboration necessary to ensure future competitiveness
- Imminent risk that actors choose to prioritize investments and research collaborations in other regions if not taking action now

Time to act: Select focus, initiate projects and generate results

Focus essential to become competitive

- Need to identify and focus efforts in prioritized areas, potential areas of excellence, where Health Innovation West can become world class by leveraging regional strongholds and opportunities
- Within these areas, concrete projects and initiatives can be formed to drive immediate action
- By doing do, success cases can be generated contributing to a positive feedback loop over time that supports in turning Health Innovation West into an internationally competitive and renowned life science cluster

Recommendation to focus efforts in five potential areas of excellence

Five primary areas have been identified with high perceived industrial relevance and opportunities to leverage regional strongholds:

- Material Science & Infection control
- Regenerative medicine & ATMP
- Advanced Drug Delivery
- Digital health & AI
- Medical imaging

Specific projects and niches need to be collaboratively identified within the prioritized areas of excellence also considering the synergies and interdependencies between areas. Areas predominantly represent future potentials rather than traditional scientific strongholds

Recommendation to focus efforts in five potential areas of excellence

The five areas have been selected based on perceived industrial relevance and opportunities to leverage regional strongholds

Area	Prio[1]	Why an Area of Excellence?	Possible collaborative areas[2]	Considerations and risks
Material Science & Infection control	●●◐	▪ Existing industrial and academic stronghold ▪ Key priority for many companies and need for partnering, accentuated during COVID-19 pandemic ▪ Opportunity to leverage strongholds and enable collaboration rather than major competence build-up	▪ Sustainable materials, e.g. biodegradable plastics ▪ Bio-active implants and materials ▪ Antimicrobial properties ▪ Materials for drug delivery	▪ Access to healthcare for testing key, need to overcome barriers ▪ Several previous initiatives. Need to gather learnings ▪ Management of multiple (partly-competitive) actors
Regenerative medicine & ATMP	●●●	▪ Strong anchor driver in AstraZeneca strategic focus and substantial investment in area with lead here ▪ Global demand and increasing trend, possibility to take position in growing field ▪ Available infrastructure, initiatives and collaborations	▪ Therapeutic oligonucleotides ▪ Base research regen. mechanisms & pathways ▪ Mechanisms and competence for commercial scale manufacturing of ATMPs[3]	▪ Relatively limited area today although growing ▪ Not a current academic stronghold, time needed to develop ▪ Substantial funding needed to establish centra
Advanced Drug Delivery	●●○	▪ Highly multidisciplinary field with cross-sector relevance ▪ Opportunity to leverage FoRmulaEx center and AstraZeneca capacity ▪ Tightly connected to Regenerative medicine & ATMP	▪ Delivery systems for oligonucleotide- and modRNA-projects ▪ Lipid nanoparticles ▪ 3D printed cellular assays	▪ Not a traditional regional stronghold ▪ Drug delivery traditionally recognized as area of expertise in nearby regions (e.g. Uppsala) ▪ Scientific build-up; substantial financing likely needed
Digital health & AI	●●●	▪ A top-priority across the industry ▪ External partnering vital to access expertise ▪ Proximity to ICT-sector ▪ Major local initiatives and capacity to leverage, e.g. AI Sweden, CHAIR	▪ Advanced data analytics of clinical and omics data ▪ Miniaturized sensors ▪ Innovative platforms utilizing connected devices ▪ Clinical trial data management	▪ “Buzzword”-area, need to find specific niche, e.g. application driven ▪ Access to data sets ▪ High competition and relatively low AI research productivity compared to other countries and regions
Medical imaging	●●◐	▪ World-class but underutilized infrastructure (BoIC). New lab planned for 2021 ▪ Wide relevance and applicability, connection to AI ▪ Synergies with ICT/mobility, e.g. pattern recognition	▪ Combine advancements in high-tech hardware (e.g. PET, MRI) with AI and pattern recognition ▪ Diagnostics and biomarker identification ▪ Clinical trial endpoint	▪ Not a traditional scientific stronghold ▪ Access to data sets ▪ “Competition” from healthcare delivery, e.g. for BoIC

[1]Indicative prioritization based on overall attractiveness of identified potential focus areas based on an overall summary of cluster strongholds, industry interest, opportunities for cross-sector collaboration and impact potential based on current information [2]Examples of collaborative areas of interest highlighted during interviews. Specific areas for collaboration and concrete projects need to be explored jointly with concerned stakeholders [3]Larger scale manufacturing per see preferably located in regions with existing manufacturing facilities

The work has just begun. Now it’s time to turn ambition into execution

Aim for concrete projects in prioritized areas with possibility to show short-term success combined with work to establish critical long-term enablers

Recommended way forward

A dedicated operative team is needed to drive the work ahead towards execution

1. Assign team with operative capacity (Critical!)

- Agree on areas of excellence to prioritize (preferably 3-4)
- Select and assign dedicated lead and team per prioritized focus area with operative capacity and relevant[1] industrial experience
- Ensure necessary funding, mandate and accountability

2. Connect actors and identify concrete projects

- Jointly explore mutual needs and interests in prioritized areas
- Aim for projects and cases with potential for quick-wins
- Identify critical long-term enablers

3. Ensure outcome-driven action

- Outline actionable plan with prioritized projects (quick-wins and long-term enablers)
- Dare to specify concrete goals, deliverables and timeline (still allowing for rapid learning and pivoting)
- Ensure necessary funding

Enablers

Six enabling factors with importance for building long-term success

Establish clear entry points for external collaborations

Improve opportunities for swift and reliable testing

Create front-door for life science

Ensure availability of quality and regulatory expertise

Improve potential for job-mobility and training

Improve conditions for innovation adoption

[1]Preferably including but not limited to industrial R&D experience

Contents

Health Innovation West Cluster Ecosystem

Academia

- University of Gothenburg
- Sahlgrenska Academy
- Specialist Medical Training Program Innovation and technology
- Chalmers University of Technology
- Chalmers School of Entrepreneurship
- University of Borås
- University of Skövde
- University West

Healthcare

- Sahlgrenska University Hospital
- VGR Regional hospitals
- Halland hospital Halmstad
- Private clinics

Industry

- International life science companies
- SMEs and startups
- ICT industry

Support & Expertise

- Gothia Forum
- Business Region Göteborg
- Innovationsplattformen
- Medtech West
- Centre of Registers Västra Götaland
- HTA-Centrum
- ATMP-centre Gothia forum

Incubators / Science Parks

- Sahlgrenska Science Parks
- Chalmers Ventures
- GU Ventures
- Gothia Science Park
- Lindholmen Science Park
- Innovatum Incubator
- Borås Incubator

Hubs & collaborative platforms

- AZ BioVentureHub
- AI Innovation of Sweden
- PICTA
- AllAgeHub
- Genomic Medicine Centre (GMC Väst)

Research Infrastructure

- RISE
- Wallenberg Centre for Molecular and Translational Medicine
- Centre for Imaging and Intervention (BoIC)
- Clinical Trial Center – Gothia Forum
- Wallenberg Centre for Protein Research - Systems Biology of the Druggable Proteome
- Swedish National Cord Blood Bank
- Stem Cell- and Component Laboratory
- Biobank West
- Nanosims / NCIMS (National center for imaging mass spectrometry)
- Swedish NMR Centre

GU Core facilities

- Biobank Core Facility
- Bioinformatics Core Facility
- Centre for Cellular Imaging (CCI) Core Facility
- Genomics Core Facility
- Laboratory for Experimental Biomedicine (EBM)
- Mammalian Protein Expression (MPE) core facility
- Proteomics Core Facility (PCF)

Investments / Funding

- Public venture capital (ALMI Invest)
- Regional funding (VGR)
- Angel network (Connect West)
- Venture capital (GU Ventures, Chalmers Ventures)

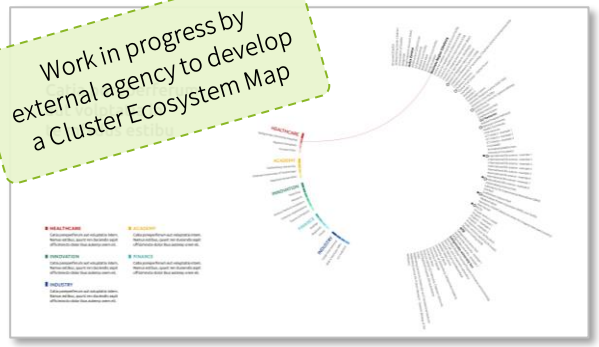
Chalmers centres

- Chalmers AI Research Centre, CHAIR
- FoRmulaEx Centre
- Graphene Centre
- Centre for Healthcare Architecture (CVA)
- Centre for Healthcare Improvement (CHI)
- Centre for Skin Research, SkinResQU
- Gothenburg Centre for Systems Biology
- 3D Bioprinting Center Chalmers

Events

- Park Annual
- Vitalis
- #Connect2Capital
- LifeTech

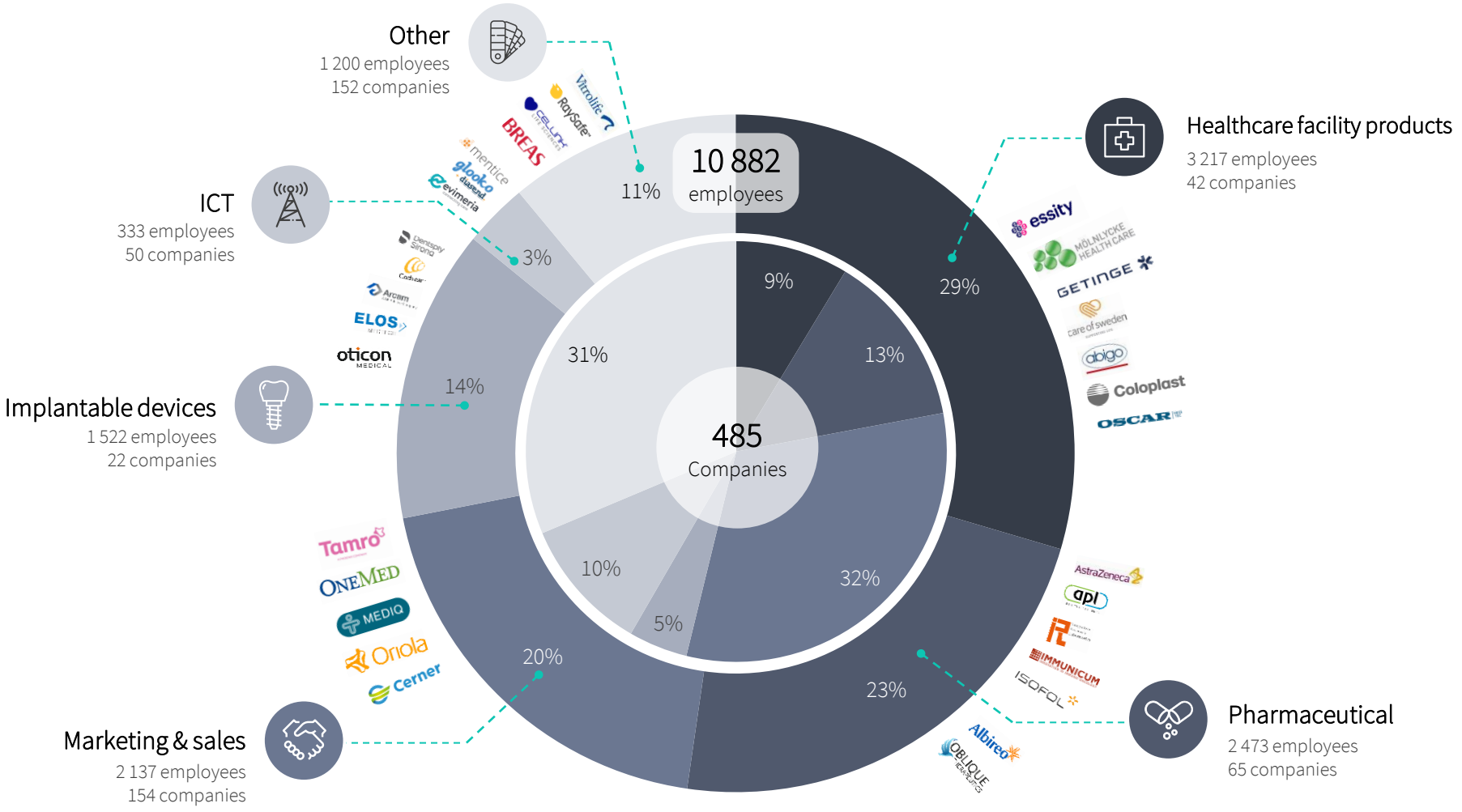
Work in progress by external agency to develop a Cluster Ecosystem Map



Contents

Industry strongholds in healthcare facility products, pharmaceuticals and implants

Healthcare facility products, Pharmaceuticals and Implantable devices are the largest sub-sectors in number of employees, in addition to marketing & sales companies



Comment

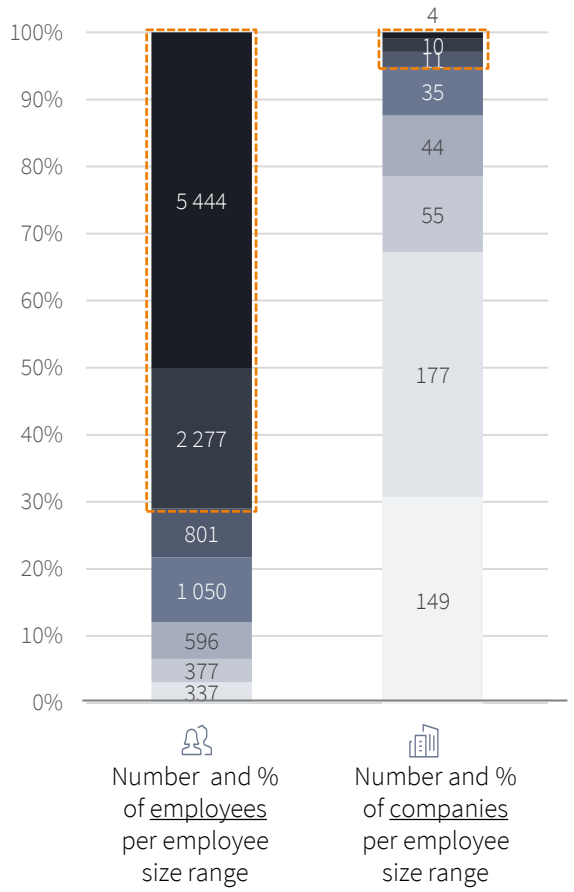
- There are **10 882 employees** working within life science at **485 companies** identified in West Sweden
- **19%** of the life science employees in Sweden work in West Sweden[1]
- **Healthcare facility products** is the largest sector in West Sweden with 29% of the employees. Within this group, some of the **major companies** in the region are found including major actors within **Personal- and wound care** like Essity, Mölnlycke Health Care and Abigo
- **Pharmaceutical** is the second largest sector in terms of number of employees, predominantly driven by AstraZeneca accounting for 90% of the employees in this sector
- **Implantable devices**, represents the third largest sector (Sales & Marketing exluceded) with 14% of the employees and 5% of the companies, including major actors like Dentsply Sirona and Cochlear

[1]Numbers from 2016 for Västra Götaland and Halland, source: Tillväxtanalys, 2018. Note: Numbers of employees are for 2018. Number of companies are active companies as of 2020. Logotypes represent examples of companies in the sub-sector. Source: Numbers are for life science companies with workplaces in Västra Götaland and Halland, and only include employees at the sites in these regions. See appendix for information about how the companies have been selected and categorized. Financial figures have been obtained from Allabolag if not otherwise noted

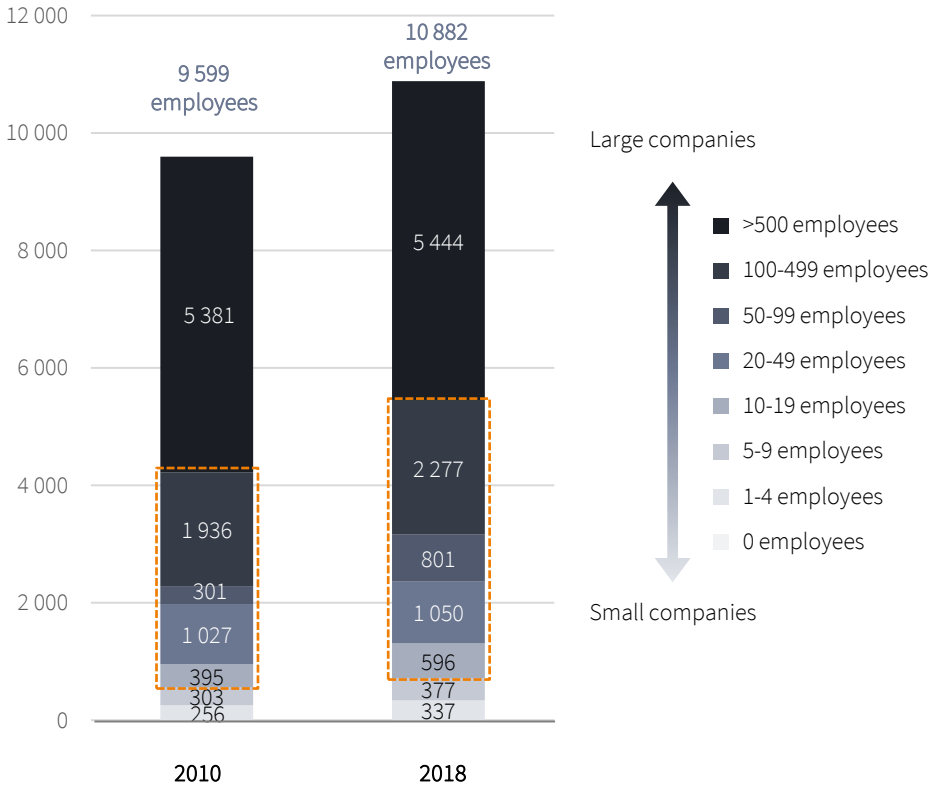
A mix of small and large companies

The life science industry in West Sweden consists of many small companies, together with a few large actors that account for the majority of employees

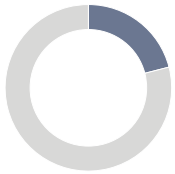
>70% of employees work in 3 % of the companies



Primary employee growth is in the middle-sized companies



Number of employees per employee size range, 2010 and 2018



21 % of the companies have 10 employees or more

47% of the companies have increased their number of employees since 2010[1]

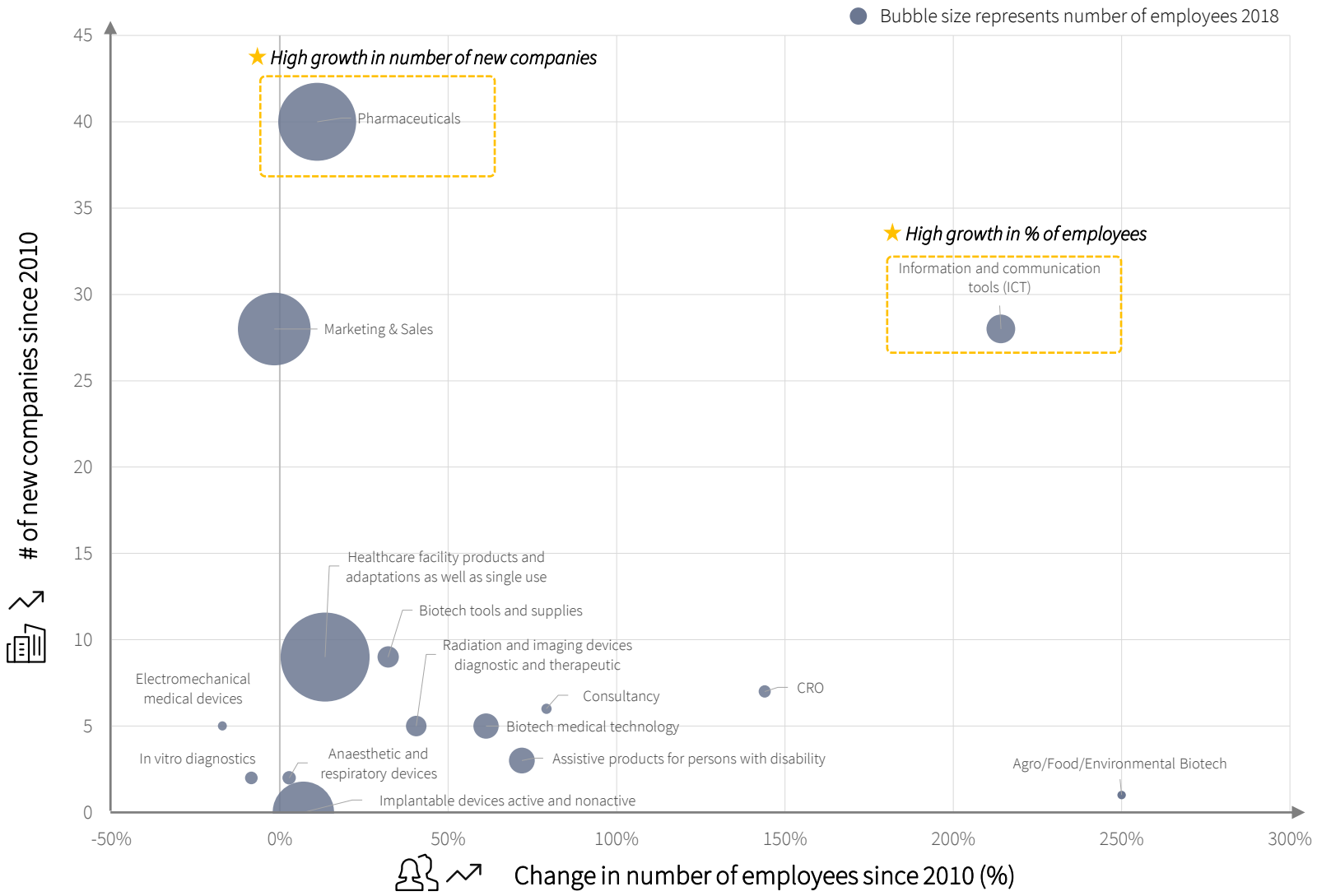
39% of the companies were founded after 2010

[1]Of companies still active 2020

Source: Numbers are for life science companies with workplaces in Västra Götaland and Halland, and only include employees at the sites in these regions. See appendix for information about how the companies have been selected and categorized. Financial figures have been obtained from Allabolag

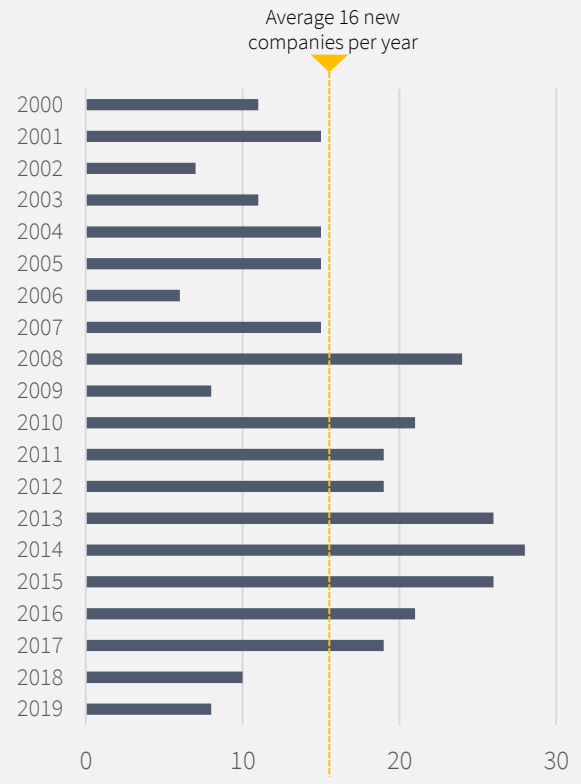
ICT is the fastest growing sub-sector of life science companies

The ICT sub-sector has grown >200% since 2010 and is together with Pharmaceuticals and Marketing & sales the sector where the majority of new companies are started



Number of companies founded per year

Number of life science companies founded per year in West Sweden since 2000. Only including companies still active 2020



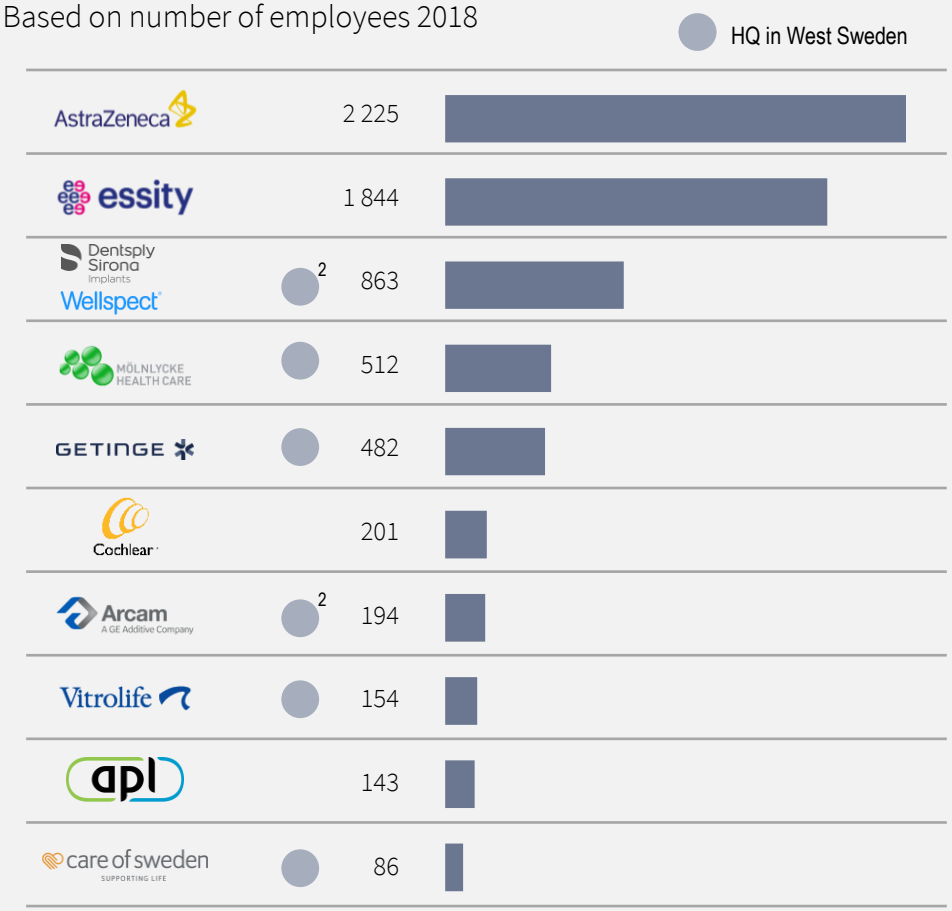
Note: Growth in number of employees are for the years 2010-2018. Number of new companies are 2010-2020, but only includes companies still active 2020. *Biotech production* and *Others* not included in graph due to <10 employees and no growth.
Source: Numbers are for life science companies with workplaces in Västra Götaland and Halland, and only include employees at the sites in these regions. See appendix for information about how the companies have been selected and categorized. Financial figures have been obtained from Allabolag.

The presence of big companies represents a key regional strength

Enabling access to commercialization and scale-up capacity

Top-10 largest life science companies in West Sweden[1]

Based on number of employees 2018



AstraZeneca – a key regional stronghold and opportunity

- One of three AstraZeneca global R&D sites
- Home of 2 of 3 focus areas; CMVC[3] and RIA[4]
- SEK 1,5 billion invested since 2010 to develop the site
- 2000 + employees, vast majority R&D
- SEK 15 billion allocated to research via site per year
- Spin-off potential

Antaros Medical, ondosis, CAPTARIO, Cinclus PHARMA, EMERITI BIO

Examples of companies with connection to AstraZeneca

Why important?

> Access to commercialization and scale-up capacity and know-how

> Partnering opportunities for startups, researchers and entrepreneurs with geographical proximity

> Major investments with positive spill-over effects

> Spin-off opportunities

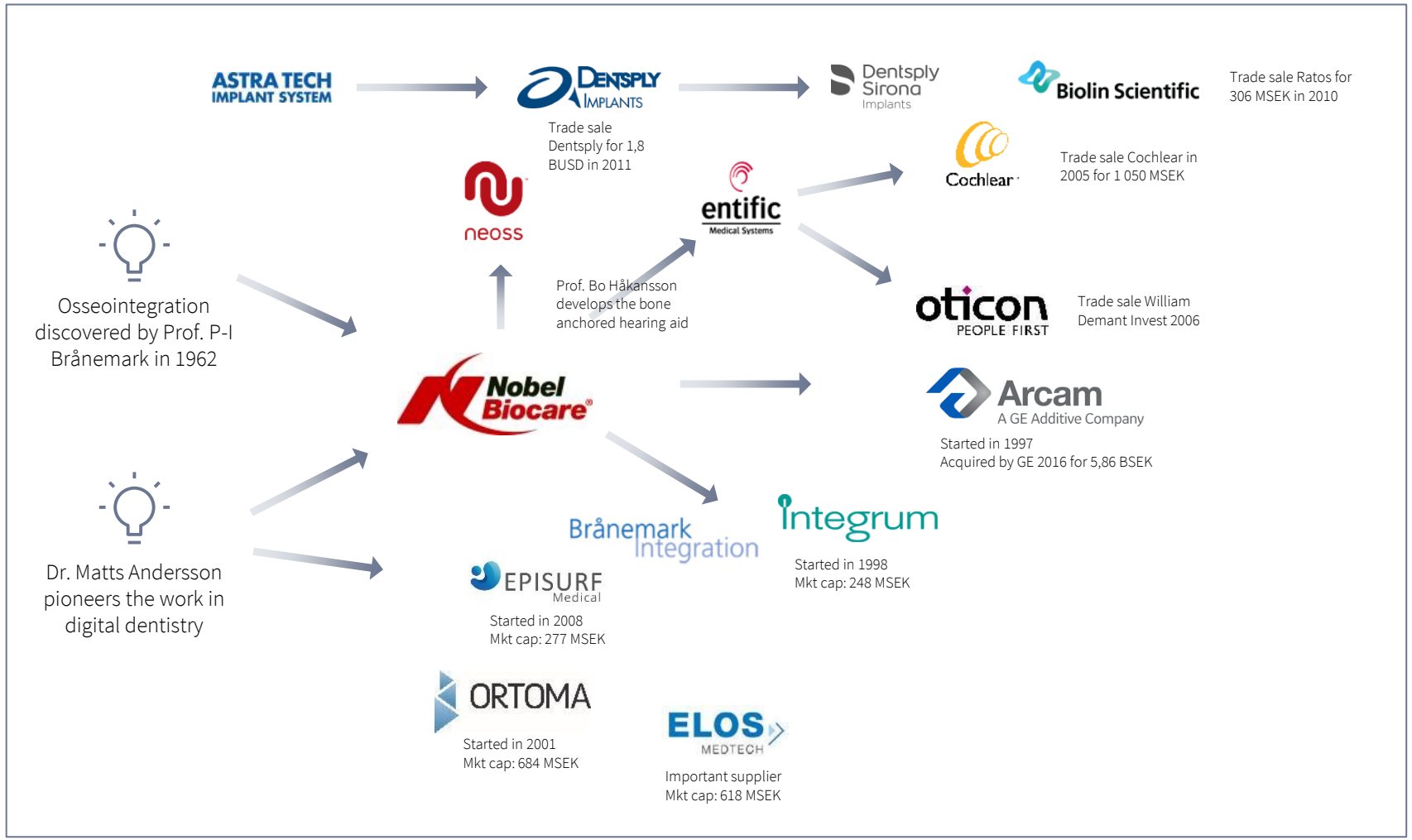
> Career opportunities for domestic and international hires as well as co-travel partners and family

[1]Excluding companies in Marketing and sales category. [2]Headquarter of Dentsply Sirona Implants and of Wellspect are located in Molndal, however the global headquarter of the Dentsply Sirona group is located in US. Arcam part of General Electric. Arcam is included on the list due to high presence in life science sector [3]CVMD: Cardiovascular & Metabolic Disease [4]RIA: Respiratory, Inflammation & Autoimmunity

An industrial tradition of building successful enterprises

Example of how the implant medtech cluster has evolved and continues to create new business opportunities

*Estimated total market Cap/EV: **4 600 MEUR***



- **Culture** characterized by **entrepreneurship** and **company building**
- History of **Innovation** in **close collaboration** between industry and the healthcare system
- **Scientific discoveries** resulting in internationally **successful companies**
- Access to necessary **commercialization and company-building capacity** creates opportunities for **dynamic cluster development**

Source: Sahlgrenska Science Park (2018) The power of coation. Note market valuations have been updated to valuations noted as of 2020

Potential for opportunities in big data, machine learning and AI

In addition to the companies active within AI in life science, West Sweden has a large amount of companies and ongoing initiatives in other verticals working with AI

Source: West Sweden Artificial Intelligence – An inspirational map, April 2018 with minor adjustments

West Sweden's start-up environment

CHALMERS VENTURES

1st in Sweden
World top 3
(2019/2020)

CHALMERS VENTURES

1st in Sweden
World top 10
(2019/2020)

GU Ventures

2nd in Sweden
World top 20
(2019/2020)

Top ranked incubators

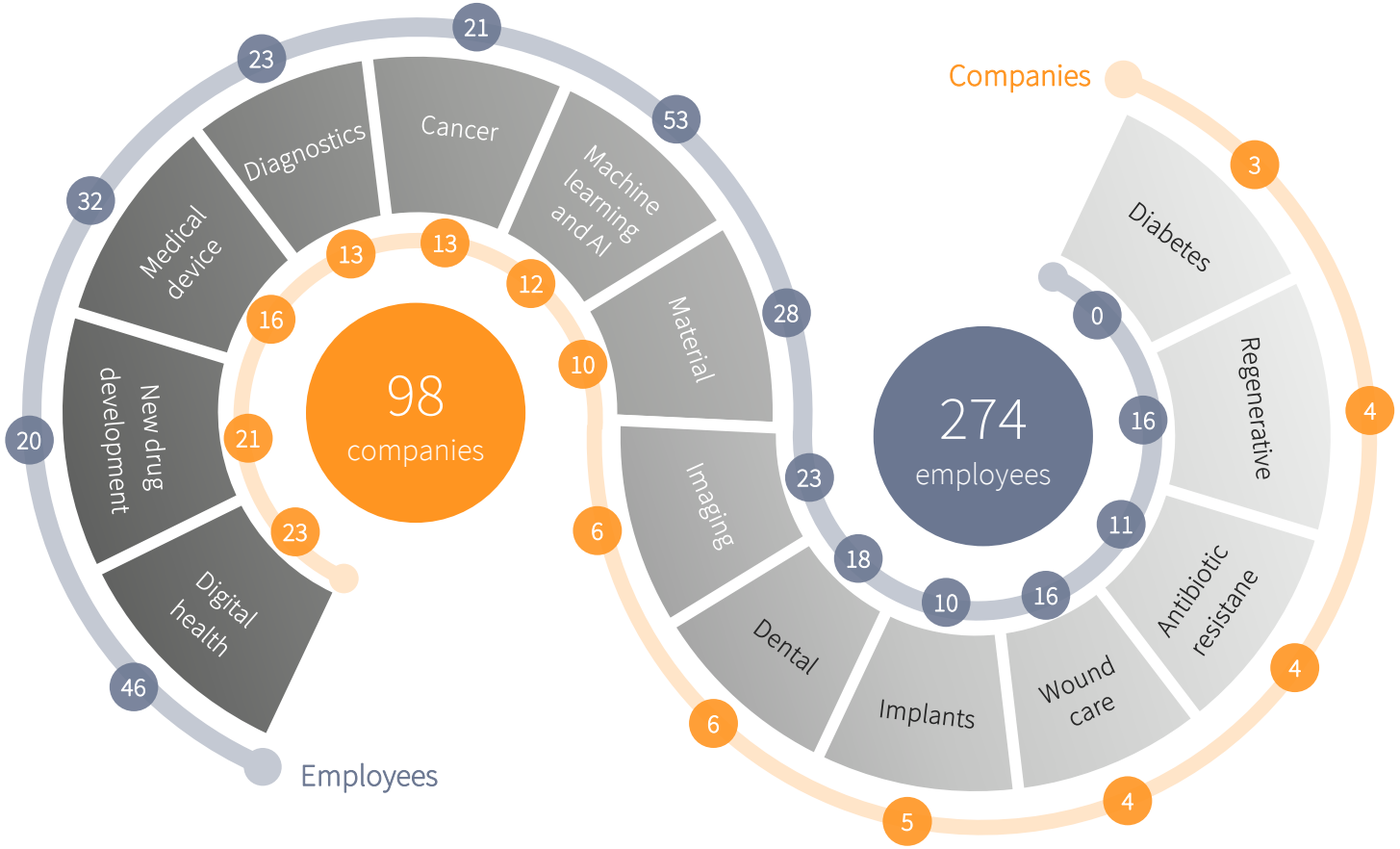
Eight incubator and science parks environments within the region with presence in life science.

Chalmers Ventures and GU Ventures were both on top 20 in the world in 2019/2020 UBI Global ranking, ranked as # 1 and 2 in Sweden. UBI Global ranks incubation programs from around the world. However it should be noted that the incubator needs to apply to become part of the assessment and many of the world's renowned incubators are not included in the ranking.

Start-up companies focused on digital health and new drug development

What do West Sweden's life science start-ups focus on?

Number of companies and employees per area



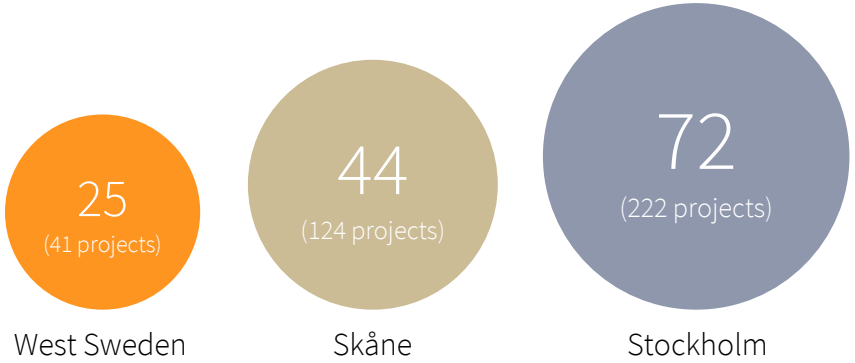
>10 employees

Note: The companies included are founded the last 5 years and/or part of the innovation ecosystem in West Sweden, excluding companies in Marketing and sales category. Companies can be present in several categories. See appendix for description of how the categorization was conducted. Cellink has been excluded from the employee count due to the high number of employees compared to other companies.

SME[1] Drug Development: Small drug pipeline compared to other regions*

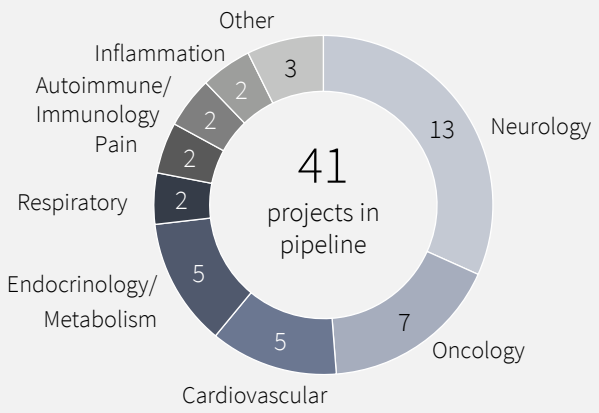
The drug pipeline of pharmaceutical companies with headquarters in West Sweden is significantly smaller than Stockholm and Skåne

Number of companies per region with drugs in pipeline:

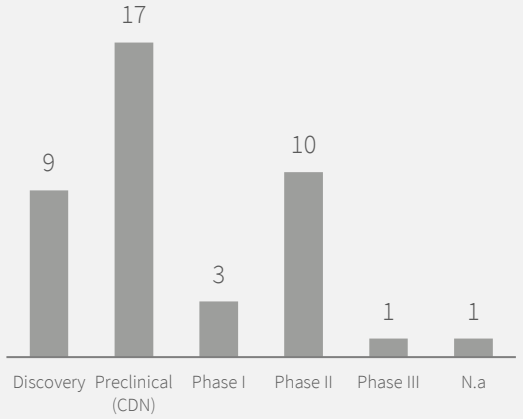


Drug pipeline in West Sweden

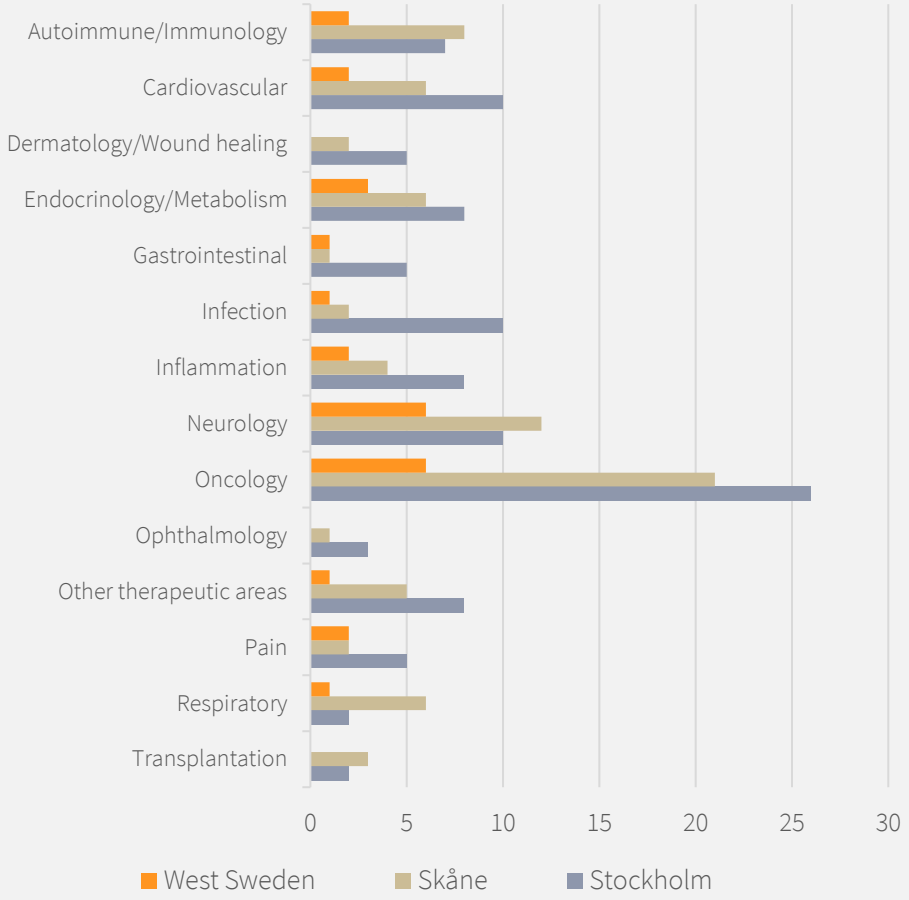
Projects per therapeutic area



Projects per clinical phase



Number of companies per therapeutic area[2]



*Note: Only includes companies with HQ in the region, AstraZeneca therefore not included. [1]Small and medium-sized enterprises, here referring to companies with 0-249 employees. All but one pharmaceutical company with HQ in Sweden (Sobi) included in the data are SMEs. [2]Note that companies can be included in more than one area, the total might therefore not equal to the number of companies.
Source: The Swedish Drug Discovery and Development Pipeline Report 2020 (SwedenBIO)

Contents

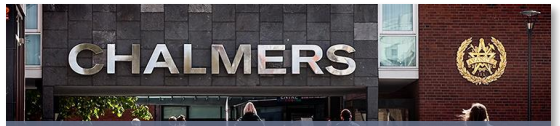
Universities in Västra Götaland

The five universities in the region make out the backbone of the academic excellence in the region with a total of 50 000+ students and 5 700+ researchers

1. University of Gothenburg

- Full year students: **27 251**
- Researchers: **3 025**
- Scientific articles: **44 553**

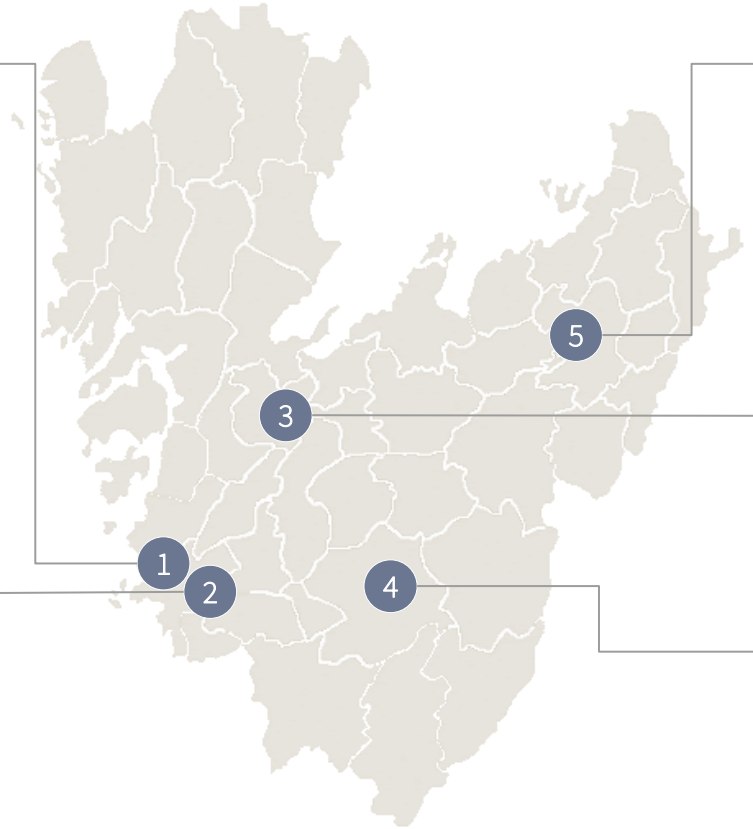
The region's largest university with almost 30 000 full time students of which 5 300 study at the medical faculty Sahlgrenska academy with education and research in medicine, dentistry and healthcare sciences.



2. Chalmers University of Technology

- Full year students: **9 744**
- Researchers: **2 356**
- Scientific articles: **26 206**

Strong focus on life science with *Health Engineering* as one of six areas of advance. The other areas are *Energy, Information and Communication Technology, Materials Science, Production* and *Transport*. A new bachelor's program in Biomedical Engineering introduced in 2020.



5. University of Skövde

- Full year students: **3 722**
- Researchers: **110**
- Scientific articles: **1 442**

Five research fields, of which two are *System Biology* and *Digital Health Research.* Other areas of particular focus and highlighted strengths include gamification, behavioral science and bioinformatics.

3. University West

- Full year students: **5 100**
- Researchers: **120**
- Scientific articles: **1 029**

Three prioritized research areas: *Work integrated learning*, *Child and youth studies* and *Production technology*. Research also conducted in the fields of the Humanities and Nursing and Health Sciences.

4. University of Borås

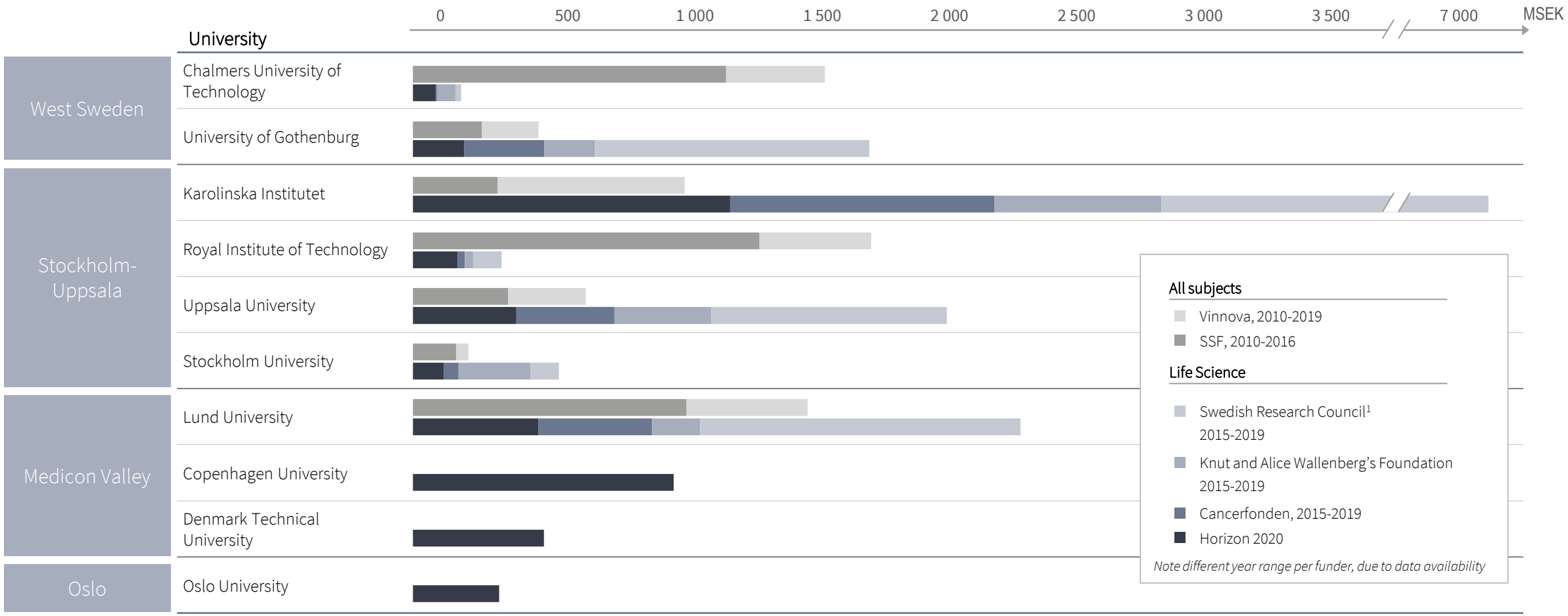
- Full year students: **5 894**
- Researchers: **140**
- Scientific articles: **1 620**

Six prioritized research areas, one being *The human perspective in care,* including research in emergency and prehospital care. Another prioritized area is *Textile and faschion,* applying high-tech use of textiles in e.g. health and life science.

Note: Researchers includes research students. Scientific articles includes articles in all subjects published 2000-2020
Source: University websites, Web of Science

Comparison of research funding overview per university

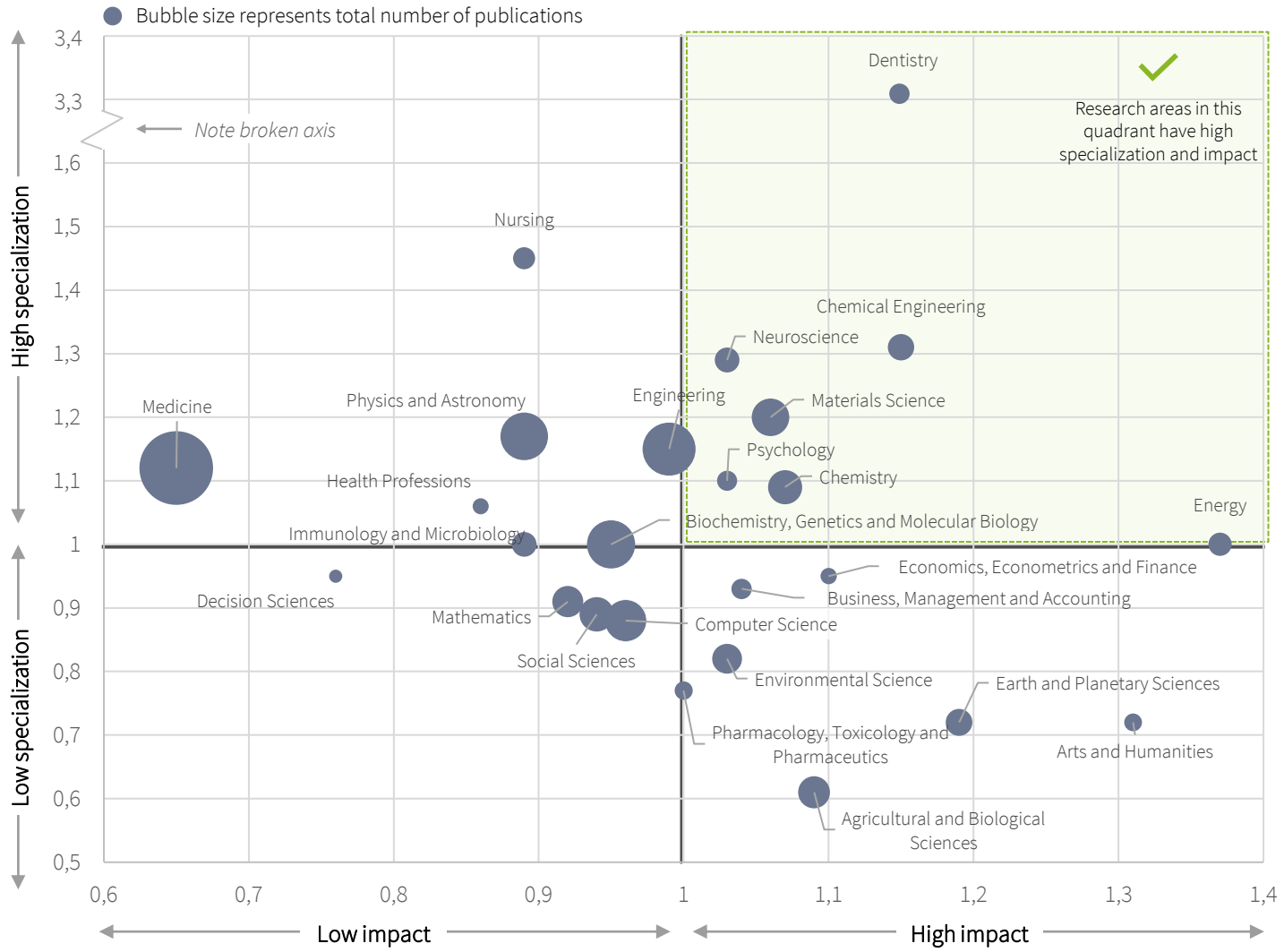
Karolinska Institutet outstanding in funding received for life science research, while GU's performance is slightly below other major universities such as Uppsala and Lund



[1]Categories included in life science: Annan medicin och hälsovetenskap, Hälsovetenskap, Klinisk medicin, Medicinsk bioteknik, Medicinska och farmaceutiska grundvetenskaper, Medicinteknik
Sources: European Commission, Swecris, Knut and Alice Wallenberg's Foundation, Cancerfonden

Scientific strongholds in Västra Götaland: Overarching Research Areas

Rating of all research areas in an evaluation by VGR 2016



Comment

- The chart presents an assessment of academic research in West Sweden based on impact and specialization, see definitions below
- The research areas located in the upper-right quadrant represent the areas were West Sweden shows high performance relative to the Nordic average.
- *Dentistry* is ranked high and by far the research area with highest specialization. Other areas ranked high in the assessment are *Energy, Chemical engineering, Chemistry, Materials Science, Psychology* and *Neuroscience*
- A high amount of articles are published within *Medicine*, but these have on average a lower degree of citation compared to other Nordic regions.

Definitions:

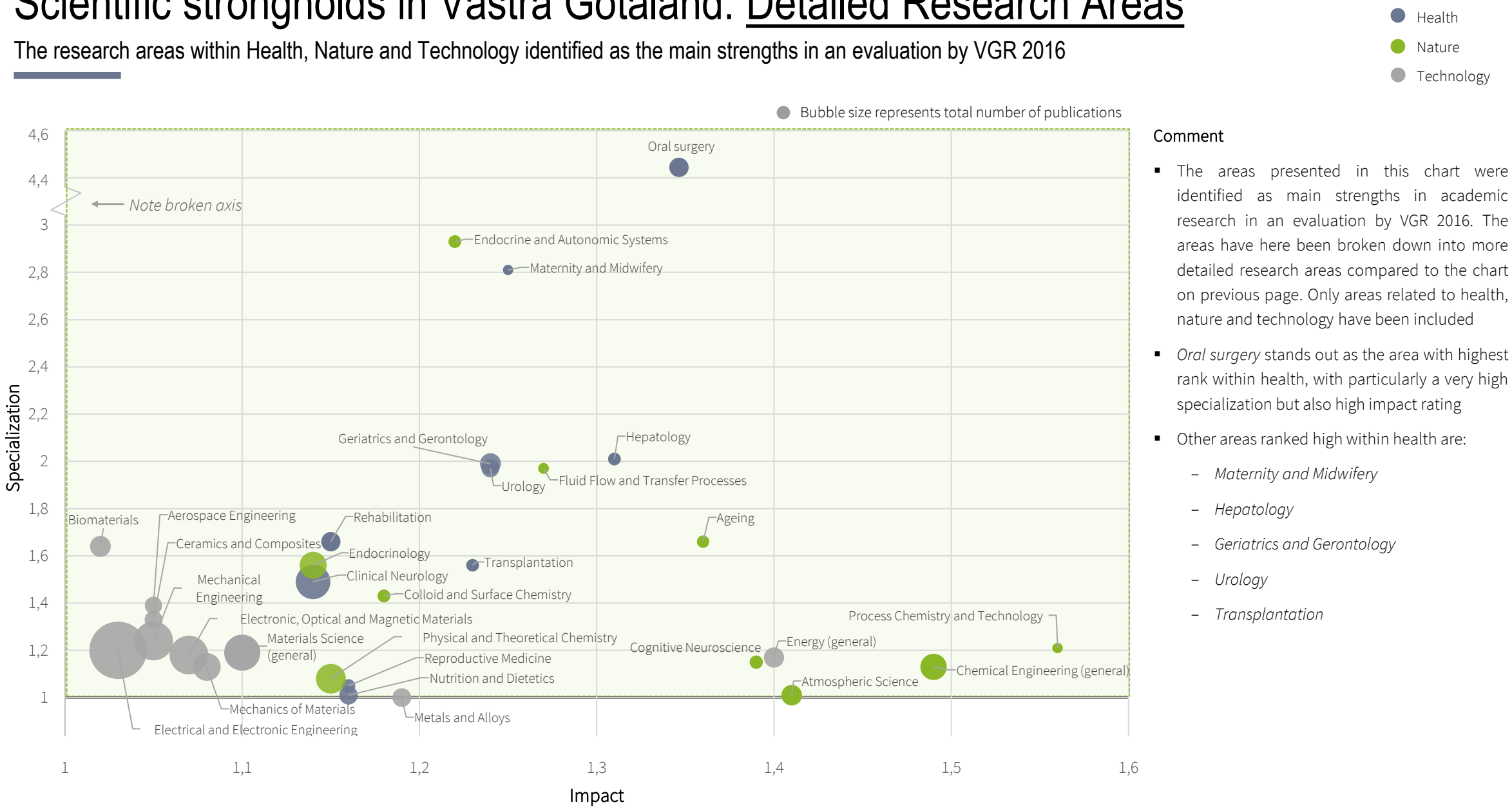
$$\text{Specialization} = \frac{\text{The subjects's share of total publications in Västra Götaland}}{\text{The subject's share of total publications in the Nordics}}$$

$$\text{Impact} = \frac{\text{Average citations per publication in Västra Götaland}}{\text{Average citations per publication in the Nordics}}$$

Note: Based on a mapping conducted by VGR 2016, bibliometric assessment of publications available in Scopus and published in the years 2009-2013.
Source: VGR 2016 Specialiseringar inom näringsliv, akademi och offentlig sektor i Västra Götaland

Scientific strongholds in Västra Götaland: Detailed Research Areas

The research areas within Health, Nature and Technology identified as the main strengths in an evaluation by VGR 2016



Comment

- The areas presented in this chart were identified as main strengths in academic research in an evaluation by VGR 2016. The areas have here been broken down into more detailed research areas compared to the chart on previous page. Only areas related to health, nature and technology have been included
- *Oral surgery* stands out as the area with highest rank within health, with particularly a very high specialization but also high impact rating
- Other areas ranked high within health are:
  - *Maternity and Midwifery*
  - *Hepatology*
  - *Geriatrics and Gerontology*
  - *Urology*
  - *Transplantation*

Note: Based on a mapping conducted by VGR 2016, bibliometric assessment of publications available in Scopus and published in the years 2009-2013.
Source: VGR 2016 Specialiseringar inom näringsliv, akademi och offentlig sektor i Västra Götaland

Most frequent keywords for top-rated researchers

Many researchers in West Sweden focused on cardiovascular system, neuroscience and metabolic area

Most frequent keywords

Less frequent keywords

Comments

- The areas presented in this graph are the most common tagged keywords for life science researchers in West Sweden to identify areas of focus for prominent researchers in the region. Note that many keywords may apply to the same research(er)
- Note that this overview does not necessarily indicate relative strength compared to others, rather relative density of focus
- **Cardiovascular system** represents one of the most common areas, including Cardiovascular disease, Heart failure, Myocardial Infarction and Hypertension
- **Neuroscience** clear focus area with keywords such as Alzheimer, Brain, Stroke, Dementia, Mental disorders, Amyloid beta-Peptides and tau Proteins
- Frequent presence also seen in the **metabolic area**, including e.g. obesity and diabetes
- **Imaging, cancer and bacteria** are also present among the most common areas with more than one keyword

Source: Based on the 5 most frequent keywords per researcher (excl. Organisms and animal diseases) of the 500 highest ranked researchers on Monocl affiliated to universities in West Sweden. See appendix for more information about Monocl and how the platform was used.

Examples of prominent researchers in West Sweden

Examples of researchers based on input from interviews as well as reviewed data

Annika Rosengren

Professor of Medicine, Institute of Medicine, Sahlgrenska Academy, University of Gothenburg

Research focus on Cardiovascular epidemiology, cohort studies and register studies. Member of steering committee for several large international observational studies such as INTERHEART, INTERSTROKE and PURE, and takes part in SCAPIS.

Achievements (examples)
- Ranked #3 on Monocl top medical expert rank
- Received high amount of funding last five years

Fredrik Bäckhed

Professor at Department of Molecular and Clinical Medicine, University of Gothenburg

Leads a research team specialized on the significance of the gut microbiota to health. The overall aim of their research is to clarify the role of bacteria associated with the human body in the development of metabolic diseases as well as delineating whether altered gut microbiota contributes to the beneficial effects of bariatric surgery.

Achievements (examples)
- Top cited researcher
- Appointed Wallenberg Scholar 2019

Henrik Zetterberg

Professor/Chief physician at Department of Psychiatry and Neurochemistry, Sahlgrenska Academy, GU

World leading researcher with main focus on fluid biomarkers for central nervous system diseases, Alzheimer's disease in particular. He has published more than 1100 papers and works closely together with Kaj Blennow.

Achievements (examples)
- Top cited researcher
- Has received numerous awards including Fernström Prize for promising young researcher
- Wallenberg Academy Fellow 2014

Jens Nielsen

Professor, Quantitative Systems Biology, Chalmers

Leads a research group of more than 60 people with focus on systems biology of metabolism, including studying regulatory pathways conserved in the Eukaryal kingdom, developing efficient cell factories for sustainable production of fuels and chemicals, and developing metabolic models for Eukaryal cells.

Achievements (examples)
- Top cited researcher
- Inventor of more than 50 patents
- Has founded several companies

Joakim Larsson

Professor at Department of Infectious Diseases, University of Gothenburg

Leads a group engaged in research on several aspect of antibiotic resistance, with a particular expertise in the environmental dimensions, spawning from a long-standing interest in pharmaceuticals in the environment.

Achievements (examples)
- Top cited researcher
- More than 50 million SEK from Swedish research council the last 10 years

Kaj Blennow

Professor/chief physician at Department of Psychiatry and Neurochemistry, Sahlgrenska academy, GU

World leading researcher within biomarkers for Alzheimer's disease and other brain disorders. Research aim to understand why the synapses of nerve cells are damaged in Alzheimer's disease and especially studies the protein neurogranin, only found in the synapses where it has an important function for memory

Achievements (examples)
- Top cited researcher
- Has received numerous international awards including Alois Alzheimer Research Award 2001, Alzheimer's Association Lifetime Achievement Award 2011

Karl Swedberg

Senior Professor of Cardiology and Care Science, Department of Molecular and Clinical Medicine, Sahlgrenska Academy, GU

Most well-known for his research on heart failure and myocardial infarction. He was the first to report on survival benefits of a beta-blocker (1979), an ACE-inhibitor (1987), an angiotensinreceptor blocker (2003) and recently an ARNI (angiotensin receptor antagonist and neprilysin inhibitor 2014) in chronic heart failure.

Achievements (examples)
- Top cited researcher with > 65 000 citations
- Scientific Advisor to the University of Gothenburg Centre for Person Centred Care (GPCC)

Maria Falkenberg

Professor in Biomedical Laboratory Science

Department of Medical Biochemistry and Cell biology, GU

Leads a research group focusing on the basic mechanisms of human mitochondrial DNA replication and how this process is regulated. They also study the effects of pathological mutations in human disease. The research is based mainly on in vitro biochemical approaches using recombinant proteins and artificial templates.

Achievements (examples)
- Elected to the Royal Swedish Academy of Sciences in 2015
- Appointed Wallenberg Scholar 2019

Max Ortiz Catalan

Associate Professor, Electrical Engineering

Head of the Bionics Research Unit, Chalmers

Research focus on neural control of artificial limbs via osseointegrated implants. This involves bio-electric signals acquisition and processing, neural interfaces, machine learning, osseointegration, and neurostimulation. Founded the Biomechatronics and Neurorehabilitation Laboratory.

Achievements (examples)
- Has received many national as well as international awards, including Chalmers Foundation Award 2020, Henry Wallman Prize 2019

Sven Enerbäck

Professor of Medical Genetics

Head of Department Institute of Biommedicine, University of Gothenburg

Has gained international recognition for his research on fat cells at the molecular level. Discovered that not only infants but also adults have active brown adipose tissue that affects metabolism, which opened up new opportunities to find methods for treating obesity.

Achievements (examples)
- Appointed Distinguished Professor by the Swedish Research Council in January 2020
- Chairman for class of medical sciences, the Royal Swedish Academy of Sciences

Note: These researchers are selected based on a subjective assessment of data including publications, citations, ranking on Monocl, research funding as well as input during interviews and only presents examples of prominent researchers in the region. The researchers are presented in alphabetic order. See coming pages for an overview of more top researchers based on different data points and sources.

Example areas with prominent research in West Sweden

Based on Monocl search for a limited selected number of MeSH[1] keywords. Areas where researchers in West Sweden are ranked as top-5 in the Nordic countries have been included. The overview is intended to provide examples of specific areas with prominent research teams as prioritized by the Monocl database.

Keyword	Total # of experts in Nordic countries	West Sweden in top-5					Comment
		1	2	3	4	5	
Mitochondrial DNA	2 593		x	x			M. Falkenberg, C. Gustafsson (#9 and 19 globally)
DNA	23 972					x	M. Falkenberg. F. Westerlund on #8
Osseointegration	671	x	x	x	x		A. Wennberg #7 globally
Systems Biology	1 126	x			x	x	J. Nielsen (#2 globally) M. Krantz, J. Boren
Neurological Disorders	34 155	x	x				H. Zetterberg, K. Blennow (#1 and 2 globally)
Midwife	842		x				I. Lundgren
Prostheses and implants	9 044			x			A. Wennberg
Anaplastic Lymphoma Kinase	259	x	x		x		R. Palmer (#11 globally), B. Hallberg, T. Martinsson
Gene Expression Profiling	12 238		x				J. Nielsen
Exosomes	936	x			x		J. Lötvall (#5 globally), C. Lässer
In-vitro fertilization	1 204			x			C. Bergh
Irritable Bowel Syndrome	873	x	x		x		M. Simrén (#1 globally), H. Törnblom, L. Ohman
Osteoporosis	3 106			x			C. Ohlsson

[1]Medical Subject Headings, vocabulary produced by the National Library of Medicine
Source: Monocl. See appendix for more information about Monocl and how the platform was used.

Top 20 medical experts affiliated to universities in West Sweden

Top 5 per category

Web of science highly cited researchers 2019[2]

#	Name	University	Department	Most frequent MeSH keywords	Publications	Publications as last author	Meeting presentations	Citations[1]
1	Henrik Zetterberg	GU	Psychiatry and Neurochemistry	Alzheimer Disease; Amyloid beta-Peptides; Tau Proteins; Peptide Fragments; Amyloid beta-protein (1-42)	1179	161	188	38 819
2	Kaj Blennow	GU	Psychiatry and Neurochemistry	Alzheimer Disease; Amyloid beta-Peptides; Tau Proteins; Peptide Fragments; Amyloid beta-protein (1-42)	1305	230	151	68 132
3	Annika Rosengren	GU	Molecular and Clinical Medicine	Cardiovascular Diseases; Myocardial Infarction; Coronary Disease; Stroke; Hypertension	411	76	21	24 578
4	Claes Ohlsson	GU	Internal Medicine and Clinical Nutrition	Bone and Bones; Estradiol; Insulin-Like Growth Factor I; Absorptiometry Photon; Osteoporosis	578	148	28	35 282
5	Karl Swedberg	GU	Molecular and Clinical Medicine	Heart Failure; Stroke Volume; Tetrazoles; Myocardial Infarction; Benzimidazoles	511	107	13	68 761
6	Turgut Tatlisumak	GU	Clinical Neuroscience	Stroke; Brain Ischemia; Cerebral Hemorrhage; Magnetic Resonance Imaging; Tissue Plasminogen Activator	352	103	6	11 851
7	Magnus Simrén	GU	Internal Medicine and Clinical Nutrition	Irritable Bowel Syndrome; Gastrointestinal Diseases; Feces; Intestinal Mucosa; Gastrointestinal Transit	290	94	21	11 695
8	Jan Boren	GU	Molecular and Clinical Medicine	Triglycerides; Apolipoproteins B; Liver; Atherosclerosis; Lipoproteins, VLDL	293	58	14	12 874
9	Björn Redfors	GU	Molecular and Clinical Medicine	Percutaneous Coronary Intervention; Coronary Artery Disease; Coronary Angiography; Myocardial Infarction;…	138	3	37	1 561
10	Mikael Landén	GU	Psychiatry and Neurochemistry	Bipolar Disorder; Schizophrenia; Psychotic Disorders; Depressive Disorder Major; Brain	240	84	6	11 795
11	Jon Karlsson	GU	Orthopaedics	Anterior Cruciate Ligament Injuries; Joint Instability; Anterior Cruciate Ligament; Arthroscopy; Knee Joint	357	120	2	8 919
12	Ingmar Skoog	GU	Psychiatry and Neurochemistry	Dementia; Alzheimer Disease; Brain; Cognition Disorders; Hypertension	339	113	21	14 927
13	Bo Jacobsson	GU	Obstetrics and Gynecology	Fetal Membranes, Premature Rupture; Amniotic Fluid; Premature Birth; Chorioamnionitis; Obstetric Labor, Premature	284	86	4	8 099
14	Philip Moons	GU	Care in Long-term Conditions	Heart Defects, Congenital; Diabetes Mellitus, Type 1; Cardiovascular Diseases; Arrhythmias, Cardiac;Pregnancy…	301	83	12	6 539
15	Lennart Jacobsson	GU	Rheumatology and Inflammation Research	Arthritis, Rheumatoid; Sjogren's Syndrome; Tumor Necrosis Factor-alpha; Spondylitis, Ankylosing; Arthritis, Psoriatic	261	68	52	12 133
16	Mattias Lorentzon	GU	Internal Medicine and Clinical Nutrition	Absorptiometry, Photon; Osteoporosis; Fractures, Bone; Bone and Bones; Osteoporotic Fractures	194	43	34	14 469
17	Elmir Omerovic	GU	Molecular and Clinical Medicine	Myocardial Infarction; Percutaneous Coronary Intervention; Takotsubo Cardiomyopathy; Acute Coronary Syndrome…	147	60	31	4 379
18	Johan Herlitz	Borås	Caring Science	Myocardial Infarction; Cardiopulmonary Resuscitation; Heart Arrest; Electrocardiography; Coronary Artery Bypass	598	161	5	25 474
19	Björn Eliasson	GU	Molecular and Clinical Medicine	Diabetes Mellitus type 2; Cardiovascular Diseases; Diabetes Mellitus type 1; Glycated Hemoglobin A; Blood Glucose	186	29	22	11 220
20	Max Petzold	GU	Public Health and Community Medicine	Malaria; Artemisinins; Malaria, Falciparum; Dengue; Diagnostic Tests, Routine	254	32	6	39 223
-	Jens Nielsen	Chalmers	Systems and Synthetic Biology	Saccharomyces cerevisiae; Muscle skeletal; Saccharomyces cerevisiae proteins; Glucose; Gene expression profiling	1452	659	19	41 706
-	Fredrik Bäckhed	GU	Molecular and Clinical Medicine	Obesity; Intestines; Intestinal Mucosa; Gastrointestinal Tract; Bacteria	168	58	58	34 180
-	Joakim Larsson	GU	Infectious Diseases	*n/a in Monocl*	156[1]	*n/a in Monocl*		8 493

Note: Sorted according to relevance last 5 years (Monocl). Some researchers that are or have been active at more than one university may not be included on the list due to that they have several profiles on Monocl and hence not all activities are assigned to their profile for West Sweden. Three top-cited researchers affiliated to universities in West Sweden have been added to the list

Source: Monocl if not otherwise noted. [1]Web of Science [2]Scientists who produced multiple papers ranking in the top 1% by citations for their field and year of publication

Top research grant recipients

Total funding since 2015 from a selected number of organizations to individuals affiliated to universities in West Sweden

Rank	Name	University	Research field (main)	Total funding (SEK)[1]
1	Maria Falkenberg	GU	Human mitochondrial DNA replication	69 549 850
2	Gunnar C Hansson	GU	Structure and function of mucins	67 500 000
3	Sven Enerbäck	GU	Endocrinology and diabetes	57 800 000
4	Ruth Palmer	GU	Neuroblastoma, childhood cancer	46 800 000
5	Thomas Nyström	GU	Aging and protein quality control	44 700 000
6	Fredrik Bäckhed	GU	Microbiome research	43 200 000
7	Jens Nielsen	Chalmers	Bioinformatics and systems biology	35 224 178
8	Tommy Martinsson	GU	Neuroblastoma, childhood cancer	33 200 000
9	D G Joakim Larsson	GU	Microbiology, antibiotic resistance	32 900 000
10	Göran Dellgren	GU	Anesthesia and intensive care	30 000 000
11	Anders Rosengren	GU	Diabetes	26 772 300
12	Andrew Ewing	GU	Chemical imaging	25 000 000
13	Fredrik Westerlund	Chalmers	Nanotechnology for studies of single molecules	23 409 455
14	Georg Kuhn	GU	Neuroscience	22 576 000
15	Göran Landberg	GU	Cancer and oncology	21 825 000
16	Davide Angeletti	GU	Immunology	20 816 970
17	Henrik Zetterberg	GU	Neuroscience	19 850 930
18	Hiroki Shibuya	GU	Cell Biology	19 800 000
19	Annika Rosengren	GU	Cardiovascular disease	17 800 000
20	Emma Börgeson	GU	Obesity and cardiometabolic disease	17 000 020

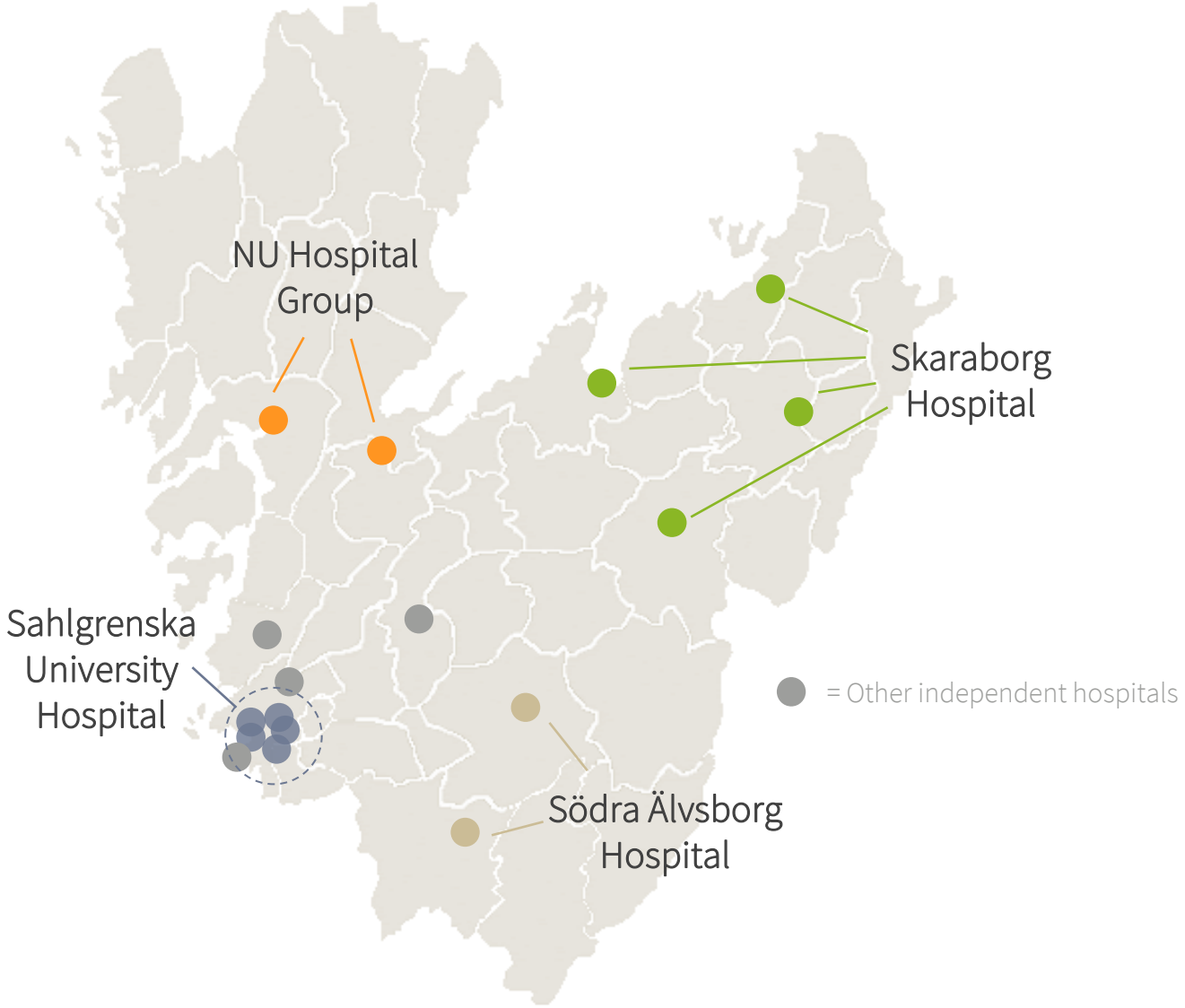
Comments

- Cancer and especially childhood cancer is an area that receives a high amount of funding in relation to other areas, in line with overall life science funding for which oncology stands out as a therapeutic area that receives significant funding overall
- In addition, significant funding is provided to researchers within e.g. metabolic diseases, neurological diseases and systems biology
- It can be noted that only two of the researchers on the list represents Chalmers. This is however natural as the number of researchers focusing on life science is much higher at GU than Chalmers
- Funding from the Swedish Knowledge Foundation is not included in the graph due to that no specific individuals are specified in the funding data. It should however be noted that University of Skövde in the last 5 years have received at least 50 million SEK for projects related to life science, and of this >30 million SEK are for projects driven by the research group in Translational Bioinformatics

Note: A categorization of the research grants has been conducted in the analysis when needed to only include grants assessed to be relevant for life science. In case of several individuals on the same funding application, only the one titled as project lead has been included. [1]The funding organizations and years included in the data are: Cancerfonden 2015-2019, European research council 2015-2020, Knut and Alice Wallenberg Foundation 2015-2019, Swedish Foundation for Strategic Research (SSF) 2015-2016, Swedish Research Council 2015-2019, Vinnova 2015-2019.
Sources: European Commission, SweCRIS, Knut och Alice Wallenbergs stiftelse, Cancerfonden, Swedish Knowledge Foundation

The hospitals in West Sweden

There is a total of 17 hospitals in the region divided into 4 hospital groups plus 4 independent hospitals



Sahlgrenska University Hospital's centers

Centers for care areas where the hospital aims to have a leading competence both nationally and internationally.

- Breast Center
- CF Center (Cystic Fibrosis)
- Center for Advanced Reconstruction of Extremities (C.A.R.E.)
- Center for Huntington's Disease
- Center for highly specialized epilepsy care
- Center for Medical Genomics
- Center for Rare Diagnoses (CSD)
- Geriatric Development Center
- Gothenburg Emergency Medicine Research Group (GEMRG)
- COPD center
- Prostate Cancer Center
- Intestinal Weight Center
- Transplant Center

Residency education in Innovation and Technology

Sahlgrenska University Hospital launched a new residency education in 2019 with focus on innovation and technical solutions. This is a part of Sahlgrenska´s active work to meet the challenges of the future in healthcare by encouraging innovation. The participants will get the needed knowledge and tools to drive their own innovation projects at the hospital. This is the first education of its kind in Sweden.

National specialized medical care Sweden

Granted licenses per hospital by the Swedish National Board of Health and Welfare

	Västra Götalandsregionen	Region Skåne		Region Stockholm			Region Uppsala	Region Östergötland	Region Västerbotten	
Areas of care	Sahlgrenska universitetssjukhuset	Skånes universitetssjukhus Lund	Skånes universitetssjukhus	Karolinska universitetssjukhuset	S:t Eriks ögonsjukhus	Södersjukhuset	Akademiska sjukhuset	Universitetssjukhuset i Linköping	Norrlands universitetssjukhus i Umeå	Total
Anorektala och urogenitala missbildningar, Hirschsprungs sjukdom		X		X						2
Barn med cochleaimplantat				X						1
Barnglaukom och barnkatarakt	X				X					2
Endometrios	X		X			X	X			4
EXIT				X						1
Hjärtkirurgi på barn och ungdomar	X		X							2
Hjärtkirurgi på vuxna med medfödda hjärtfel	X		X							2
Hjärttransplantation	X		X							2
Intrauterina behandlingar				X						1
Kraniofacial kirurgi	X						X			2
Levertransplantation	X			X						2
Lungtransplantation	X		X							2
Medfödda missbildningar på matstrupen		X		X						2
Kirurgi vid medfött diafragmabråck			X	X						2
Kirurgi vid medfödda missbildningar på matstrupen		X		X						2
Plexus brachialisskador						X			X	2
Svåra brännskador							X	X		2
Trofoblastsjukdomar				X						1
Ögononkologi					X					1
Total per hospital	8	3	6	9	2	2	3	1	1	35
Total per county council	8	9		13			3	1	1	35

Note: According to Swedish regulations national specialized medical care can be performed at a maximum of five healthcare units in the country. They are required to meet criteria to provide competence, availability and to work in multidisciplinary teams in order to provide the best possible care to the patient. In July 2018 a new regulation was set in place in order to concentrate a larger section of national specialized medical care
Source: National Board of Health and Welfare (Socialstyrelsen)

Summary: Scientific strongholds

Research areas that based on reviewed data and interviews have emerged as scientific strongholds for West Sweden. A short summary of the main supporting data is given per area

Dentistry and Oral surgery

- Highly ranked in the specialization and impact assessment of academic research. The area with highest specialization of all overarching research areas
- University of Gothenburg ranked very high on Shanghai ranking in Dentistry & Oral Sciences
- The Brånemark Clinic is one of most well known implantology clinics in the world

Cardiovascular & metabolic disease

- Cardiovascular diseases the most common area of research among the top-rated researchers in the region
- Also obesity and diabetes very common keywords among top researchers
- Several prominent and highly cited researchers within these fields, that also receive a high amount of research funding (e.g. Bäckhed, Enerbäck, Hansson, Rosengren, Swedberg)

Biomaterials

- High ranking in specialization and impact assessment of academic research
- Strong presence of globally leading researchers within the field of osseointegration
- Peter Thomsen internationally leading researcher within Biomaterials, professor at the Department of Biomaterials at GU[1]

System biology and bioinformatics

- Research group in Translational Bioinformatics at University of Skövde that receives a high amount of funding and collaborates with many industrial partners
- Research group of more than 60 people at Quantitative Systems Biology at Chalmers, receives high amount of funding. Lead by Jens Nielsen, ranked #2 globally on Monocl for Systems biology

Genetic research

- Messenger RNA, Gene Expression Profiling and DNA sequence analysis among the most common keywords for the top-rated researchers in the region
- Research team at Department of Medical Biochemistry and Cell biology focusing on mitochondrial DNA replication. Lead by Maria Falkenberg who receives very high amount of research funding
- Genetic research and RNA mentioned as scientific stronghold in interviews

Transplantation

- High ranking in specialization and impact assessment of academic research
- National specialized medical care at Sahlgrenska University Hospital
- The team behind the uterus transplantation highlighted by many interviewees
- Area not explicitly visible among top ranked researchers

Neuroscience & Geriatrics

- Neuroscience and Geriatrics & Gerontology ranked high in specialization and impact assessment of academic research
- World leading researchers (Blennow, Zetterberg) within Alzheimer's disease
- One of the most common areas of research among the top-rated researchers in the region
- Highlighted as a scientific stronghold by several interviewees

Maternity and Midwifery

- Maternity and Midwifery ranked high in specialization and impact assessment of academic research, with very high specialization
- Reproductive medicine ranked high in specialization and impact assessment of academic research
- Highlighted as a scientific stronghold by several interviewees

Basic oncology research

- High amount of research funding relative to other areas. This is however a common pattern in life science research overall and it can hence not be concluded that West Sweden receives especially high funding in cancer research compared to other regions
- Highlighted as a scientific stronghold in interviews

Complementary areas

Other complementary fields of research that are not exclusively related to life science but have connected application areas. Areas that have come up in the analysis include:

- Materials science; high ranking in specialization and impact assessment, mentioned by interviewees as scientific stronghold
- Chemistry; high ranking in specialization and impact assessment, mentioned by interviewees as scientific stronghold
- Energy; very high impact in specialization and impact assessment

[1]Not included in Monocl data as he is also affiliated to Aarhus University in Denmark

Contents

The quantitative and qualitative data highlight availability of prominent and unique infrastructure and initiatives in West Sweden

Established infrastructure

Sahlgrenska University Hospital

- One of the largest hospitals in northern Europe with 1 950 hospital beds
- The country´s center for certain specialized care in several areas, including organ transplantation and heart surgery

AstraZeneca research site

- One of AstraZeneca's three strategic, global R&D centers
- 2 400 employees on site
- 2 000 scientists from 50 countries

WCMTM

- Wallenberg Centre for Molecular and Translational Medicine
- 620 million SEK investment over 10 years
- Focus molecular medicine aspects of metabolic and degenerative diseases, neuroscience, inflammation, cancer and life science chemistry

Gothia Forum

- Single point of entry to conduct clinical trials for all hospitals in the region
- Mission to strengthen clinical research in VGR and work as a forum and resource for researchers and industry

BioVentureHub

- Globally-renowned life science innovation hub launched in in 2014
- 30+ companies and partners with continued funding of SEK 30 million for the coming five-year period

BOIC

- Sahlgrenska Image and Intervention Center
- 2 billion SEK investment in one of Europe's most advanced centers for diagnostics and imaging
- New research lab planned for 2021

Ongoing projects

GoCo

- Development of health innovation cluster
- SEK 3,5 billion investment with target to offer 100 000 square meters of office, retail and living space when completed

Sahlgrenska Life

- Plans to develop the area around Sahlgrenska with new buildings of totally more than 100 000 square meters
- Objective to create a national center for life science with natural connections between the hospital and GU, to facilitate translational research and innovation

Note. The included examples represents a limited selection of available infrastructure and projects commonly highlighted as prominent examples and potential building blocks for cross-sector collaborate researches by interviewees

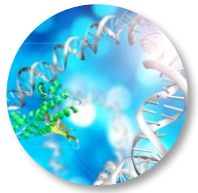
Examples of recent and ongoing initiatives

AI Sweden

- National centre for applied AI research and innovation officially hosted by Lindholmen Science Park
- Funded by Vinnova, VGR and almost 70 partners from the industrial and public sectors, research institutions, and the academic world

CHAIR – Chalmers AI Research Centre

- Major initiative that aims to significantly increase Chalmers' expertise and excellence in Artificial Intelligence
- SEK 370 million investment over ten years



FoRmulaEx Centre

- Industrial research center for functional RNA delivery
- At least 75 million SEK to be invested in eight-year agreement between CTH, GU, KI and industry partners (e.g. AstraZeneca)

ATMP Center SU

- New center with purpose to offer advice and support for researchers and companies to initiate clinical trials for ATMP or introduce in healthcare
- E.g. support in preparing project description, IMPD, regulatory questions or access to GMP premises

Clean Care

- Project coordinated by RISE, centered at Sahlgrenska aiming to prevent spread of infection and antibiotic resistant microbes in healthcare
- Cross-sector collaboration with 12 participants from academia, industry and healthcare with a total budget of 22,5 million SEK

Health Works

- Under establishment by AstraZeneca in Gothenburg
- Target to establish infrastructure to create and test innovation involving patients, healthcare and industry

Knowledge exchange collaborations for small & medium-sized companies (SMEs)

- SMEs affiliated to Sahlgrenska Science Park and AZ BioVentureHub are offered free access to expertise in large life science companies
- Collaborations established with AstraZeneca, IBM and Mölnlycke

Comprehensive Cancer Center

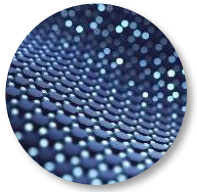
- Accreditation process initiated by Sahlgrenska University Hospital to become a Comprehensive Cancer Center
- The hospital must show a high quality in both cancer care and research to become accredited by European Cancer Institutes

SCAPIS AI-platform

- Pilot 2-year project funded by Vinnova with aim to make high-quality medical datasets available to AI research and development
- Led by SCAPIS[1] at the University of Gothenburg together with AI Sweden and AIDA[2] in Linköping

BioMine University of Skövde

- Data-mining for identification, selection and validation of biomarkers
- Collaboration between School of Bioscience and industrial partners (e.g. AstraZeneca, Takara Bio, Unilabs, 1928 Diagnostics, TATAA Biocenter)



CoSiMa – Chalmers new materials

- Concept for industrial development for the sustainable soft materials of the future
- Chalmers together with partners (e.g. AstraZeneca, Essity, Tetra Pak and Stora Enso)

Sweden a leader in advanced therapies 2030

- 5-year project aiming for a long-term transformation of the innovation system for advanced therapies
- Cross-sector collaboration coordinated by RISE with SEK 10 million funding from Vinnova

[1]The aim of the Swedish CArdioPulmonary bioImage Study (SCAPIS) is to predict and prevent cardiovascular disease (CVD) and COPD. SCAPIS will provide a nationwide, open-access, population-based cohort for the study of cardiovascular disease (CVD) and chronic obstructive pulmonary disease (COPD). SCAPIS has recruited 30,154 men and women aged 50 to 65 years with detailed imaging and functional analyses of the cardiovascular and pulmonary systems [2]AIDA: Analytic Imaging Diagnostics Arena

Contents

Summary: Regional strongholds

Industry

- Presence of large life science companies enabling access to commercialization and scale-up capacity
- Particular industrial strongholds in:
  - Drug development (manifested by AstraZeneca R&D site and associated strongholds)
  - Advanced wound care and health facility products
  - Implants and anatomical reconstructions
- Digital health the fastest growing segment
- Proximity to tech and automotive industry

Scientific / Academia / Clinical

- Traditional life science strongholds:
  - Dentistry and oral surgery
  - Cardiovascular and metabolic diseases
  - Biomaterials
  - Transplantation
  - Neuroscience & Geriatrics
  - Maternity and midwifery
- Additional strengths in: System biology and bioinformatics, basic research oncology, genetic research
- Complementary not exclusively life science: Chemistry, materials science and energy
- Prominent research initiatives and infrastructure

General infrastructural strengths

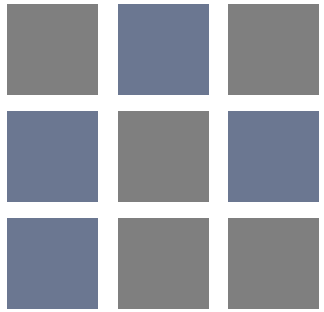
- Strong public collaboration between universities and healthcare
- Presence of one of the largest university hospitals in Europe
- “A get things done” - mentality
- Developed innovation system and support functions with well-established collaborations between public actors within the system
- Active region supporting Life Science
- High quality clinical research
- Geographical proximity

Note. The summary of the regional strongholds represents the consolidated view based on the reviewed quantitative data and input provided by interviewees (particularly regarding general infrastructural strengths)

Contents

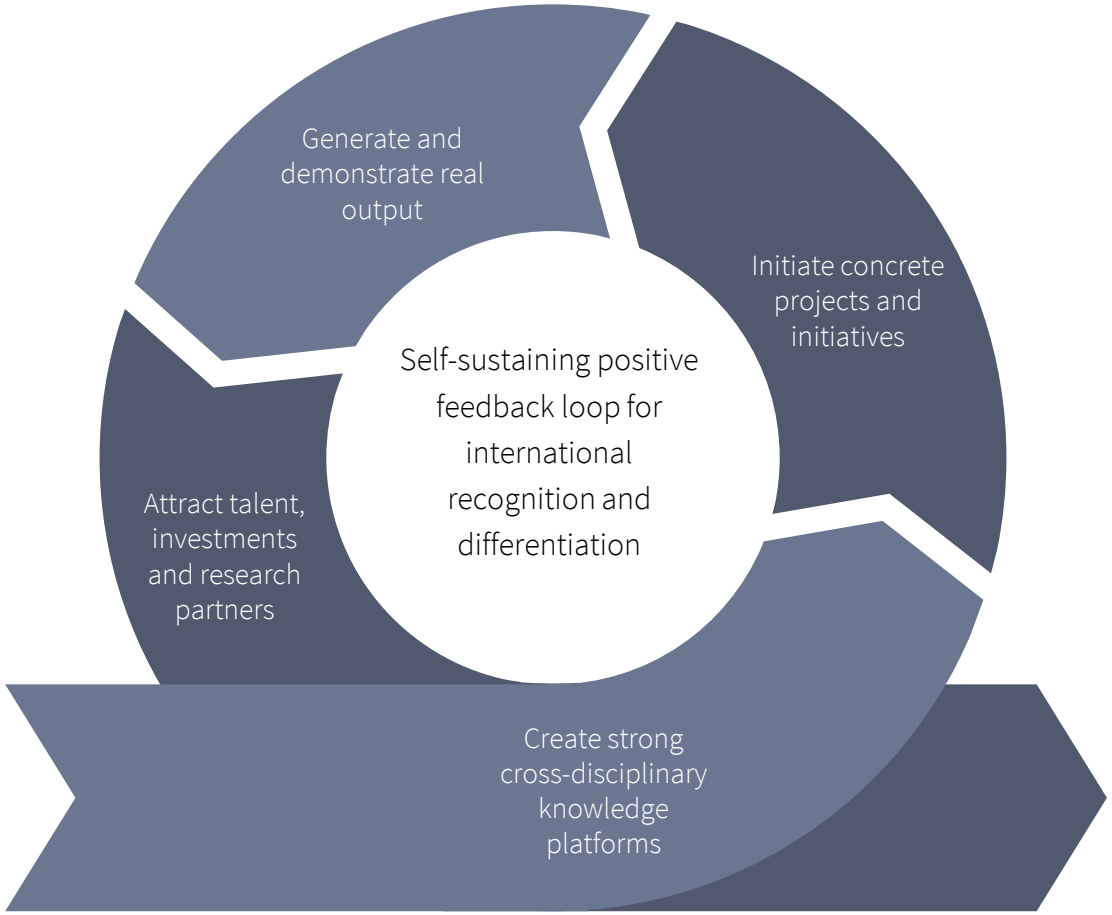
Focus essential when building a world class life science cluster

The ambition is to identify and focus efforts in prioritized areas where Health Innovation West can become world class by leveraging regional strongholds and opportunities



Select focus in areas with:

- Mutual cross-sector interests and common denominators for both public and private actors
- Opportunity to leverage existing strongholds and combine them in new and innovative ways
- Fulfill a Nordic need to enable critical mass
- High impact potential; substantially improved patient health and opportunity for real commercial successes and societal impact

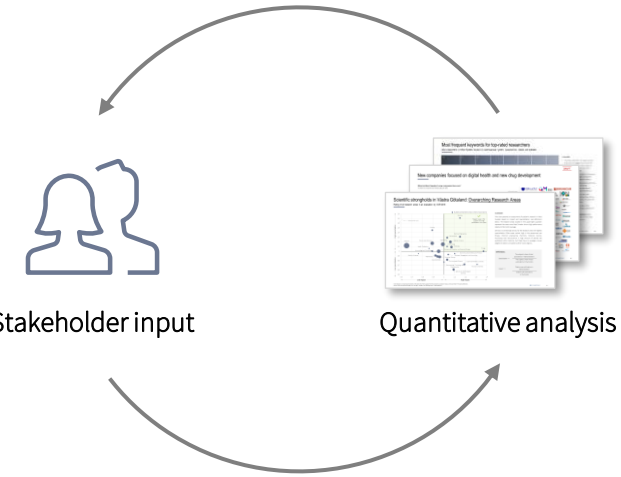


A world class Life Science cluster

- Competitive edge that attracts talents, investment and research collaborations
- Supports innovation, business development and economic growth
- Retains companies and talents

Methodology: Initial identification of candidates for areas of excellence

An initial identification of possible areas of excellence has been conducted with particular focus on the expressed industrial needs



1a. Identify strategic areas of interest

1b. Quantitative cluster review

- Identify industrial needs and priorities based on stakeholder interviews
- Gather quantitative data to analyze cluster performance
- Identify regional strongholds and opportunities

2. Initial prioritization

- Identify and group possible candidates for areas of excellence
- Prioritize areas with highest perceived industrial relevance

3. Area specific analysis

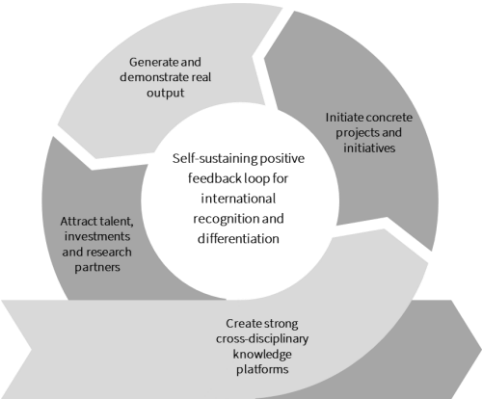
- Conduct high level assessment of prioritized areas
- Identify specific areas of interest
- Conclude on perceived potential

Comments on methodology

- A dual approach combining quantitative analysis of regional strongholds with qualitative input from stakeholders has been used in this initial assessment
- Interviewees have been asked to elaborate upon areas of strategic importance for the organization and need for cross-sector collaboration
- In the initial prioritization, emphasis has been assigned to qualitative input from interviews regarding expressed organizational needs and strategic priorities, particularly from an industrial perspective to ensure industry relevance
- Prioritized areas have been analyzed on a high level per area. The intention is that these areas will serve as input in the future work in finding concrete mutual areas of interest and develop a joint roadmap

Selection to focus and generate results, and by doing so, benefiting the region as a whole

- Focus is essential to increase chances of successfully building a world-class life science cluster
- Intention is to drive immediate action in selected areas of excellence where a clear mutual need and interest exist
- The ability to short-term show success stories will be crucial for building the cluster attractiveness and thus benefit the entire cluster development
- At the same time, it is important to continue to nurture regional strongholds



Prioritized areas of excellence with industrial relevance

Five primary areas have been identified and evaluated more thoroughly in this initial assessment

Sustainable Health

Materials science & Infection control

Interdisciplinary field involving a wide range of fields and applications including development of novel sustainable materials, bio-active implants and regenerative materials, and materials with antibacterial properties

Regenerative medicine & ATMP

Therapeutics aiming to replace or restore organs or tissues to normal function. This could include cell therapies, tissue engineering, or gene therapies. Advanced Therapy Medicinal Products (ATMP) is a specific class regulated by EMA[1]

Advanced Drug Delivery

Methods of delivering medication to a patient in a manner that increases the concentration of the medication in specific parts of the body whilst minimizing nonspecific side effects

Digital Health & AI

Use of transformative technologies such as AI, predictive analytics, sensors, IoT, blockchain, connected devices and cloud platforms to create better and more efficient disease prevention, detection and cure

Medical Imaging

Technique and process of creating visual representations of the interior of a body for clinical analysis and medical intervention, and visual representation of the function of organs or tissues

Runner-ups. Examples of other areas not prioritized for initial focus

- Healthy aging
- Oncology
- IVF and transplantation
- Prevention & lifestyle
- Precision medicine
- Healthcare delivery and efficiency

Comments

Five primary areas have been identified and prioritized as main candidates for areas of excellence to scrutinize further based on the qualitative and quantitative data. These areas have been selected with a particular focus on the perceived industrial priority. The importance of a sustainable mindset has been emphasized and should be a natural part in all areas. In addition to the five prioritized areas, a number of “runner-ups” with potential have been identified but for different reasons not considered as first choices for initial focus. It is important to note that some of the categories follow a somewhat different logic in terms of categorization. It is not the intention to claim that this categorization is the only possible one but highlight how the industry can be divided into different sub-categories that could serve as dedicated focus areas although more specific niches need to be identified, e.g. for ‘Digital Health & AI’ which is broadly defined at this point. Obviously, the selected areas are dependent on the obtained input and organizations involved in the initial analysis. Even so, the five selected areas is considered to represent and be of relevance for a major share of the region’s life science industry. The aim is that these areas would provide a platform being inclusive enough but not too wide for continued dedicated work to identify specific and concrete projects and initiatives as well as for communication.

[1]European Medicines Agency

Building the world's most sustainable healthcare

Sustainability should be an integrated and natural part of Health Innovation West as highlighted by interviewees

Part of the problem, part of the solution

5% to 15% of carbon emissions derive from health services in developed countries[1]. Other environmental issues includes pharma leakage and antibiotic resistance

An arising executive priority

More and more companies raise sustainability as top-priority. Interviewees highlight sustainability as key priority and focus for Health Innovation West

Key to attract talent

42% of the modern workforce wants to work for an organization that has positive impact on the world. For millennials, 62% want to work for a company that makes a positive impact[2]

Build on regional strongholds

Sweden and West Sweden is generally seen as a leader in sustainability and possibilities exist to build on both academic and industrial knowledge and capacity in the region

[1]WHO Health Central to climate change action [2]Global Tolerance The Values Revolution

Area overview:

1. Material science & Infection Control

Key Drivers

- Substantial need for healthcare to find alternatives to antibiotics not leading to antibiotic resistance
- Increased requirements from authorities and users to reduce environmental burden
- More difficulties to differentiate on “standard” materials
- Global biomaterial market expected to reach USD 207 billion by 2024 growing at a CAGR of 14,5 % driven by e.g. increased governmental funding and demand for medical implants[1]

Industry stronghold and relevance

High

- *Implants and anatomical reconstruction*: Cochlear, Dentsply Sirona, Arcam, Elos Medtech, Episurf Medical, Integrum, Neoss, Nobel Biocare, Oticon, Promimic
- *Wound care and single use:* Abigo, Amferia, Essity, Mölnlycke, Wellspect Healthcare
- *Other related:* AstraZeneca, Cellink, Getinge, 1928 Diagnostics

Scientific and academic stronghold

High

- Traditional and acknowledged scientific stronghold
- Odontology and Material science, including biomaterials top-rated in bibliometric analysis
- Less prominent scientific stronghold in skin care and wound management, few key opinion leaders noted
- *Infrastructure and initiatives (examples)*: Biomaterials Research Centre, University of Gothenburg, SuMo, BioMatcell, CoSiMa, The Graphene Flagship center

Possible initiatives and collaborative areas

Materials with enhanced properties at competitive cost

- Sustainable materials, e.g. biodegradable plastics
- Bio-active implants and regenerative materials (e.g. for improved bone regeneration and wound healing)
- Antimicrobial properties
- Materials for drug delivery

Overall attractiveness

Med/High

- Existing and evident industrial and academic stronghold
- Key priority among many companies and perceived openness for collaboration. A need accentuated during COVID-19 pandemic
- Possibility to leverage existing strongholds and build cluster by facilitating cross-collaboration rather than major competence build-up
- Possibility to build competitive advantage if enabling improved access to healthcare

Considerations and risks

- Need to overcome barriers to improve access to healthcare and possibility for swift and reliable testing highlighted as key
- Several previous initiatives within the field although success and clear outcome not clearly evident. Need to gather learnings
- Management of multiple (partly-competitive) industrial actors

[1]Markets and markets Biomaterials Market by Type of Materials (Metallic, Ceramic, Polymers, Natural) & By Application (Cardiovascular, Orthopedic, Dental, Plastic Surgery, Wound Healing, Neurological disorders, Tissue Engineering, Ophthalmology) - Global Forecast to 2024

Area overview:

2. Regenerative medicine & ATMP

Key Drivers

- New group of therapies representing a possible paradigm shift for medical treatments for almost all types of diseases
- 1.000+ regenerative medicine and advanced therapy clinical trials were ongoing worldwide as of the end of H1 2020 and USD 10,7 billion in funding have been raised globally in H1 2020[1]
- Ongoing race to establish centers
- The ATMP market is expected to reach USD 9,6 billion by 2026, growing at a CAGR of 17,4 % between 2015-2026[2].

Industry stronghold and relevance

High

- Pharmaceuticals: AstraZeneca, Alpha Therapy Solutions AB, Cline Scientific, Corline Biomedical, Immunicum,
- Other: Cellink, Dentsply Sirona (SYMBIOS), Takara Bio, TATAA Biocenter, VeriGraft, Vitrolife, XVIVO Perfusion, 1928 Diagnostics
- Comment: AstraZeneca by its' own represents a major industrial anchor in the region complemented by several additional actors with relevance and interest in the area that combines a wide range of complementary relevant expertise. Established collaborations exist.

Scientific and academic stronghold

Med

- Scientific stronghold to large extent made up by AstraZeneca competence build-up in area, particularly related to oligonucleotides and regenerative medicine
- Not considered an academic stronghold today although prominent groups exist in related fields, e.g. Mitochondrial DNA
- Low general score in area specific bibliometric analysis
- *Infrastructure and initiatives (examples)*: OligoNova, ATMP Centre, RISE ATMP, Stem cell bank

Possible initiatives and collaborative areas

- Therapeutic oligonucleotides, Short, single- or double-stranded DNA or RNA molecules that have a wide range of applications in genetic testing, research and forensics. Major research priority and investment for AstraZeneca
- Regenerative mechanisms and pathways
- Mechanisms and competence for commercial scale manufacturing of ATMPs

Overall attractiveness

High

- Strong driver in AstraZeneca substantial investment in area
- Global demand and increasing trend, possibility to take position in growing field
- Established collaborations between e.g. AstraZeneca, Takara Bio and TATAA Biocenter
- Good availability of related research infrastructure and initiatives in the region, e.g. "Sweden a leader in advanced therapies 2030"

Considerations and risks

- Relatively limited area today although growing
- Not a current academic stronghold, time needed to develop
- Substantial funding needed to establish centra

[1]ARM Global Regenerative & Advanced Therapy Medicine Sector Report: H1 2020. [2]Grand View Research Advanced Therapy Medicinal Products Market Size, Share & Trends Analysis Report By Therapy Type (Cell, CAR-T, Gene Therapy, Stem Cell, Non-stem Cell), By Region, And Segment Forecasts, 2020 - 2026

Area overview:

3. Advanced Drug Delivery

Key Drivers

- Optimizing drug delivery plays a central role in drug development
- New drug delivery systems are needed for targeted and controlled release of novel molecules to optimize their potential benefits for patients
- Tightly connected to advancements and rapid development in the regenerative and ATMP field, e.g. for delivery of oligonucleotide drugs

Industry stronghold and relevance

Low/Med

- Companies: AstraZeneca, Cellink, Cline Scientific, Corline Biomedical, TATAA Biocenter, Toleranzia
- Comment: Industry relevance to large extent driven by AstraZeneca interest in field and connection to development of advanced therapies. Common denomniators do also exist related to material science area and delivery of active substances in conjunction with medical devices

Scientific and academic stronghold

Low/Med

- FoRmulaEx center and related competence build-up
- Score below average in area specific bibliometric analysis
- Prominent research groups in e.g. field of exosomes
- *Infrastructure and initiatives (examples)*: FoRmulaEx

Possible initiatives and collaborative areas

- Delivery systems for oligonucleotide- and modRNA-projects
- Lipid nanoparticles
- 3D printed cellular assays

Overall attractiveness

Medium

- Area tightly connected to area “Regenerative Medicine & ATMP”
- Opportunity to leverage FoRmulaEx and competence that are built up
- Less evident as specific stand-alone area of focus in relative comparison with others although rationales exist
- Highly multidisciplinary field with cross-sector relevance. Links and collaborations do exist

Considerations and risks

- Not a traditional regional stronghold
- Drug delivery traditionally recognized as area of expertise in nearby regions (e.g. Uppsala)
- Scientific build-up needed; substantial financing likely needed

Area overview:

4. Digital Health & AI

Key Drivers

- Many application areas, some of the most promising being diagnostics, image processing, drug development and population biobanks
- Enable faster and better data analytics, ultimately resulting in more precise and earlier diagnosis and treatment
- Important applications in the field of precision medicine
- Global AI healthcare market expected to grow from USD 4,9 billion in 2020 to USD 45,2 billion by 2026[1]

Industry stronghold and relevance

High

- Life Science large actors: AstraZeneca, Dentsply Sirona, Essity, Getinge, Mölnlycke, Wellspect,
- Growth companies with digital focus (examples): 1928 Diagnostics, Antaros Medical, Aweria, Integrum, Mentice
- ICT/Mobility sector: Volvo, Zenuity, Autoliv, RUAG, Ericsson, et al.
- Comment: Broad relevance in the sense that majority of companies seek to utilize data and AI either in their product/offer or to increase internal efficiency

Scientific and academic stronghold

Med

- Below average in area specific bibliometric analysis but several prominent research groups
- Strength in e.g. bioinformatics , behavioral science
- KTH and Linköping University identified in Vinnova report to have the highest publication volume in Sweden[2]
- *Infrastructure and initiatives (examples)*: AI Sweden, CHAIR

Possible initiatives and collaborative areas

- Advanced data analytics of clinical and omics data
- Miniaturized sensors and connected devices
- Innovative platforms and product digital interfaces
- Clinical trial data management
- Enable access to data sets (e.g. for register-based randomized studies)

Overall attractiveness

High

- A top-priority for all interviewed actors. Many lack competence in-house and are therefore interested in external collaborations
- Possibility to connect available expertise
- Opportunity to leverage proximity to ICT-sector and capacity
- Necessity although broadly defined at this point. Need to identify more specific niche areas

Considerations and risks

- “Buzzword”-area, need to find niche, e.g. application driven
- Sharing of data in ethically sustainable way
- High competition and relatively low research productivity within AI compared to other countries as well as lower publication volume compared to e.g. KTH and Linköping University[2]

[1]Markets and Markets Artificial Intelligence in Healthcare Market with Covid-19 Impact Analysis by Offering (Hardware, Software, Services), Technology (Machine Learning, NLP, Context-Aware Computing, Computer Vision), End-Use Application, End User and Region - Global Forecast to 2026. [2]Vinnova (2018) Artificiell intelligens i svenskt näringsliv

Area overview:

5. Medical imaging

Key Drivers

- Powerful opportunity to accelerate the identification and application of personalized treatments that are less invasive, faster and potentially more cost-effective
- Technology advancements and new promising applications of AI
- Potential for real-world data to enhance clinical trial evidence
- Expected growth in precision medical imaging market from USD 120 million to over USD 8 billion by 2027[1]

Industry stronghold and relevance

Med

- Life Science: AstraZeneca, Antaros Medical, Dentsply, Essity, Luxbright, Medfield Diagnostics, Mentice, Micropos Medical, Ortoma, RTI Group, Unfors RaySafe
- ICT/Mobility: Volvo, Zenuity, Autoliv, RUAG, Ericsson, et al.
- Comment: Wide relevance and applicability, together with a few niche companies. Synergies with ICT/mobility, e.g. pattern recognition

Scientific and academic stronghold

Med

- *Infrastructure and initiatives (examples)*: BoIC, Bild- och interventionscentrum, Centre for Cellular Imaging (CCI) at GU, Department of Radiation Physics , Swedish NMR centre, Chase / ChaseOn
- Below average in area specific bibliometric analysis

Possible initiatives and collaborative areas

- Combine advancements in high-tech hardware (e.g. PET, MRI) with AI and pattern recognition for enhanced image analysis
- Discovery of novel imaging biomarkers to quantitate disease progression and regression
- Inclusion as clinical trial endpoint

Overall attractiveness

Med/High

- Industry stronghold with several successful companies of relevance within the field
- World-class but underutilized infrastructure (e.g. BoIC). A new lab planned for 2021 with construction initiation during autumn 2020
- Strong connection to global life science trends (e.g. ATMP / Precision medicine)

Considerations and risks

- Not a traditional scientific stronghold
- Limited bandwidth for research in addition to delivery of healthcare to patients, e.g. for BoIC
- Sharing of data in ethically sustainable way
- Discussions and work on the agenda for long to improve access although slow evident progress. Construction ongoing to establish research facilities

[1]Frost & Sullivan Growth Opportunities in Precision Medical Imaging, Forecast to 2022

Contents

An underutilized ecosystem with challenges that need to be addressed accordingly

Highlighted challenges

West Sweden has strong opportunities and a solid track record of developing groundbreaking innovation within life science. The region is characterized by a strong life science industry with several international leading companies with origin and base in the region, academic strongholds with internationally eminent research teams, high quality clinical research as well as the proximity to a growing ICT sector that creates unprecedented opportunities. The strong collaboration between academia and healthcare is an important contributing factor that has resulted in many innovations and internally leading companies.

However, despite the strong conditions, it is evident that the life science ecosystem in the region is not reaching its full potential and several challenges and barriers have been highlighted during the interviews with key stakeholders. The region has not been able to appropriately respond to the challenges and increased competition in a rapidly evolving global environment. In order to become an attractive and internationally leading life science cluster that advances cutting-edge health and life science innovation, there are certain challenges which must be addressed and overcome.

To be able to prioritize among efforts and outline a concrete roadmap to drive action, one must be aware and acknowledge the starting point and current improvement potentials. The purpose with this section is therefore to present a summary of the challenges and barriers that have been mentioned during conversations with key stakeholders. The high-level summary of the expressed challenges is presented to the right and further elaborated on the following pages. It is important to be humble and acknowledge that the full picture of a specific topic may not be covered within this initial overview.

1. **Limited and underutilized real cross-sector collaboration**
   - Anti-commercial mindset
   - Lack of clear entry points
   - Lack of forums and platforms to facilitate collaboration
2. **Difficulties to access the healthcare system for collaborative research and testing**
   - Difficult to initiate clinical research
   - Limited access to reliable and swift clinical testing
   - Strong register data not utilized
   - Limited access to cutting edge research infrastructure
   - Difficulties to get innovation implemented and adopted
3. **Lack of clear cluster overview and “front-door” for Life Science West Sweden**
   - Unclear roles and responsibilities
   - Difficulties to navigate in the ecosystem
4. **Difficulties to recruit talent and necessary expertise**
   - Limited cross-sector mobility
   - Challenging to attract top-talent
5. **Lack of clear vision, action and organization with mandate to drive change**
   - Historical absence of concrete action
   - No executive capacity with accountability

1. Limited and underutilized real cross-sector collaboration

Life Science in West Sweden has historically been characterized by strong links and fruitful collaboration between industry, academia and healthcare to drive innovation and improved patient outcome. The strong collaborative environment between Sahlgrenska University Hospital, Gothenburg University / Sahlgrenska Academy and Chalmers is still one of the prominent strengths in the region. Further, the collaboration between publicly funded supporting organizations is also seen as good. However, it is evident that the concrete collaboration between the industry and public sector is relatively limited and underutilized as of today. Indeed, cross-sector collaboration is taking place, but much is happening on an ad-hoc basis on individual level in already established relationships.

Anti-commercial mindset

There is a certain degree of frustration among many industrial actors regarding the difficulties and apparent lack of willingness to engage in and initiate concrete collaborations and joint research initiatives with mutual value. It has repeatedly been mentioned that many experience a reluctance among academics and healthcare to engage in close industry-academic collaboration and note a perceived desire to keep the industry on arm's length distance. As a consequence, it is evident that many companies seek collaborations with other research partners in other regions. At the same time, it takes two to tango. Successful cross-sector collaboration presupposes a joint interest, understanding, trust and engagement to utilize the available structures and engage in dialogue to find common ground. It has also been noted from industrial actors that there is room for internal improvement for how external outreach activities are managed and prioritized.

Lack of clear entry points

One clear barrier is the absence of clear entry points and dedicated point-of-contact for external collaborations. Large and complex organizational structures make it difficult to find and get access to the right people. Industrial actors experience that inquiries often are being tossed around within the organization without being able to find the right person and might thus lose patience, or that responsibilities are distributed in multiple departments making it difficult to reach decisions. The desire to have clear point-of-contact has been emphasized similar to structures utilized by KI and SciLifeLabs with a function for external collaborations. Correspondingly, it can be a daunting task for researchers and entrepreneurs to find the right person in major industrial companies without knowledge about the internal organizational structures and associated roles and responsibilities. It is noticeable that few of the major companies in the region have clear channels and platforms for external collaborations.

Lack of forums and platforms to facilitate collaboration

Another contributing factor to the limited cross-sector collaboration is the current lack of established forums and meeting places that provides the right conditions for life science actors to meet and explore opportunities for cross-sector collaboration. Available arenas including e.g. Biotech Center and the BioVentureHub offer important infrastructure for life science companies and researchers but have not evolved into dynamic meeting grounds for creative and constructive dynamics between actors. Hopefully, GoCo and Sahlgrenska Life can fulfill this need.

> *"My experience is that one wants to keep companies on arm's length distance. That culture is stronger in Gothenburg"*

> *"We want to improve our collaboration with the universities. That's a weakness that we have to work with. We also need to think about how to organize ourselves"*

> *"It is important that the industry understands the needs of the healthcare and use the public sector to drive innovation to ensure that companies are working with the needs"*

The companies' top collaborators in scientific publications

University in West Sweden

University in rest of Sweden

Wellspect, AstraZeneca and Getinge have had more collaborative publications with other Swedish Universities than with the ones in West Sweden last 20 years

Dentsply Sirona

	Organization	Records	% of publications
1	University of Gothenburg	30	9,0%
2	University of Bern	19	5,7%
2	University of Zurich	19	5,7%
4	Malmo University	18	5,4%
5	State University system of Florida	14	4,2%
37	Uppsala University	8	2,4
78	Umea University	4	1,2%

Vitrolife

	Organization	Records	% of publications
1	University of Melbourne	15	28,8%
2	Chu de Montpellier	8	15,4%
3	Inserm	8	15,4%
4	Universite de Montpellier	8	15,4%
5	University of Toronto	8	15,4%
13	Lund University	2	3,8%
13	Sahlgrenska University Hospital	2	3,8%
13	Skane University Hospital	2	3,8%
13	Livio fertilitetsctr Gothenburg	2	3,8%

Wellspect Healthcare

	Organization	Records	% of publications
1	Karolinska Institutet	5	20%
2	Karolinska University Hospital	3	12%
3	University college London	3	12%
4	University college London Hospitals Nhs Foundation Trust	3	12%
5	University of British Columbia	3	12%
7	Stockholm south gen hosp	2	8,0%

AstraZeneca

	Organization	Records	% of publications
1	Harvard University	3273	9,9%
2	University of California System	1937	5,9%
3	University of London	1684	5,1%
4	Brigham Women's hospital	1602	4,8%
5	University of Toronto	1497	4,5%
12	Karolinska Institutet	1059	3,2%
22	Uppsala University	817	2,4%
41	University Of Gothenburg	620	1,9%
86	Lund University	408	1,2%
93	Karolinska University Hospital	392	1,2%

essity SCA

	Organization	Records	% of publications
1	United States dept. of agriculture	39	10,1%
2	Mississippi State University	37	9,5%
3	Chalmers University of Technology	36	9,3%
4	Mid Sweden University	34	8,8%
5	Royal Institute of Technology	24	6,2%
6	Swedish university of agricultural SLU	19	4,9%
16	Linkoping University	9	2,3%
16	Lulea University of Technology	9	2,3%
16	University of Gothenburg	9	2,3%
24	Karolinska Institutet	7	1,8%
24	Linnaeus University	7	1,8%
31	Sahlgrenska University Hospital	6	1,5%
42	University of Borås	4	1,0%

MÖLNLYCKE HEALTH CARE

	Organization	Records	% of publications
1	Tel Aviv University	14	8,2%
2	University of Toronto	13	7,6%
3	University of Melbourne	12	7,0%
4	University of Nebraska Medical Center	10	5,8%
4	University of Nebraska System	10	5,8%
9	Cochlear	7	4,1%
20	Chalmers University of Technology	5	2,9%
20	University of Gothenburg	5	2,9%
32	Jönköping University	4	2,3%
32	Lund University	4	2,3%
32	Sahlgrenska University Hospital	4	2,3%
32	Skåne University Hospital	4	2,3%
61	Biomatcell Vinn Excellence	2	1,2%
61	Karolinska Institutet	2	1,2%

GETINGE

	Organization	Records	% of publications
1	Assistance publique hopitaux Paris	10	15,2%
2	University of Toronto	9	13,6%
3	Inserm	8	12,1%
4	Hopital universitaire pitie salpetriere	6	9,1%
4	Karolinska institutet	6	9,1%
4	University of copenhagen	6	9,1%
23	Royal institute of technology	3	4,5%
49	Karolinska university hospital	2	3,0%
49	Linkoping university	2	3,0%
49	Uppsala university	2	3,0%

Note: The search was performed on Web of Science for all publications in the years 2000-2020 with the company name as Funding Agency. The included organizations are top 5 plus all universities in Sweden on top 100 and with more than 1 funded publication. Note that the company itself has been excluded in the cases where it was one of the top 5 enhanced organizations, e.g. the top enhanced organizations for AstraZeneca is AstraZeneca.
Source: Web of Science

2. Difficulties to access the healthcare system

Access to the healthcare system is crucial for clinical research and testing of new therapies and medical devices. A number of challenges have been highlighted:

Difficult to initiate clinical research

The quality of clinical research in Västra Götaland is top-ranked according to the national ALF funding distribution assessment by the Swedish Research Council[1]. The quality of the scientific output and prerequisites for clinical research are ranked as "very high quality." However, the industrial access to initiate clinical research is reported as limited with unfavorable conditions and general inertia and bureaucracy. Improving the attractiveness for industry-sponsored clinical studies is a national concern although interviewees indicate that other regions in Sweden are seen as more agile and open for clinical collaboration.

The unfavorable conditions and lack of incentives for healthcare personnel to engage in research has been emphasized. Often, there is limited bandwidth to participate in clinical research as delivery of healthcare to patients leaves little room for other activities. One key factor to attract clinical studies or study sites is the ability to promptly answer to study feasibility requests. The process for managing feasibility requests has been highlighted as an area for improvement.

> *"Imagine if Western Sweden was known as the region where evidence is generated, where new innovation is adopted"*

Limited access to reliable and swift clinical testing

Access to settings that could offer the opportunity for reliable and efficient smaller scale studies and testing in a clinical environment has for long been asked for and is highlighted as a well-recognized problem. To generate necessary evidence required for regulatory approval, access to clinicians and patients is often required. As the regulatory requirements for clinical evidence increase (e.g. MDR), the opportunity to offer researchers to swiftly test e.g. new medical devices in a clinical setting according to necessary quality standards would offer a competitive advantage and possibility for differentiation for the region if not being able to compete on cost.

Strong register data not utilized

The availability of high-quality register data is a particularly underutilized asset. There is a high perceived ambition from leadership in the region to utilize the data, but it has been difficult to succeed in implementing this ambition into concrete projects to drive innovation. Actors experience skepticism and resistance in making the data available for privately-held actors. In some cases, it is reported that inquiries and specific research questions that are perceived as possible in other regions are interpreted differently here and not considered feasible. Many industrial actors experience a lack of a solution-oriented mindset when it comes to sharing data in an ethical sustainable way. The region has strong opportunities to conduct register-based randomized clinical studies (real-world studies) as well as combining register data and omics sciences, including imaging and AI and thus truly leveraging the unique competitive advantages in the region.

Limited access to cutting edge research infrastructure

Significant investments have been made in cutting edge research infrastructure. One prominent example is the Image and Intervention Center (BoIC) inaugurated in 2016. Despite the ambition to use BoIC both for clinical use and research, limited research has been conducted during the four years since start. Consequently, actors with interest in using the technologies instead choose to conduct collaborative research and invest in other regions. For successful utilization and collaboration, available infrastructure needs to be made accessible for companies, which is especially important within Life Science. Good examples do exist in the region for collaboration based on mutual benefit of using research infrastructure including investments in the advanced instrument NanoSIMS as well as the DNP-NMR instrument at the Swedish NMR-center in Gothenburg.

Difficulties to get innovation implemented and adopted

Related to above, getting innovation reimbursed and implemented into clinical use is repeatedly reported as a problem area where the perception is that Västra Götaland is lagging behind compared to other regions such as Stockholm and Skåne. In particular, innovation procurement and tendering has been highlighted as important tool to foster innovation. Since 2015, Koncerninköp at Region Västra Götaland have had the mission to develop the region's innovation procurement strategy. However, stakeholders experience a limited progress in this regard and call for procurement processes less rigid and limited to existing solutions.

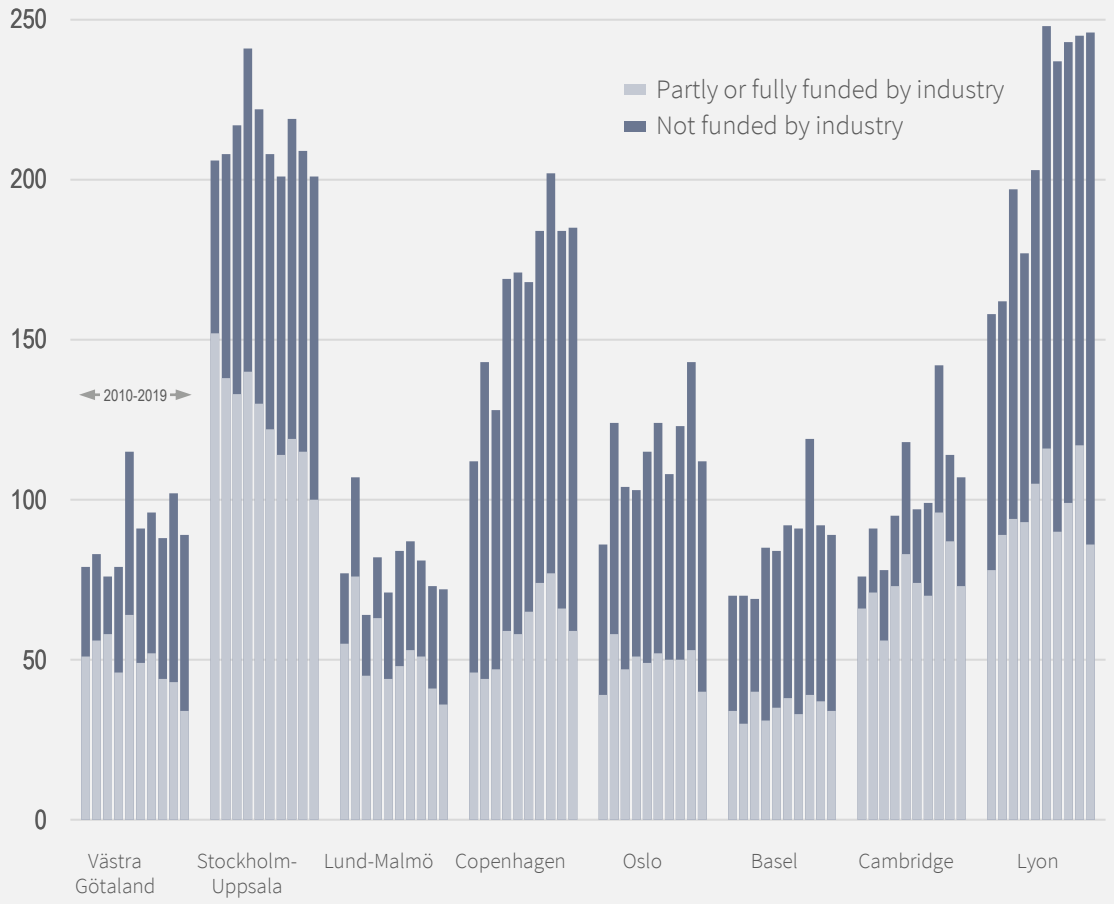
[1]Vetenskapsrådet (2018) Utvärdering av den kliniska forskningens kvalitet vid de landsting som omfattas av ALF-avtalet

West Sweden is not the top choice for location of clinical trials

The number of clinical trials in West Sweden is limited compared to Stockholm-Uppsala and the difference is even larger when comparing industry sponsored trials

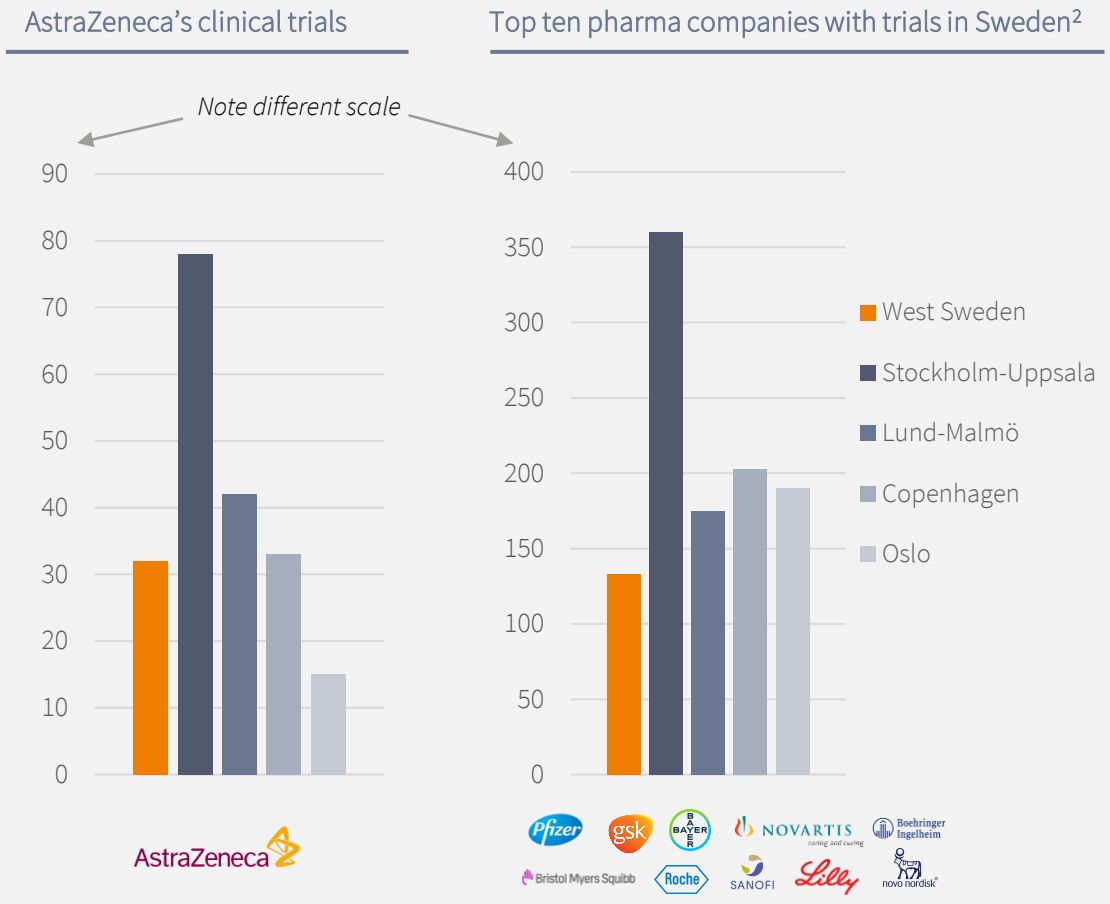
Total number of clinical trials per region

Clinical trials with start year 2010-2019[1]



Clinical trials sponsored by industry

Number of clinical trials per location with start year 2010-2019



[1]All trials with at least one location in the region. [2]Top ten based on number of trials in Sweden with start year 2010-2019. Includes Pfizer, GlaxoSmithKline, Novartis, Hoffman-La Roche, Bayer, Novo Nordisk, Sanofi, Boehringer Ingelheim, Bristol-Myers Squibb, Eli Lilly

Source: Clinicaltrials.gov

A need for collaborative innovation and access throughout product development

Access to necessary expertise and clinical settings is a critical need with possibility for regional differentiation if being successful

Market approval

	Product development	Test and verification	Commercialization & Innovation adoption
Examples objectives	▪ Identify new materials, components and design with enhanced properties ▪ Understand underlying mechanisms and properties ▪ Ensure fit product – medical need	▪ Build evidence for e.g. CE-marking ▪ Test in clinical setting with patients and clinicians ▪ User input, feedback	▪ Build post-market wide evidence building ▪ Engage KOLs ▪ Ensure reimbursement
Industrial needs to address	▪ Provide access to leading research and infrastructure ▪ Build needed competence platforms ▪ Engage in joint research initiatives with international reach if needed ▪ Provide early stage user / design input	▪ Establish environment for swift and reliable testing ▪ Provide clear entries for stakeholder clinical input and feedback	▪ Access to study sites in global multi-center studies ▪ Facilitate innovation-oriented decision-making processes for adoption of innovation
	Base research focus	Clinical centered	

Comments

- The illustration summarizes some examples of organizational needs throughout the product development life cycle and how to address them
- The need for collaboration and access is dependent on e.g. the stage of research, project and type of organization. Obviously, the need for a small startup will differ compare to international life science companies

3. Lack of clear cluster overview and “front-door” for Life Science West Sweden

Unclear roles and responsibilities

The Life Science scene in West Sweden is characterized by numerous strong elements and supporting infrastructure as previously highlighted. However, it is clear that most of the organizations and stakeholders have limited knowledge about the available elements, initiatives and possible opportunities outside the direct organizational (or individual) focal points and established ways of working. In addition, the roles and responsibilities for different actors and initiatives are commonly described as unclear and sometimes hard to differentiate. Some even state that they have a better overview of available organizations in other cluster environments.

One prominent example of above is related to the two major ongoing multi-billion initiatives in the region, Sahlgrenska Life and GoCo. Having two major life science investments on that magnitude is somewhat unique considering the size of the region. However, there is limited evidence and clarity of how these major initiatives are intended to complement each other and lever interaction between the two projects. The Sahlgrenska Life project was paused awaiting an investigation lead by Harriet Wallberg (former University Chancellor at KI) with purpose to investigate the overall focus in the Life Science area for University of Gothenburg. The investigation was recently completed.

Difficulties to navigate in the ecosystem

The absence of a clear cluster overview and “front-door” makes it difficult for organizations and individuals to navigate in the life sciences ecosystem and connect to regional expertise and uncover possible scientific and business opportunities. If considering the difficulties for domestic actors to successfully navigate in the ecosystem, one could imagine difficulties for international actors. Ergo, a need has been expressed to professionally describe and communicate the possibilities and strongholds of the region to ensure that the available infrastructure is leveraged in a better way and consequently improve chances to support growth. This would be beneficial both for inbound inquiries but also when actively promoting Health Innovation West internationally e.g. through international conferences and conventions. The Health Innovation West cluster initiative has an important role to fill here.

> *“I do not even know how many biotech companies that exist in Gothenburg. There is a clear pattern, I know more companies in Lund… This says something about the failure in Gothenburg”*

> *“The elephant in the room is how everyone plays a role in this. It is quite similar to build Sahlgrenska Life and GoCo but there has not even been discussions on the right level to ensure that one plus one equals more than two. Meeting with 60 persons, what to expect?!”*

4. Difficulties to recruit talent and necessary expertise

The ability to attract, recruit and retain talent and necessary expertise is of utmost importance to attract life science companies and support growth. An ability which becomes even more important as the competition for talent is constantly getting fiercer.

Although highlighted as the number one organizational need by most, the perceived challenges to attract and recruit necessary expertise differ among organizations and whether this is seen as an inhibiting factor. Although not within the scope of this report to outline the specific competence needs, regulatory and quality assurance has been highlighted as a specific shortage area especially for medical device companies accentuated by the ongoing transition to the new Medical Device Regulation (EU MDR).

Limited cross-sector mobility

A challenge that has been highlighted is the limited mobility and interfaces between academia, healthcare and industry in the region, a challenge recognized as a national challenge. Industrial experiences and merits are perceived to be valued low and not particularly meritorious within the academia and healthcare. In addition, factors such as wage differences, lack of incentives, cultural differences and IP-management hamper the cross-sector mobility and rationales for researcher to engage in collaborative research.

Actors call for more efficient use of job-rotation and shared positions within the region that would contribute in valuable exchange and development of knowledge and expertise with mutual value for all parties.

Challenging to attract top-talent

The importance of being able to recruit, retain and develop internationally leading young researchers and experts has been emphasized. Attracting international leading researchers tend to result in positive effects on the innovation ecosystem overall and contribute in attracting additional expertise and investments. A strong determining factor for the ability to attract talent is the opportunity to offer the needed infrastructure necessary to move and live in a new country. Related to this, the ability to provide competitive accommodation has for example been reported as more difficult in the region compared to e.g. Stockholm and Skåne. Initiatives are ongoing but it is perceived that more can be done to strengthen and leverage the infrastructure and factors of importance when people are deciding where to move and work. One important factor is the ability to provide qualified employment for the possible co-moving partner. The presence of large international industrial companies within the region as well as a large pool of SMEs provides strong conditions for career development also for the respective partner, an opportunity that is perceived as underutilized today.

> *"We need more suppliers of competence. There are major shortage areas. One could for example help young researchers not interested in an academic career to educate themselves in post-market surveillance, regulatory, QP etc."*

> *"Within the academia it is only meritorious to be in the academia. One cannot move to the industry and see this as a credit when going back to the academia. Then you become the black sheep"*

5. Lack of clear vision, concrete action and organization with mandate to drive change

Historical absence of concrete action

"Vision without action is just a dream, action without vision just passes the time, and vision with action can change the world." – Nelson Mandela

Change does not come without dedicated work and action. To position and develop West Sweden into an internationally competitive life science cluster, it is now critical to move from friendly discussions to action in order to avoid losing out on opportunities in the region. Throughout the work, the recurrent theme and expectation from involved stakeholders, particularly from the industrial side, is the desire and expectation to move to concrete action and show some results. Many of the highlighted challenges presented in this chapter do not likely come as surprises for the many who are active in the West Sweden life science ecosystem. It has been noted that limited progress has been made despite the numerous efforts conducted throughout the years to highlight and address the needs and challenges.

No executive capacity with accountability

The importance of an executive capacity to facilitate a change is acknowledged and stressed. It is clear that there is a true openness and high ambition from the executive management on all sides to increase cross-sector collaboration. However, in the end of the day, a dedicated team with mandate and accountability is needed to drive the work to turn this ambition into concrete projects with mutual benefits and tangible results. This includes the work to unite key stakeholders with common vision and agreed goals, outlining the roadmap in selected areas and importantly continuously follow-up on the work and act as the facilitating bonding kit. Without this, there is an imminent risk that the noted challenges will still remain, and the built-up momentum is lost.

> *"The region, politicians, industry, academia and healthcare need to agree on areas where to become world-class and promote the region… Road map and concrete actions are needed"*

> *"We have a lot that we would like to do in collaboration with others. If I would go to Lindholmen with an idea about self-driving cars, then people would come from all sides and want to get in. But there is no such vision in our area. People do not know about it"*

> *"Select the right people, give them mandate and things will happen"*

Contents

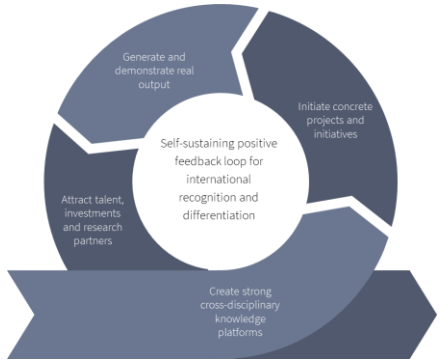
Overall conclusions: Potential exists. Execution now necessary

Health Innovation West has the potential to become a renowned world class cluster by leveraging strongholds and built-up momentum…

Overall conclusions and reflections:

- Health Innovation West certainly possess **elements necessary to become an internationally renowned world class** life science cluster:
  - Strong industrial **anchor companies** and capacity
  - History of close cross-sector collaboration and **"get-things-done"** mentality
  - **Internationally eminent strongholds** to leverage
  - Major **initiatives and infrastructure**
- The ecosystem is **far from optimally utilized** and **challenges exists** including difficulties to access healthcare which need to be addressed accordingly
- Encouraging key take-away that there is a perceived true **openness *and* the expectation to strengthen cross-sector collaboration** necessary for future competitiveness
- A **built-up momentum** exists and expectation for **execution**

…which calls for execution and identification of concrete projects…



- "Rome wasn't built in a day" – need to **start in prioritized areas** to **drive immediate action** and show results
- In the end of the day, **execution is down to people**. Gather the right people in the right forums and **provide necessary funding, mandate and responsibility** to drive action

…preferably within five prioritized areas

- **Five prioritized areas** identified with high perceived **industrial relevance** and opportunities to **leverage regional strongholds**
- Areas predominantly represent **future potentials** rather than traditional scientific strongholds
- Intention that areas should **guide future** work in finding **concrete projects** to address needs and challenges step-by-step

The recommendation is to identify concrete projects within the five prioritized areas

The five areas have been selected based on perceived industrial relevance and opportunities to leverage regional strongholds

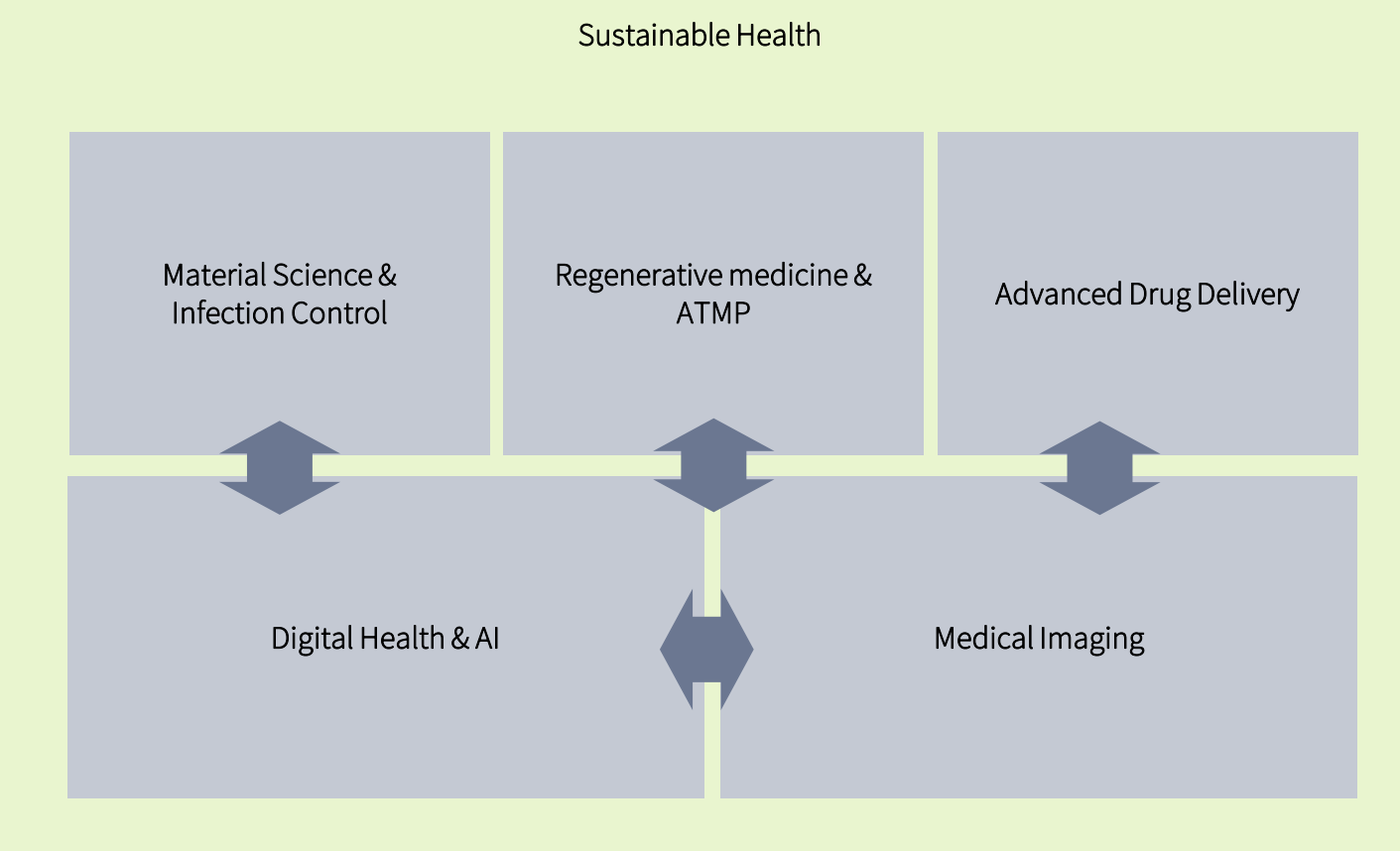
Area	Prio[1]	Why an Area of Excellence?	Possible collaborative areas[2]	Possibilities and actions
Material Science & Infection control	●●◐	▪ Existing industrial and academic stronghold ▪ Key priority for many companies and need for partnering, accentuated during COVID-19 pandemic ▪ Opportunity to leverage strongholds and enable collaboration rather than major competence build-up	▪ Sustainable materials, e.g. biodegradable plastics ▪ Bio-active implants and materials ▪ Antimicrobial properties ▪ Materials for drug delivery	▪ Facilitate ways to connect actors to explore common needs ▪ Establish possibility for swift and reliable testing, supported by clear entry point-of-contact
Regenerative medicine & ATMP	●●●	▪ Strong anchor driver in AstraZeneca strategic focus and substantial investment in area with lead here ▪ Global demand and increasing trend, possibility to take position in growing field ▪ Available infrastructure, initiatives and collaborations	▪ Therapeutic oligonucleotides ▪ Base research regen. mechanisms & pathways ▪ Mechanisms and competence for commercial scale manufacturing of ATMPs[3]	▪ Continue to build on infrastructure and ongoing initiatives (e.g. OligoNova) ▪ Explore possibilities and feasibility to build academic capacity and establish oligonucleotide center ▪ Increase ambition for clinical study initiation
Advanced Drug Delivery	●●○	▪ Highly multidisciplinary field with cross-sector relevance ▪ Opportunity to leverage FoRmulaEx center and AstraZeneca capacity ▪ Tightly connected to Regenerative medicine & ATMP	▪ Delivery systems for oligonucleotide- and modRNA-projects ▪ Lipid nanoparticles ▪ 3D printed cellular assays	▪ Consider inclusion in ATMP area ▪ Nurture and build on FoRmulaEx investment
Digital health & AI	●●●	▪ A top-priority across the industry ▪ External partnering vital to access expertise ▪ Proximity to ICT-sector ▪ Major local initiatives and capacity to leverage, e.g. AI Sweden, CHAIR	▪ Advanced data analytics of clinical and omics data ▪ Miniaturized sensors ▪ Innovative platforms utilizing connected devices ▪ Clinical trial data management	▪ Establish right forums and identify niches ▪ Identify ways to share data in an ethically sustainable way ▪ Assign project funding for collaborative projects, e.g. within AI Sweden
Medical imaging	●●◐	▪ World-class but underutilized infrastructure (BoIC). New lab planned for 2021 ▪ Wide relevance and applicability, connection to AI ▪ Synergies with ICT/mobility, e.g. pattern recognition	▪ Combine advancements in high-tech hardware (e.g. PET, MRI) with AI and pattern recognition ▪ Diagnostics and biomarker identification ▪ Clinical trial endpoint	▪ Improve access to BoIC for cross-collaborative research (work ongoing to establish R&D setting) ▪ Identify how to share data in an ethically sustainable way ▪ Increase ambition for clinical study initiation

[1]Indicative prioritization based on overall attractiveness of identified potential focus areas based on an overall summary of cluster strongholds, industry interest, opportunities for cross-sector collaboration and impact potential based on current information [2]Examples of collaborative areas of interest highlighted during interviews. Specific areas for collaboration and concrete projects need to be explored jointly with concerned stakeholders [3]Larger scale manufacturing per see preferably located in regions with existing manufacturing facilities

Five areas with interdependencies and possible synergies

Applied areas

Technology platforms

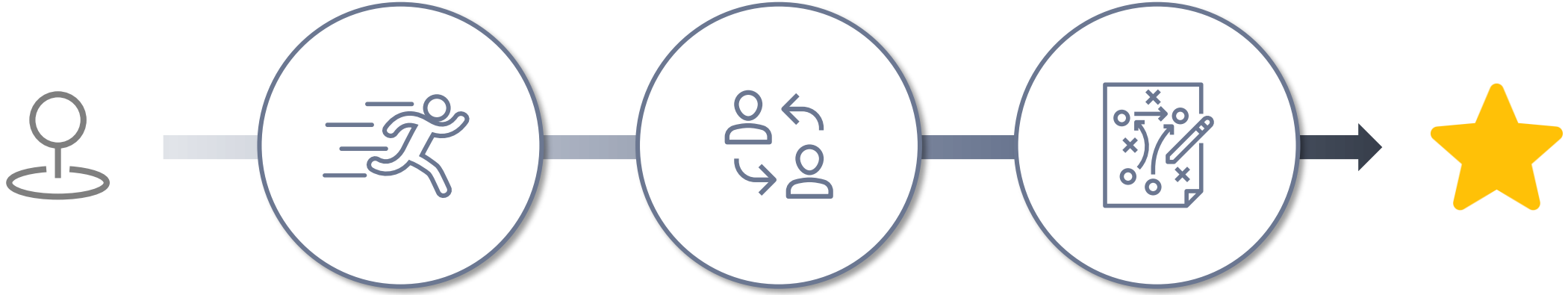


Cross-area synergies and interdependencies

- Synergies and interdependencies exists between areas which calls for coordination, e.g.:
  - Applying AI and ML within the field of medical imaging
  - Innovative materials for advanced drug delivery within the field of regenerative medicine & ATMP
- 'Advanced Drug Delivery' possible to be incorporated within the area 'Regenerative medicine & ATMP' due to close interdependencies and synergies as well as less perceived overall attractiveness as stand alone focus area at this moment
- A constantly evolving field. Consequently, prioritized areas need to evolve and be constantly reviewed

The work has just begun. Now it's time to turn ambition into execution

Aim for concrete projects in prioritized areas with possibility to show short-term success combined with work to establish critical long-term enablers



The starting point

Initial list of prioritized areas

Built-up momentum and (impatient) expectation for action

Ever-increasing global competition for talents and investments

Assign team with operative capacity

Agree on areas of excellence to prioritize

Select and assign dedicated with operative capacity and relevant[1] industrial experience

Ensure necessary funding, mandate and accountability

Connect actors and identify concrete projects

Jointly explore mutual needs and interests in prioritized areas

Aim for projects and cases with potential for quick-wins

Identify critical long-term enablers

Ensure outcome-driven action

Outline actionable plan with prioritized projects (quick-wins and long-term enablers)

Dare to specify concrete goals, deliverables and timeline (still allowing for rapid learning and pivoting)

Ensure necessary funding

Execution and delivery

Short-term success

Proof in model

Opportunities for major investments

[1]Preferably including but not limited to industrial R&D experience

Six enabling factors with importance for building long-term success

Triathlon Group recommends particular focus on six enablers as part of the work ahead

Establish clear entry points for external collaborations

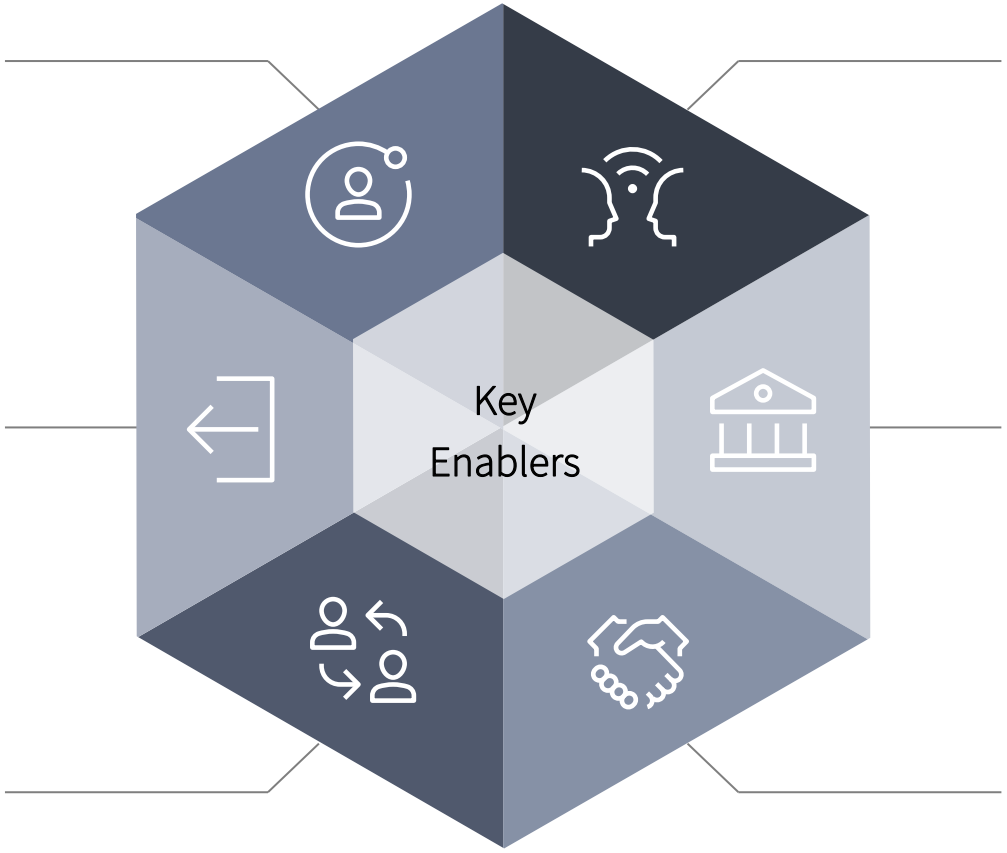
- Professional “Spider”-functions with the right seniority, responsibility and drive that manage inquiries and can provide necessary guidance (Healthcare and industry)
- Learn from reported best practice examples, e.g. SciLifeLab, KI and Trial Nation / Clinical Trials Denmark

Create front-door for life science

- Establish single point of entry for life science in West Sweden via intuitive platform with clear overview of the ecosystem (as intended by Health Innovation West)
- Clearly define and communicate available support

Improve potential for job-mobility and training

- Identify ways to provide necessary re-training, job-rotation and competence development
- E.g. master in collaboration with industry and academia, sabbaticals and industrial post-docs



Improve opportunities for swift and reliable testing

- Commit to establish environments to generate necessary evidence in selected areas
- Co-explore enablers for clinical studies, e.g. how to improve process for study feasibility requests

Ensure availability of quality and regulatory expertise

- Key enabler for cluster competitiveness but is a current bottleneck
- Map specific actual needs and explore potential for training initiatives with industrial relevance

Improve conditions for innovation adoption

- Use innovation procurement and tendering as an important tool to foster innovation
- Engage in unconditional cross-sector talks for how to enhance current processes and share learnings

Raising the ambition:

Build recognition for *real* cross-sector collaboration

"Imagine if Western Sweden was known as the region where evidence is generated, where new innovation is adopted*"

*Quote heard during interviews

Contents

1. Material science & Infection Control

Bibliometric comparison

Topic	H-index									Number of publications								
	West Sweden	Average (ex. Boston)	Stockholm-Uppsala	Medicon Valley	Oslo	Lyon	Basel	Cambridge	Boston	West Sweden	Average (ex. Boston)	Stockholm-Uppsala	Medicon Valley	Oslo	Lyon	Basel	Cambridge	Boston
Materials Science, Biomaterials[1]	39	37	46	36	25	28	41	44	74	241	239	443	232	122	126	222	288	988
Materials Science, Ceramics[1]	12	12	26	6	9	9	3	21	7	40	60	196	23	37	25	3	93	31
Materials Science, Textiles[1]	18	11	29	11	1	6	6	7	5	91	46	160	31	3	14	8	15	9
Polymer Science[1]	37	39	61	40	28	36	27	45	34	464	446	1 025	483	218	354	138	443	253
Nanoscience & Nanotechnology[1]	65	70	92	86	37	37	54	118	118	930	1 149	2 156	1 375	305	310	491	2 477	2 127
Biomaterial*	34	26	35	24	19	17	23	33	66	172	139	268	138	79	50	98	171	541
Dentistry Oral Surgery Medicine[1]	64	37	29	54	36	24	39	16	59	1 155	602	550	1 314	518	157	434	86	1 954
Osseoint*	42	20	20	28	9	8	26	5	23	296	93	67	163	24	14	75	9	139
Implant*	73	62	62	71	47	51	64	68	146	1 297	1 089	1 493	1 722	634	726	937	815	4 952
wound car*" OR "wound manag*	7	7	10	14	4	4	5	3	21	12	16	30	41	6	7	7	8	105
Dressing* wound*	8	9	11	16	2	10	5	8	28	19	22	31	55	4	16	13	17	94
Pressure ulcer	7	6	13	10	6	3	2	1	12	12	11	33	12	8	7	5	1	47
Virology[1]	32	49	52	58	32	52	50	65	102	145	468	756	511	189	620	299	759	2 131
Microbiology[1]	75	95	115	124	66	69	80	137	179	1 415	2 371	3 767	3 935	1 229	1 403	1 646	3 202	6 093

Note. This analysis is not claimed to be a fully comprehensive overview but should rather be seen as an attempt to give a high-level indication for selected areas and keywords highlighted by experts. See appendix for more information about how the bibliometric search was conducted

H-index definition
A H-index of *n* means that there are at least *n* publications with at least *n* citations. See appendix for more information.

≥ average | Average to -15% | -15% to -30% | < - 30%

Note: The asterisk (*) represents any group of characters, inlcuding no character, e.g. Implant* will result in search results including implant, implants, implantable etc. 1Web of Science Categories
Source: Web of Science

1. Material science & Infection Control

Collaborative environment and research infrastructure

Highlighted initiatives and research infrastructures

- BIOMATCELL
  BIOMATCELL VINN Excellence Center of Biomaterials and Cell Therapy, GU. Collaborates with e.g. Arcam, Neoss, Integrum. Funding from Vinnova 2007
- CoSiMa
  Concept for industrial development for the sustainable soft materials of the future. Partners include Essity Hygiene and Health AB, AstraZeneca, Tetra Pak and Akzo Nobel
- SuMo Biomaterials Vinn Excellence Center – research center Chalmers, funded by Vinnova 2015-2017. Partners include SCA, AstraZenca, Mölnlycke
- The Graphene Flagship
  A 10-year research and innovation endeavor with a total project cost of 1,000,000,000 euros, funded jointly by the European Commission and member states and associated countries. Coordinated by Chalmers
- 2D-Tech
  2D material-based technology for industrial applications (2D-TECH) is a Vinnova competence center hosted at the Chalmers University of Technology
- Biomaterials Research Centre, University of Gotheburg
  Aim to be a collaborative organization for biomaterials research in Sweden
- Smart Textiles
  An innovative environment that comprises a close collaboration between the University of Borås, RISE Research Institutes of Sweden (previously SP), Swerea IVF and the Borås Incubator.
- Centre for Additive Manufacture - Metal (CAM2)
  Focus on material and process development for powder-based metal additive manufacturing (3D printing). one of only thirteen Vinnova (innovation agency) funded competence centres in Sweden.
- Skaraborg Hospital Wound Centre Skövde
  Multidscipolinary center for management of patients with difficult-to-heal leg or foot ulcers.

Area outlook / Example initiatives in other regions

- Hero-m 2 Innovation, KTH Royal Institute of Technology
  The aim and goal is to develop theoretical tools and competence for fast, intelligent and cost-efficient materials development together with Swedish industry. Coordinated by KTH Royal Institute of Technology with 35 million SEK funding from Vinnova for May 2017-April 2022
- BioMaC Innovation, KTH Royal Institute of Technology
  The objective of the VINN Excellence Centre BiMaC Innovation is to become an internationally leading biomaterials science centre
- FunMat, Linköping University
  A second generation VINN Excellence center in material science. Focusing its efforts to three application areas: functional surfaces for cutting tools, fuel cells, and batteries
- KTH Materials Platform
  Connects more than 1000 researchers in over 80 research groups and around 26 competence centres in six thematic areas related to materials issues

In general, few life science clusters that highlight material science and infection control as profile area

2. Regenerative medicine & ATMP

Bibliometric comparison

Topic	H-index									Number of publications								
	West Sweden	Average (ex. Boston)	Stockholm-Uppsala	Medicon Valley	Oslo	Lyon	Basel	Cambridge	Boston	West Sweden	Average (ex. Boston)	Stockholm-Uppsala	Medicon Valley	Oslo	Lyon	Basel	Cambridge	Boston
Cell Biology[1]	75	118	139	132	86	82	122	191	294	833	1 964	3 060	2 513	946	912	1 597	3 887	9 187
Cell & Tissue Engineering[1]	26	35	42	39	22	22	36	56	90	93	167	301	197	63	70	174	274	780
Endocrinology & Metabolism[1]	90	89	105	127	66	73	65	100	172	1 609	1 828	2 735	4 072	961	889	704	1 829	6 064
Engineering Biomedical[1]	51	46	52	51	33	41	43	51	96	437	483	771	593	285	435	384	475	2 685
Cell therap*	15	22	30	31	17	14	19	25	56	36	72	135	113	42	32	59	89	361
Gene therap*	14	23	30	29	11	19	27	31	70	48	100	161	152	27	58	91	162	645
Tissue Eng*	29	27	42	15	16	20	37	31	83	103	107	204	51	49	54	144	145	764
Stem cell*	62	99	118	109	65	72	103	163	247	687	1 406	2 135	1 717	699	866	1 338	2 400	6 714
Regenerative medicin*	13	18	28	14	7	6	23	32	62	29	56	102	37	15	15	69	123	301
Regeneration	43	47	63	46	29	29	48	74	121	374	439	851	521	190	148	359	630	1 924
Genomic*	63	110	124	133	85	78	83	202	256	557	1 542	2 346	1 939	994	801	858	3 299	5 807
Oligonucleotide*	21	29	43	29	20	19	22	48	72	80	134	285	147	58	67	84	217	481
mRNA	51	70	82	77	60	52	73	96	133	641	1 069	2 032	1 665	817	471	649	1 211	3 389
Mitochondri*	60	74	92	87	52	53	60	116	169	644	1 087	1 948	1 636	599	417	580	1 784	2 901
Bioinformatics	26	38	48	43	27	19	25	75	70	104	215	342	267	119	72	112	492	662

≥ average | Average to -15% | -15% to -30% | < - 30%

Note: The asterisk (*) represents any group of characters, inlcuding no character, e.g. Implant* will result in search results including implant, implants, implantable etc. [1]Web of Science Categories
Source: Web of Science. See appendix for more information about how the bibliometric search was conducted

2. Regenerative medicine & ATMP

Collaborative environment and research infrastructure

Highlighted initiatives and research infrastructures

- Project "Sweden a leader in advanced therapies 2030"
  Five-year cross-sector project aiming to achieve a long-term transformation of the innovation system for advanced therapies. 10 million SEK funding from Vinnova coordinated by RISE
- ATMP-center Sahlgrenska, Gothia Forum
  New center with purpose to offer advice and support for researchers and companies to initiate clinical trials for ATMP or introduce in healthcare. E.g. project description support, IMPD, regulatory advice, access to GMP premises
- Stem Cell Laboratory at Sahlgrenska University Hospital
  Accredited to utilize, process, freeze and store stem cells for hematopoietic stem cell transplantation at the Department of Clinical Immunology and Transfusion Medicine
- Stem Cell Biobank at The Queen Silvia's Hospital for Children
  Accredited by IVO and JACIE, and well known in the rest of the world.
- Sahlgrenska Biobank
  Coordinates the collection, handling and storage of biobank samples
- Cell and Tissue Laboratory at Sahlgrenska University Hospital
  GMP-certified cell culture facility for transplantations at the Department of Clinical Chemistry
- 3D Bioprinting Center at Chalmers University of Technology
  Prints cells and tissues needed for research, drug screening and tissue engineering. Evaluates biocompatible biomaterials, or bioinks, for 3D bioprinting with living cells.
- RISE Research Institutes of Sweden
  Offers advanced research facilities and services within ATMP
- Laboratory for Transplantation and Regenerative Medicine
  Development and deciphering mechanisms of novel therapeutic and diagnostic applications in organ transplantation and regenerative medicine
- Genomic Medicine Sweden
  National venture for the implementation and development of precision medicine in Sweden. 1 of 7 centers in Gothenburg

Area outlook / Example initiatives in other regions

- CAMP – National (Coordinators Umeå University, Director RISE Gothenburg)
  Centre for Advanced Medical Products (CAMP)
- Swelife ATMP – National (Project Lead KI)
  The aim of the project is to strengthen Sweden's competitiveness in advanced therapies (ATMP), primarily within cell and gene therapy
- ATMP Sweden – National
  The national network of Sweden's activities within medicines based on genes, cells or tissue engineering, classified as Advanced Therapy Medicinal Products (ATMPs) in Europe
- Centre for Advanced BioProduction, AdBIOPRO – Stockholm
  Vision to become an internationally leading sustainable and dynamic centre for research on advanced bioproduction. 28,5 MSEK Vinnova funding
- Karolinska Cell Therapy Center (KCC) – Stockholm
  Supports and facilitates for researchers, clinicians and industrial companies that aim to develop quality assured Advanced Therapy Medicinal Products (ATMPs) and cell therapy products for unmet clinical needs
- Testa Center - Uppsala
  A high-quality, pilot-scale biopharmaceutical manufacturing facility

3. Advanced Drug Delivery

Bibliometric comparison

Topic	H-index									Number of publications								
	West Sweden	Average (ex. Boston)	Stockholm-Uppsala	Medicon Valley	Oslo	Lyon	Basel	Cambridge	Boston	West Sweden	Average (ex. Boston)	Stockholm-Uppsala	Medicon Valley	Oslo	Lyon	Basel	Cambridge	Boston
Nanoscience & nanotechnology[1]	67	72	95	88	38	38	55	122	120	963	1 179	2 212	1 406	318	313	500	2 543	2 175
Cell Biology[1]	75	118	139	132	86	82	122	191	294	833	1 964	3 060	2 513	946	912	1 597	3 887	9 187
Virology[1]	32	49	52	58	32	52	50	65	102	145	468	756	511	189	620	299	759	2 131
Immunology[1]	60	84	105	99	69	61	92	101	177	917	1 799	3 366	2 832	1 253	1 195	1 444	1 589	7 670
Biophysics[1]	38	50	60	52	32	35	53	81	78	374	645	1 103	943	312	342	489	950	1 653
Biotechnology & Applied Microbiology[1]	61	76	84	94	50	46	64	130	148	810	1 118	1 762	1 650	492	518	710	1 887	2 389
Chemistry, Organic[1]	35	41	60	34	30	30	43	52	51	330	516	988	580	212	244	635	624	739
Mathematical & Computational Biology[1]	32	45	48	44	30	34	40	88	86	224	541	684	494	252	287	437	1 408	1 895
Microbiology[1]	75	95	115	124	66	69	80	137	179	1 415	2 371	3 767	3 935	1 229	1 403	1 646	3 202	6 093
Pharmacology & Pharmacy[1]	59	66	79	78	53	42	75	73	97	1 198	1 982	3 128	3 038	1 003	1 028	2 804	1 675	5 015
Drug deliver*	32	39	46	51	32	23	32	49	99	199	309	486	571	212	132	221	340	1 196
Administration route	3	7	11	9	5	6	9	4	7	9	13	25	20	9	8	19	4	14
Exosome*	33	27	40	26	25	16	18	28	69	86	70	132	63	58	30	39	84	330

≥ average | Average to -15% | -15% to -30% | < - 30%

Note: The asterisk (*) represents any group of characters, inlcuding no character, e.g. Implant* will result in search results including implant, implants, implantable etc. [1]Web of Science Categories
Source: Web of Science. See appendix for more information about how the bibliometric search was conducted

3. Advanced Drug Delivery

Collaborative environment and research infrastructure

Highlighted initiatives and research infrastructures

FoRmulaEx centre

- Industrial research centre at Chalmers University of Technology for functional RNA delivery
- Eight-year collaboration between Chalmers, University of Gothenburg, Karolinska Institutet and company partners
- AstraZenca is the leading company partner
- Funding received from the Swedish Foundation for Strategic Research (SSF)

Research projects within:

- Lipid Nanoparticle Generation and Characterization
- RNA Synthesis, Fluorescence-based Probe Design and Characterization
- Exosome Biology and RNA-loading
- Quantification of Endosomal Escape and Functional Delivery
- Novel Imaging Tools and Cellular Particle Tracking
- Cellular Uptake and Intracellular Trafficking Mechanisms

Area outlook / Example initiatives in other regions

- The Swedish Drug Delivery Center (SweDeliver), Uppsala
  34 million SEK from Vinnova 2020-2024 to continue building the competence center and position the region as world leading in drug delivery science
- NextBioForm, Centre for formulation and processing of biologics, National (RISE coord.)
  Focus is on improved product stability, development of new easy to use formulation platforms and excipients. The centre brings together 18 partners from the institute, academic, hospital and industry sectors
- Swedish Drug Delivery Forum, Uppsala University
  Collaboration project between Uppsala university and 10 industrial partners. The project received 18 million SEK from Vinnova in 2017, with the aim to develop a world leading research environment for Drug Delivery
- Uppsala University Drug Optimization and Pharmaceutical Profiling (UDOPP)
  National resource facility integrated within the SciLifeLab platform for Drug Discovery and Development
- Drug Delivery Research Group, Uppsala University
  Department of Pharmacy
- Medicon Valley Beacon
  Drug Delivery Identified as ”Beacon” area by Medicon Valley in 2014/2015
- Center for Single Particle Science and Engineering, Southern Denmark University
  Research center with the primary goal to develop novel strategies using micro- and nano- technology to improve drug delivery, specifically for cancer treatments

4. Digital Health & AI

Bibliometric comparison

Topic	H-index									Number of publications								
	West Sweden	Average (ex. Boston)	Stockholm-Uppsala	Medicon Valley	Oslo	Lyon	Basel	Cambridge	Boston	West Sweden	Average (ex. Boston)	Stockholm-Uppsala	Medicon Valley	Oslo	Lyon	Basel	Cambridge	Boston
Computer science artificial intelligence[1]	21	29	38	31	19	27	8	51	45	200	261	360	319	143	216	39	552	641
Computer Science, Software Engineering[1]	25	26	28	31	26	25	11	39	28	364	318	372	389	284	255	27	533	375
Computer Science, Interdisciplinary Applications[1]	36	45	51	49	37	33	35	75	76	458	579	901	639	385	282	268	1 123	1 336
Medical Informatics[1]	17	26	32	28	26	13	21	38	63	110	219	393	236	187	94	188	325	1 462
Mathematical & Computational Biology[1]	32	46	46	43	30	33	40	86	84	223	527	657	483	243	282	422	1 381	1 855
Behavioral Sciences[1]	31	37	45	36	32	30	31	53	56	207	409	676	494	349	199	186	754	1 151
Computer Science, Information Systems[1]	32	39	50	40	42	23	27	57	63	389	453	840	515	397	223	110	695	1 148
Machine learning	20	31	28	29	21	17	34	55	63	167	280	382	283	159	86	169	715	1 171
Artificial intelligence, AI	15	20	25	22	15	13	17	30	43	65	123	221	159	91	63	75	190	441
Big Data	12	17	19	19	17	9	11	28	38	54	92	138	129	83	35	39	166	349
Sensors	45	58	73	62	48	42	44	91	117	747	894	1 574	945	535	386	368	1 701	2 079
Medical device	6	8	14	13	2	9	4	10	26	10	22	39	36	4	27	12	28	134
Pattern recogni*	18	28	29	34	22	24	23	38	57	61	104	152	194	73	50	53	142	276

≥ average | Average to -15% | -15% to -30% | < - 30%

Note: The asterisk (*) represents any group of characters, inlcuding no character, e.g. Implant* will result in search results including implant, implants, implantable etc. [1]Web of Science Categories
Source: Web of Science. See appendix for more information about how the bibliometric search was conducted

4. Digital Health & AI

Collaborative environment and research infrastructure

Highlighted initiatives and research infrastructures

- AI Sweden
  Previously AI Innovation of Sweden. Swedish National Center for applied Artificial Intelligence. One node (the first one established) at Lindholmen Science Park. One of the ongoing projects is SCAPIS AI platform for analysis of heart images, led by Sahlgrenska Academy
- CHAIR Chalmers AI research center
  A centre of excellence in AI with research focus on both basic and applied AI, hosted by Chalmers Areas of Advance ICT. Researchers from several departments will collaborate with industry partners. The Chalmers Foundation co-finance the centre together with Chalmers and industry partners. Life Science and Health Engineering is one of 3 prioritized areas and Sahlgrenska University Hospital is one of the Core Partners
- Education within AI
  Chalmers assigned by the government to coordinate national effort in special university education within AI (2018)
- WACQT
  Wallenberg Centre for Quantum Technology, a 12-year research effort with investment of 1 billion SEK, aiming to secure Swedish expertise within the main areas of quantum technology
- SII-LAB
  The Stena Industry Innovation Lab. Lab offering possibilities to test digitalized production in practical test beds. The lab offers fast communication systems with 5G, collaborative robots as well as virtual and augmented reality techniques for assembly

Automotive / ICT:

- Lindholmen Science park
  Arena for collaboration, focus on future mobility for people and goods. Jointly owned by Chalmers University of Technology, the City of Gothenburg and the business community. Host for AI Sweden
- Mobility-Xlab
  Collaboration hub founded in 2017 by six global companies (CEVT, Ericsson, Veoneer, Volvo Cars, Volvo Group & Zenuity) to create and develop new innovations within future mobility – with each other and with startups. Hosted by Lindholmen Science Park with support from Vinnova & Västra Götalandsregionen

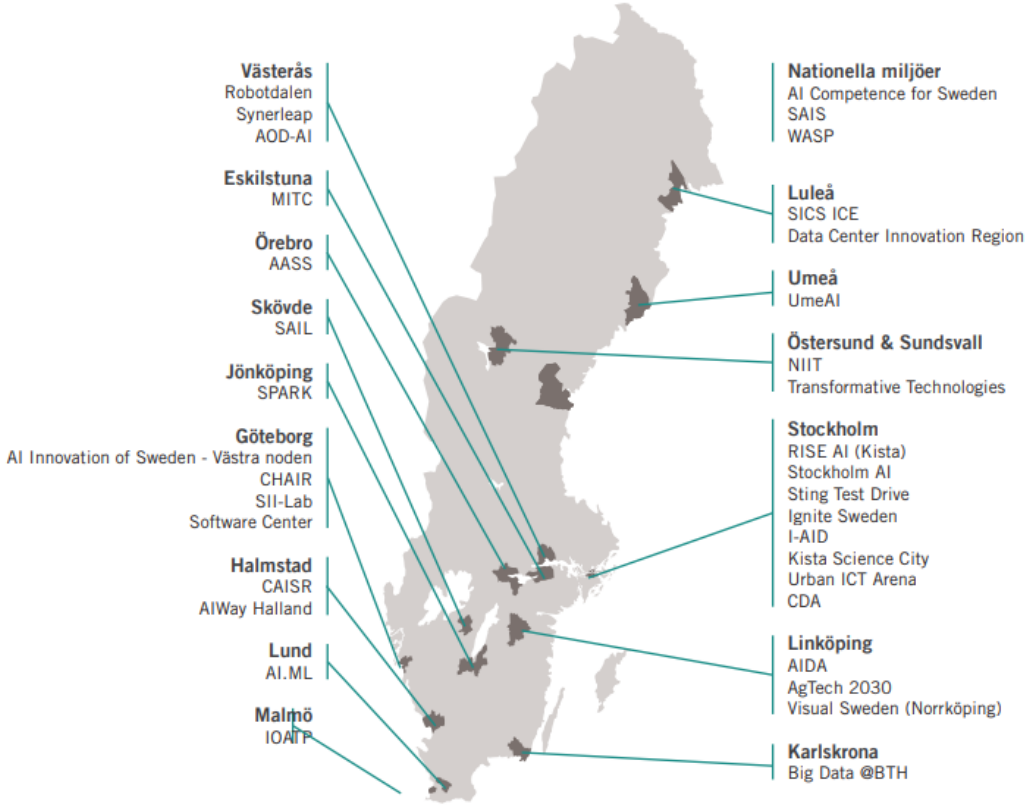
Area outlook / Example initiatives in other regions

- WASP - National
  Wallenberg AI, Autonomous Systems and Software Program. Major national initiative for strategically motivated basic research, education and faculty recruitment in artificial intelligence, autonomous systems and software development. The research is conducted at seven Swedish universities, including Chalmers
- Invest in Stockholm
  Invest In Stockholm recently released *Stockholm Life Sciences AI/ML Guide* where the AI-driven development and world-class AI-research at KTH is highlighted. *"Stockholm is fast becoming a hub for companies looking to apply AI and ML to the life sciences"*
- Vinnova AI report
  In a report released by Vinnova in 2018, *Artificiell intelligens i svenskt näringsliv och samhälle,* it was concluded that the research productivity in Sweden within AI is relatively low compared to other countries. KTH and Linköping University are identified as having the highest publication volume within Sweden

4. Digital Health & AI

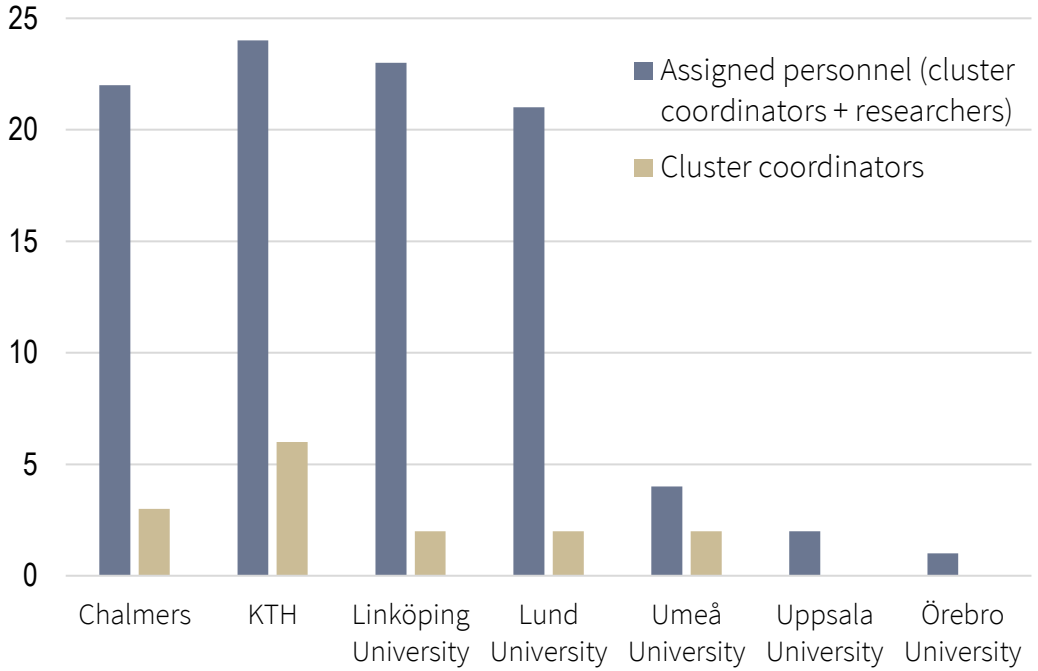
AI Benchmark: There is an intense activity with numerous initiatives throughout Sweden

AI-environments Sweden



WASP Brainpower

Wallenberg AI, Autonomous Systems and Software Program organization



Note. WASP is divided into 12 thematic clusters. Each cluster involves university, industrial, and affiliated PhD students with an assigned team. PhD students have not been included in this overview
Source: WASP homepage

Source: Vinnova rapport VR 2019:05 AI-miljöer i Sverige

5. Medical Imaging

Bibliometric comparison

Topic	H-index									Number of publications								
	West Sweden	Average (ex. Boston)	Stockholm-Uppsala	Medicon Valley	Oslo	Lyon	Basel	Cambridge	Boston	West Sweden	Average (ex. Boston)	Stockholm-Uppsala	Medicon Valley	Oslo	Lyon	Basel	Cambridge	Boston
Radiology, Nuclear Medicine & Medical Imaging[1]	39	66	72	77	62	58	52	74	130	553	1 152	1 805	1 884	849	999	828	1 147	8 344
Neuroimaging[1]	16	40	46	44	29	37	27	56	80	53	210	339	227	132	174	145	398	1 453
Medical imag*	9	14	16	13	11	15	11	16	44	24	45	61	49	35	57	31	61	258
Medical simulati*	10	17	24	25	13	11	12	16	45	32	73	122	147	53	59	38	63	525
Biosensor*	24	27	31	44	10	20	23	35	52	85	137	261	263	21	73	81	172	333
Sensor* medic*	15	16	20	19	12	10	13	21	44	53	60	94	79	47	30	43	72	317
Magnetic resonance imaging	45	65	73	64	63	61	61	88	130	437	876	1 098	1 257	777	547	737	1 282	4 430
Crystallography[1]	16	25	30	27	16	10	24	51	10	116	212	294	328	118	46	112	470	56
NMR	45	54	60	56	32	48	49	91	69	496	773	1 222	1 053	297	409	591	1 342	820
Pattern recogni*	18	28	29	34	22	24	23	38	57	61	104	152	194	73	50	53	142	276

≥ average | Average to -15% | -15% to -30% | < - 30%

Note: The asterisk (*) represents any group of characters, inlcuding no character, e.g. Implant* will result in search results including implant, implants, implantable etc. [1]Web of Science Categories
Source: Web of Science. See appendix for more information about how the bibliometric search was conducted

5. Medical Imaging

Collaborative environment and research infrastructure

Highlighted initiatives and research infrastructures

- BoIC, Bild- och interventionscentrum
  Sahlgrenska Image and Intervention Center. 2 billion SEK investment in one of Europe's most advanced centers for diagnostics and imaging. Construction currently ongoing for establishing research facility
- Centre for Cellular Imaging (CCI)
  National core facility at University of Gothenburg that integrates both light and electron microscopy. CCI is part of the National Microscopy Infrastructure (NMI) that was funded in 2016
- Department of Radiation Physics
- Swedish NMR centre
  National research infrastructure at University of Gothenburg that provides access to state-of-the-art NMR instrumentation and methodology
- Chemical Imaging Infrastructure (CII)
  World-unique research infrastructure with a primary focus on high lateral resolution imaging mass spectrometry. The NanoSIMS 50L in Gothenburg is the first of these instruments in Scandinavia. Hosted by the Department of Chemistry and Chemical Engineering at Chalmers and by the Department of Chemistry and Molecular Biology at University of Gothenburg
- Chase / ChaseOn
  Antenna systems research at Chalmers, with application fields including sensor systems and medtech. Received 35 million SEK from Vinnova in 2017. Results include a stroke diagnosis system and the founding of Medfield Diagnostics

Area outlook / Example initiatives in other regions

- Karolinska Experimental Research and Imaging Centre (KERIC) - Karolinska
  Testbed, core facility offering different imaging analyses in experimental systems
- Analytic Imaging Diagnostics Arena (AIDA) – Linköping
  National arena for research and innovation around Artificial Intelligence (AI) for medical imaging diagnostics. Has initiated a data hub to facilitate sharing of data in safe and ethical ways. Received 27 million SEK from Vinnova 2017
- Center for Medical Image Science and Visualization (CMIV) – Linköping
  Multidisciplinary research center initiated by Linköping University, Region Östergötland and Sectra. Focused on image analysis and visualization for applications within health care and medical research

Contents

Contents

Methodology 1(3)

Company selection

Life Science companies have been included in the analysis based on the criteria that they should be active and have a pronounced focus on life science (defined as at least approximately 1/3 of business related to life science) and have at least one workplace registered in Västra Götaland or Halland. The company list used in earlier reviews of the life science industry, conducted by Tillväxtverket, was used as a starting point. Companies active in the incubators and other startup environments have been added, as well as companies found in specific searches based on industry codes (SNI). The list of companies has then been reviewed and iterated within the core team, experts in the Triathlon & ISEA organization as well as other selected experts. Some companies have been removed due to that they are not considered to have enough portion of their business within the life science segment, or that they do not have any active business. Focus has been on active companies and it is therefore possible that companies that are inactive or has been acquired could have been overlooked in the historical data. It is important to note that this could affect the growth numbers when comparing to 2010.

Financial data

Financial figures per company where obtained from Allabolag. 2018 has been used as base for figures regarding number of employees, due to that figures for 2019 are not yet available for all companies. For the larger companies with registered workplaces in several regions, information was also obtained about employee size range[1] for the workplaces in Västra Götaland or Halland, as the exact number of employees was not possible to obtain from Allabolag. To get a more exact number of employees, the larger companies have been contacted and asked to provide this data. For smaller companies and in the cases where this data has not been obtained, the number of employees have been assumed to be the average of the given size range. It is important to note that many life science companies work with service providers and consultants to large extent. Consequently, the number of employees may not reflect the active team as employees may be on e.g. consultancy contracts and thus not visible in the statistics.

Company categorization

The categories used are the same as used by Tillväxtverket in earlier reviews of the life science industry, see categories and definitions on separate page. New companies added to the list have been categorized and then iterated within the core team, experts in the Triathlon & ISEA organization as well as other selected experts. A few of the companies categorized in earlier reviews have been moved to another category after this iteration. Each company has only been assigned to one category. Many companies have diverse business and would theoretically fit into more than one category, but these have been assigned to the category where they have been assessed to have the main part of their business and focus.

In addition to the main categorization of companies, the recently founded companies have been tagged with additional keywords on a more detailed level. This was done by reviewing the companies' webpages, or when not available the company descriptions on e.g. Incubators' webpages, to identify the main keywords used to describe the company's business. The keywords were then grouped to form categories, e.g. Digital platform, cloud platform, cloud service, app etc. were all grouped into "Digital Health".

[1]Defined employee size ranges are 0, 1-4, 5-9, 10-19, 20-49, 50-99, 100-199, 200-499, 500-999, 1000-1999 and 2000 or more employees

Methodology 2(3)

Interviews

37 individuals have been interviewed in the work with this report. 18 of them represent industry and 19 are from academia, public sector and other organizations in the ecosystem e.g. incubators and support functions. When selecting the interviewees, the aim was that the largest actors in the region, from industry, academia and public sector, should be represented. The interviewees were selected based on recommendations from core team and from other interviewees. The majority of interviews have been conducted over phone or digital given the current COVID-19 pandemic. The questions have been open-ended and related to strengths in the region, organizational needs, opportunities, available collaborations and potential focus for a cluster organization.

Interviewee organizations

Industry	Academia, public sector and other
Abigo	BRG
Antaros Medical	Chalmers
AstraZenca	Gothia Forum
AstraZeneca BioVentureHub	GU Ventures
Cellink	Innovationsplattformen VGR
Dentsply Sirona Implants	Medicon Valley Alliance
Essity	RISE
Getinge	Sahlgrenska Academy (GU)
Mölnlycke Health Care	Sahlgrenska University Hospital
Vitrolife	University of Gothenburg
Wellspect	

About Monocl

Monocl is a cloud-based stakeholder platform with information about millions of stakeholders withing the life science field. For each stakeholder, there is information about publications, meeting presentations, clinical trials and research funding with detailed classification according to MeSH (Medical Subject Headings) keywords. By using machine learning and sophisticated algorithms, Monocl gathers this information and lets the user search for medical experts, opinion leaders and scientists across the world within specific research fields.

How Monocl was used for data collection to the analysis

Monocl has been used to identify top ranked researchers in West Sweden and pinpoint within which fields of research they are active. This has been done by search based on the researchers' primary affiliation. Each expert in Monocl only has one affiliation assigned, which results in that some researchers who work at more than one university (e.g. one in Denmark and one in Sweden) are sometimes missed in the search.

Searches based on specific MeSH keywords have also been conducted to identify research fields where West Sweden has a strong position in relation to the Nordic countries, as well as globally. A limited number of MeSH keywords were selected for this search, all related to research fields identified as strengths in the region based on other data and what has been mentioned in interviews.

Methodology 3(3)

Metrics for bibliometric review

Web of Science has been used for gathering bibliometric data for specific categories and keywords related to prioritized areas. In addition to number of publications, H-index was chosen as metric for benchmarking with other cluster regions. A H-index of *n* means that there are at least *n* publications with at least *n* citations. H-index is easy to calculate, relatively easy to understand and is considered useful for benchmark between regions as it combines productivity and impact into one metric. This metric has limitations, for example the Swedish Research Council[1] does not recommend the use of H-index and argues that it can be misleading. Instead they recommend the use of Mean Normalized Citation Score (MNCS) and share of publications among top 10% publications. As the intention with the bibliometric data in this report is to conduct a high-level search that can be presented in an easily understandable format, H-index in combination with number of publications is considered useful despite the possible drawbacks. The H-index is never used for direct comparison between different reserach categories. Instead, the performance of West Sweden is compared to the average of the other benchmark regions within each specific category.

Benchmark regions

Benchmark regions have been selected with ambition to represent both nearby cluster environments as well as internationally prominent life science clusters as comparative benchmark and indication of “world class”.

Categories, keywords and data filters in bibliometric review

Articles have been searched for by using Web of Science Categories as well as a limited number of free keywords to get more specific results in certain areas. The keywords selected have been iterated with experts in the Triathlon & ISEA organization as well as other selected experts. The document type has been limited to articles. Keywords that resulted in very few articles for West Sweden as well as other regions were later excluded from the presented data.

It is important to **note** that this analysis is <u>not claimed to be a fully comprehensive overview</u> but rather should be seen as an attempt to give a high-level indication for areas and key words highlighted by experts.

Publication years

Focus in this review has been to assess the status and trend of recent research, which is why 2010-2020 was chosen as publication years in the search to ensure that recent publications are included in the data. Bibliometric reviews often exclude publications from the latest 1-3 years due to that recent publications naturally have a lower number of citations. H-index is dependent on citations but is however not negatively impacted by adding additional articles with fewer citations to the dataset (in contrast to e.g. mean citation score). Articles published 2010-2020 were therefore used also for the H-index calculation, even if the most recent published articles have little impact on the metric due to limited number of citations.

Prominent research

Identification of prominent researchers and research teams are based on findings in bibliometric data, ranking on Monocl platform, research funding data as well as input from interviews. The research highlighted is based on subjective assessment of the received input and is highly influated by which groups and individuals the interviewees have highlighted.

[1]Source: Riktlinjer för användning av bibliometri vid Vetenskapsrådet

Definitions of industry sub-sectors

Agro/Food/Environmental Biotech
Companies that conduct research, development, production and sales of agricultural, environmental and food-related biotechnology. Agriculture biotech may for example involve genetic modification of crops or development of microorganisms that protect them. In the environmental area, there may be products for e.g. water purification and sampling. In food-related biotechnology, there are companies that develop probiotics or different diets to prevent ill health.

Anesthetic and respiratory devices
Companies in this segment develop products that monitor and control patients' breathing. The products are mainly used in intensive care units and operating rooms.

Assistive products for persons with disability
This segment includes products such as walking aids, walkers, wheelchairs and hearing aids.

Biotech medical technology
Offers medical devices that have a biotech base. These products include e.g. instruments for in vitro fertilization, blood plasma, cell therapy and products for replacement of human tissues.

Biotech production
This business segment performs production of biomolecules, cells and microorganisms that are used in, for example, drugs or diagnostic tests. Biomolecules are in many cases enzymes or antibodies. The customers are primarily other pharmaceutical or biotechnology companies.

Biotech tools and supplies
Delivers products and services for production, research and development and includes bioseparators, biosensors and products for biomolecular analysis and bioinformatics.

Consultancy
Consultancy companies dedicated to life science industry. Often specialized in e.g. regulatory affairs or medicinal product development.

CRO, Contract research
Companies in contract research offer products and services that make it easier for other companies to carry out clinical trials and evaluations and to manage regulatory processes. Some companies in this business segment have developed their own analysis platforms.

Electromechanical medical devices
In this segment, there are companies that offer medical devices that are used, among other things, for treatment and monitoring of patients. These include life-sustaining systems, neonatal monitoring systems and dialysis systems.

Healthcare facility products and adaptations as well as single use
Companies in this business segment produce and sell equipment, fixtures and disposable products for healthcare. Examples of equipment are disinfection systems, patient lifts, hygiene solutions and operating tables, as well as disposable products such as syringes, contrast fluid, incontinence protection and wound care products.

Implantable devices active and nonactive
Orthopedic, dental and other medical implants are included in this segment. They can be biologically active such as pacemakers or bone-anchored hearing aids or inactive such as hip or knee prostheses.

Information and communication tools (ICT)
This segment includes IT solutions for medical use and includes for example medical records systems, training and education software and telemedicine systems.

In vitro diagnostics
These companies develop tools and techniques for diagnosis and most of the customers are healthcare, companies in clinical laboratory analysis and end consumers for home use. Biotechnology diagnostics companies often develop antibody-based tests. Medical diagnostic products can be technical equipment for measuring or visualizing diagnostic results, or in vitro diagnostic tests.

Marketing & Sales
This segment includes all the companies that do not conduct research, product development, consulting or manufacturing on their own. These companies are typically distributors of other brands. The products can be of any type within life science, e.g. pharmaceuticals, medical devices, disposable products etc.

Pharmaceutical
This business segment includes companies that conduct research, development, manufacturing and sales of pharmaceuticals and therapy. The segment includes both companies that offer pharmaceuticals based on small molecules as well as biological drugs. The sale is primarily to the health service, but there is also licensing for other pharmaceutical companies. This segment also includes companies that develop biomarkers that are used to determine which populations are relevant for a particular treatment. Companies that only carry out pharmaceutical production are also in this category, but not production of biological drugs that is included in the segment 'biotech production'.

Radiation and imaging devices diagnostic and therapeutic
Companies that offer products and services in radiation therapy and radiological examinations are in this segment. Examples of products are the gamma knife, magnetic resonance imaging, ultrasound and equipment for laser treatment.

Contents

Bibliometric comparison: Other areas

Topic	H-index									Number of publications								
	West Sweden	Average (ex. Boston)	Stockholm-Uppsala	Medicon Valley	Oslo	Lyon	Basel	Cambridge	Boston	West Sweden	Average (ex. Boston)	Stockholm-Uppsala	Medicon Valley	Oslo	Lyon	Basel	Cambridge	Boston
Cardiac & Cardiovascular Systems[1]	95	94	121	122	91	59	80	93	n/a	1 487	1 677	2 659	3 612	1 379	461	1 008	1 135	11 560
Obstetrics gynecology[1]	53	48	60	73	47	31	31	47	84	618	833	1 561	1 561	880	450	282	479	3 492
Reproductive Biology[1]	38	34	45	61	28	19	14	37	54	162	266	559	567	157	118	53	249	713
In-vitro fertili*	31	22	37	42	15	11	5	19	42	91	88	172	224	39	33	10	46	346
Transplantation[1]	34	44	48	39	36	44	49	45	78	210	356	612	384	299	351	349	286	1 572
Clinical Neurology[1]	91	96	112	113	71	83	90	114	n/a[2]	1 780	2 210	3 284	3 305	1 671	1 414	1 709	2 304	10 693
Neurosciences[1]	80	101	117	109	84	82	93	145	n/a[2]	1 740	2 832	4 589	4 083	1 630	1 506	1 917	4 357	11 038
Geriatrics & Gerontology[1]	38	41	57	48	41	27	31	47	86	339	458	904	699	416	155	222	472	1 862
Oncology[1]	70	123	140	135	107	147	129	136	n/a[2]	1 255	3 358	5 258	5 130	2 748	4 190	2 085	2 842	16 014
Cancer	109	173	n/a[2]	n/a[2]	160	192	158	244	n/a[2]	3 174	7 347	11 735	11 789	5 762	7 171	3 947	7 852	34 017
Maternity	20	18	30	19	20	15	6	19	29	97	86	182	89	93	67	11	61	238
Midwife*	16	13	26	15	12	5	9	7	17	93	65	157	91	52	14	22	28	75
Medical Informatics[1]	18	26	34	29	26	13	22	39	64	113	227	407	244	191	97	197	339	1 569
Chemistry, Medicinal[1]	40	41	41	44	26	25	57	53	55	516	588	602	749	194	167	1 155	733	1 002

≥ average | Average to -15% | -15% to -30% | < - 30%

Note: The asterisk (*) represents any group of characters, inlcuding no character, e.g. Implant* will result in search results including implant, implants, implantable etc. [1]Web of Science Categories. [2]Citation report and H-index not available from Web of Science for sets of more than 10 000 articles

Source: Web of Science. See appendix for more information about how the bibliometric search was conducted

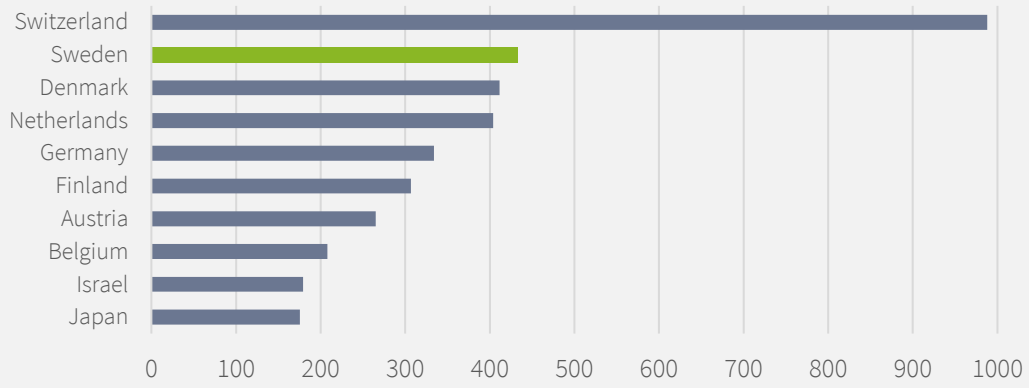
The patent productivity is relatively low in West Sweden

Sweden has a high patent productivity overall but relatively low in the life science fields, and Stockholm is the dominating region in number of patent applications

EUROPEAN PATENT APPLICATIONS IN THE WORLD

Ranking according to number of European applications per million inhabitants

All European patent applications 2019, not limited to life science



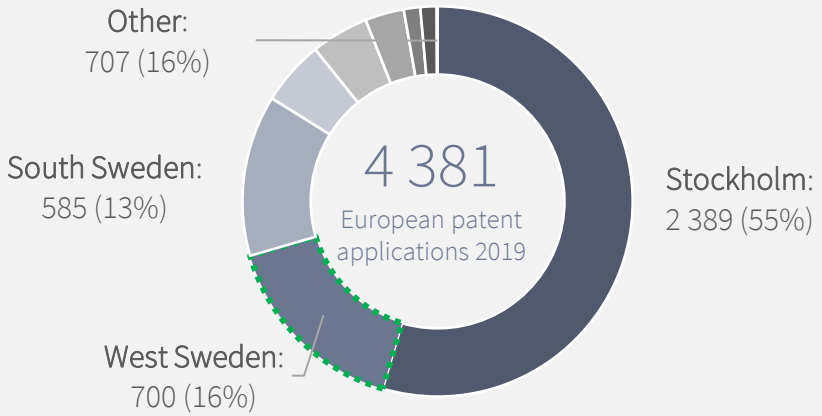
Country	Total number of patents applications in life science and per technology field, 2010-2019	Number of patent applications in life science per million inhabitants, 2010-2019
Switzerland	13 854	1 617
France	13 376	200
United Kingdom	7 942	119
Denmark	5 898	1 015
Sweden	3 706	362
Norway	767	143

Medical technology Biotechnology Pharmaceuticals

SWEDEN

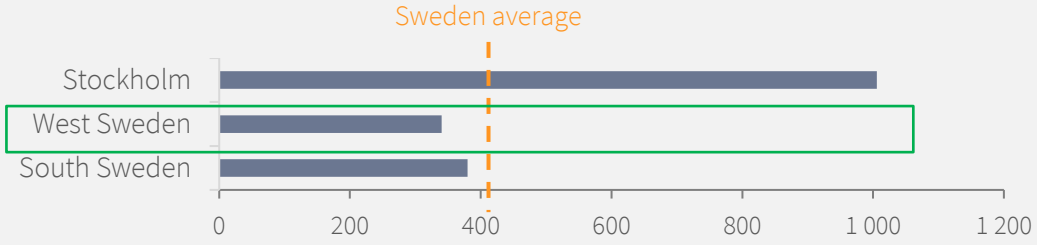
Distribution of European patent applications per region

All European patent applications 2019, not limited to life science



Number of patent applications per million inhabitants

All European patent applications 2019, not limited to life science



Note: European patent applications include direct European applications and international (PCT) applications that entered the European phase during the reporting period. The geographic origin of an application accords with the region of residence of the first applicant listed on the application form.

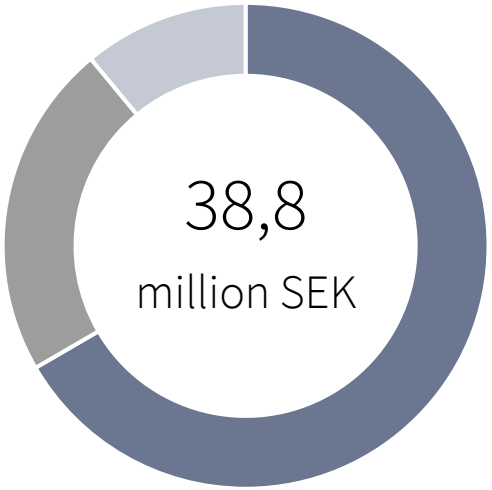
Source: EPO, SCB

VGR contributes with significant funding to life science projects and organizations

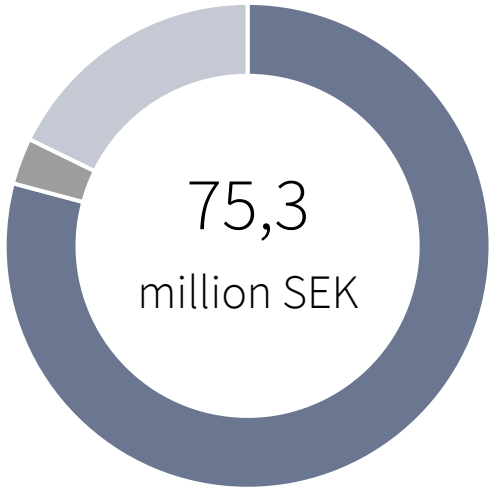
VGR has distributed more than 140 million SEK 2017-2019 within the Program for life science to projects and organizations in the region

- FoU i samverkan
- Infrastruktur för FoI inom hälso- och sjukvården
- Innovation och företagstillväxt

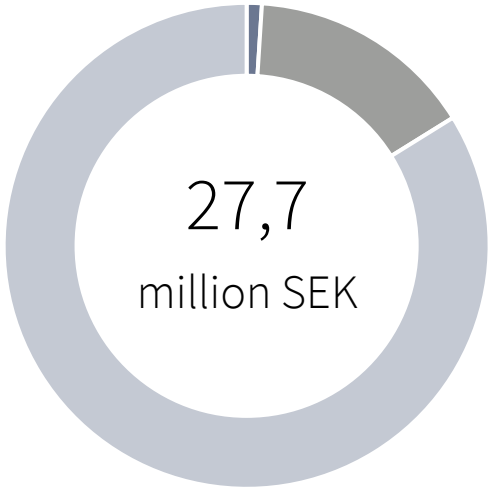
2017



2018



2019



Major projects that received funding 2017:

- Innovationsplattformen - 7 million SEK
- AllAgeHub - 5,5 million SEK
- MedTech West, Steg 4 - 6 million SEK

Major projects that received funding 2018:

- Wallenbergcentrum för Molekylär och Translationell Medicin - 12,5 million SEK
- Gothenburg Research School of Healthcare Engineering, 8 million SEK
- Prehospital ICT Arena 3 - PICTA 3 - 5,7 million SEK

Major projects that received funding 2019:

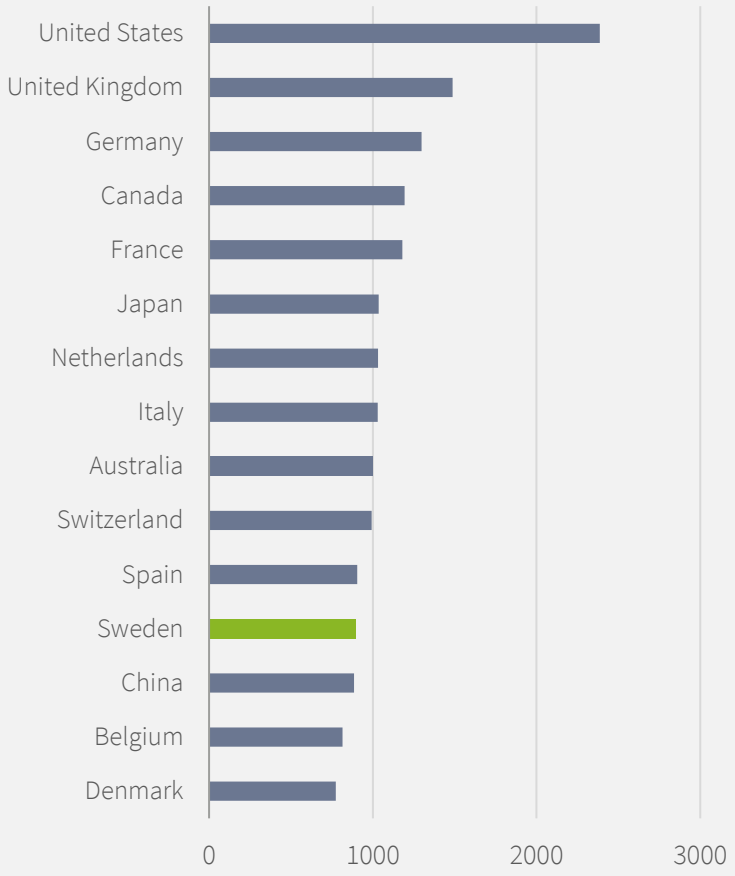
- AstraZeneca Bio Venture Hub - 10 million SEK
- Etableringsstöd Life Science (Foreign Direct Investment) - 1,6 million SEK
- Utveckling av verktyg med artificiell intelligens för förbättrad kvalitet och effektivitet i hälso - och sjukvård i VGR (Sahlgrenska) - 1,5 million SEK

Note: Business support to organizations are included in the total amount and constitutes 51,8 million SEK in total 2017-2019, distributed on Gothia Forum: 26,5 million SEK, Innovationsplattformen: 21 million SEK, SSP: 4,3 million SEK
Source: VGR

Scientific impact ranking overall and in Biomedical and Health sciences

Sweden's research on 12th place in overall impact ranking

Total H-index per top 15 countries, all subject areas (not only life science)



Scientific impact Biomedical and Health Sciences, ranking of Nordic universities

CWTS Leiden ranking 2020. Based on articles in the time period 2015-2018

#	University	Number of publications	P (top 10%)[1]	PP (top 10%)[2]	Europe ranking
1	Karolinska Institutet	20 056	3 450	17.2%	2
2	Univ Copenhagen	14 895	2 415	16.2%	5
3	Univ Oslo	10 150	1 607	15.8%	24
4	Lund Univ	9 325	1 423	15.3%	28
5	Univ Helsinki	8 927	1 365	15.3%	29
6	Univ Gothenburg	8 400	1 454	17.3%	31
7	Uppsala Univ	8 300	1 251	15.1%	33
8	Univ South Denmark	7 007	1 064	15.2%	45
9	Aarhus Univ	6 152	883	14.4%	54
10	Univ Bergen	4 983	818	16.4%	77
11	Umeå Univ	4 418	623	14.1%	89
12	Univ Turku	3 886	572	14.7%	102
13	Linköping Univ	3 742	458	12.2%	107
14	Norwegian Univ Sci & Technol	3 616	523	14.5%	110
15	Aalborg Univ	3 528	454	12.9%	114
- - -					
19	Stockholm Univ	2 182	311	14.2%	177
22	Örebro Univ	1 391	206	14.8%	222
23	KTH Royal Inst Technol	1 099	134	12.2%	247
25	Swed Univ Agr Sci	970	112	11.6%	263
26	Chalmers Univ Technol	717	78	10.9%	304
31	Luleå Univ Technol	217	26	12.2%	400

[1]Number of publications of a university belonging to the top 10% of their field. [2]Proportion of the publications of a university belonging to the top 10% of their field

Sources: Scimago Journal & Country Rank, CWTS Leiden ranking

University ranking heat map in life science subjects

Top Danish, Norwegian and Swedish universities' position on Shanghai ranking 2019

High rank — Low rank

Top-ranked Sweden

University	Clinical medicine	Public health	Dentistry & Oral Sciences	Nursing	Medical Technology	Pharmacy & Pharmaceutical Sciences	Biological Sciences	Human Biological Sciences	Biomedical Engineering	Materials Science & Engineering	Biotechnology
Chalmers University of Technology							201-300			151-200	101-150
Karolinska Institutet	21	6	51-75	6	51-75	4	15	24	51-75		44
KTH Royal Institute of Technology							201-300		201-300	101-150	101-150
Linköping University			201-300	50	201-300	201-300		201-300		101-150	
Lund University	76-100	49	201-300	51-75	76-100	201-300	101-150	101-150	151-200		101-150
Malmö University			51-75	151-200							
Stockholm University		201-300			201-300		151-200	201-300			101-150
Swedish University of Agricultural Sciences							201-300				151-200
Umea University	201-300	76-100	101-150	101-150	201-300		151-200	201-300			
University of Gothenburg	51-75	76-100	26	76-100	201-300	201-300	31	22	101-150		
Uppsala University	51-75	46	201-300	35	51-75	18	51-75	101-150	101-150	101-150	51-75
Örebro University		201-300		151-200							
Aalborg University	151-200	76-100		201-300							
Aarhus University	51-75	31	76-100	101-150	46	151-200	101-150	101-150	201-300	201-300	101-150
Technical University of Denmark		201-300			101-150	51-75	101-150	201-300		101-150	6
University of Copenhagen	27	14	40	76-100	27	6	33	50	151-200	201-300	10
University of Southern Denmark				101-150	201-300	201-300	201-300	201-300			201-300
Norwegian University of Life Sciences											201-300
Norwegian University of Science and Technology	201-300	151-200		201-300	201-300		21	16		201-300	
University of Bergen	76-100	42	51-75	101-150	51-75		151-200	151-200			
University of Oslo	47	32	76-100	51-75		151-200	101-150	101-150	201-300		201-300
University of Tromso		76-100	201-300	201-300							

Note: Not all universities ranked in the "Nursing" subject are included. Color indicate position on ranking
Source: Shanghai Ranking

Major LS-companies involvement in Vinnova-funded projects (and other)

Company	Project title	Timeline	Funding	Role	Partners	Other (Examples)
AstraZeneca	BioVentureHub 2.0	Jan 20-Dec 24	20 718 035	Coordinator	See homepage	▪ AI Innovation of Sweden ▪ Wallenberg Centre for Molecular and Translational Medicine ▪ GoCo ▪ FoRmulaEx ▪ Wallenberg Centre for Protein Research ▪ SuMo Biomaterials, CoSiMa ▪ + numerous academic collaborations
	Revealing nano-structure of Pharmaceutical formulations with advanced synchrotron x-ray techniques	Jun 19-Jun 20	500 000	Partner	Chalmers (Lead)	
	Functionalized graphene quantum dots as drug carrier	Dec 18-Sep 19	300 000	Partner	SHT Smart High-Tech (Lead), Chalmers	
	Development of novel precision medicine approach for management of heart failure with preserved ejection fraction	May 19-Apr 22	5 750 000	Coordinator	n/a	
Cochlear®	Novel MEMS Microphone Packaging Technology for an Inner Ear Microphone	Sep 18-Aug 20	439 106	Partner	Linköping University (Lead)	
	Supporting Hearing in Elderly CItizens (SHiEC)	May 14-May 17	1 786 860	Partner	Belgium and Netherland consortium	
Dentsply Sirona	DigiLean Digitalization concept for learning and knowledge reuse	Nov 15-May 16	500 000	Partner	Chalmers (lead), Toyota Material Handling, Yolean	▪ Odontologen collaborations
essity	Development of plastic film winner	Nov 18-Dec 19	850 000	Partner	RISE (Lead), Trioplast, ICA	▪ SuMo Biomaterials, CoSiMa ▪ Swedish Medical Language Data Lab ▪ Simulations for sustainable hygiene products (Chalmers)
	PRODIP - Protein based bio-superabsorbants in dipers	Nov 15-Dec 20	5 000 000	Partner	SLU (Lead), KTH, Lantmännen	
GETINGE	Clean Care – technologies for infection prevention in hospitals	May 18-Feb 21	9 986 819	Partner	RISE (Lead), 15+ partners (e.g. Department of Orthopedics, SU)	▪ BioVentureHub
	Creating innovation in Pharma and Pharmaceutical Production for better health	May 18-Dec 19	299 473	Partner	KI (Lead), SMNC	
	Reduce healthcare-related infections by innovative cleaning and sterilization processes and smart materials	Dec 16-Aug 17	500 000	Coordinator	n/a	
MÖLNLYCKE HEALTH CARE	Monitoring of the fluid distribution in soft porous materials in real-time using Neutron Radiography	Nov 18-Jan 20	500 000	Partner	RISE (Lead), Lund University	▪ SuMo Biomaterials ▪ Biofilm Infection Control (Gothenburg University industrial PhD) ▪ AZ BioVentureHub Collaboration
	Smart release from an antimicrobial cellulose textile for sustainable treatment of chronic wounds	Jan 18-Feb 20	2 399 963	Partner	RISE (Lead), Chalmers	
Vitrolife	Eurostarsproject E! 6197 LEACH-COAT Vitrolife Sweden AB	Apr 11-Jun 13	2 068 925	Coordinator	n/a	
	Stem cell media	Dec 09-Sep 11	3 614 000	Coordinator	n/a	
Wellspect HEALTHCARE	Development of graphene-based antibacterial surface for medical devices - Efficient, safe and affordable	May 20-May 22	2 997 000	Coordinator	Chalmers	▪ Pre-study for new surface finish with local startup ▪ Discussions Innovationsplattformen ▪ 2D-Tech center, Chalmers
	Circular packaging solutions for medical device	Nov 18-May 19	500 000	Coordinator	Chalmers + industrial companies	
	Polymers with exposed graphene edges: new antibacterial materials for medtech applications	May 17-Jun 19	3 052 000	Coordinator	Chalmers (Kádár and Mijakovic groups), 2Dfab	
	Graphene sheets to prevent catheter-associated urinary tract infections	Jun 15-Jun 17	2 000 000	Coordinator	Chalmers	

Note: A key word search was performed in the Vinnova Project Database. For Cochlear, Dentsply, Mölnlycke, Vitrolife and Wellspect, all listed results have been included. Selection made for remaining with focus on projects with relevance for scope

Source: Vinnova Project Database, Triathlon analysis

About Triathlon Group

Triathlon Group is a growing professional service firm dedicated to performance improvement, with a prestigious track record. Our clients range from early phase startups, to large-scale multinationals and public institutions. Triathlon is partner owned, independent and hence a truly reliable partner in performance improvement.

By combining innovation and best practice, we develop substantial value to our clients through long-term relationship and genuine understanding of business needs in the industries we operate within. Together with ISEA, our affiliated expert organization represented by experienced experts with successful life science careers, we have long experience of helping life science companies and entrepreneurs. Triathlon's core business is our clients' 'out of the ordinary' operational management issues.

Nordic office, HQ
Gothenburg, Sweden
triathlon.se

Asia office
Tokyo, Japan
triathlongroup.jp

West Europe office
Lyon, France
triathlongroup.fr

East Europe office
Moscow, Russia
triathlongroup.ru

North America office
Dover, Delaware, USA
triathlon.se

Middle East office
Muscat, Sultanate of Oman
triathlon.se

Next steps

1. Recruit project manager for 6-month period (January-June 2021)
2. Deliver workshops in identified initial areas
3. Decide on organisational model
4. Develop interactive cluster map
5. New large meeting/activity to share information

Health Innovation West

Health Innovation West

Thank **you!**