► 2019 | Report

International Advisory Board

SciLifeLab

Karolinska Institutet

KTH Vetenskap och konst

Stockholms universitet

Uppsala Universitet

About this document

This document is a draft report prepared by the SciLifeLab management for the SciLifeLab International Advisory Board (IAB) and its site visit on March 13-15, 2019. As a working document, it has not been approved in its entirety by the SciLifeLab Board for public distribution. Revised and board-approved versions of specific report components will be prepared and distributed pending incorporation of IAB and SciLifeLab Board feedback following the site visit.

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SciLifeLab

Karolinska Institutet

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UPPSALA UNIVERSITET

Welcome and Introduction

We warmly welcome the International Advisory Board (IAB) of SciLifeLab to Stockholm and Uppsala on March 13–15, 2019.

SciLifeLab was launched almost ten years ago as a collaboration between the four host universities, and has since 2013 served as a national research infrastructure for molecular biosciences in Sweden. In the decade since, SciLifeLab has reached and, on many occasions, even surpassed the goals originally envisioned. However, the need for a national collaborative organization that promotes research and infrastructure in life sciences is more important now than ever, perhaps from a slightly different national and international perspective then ten years ago. Therefore, it is time to review both the past and the present, and to establish a new roadmap for the future.

During this visit, we will provide the IAB a broad presentation of SciLifeLab, including the host university and national perspective. The many stakeholder meetings organized will enable the IAB to review how SciLifeLab is perceived by our key interest groups. We seek advice from the IAB in formulating a bold future strategy for SciLifeLab that will benefit our stakeholders and the national life science community at large. SciLifeLab is now regarded as an established national infrastructure by its users, host universities and the government. However, we feel that its full potential has not yet been realized, and that one should view SciLifeLab as a lot more than purely an infrastructure service facility on one side, and a lot more than only a Stockholm/Uppsala-based collaborative research center on the other. These two roles and other roles will be discussed.

We thank the IAB for all the 42 recommendations provided to us in 2017. We have responded to them all and many have been acted upon, or are in the process of being executed (Appendix A). Some recommendations have been considered by the stakeholders as difficult or impossible to implement under the Swedish legislation, academic traditions or given the complex multi-university setting where SciLifeLab operates. Some recommendations address issues that solely belong to the host universities. In other cases, we have done our best to arrive at a solution through other means than suggested. We hope the IAB site visit in 2019 will more clearly illustrate what is possible for SciLifeLab to accomplish, but also what is outside the SciLifeLab mandate or expectations. As also requested by the IAB, we have prepared three white paper drafts on i) research integrity, ii) industry collaborations and iii) clinical collaborations. We have discussed the content of these papers with the SciLifeLab Board, and would like to receive comments from the IAB before we finalize them. For this IAB site visit we have organized a focused strategic review of the Drug Discovery and Development platform (DDD) as recommended. During this year's IAB site visit, we would like to ask the IAB's advice on the following two broad topics, further elaborated in the section "Key Challenges and Opportunities to be Discussed with the IAB":

1. *SciLifeLab plans for the next government budget and beyond, towards the next decade.* How do we define a roadmap for where SciLifeLab should be in the next five to ten years?
2. *SciLifeLab plans for the next phase of its infrastructure.* How do we execute the evaluation of the next-phase SciLifeLab infrastructure?

The provided report will introduce you to the background, recent developments, as well as the strategic challenges ahead for SciLifeLab. We are of course open to include any other topics suggested for discussion by the IAB, either before or during the IAB site visit.

Carl-Henrik Heldin, Olli Kallioniemi and Siv Andersson

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Abbreviations

Cryo-EM	Cryo-Electron Microscopy
CSC	Campus Solna Committee
DC	SciLifeLab Data Centre
DD	Diagnostics Development
DDD	Drug Discovery & Development
CWTS	The Centre for Science and Technology Studies, at Leiden University
ERC	European Research Council
ESS	European Spallation Source
GMS	Genomic Medicine Sweden
GU	Gothenburg University
HR	Human Resources (office or issues, at host universities)
IAB	International Advisory Board
ID	SciLifeLab Integration Director
IP(R)	Intellectual Property (Rights)
KAW	Knut and Alice Wallenberg Foundation (the largest private funder of scientific research in Sweden)
KI	Karolinska Institutet
KTH	Royal Institute of Technology (Kungliga tekniska högskolan)
LiU	Linköping University
LU	Lund University
MG	SciLifeLab Management Group
NMMP	National Molecular Medicine Fellows Program
NBIS	National Bioinformatics Infrastructure (SciLifeLab Bioinformatics, VR funded network name)
NGI	National Genomics Infrastructure
NGS	Next-Generation Sequencing
RCP	Research Community Program (SFO + national funding)
RNASeq	RNA sequencing
scRNASEQ	Single-cell RNAseq
SD	SciLifeLab Scientific Director
SFO	Strategic research area support to Universities for their SciLifeLab collaboration
SLU	Swedish University of Agricultural Sciences
SNIC	National center for high-performance computing
SU	Stockholm University
UU	Uppsala University
UmU	Umeå University
VR	Vetenskapsrådet (Swedish National Research Council)
WABI	Wallenberg Advanced Bioinformatics network (part of the SciLifeLab Bioinformatics network)
WCMM	Wallenberg Centers for Molecular Medicine (at the GU, LU, LiU and UmU)
ÖRU	Örebro University

Background to the IAB Site Visit and Program

We have planned an ambitious schedule for the IAB site visit consisting of several meetings with the many stakeholders who have a keen vested interest in SciLifeLab. Since the site visit is short, we strongly recommend the IAB to review this report in advance, as it forms a comprehensive background and overview that will facilitate productive dialog during the on-site visit.

Historical perspective on local vs. national focus

In order to understand how SciLifeLab has evolved over time, a brief historical review is necessary to clarify the transition of the organization from a local to a national focus (Figure 1). SciLifeLab was launched in 2010, based on strategic research area (SFO) funding, as a major regional research collaboration in molecular biosciences between the three universities in Stockholm, (Royal Institute of Technology – KTH, Karolinska Institutet – KI, Stockholm University – SU), together with a linked effort at Uppsala University (UU). In 2013 the government provided additional funding to expand SciLifeLab's mission to act also as a national life science infrastructure for all researchers in Sweden. This national funding is governed by the SciLifeLab Board, which includes representation from host universities, non-host universities and industry, while the original SFO funding remains under the governance of the SciLifeLab Committees at each host university. The basic funding streams of SciLifeLab thus have separate origins, governance, and purpose.

Figure 1. Time-line of how SciLifeLab has developed, focusing on more recent events. Abbreviations: National Molecular Medicine Fellows Program (NMMP), Research community programs (RCPs) and Technology Development Projects (TDPs).

In 2016, reorganization and fusion of the two operations in Stockholm and Uppsala, an international evaluation of the infrastructure, as well as the government research proposition of that year, formed the basis upon which SciLifeLab was able to work in a more unified fashion. The new governance framework was formalized as a four-party collaborative agreement (KTH, KI, SU and UU) in 2017. In addition, a separate agreement for the three Stockholm universities (KTH, KI, SU) co-located at Campus Solna was signed. The first physical SciLifeLab facilities outside of the four host universities were established in 2015, and today SciLifeLab facilities exist at all major Swedish universities, including Lund University (LU), Umeå University (UmU), Linköping University (LiU), University of Gothenburg (GU), Chalmers, and the Swedish University of Agricultural Sciences (SLU) (Figure 2). In the latest research proposition from the government (2016–2020), SciLifeLab is described as one of the three major national research infrastructures in Sweden, the other two being the MAX-IV synchrotron and European Spallation Source (ESS) in Lund. Therefore, SciLifeLab is now established as a key component of the Swedish research infrastructure landscape, providing a solid foundation upon which to further develop SciLifeLab as a national hub for the life science community in Sweden.

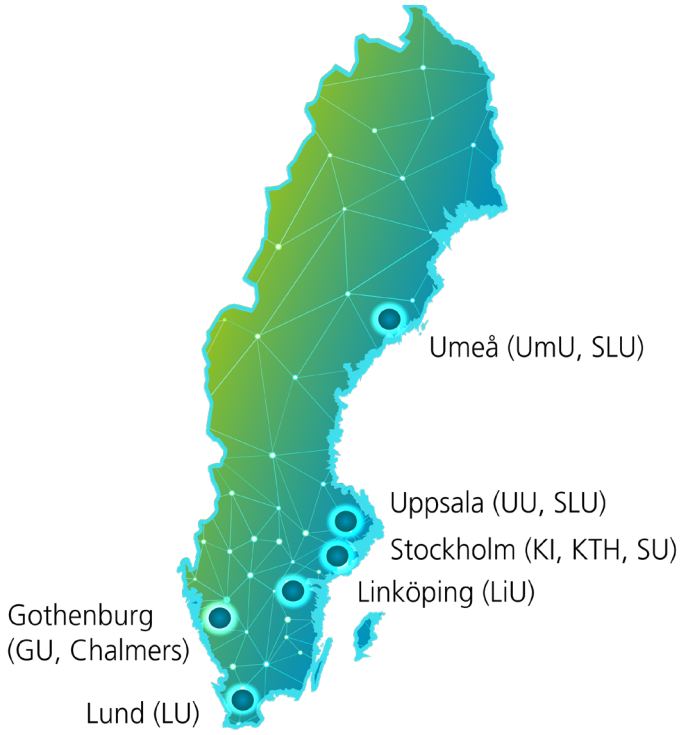

Figure 2. National distribution of SciLifeLab facilities.

Stakeholder meetings for the 2019 IAB site visit

The IAB site visit in 2017 focused heavily on national infrastructure, which is the core function of SciLifeLab and under the control of the SciLifeLab Board. Additionally, the IAB discussed SciLifeLab research collaborations, SciLifeLab Fellows' issues, and other aspects under the governance of the host universities and their respective SciLifeLab Committees (i.e. related to SFO funding). In response to the feedback received from the last visit, together with discussions with stakeholders, we have organized the 2019 IAB site visit into a more comprehensive review of SciLifeLab as a whole, including both the nationally funded and SFO-funded parts of the organization, as well as an outlook towards the future. There will be meetings with all major stakeholders considering both regional, national as well as international aspects.

Besides the SciLifeLab Management Group (MG) and the SciLifeLab Operations Office leadership, the other key stakeholders (Appendix B) that will meet with the IAB include:

- **SciLifeLab Board:** The IAB reports directly to the SciLifeLab Board, and it is important that the SciLifeLab Board can help to set the stage for the IAB site visit 2019. The IAB will start by meeting the SciLifeLab Board in the evening of March 13.
- **Host University Rectors' Council:** The rectors (vice-chancellors) of the four host universities will meet with the IAB to ensure a high-level integration of SciLifeLab's strategies with the plans, future interests and overall priorities of the four host universities.
- **Host University SciLifeLab Committees:** Plans, contributions and expectations from each host university SciLifeLab Committee will be presented to the IAB. These presentations will be held by the four SciLifeLab Integration or Scientific Directors (IDs or SDs).
- **Campus Solna Committee (CSC):** The IAB will meet with representatives from the CSC to discuss management of the physical premises of SciLifeLab at Campus Solna shared between KTH, SU and KI. Campus Solna is a focus of these meetings, as it is much more complex than the Navet building in Uppsala, due to the co-location of activities by three host universities and national infrastructure in Stockholm.
- **Host University Department Heads:** As requested by the IAB in 2017, there will be meetings with selected departmental heads from the host universities. The universities and their departments employ all SciLifeLab staff in Stockholm, Uppsala and elsewhere, and are owners of the equipment. They provide human resources, financial, legal and other services to SciLifeLab, including employer responsibilities. SciLifeLab activities exist at over 30 departments at both host and non-host universities. We have selected two to three major departments from each host university to represent this important stakeholder group.
- **SciLifeLab Fellows:** The IAB will meet with the SciLifeLab Fellows again. SciLifeLab Fellows are facing different conditions at the different host universities. For example, the SciLifeLab Fellows at UU are "embedded" in their host departments, while the SciLifeLab Fellows in Stockholm are all initially located at Campus Solna and are then expected to relocate to their host departments after six to eight years.
- **SciLifeLab Platforms:** SciLifeLab infrastructure platforms will present a short overview of their current activities and emerging plans towards the next major evaluation in 2020. The Drug Discovery and Development (DDD) platform will be presented in a special session on Friday March 15.
- **National SciLifeLab Committee (NSC):** SciLifeLab has grown from being a regional initiative into a major national research infrastructure and today almost 50% of SciLifeLab's infrastructure users come from the non-host universities. Some scientists, however, still perceive SciLifeLab as a predominantly Stockholm-Uppsala-focused organization. To ensure an improved national integration and awareness, SciLifeLab established the National SciLifeLab Committee (NSC) in 2018. NSC includes representation from all non-host universities and provides advice to the Director on future directions with a national perspective and non-host university engagement. NSC will meet two to four times per year and will also meet with the IAB during the 2019 visit.
- **RCP coordinators:** As a response to IABs recommendation we launched the concept of Research Community Programs (RCPs) in 2018 to coordinate and promote major national research networks, which also have the potential to incubate grand challenge projects. The RCP concept will be explained and each RCP coordinator will give a short presentation of their RCP.
- **SciLifeLab Data Centre (DC) and SciLifeLab Operations Office External Relations:** As many of the challenges faced by SciLifeLab relate to facets of data handling, storage, management and interoperability, along with organizational difficulties in engaging with external entities due to SciLifeLab's complex legal arrangement, the IAB will meet and discuss these issues with members of the DC and SciLifeLab External Relations Office.

Program for the International Advisory Board Visit

March 13-15, 2019

Wednesday, March 13

At the hotel (Elite Hotel Carolina Tower)

18.00 **Internal preparation meeting of the IAB**

Session chair: *Jan Ellenberg, chair of the IAB*
Participants: *IAB: Jan Ellenberg, Søren Brunak, Jo Bury, Yoshihide Hayashizaki, Sirpa Jalkanen, Janet Jansson, Jonathan Knowles, Svante Pääbo, Sarah Teichmann and Stephanie Alexander (meeting secretary)*

18.45 **Preparation meeting of the IAB with SciLifeLab representatives**

Session chair: *Jan Ellenberg, chair of the IAB*
Participants: *IAB, Chair of the SciLifeLab Board, Director, Co-Director*

19.15 **Meeting with the SciLifeLab Board**

Session chair: *Carl-Henrik Heldin, Chair of the SciLifeLab Board*
Participants: *IAB, SciLifeLab Board*

20.00 **Welcome dinner and informal meeting at Haga Bottega, Elite Hotel Carolina Tower**

Host: *Carl-Henrik Heldin, Chair of the SciLifeLab Board*
Participants: *IAB, SciLifeLab Board, Director, Co-Director, Infrastructure Director*

Thursday, March 14

SciLifeLab, Tomtebodavägen 23, Solna
Meeting room: Air and Fire

08.30 **Welcome and SciLifeLab recent developments 2017 - 2019 and ongoing plans**

(30 min overview by Director and 30 min discussion)
Session chair: *Carl-Henrik Heldin, Chair of the SciLifeLab Board*
Presenter: *Olli Kallioniemi, Director*
Participants: *IAB, SciLifeLab Board, Director, Co-Director, Infrastructure Director, Integration Directors, Scientific Directors, SciLifeLab Head and Vice-Head of Operations*

9.00 **Responses to specific previous IAB comments, and discussion on the white papers**

Documents to be provided (40 min)
Session chair: *Carl-Henrik Heldin, Chair of the SciLifeLab Board*
Presenter: *Olli Kallioniemi, Director*
Participants: *IAB, SciLifeLab Board, Director, Co-Director, Infrastructure Director, Integration Directors, Scientific Directors, SciLifeLab Head and Vice-Head of Operations*

10.10 **Coffee break**

10.30 **Host universities @ SciLifeLab (incl SciLifeLab committees from the host universities)**
(10 min presentation each of KTH, KI, SU and UU (SDs/IDs) (+ 30 min discussions)
Session chair: *Carl-Henrik Heldin, Chair of the SciLifeLab Board*
Presenter: *Integration Director (or Scientific Director)*
Participants: *IAB, Chair of the SciLifeLab Board, Director, Co-Director, Infrastructure Director, Integration Directors, Scientific Director, SciLifeLab Head and Vice-Head of Operations*

11.40 **Campus Solna (10 min + 20 min discussion)**
Session chair: *Olli Kallioniemi, Director*
Presenter: *Mats Nilsson, Scientific Director, chair Campus Solna Committee*
Participants: *IAB, Chair of the SciLifeLab Board, Director, Co-Director, Infrastructure Director, Integration Directors, Scientific Directors and Campus Solna Committee*

12.10 **Meeting with the SciLifeLab Fellows (30 min)**
Session chair: *Jan Ellenberg, chair of the IAB Presenter: TBD by Fellows*
Participants: *IAB, SciLifeLab Fellows*

12.40 **Lunch mingle and poster session with staff (50 min)**
Data centre, senior staff from facilities, post docs and PhDs (approx. 20 posters)
Poster presenters: *TBD*
Participants: *IAB*

13.30 **Meeting with selected Heads of Departments of the host universities (30 min)**
Session chair: *Carl-Henrik Heldin, Chair of the SciLifeLab Board*
Participants: *IAB, Chair of the SciLifeLab Board, Head of Departments: Department of Immunology, Genetics and Pathology, UU, Department of Cell and Molecular Biology, UU, Department of Medical Biochemistry and Biophysics, KI, Department of Microbiology, Tumor and Cell Biology, KI, Department of Protein Sciences, KTH, Department of Applied Physics, KTH, Department of Biochemistry and Biophysics, SU, Department of Molecular Biosciences, SU*

14.00 **Infrastructure: Future strategies and organization (30 min + 30 min discussion)**
Session chair: *Olli Kallioniemi, Director and Siv Andersson, Co-Director*
Presenter: *Annika Jenmalm Jensen, Infrastructure Director*
Participants: *IAB, Chair of the SciLifeLab Board, Director, Co-Director, Infrastructure Director, Integration Directors, Scientific Directors and available members of the NSC*

15.00 **Meeting with the National SciLifeLab Committee (NSC) (30 min)**
Session chair: *Jan Ellenberg, chair of the IAB Presenter: TBD*
Participants: *IAB, NSC*

15.30 **Coffee break**

15.30 **Short presentations of SciLifeLab platforms (e.g. Platform Director + 1 Facility example)**

(8+7 min/platform and 15 min general discussion in the end)
Session chair: *Annika Jenmalm Jensen, Infrastructure Director*
Presenter: *Platform Directors except DDD: Bengt Persson, Hjalmar Brismar, Anna-Lena Gustavsson, Richard Rosenquist Brandell, Ulf Gyllensten, Jochen Schwenk*
Participants: *IAB, Chair of the SciLifeLab Board, Director, Co-Director, Infrastructure Director, Integration Directors, Scientific Directors and available members of the NSC*

17.30 **Meeting with the Rectors (60 min)**

Co-chair: *Jan Ellenberg, chair of the IAB and Carl-Henrik Heldin, Chair of the SciLifeLab Board*
Participants: *IAB, Chair of the SciLifeLab Board, Rectors*

18.30 **End of day one**

19.00 **Dinner at Stallmästargården**

Host: *Carl-Henrik Heldin, Chair of the SciLifeLab Board*
Participants: *IAB, Director, Co-Director, Infrastructure Director, Integration Directors, Scientific Directors, SciLifeLab Board, Rectors, Chairperson and available members of the NSC*

Friday, March 15

SciLifeLab, Husargatan 3, Uppsala

07.45 **Taxi pick-up at the hotel, transfer to Uppsala**

09.00 **Two parallel sessions (IAB subgroups) (90 min)**

Parallell session 1: DDD program, special review and discussion
Session chair: *Annika Jenmalm Jensen, Infrastructure Director*
Presenter: *Per Arvidsson, Kristian Sandberg, DDD Directors*
Participants: *IAB, Chair of the SciLifeLab Board, Co-Director, Infrastructure Director, DDD Directors, chair and member of DDD Platform Steering Group*

Parallel session 2: Executing SciLifeLab's national mission: SciLifeLab Data Centre (45 min); external relations (45 min) (15+30 min discussion)
Session chair: *Olli Kallioniemi, Director*
Presenter: *Johan Rung, Head of Data Centre, Bengt Persson, Platform Director, Lars Hammarström, Strategic relations officer*
Participants: *IAB, Director, SciLifeLab Head and Vice-Head of Operations, Strategic relations officer, Head of Data Centre, Platform Director Bioinformatics, Head of facility, Bioinformatics Long-term Support*

10.30 **Coffee break**

10.45 **Concept of RCPs (5 min)**

Presenter: *Olli Kallioniemi, Director*

RCP presentations (10 min each, 5+5 minutes)

- Biology of Molecular Interactions
- The Human Protein Atlas
- Large-scale clinical genomics and complex diseases
- The Human Developmental Cell Atlas
- Aquatic Microbiome Research Initiative
- Phenotypic Drug Discovery in Human Disease
- Swedish Tumor Microenvironment (STorM) Program

Session chair: *Olli Kallioniemi, Director, Siv Andersson, Co-Director*
Presenter: *Coordinating PI for each RCP*
Participants: *IAB, Chair of the SciLifeLab Board, Director, Co-Director, Coordinating PI for each RCP*

12.00 **Discussion on future plans for the next four-year period**

Session chair: *Carl-Henrik Heldin, Chair of the SciLifeLab Board*
Presenter: *Olli Kallioniemi, Director, Siv Andersson, Co-Director*
Participants: *IAB, Chair of the SciLifeLab Board, Director, Co-Director, Infrastructure Director*

13.30 **Working closed lunch, followed by writing and discussion**

Session chair: *Jan Ellenberg, chair of the IAB*
Participants: *IAB*

15.00 **Initial feedback and questions**

Session chair: *Jan Ellenberg, chair of the IAB*
Participants: *IAB, Chair of the SciLifeLab Board, Director, Co-Director, Infrastructure Director*

15.30 **Additional writing session**

Session chair: *Jan Ellenberg, chair of the IAB*
Participants: *IAB*

17.00 **Return to Stockholm or transfer to Arlanda Airport**

Contact information

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Summary of responses to the IAB comments from 2017

This section aims to give the IAB an executive overview of responses to the IAB comments provided in 2017. For a full review of responses, see Appendix A.

During its last visit in 2017, the IAB made 42 specific recommendations to the SciLifeLab Board. These recommendations concerned i) Global context, ii) Challenges facing SciLifeLab, iii) Governance and structure, iv) Platforms, vi) Research, viii) Non-biomedical life sciences, ix) SciLifeLab Fellows program, x) SciLifeLab faculty, xi) Research integrity, xii) Human resources, xiii) Branding, xiv) Innovation and industrial development, xv) Clinical collaboration, and xvi) Future reviews.

We thank the IAB for these excellent recommendations, all of which have been discussed thoroughly. The SciLifeLab Board approved an initial response to these comments on Nov 2, 2017 and has overseen both the evaluation and execution of these recommendations. Appendix A contains detailed responses to each recommendation, updated as of January 2019. Below, we have summarized in brief some actions already taken, and also commented on a few challenges that remain to be addressed.

- The national role of SciLifeLab as an infrastructure is today more extensively established than before. About half of the total users of the SciLifeLab infrastructure come from the external user community outside of the host universities.
- There is a strong co-publication record from SciLifeLab-associated group leaders with the infrastructure, particularly contributing to technology development. This indicates quantitatively the joint impact of research and infrastructure, identified as a priority goal by the IAB.
- We now track both publications and detailed annual user statistics for individual facilities and universities as well as from SciLifeLab as a whole. Capabilities are emerging to analyze such data in a real-time manner providing full transparency and immediate feedback on SciLifeLab service operations.
- We have launched the first Research Community Programs (RCPs) to coordinate and promote major national research networks, which also have the potential to incubate grand challenge projects.
- A funding call for Technology Development Projects (TDPs) was announced in 2018 to stimulate collaborations in the community for technology development. These projects will commence in 2019.
- We have established a SciLifeLab Data Centre (DC) to help manage data generated at the infrastructure platforms and support many other functions at SciLifeLab.
- We have assigned a Research Coordinator for the SciLifeLab Fellows program and each Scientific Director (SD) and Integration Director (ID) is now in charge of the SciLifeLab Fellows at their respective university. We have also worked with aligning the program between the host universities as much as this is possible.
- Drafts of white papers on Research Integrity, Industrial Collaborations and Clinical Collaborations, as well as a report on the Drug Discovery and Development Platform have been produced (see Appendices C–F).
- We are exploring a number of aspects related to the legal representation of SciLifeLab in close dialog with the host universities and other stakeholders.

A few of the recommendations have been difficult to implement, either due to the fact that the suggestions mostly concern individual host universities or due to conflict with Swedish legislation, academic traditions, or the expected role of SciLifeLab. One example being the impossibility for SciLifeLab, to develop and maintain its own intellectual property (IP). IP developed within Swedish public research institutions (such as universities in Sweden, all public) is retained by the individual researcher, the so-called "Professor's Privilege". The pros and cons of this legislation have been a source of continuous debate for decades and are thus beyond the scope of this report.

A number of other challenges pointed out by the IAB following its last visit, remain a high priority but still need to be resolved. We are working towards a long-term plan for renewal and upgrade of hardware required by the Bioinformatics platform and other data-driven facilities. Data collection, management, storage and archiving continue to be major challenges that will be discussed during this IAB site visit as well. Also, the need for a harmonized procedure to address career development and conditions for SciLifeLab Fellows and SciLifeLab infrastructure staff needs continued coordination with the host universities.

Developments since 2017

This section aims to give the IAB a summarizing background to SciLifeLab and significant developments made during 2017–2018. These recent developments are the basis for the future plans and key challenges which are presented later in this report.

Introduction and Background

SciLifeLab has been assigned to be a national resource, and to serve as a center for large-scale molecular biosciences, from the Swedish government. The overall goal of SciLifeLab is to facilitate cutting-edge, multi-disciplinary life science research and collaboration that otherwise would not be possible in Sweden.

This task involves developing and maintaining unique cutting-edge infrastructure and technologies, services and data resources for life science researchers in Sweden. SciLifeLab coordinates research communities in health and environmental science, recruitment and training of young scientists, and fosters collaboration with industry, health care, public research organizations and international partners.

Integrated within the four founding universities, KTH, KI, SU and UU, SciLifeLab encompasses 40 national infrastructure facilities, around 200 research groups, and more than 1500 researchers and staff in total. The two main research sites are located in Stockholm and Uppsala, but national infrastructure facilities now exist at all major Swedish universities, including Lund University (LU), Umeå University (UmU), Linköping University (LiU), University of Gothenburg (GU), Chalmers, and the Swedish University of Agricultural Sciences (SLU).

SciLifeLab's vision is to be a strong national hub for molecular life sciences through its three public missions to the Swedish research community:

- to provide unique and enabling infrastructures for high-impact molecular life science research.
- to facilitate internationally leading collaborative research in a community of excellent scientists.
- to promote translation of biomolecular research findings into lasting societal benefits.

Examples of key developments during 2017–2018

(Explained in more detail in the sections below)

- The national role and community of SciLifeLab has been strengthened through deeper involvement of non-host universities through the National SciLifeLab Committee (NSC).
- The new governance model launched in 2017 now forms the foundation for operations and collaboration between the host universities and the SciLifeLab management.
- A four-year evaluation and funding period for the infrastructure has been developed, based on a two plus two-year model with a midterm checkup in between.
- An annual funding mechanism for expensive equipment has been launched, which helped to fund a variety of critical instruments in 2018–2019, including e.g. three Illumina NovaSeqs for next-generation sequencing (NGS).
- The Technology Development Programs (TDPs) initiative currently fund 17 projects that will develop novel add-on capabilities to SciLifeLab facilities and foster high-profile research on new technologies in the SciLifeLab community.
- SciLifeLab infrastructure service metrics show increased national utility, with 48% of users coming from outside the Stockholm and Uppsala region (excluding compute and storage users).
- User satisfaction levels of our national facilities are excellent, with 93% of users likely to come back. Users are in general also content with the level of user fees.
- Knut and Alice Wallenberg Foundation (KAW) has granted >100 MSEK to support equipment and infrastructure services for Cryo-EM and for Spatial Omics at SciLifeLab in 2018.
- Publication output from the SciLifeLab community continues to develop well from both affiliated group leaders and infrastructure users.
- The SciLifeLab Fellows program has been harmonized to the extent possible for the host university policies and practices. There are now more aligned conditions for recruitment and evaluation of tenure and permanent positions.
- We have created a strong link between the SciLifeLab Fellows and the Wallenberg Center for Molecular Medicine (WCMM) through formation of the National Molecular Medicine Fellows Program (NMMP).
- The Diagnostic Development (DD) platform has performed 5000 diagnostic whole genome (before 2015 whole exome) sequencing projects for healthcare,

resulting in a 35% success rate in diagnosis of rare diseases. There are now over 100 samples/month being processed for WGS in this program.

- The DD platform has launched the Genomic Medicine Sweden (GMS), a grand challenge project for nation-wide adaptation of genomic medicine.
- The SciLifeLab Data Centre (DC) has been established to provide the SciLifeLab infrastructure with dedicated IT and data management solutions, maximizing the impact of SciLifeLab-generated data, and promoting open science and data quality. This is the first step towards more ambitious role of SciLifeLab as a key coordinator of data in in life sciences.
- A review is being planned together with the host universities to identify an improved framework for legal representation of SciLifeLab in order to facilitate agreements and interactions with health care, industry and other national and international entities.
- We have launched the SciLifeLab External Relations Office, dedicated towards partnering and collaboration with the SciLifeLab community. Major partnering opportunities will be explored in e.g. next-generation diagnostics, precision medicine, drug discovery, biodiversity and environmental research.

Funding

The current core financing of SciLifeLab consists of three separate funding sources from the government: national infrastructure funding (National), Drug Discovery and Development funding (DDD), and strategic research area (SFO) funding (Table 1). National and DDD funding are controlled by the SciLifeLab Board, while the SFO funding is divided into four parts that go directly to each host university. SFO funding is under the control of the SciLifeLab Committees at each of the four host universities (Figure 3). The total governmental SciLifeLab funding for 2018, including all three funding streams was 423 MSEK and is 428 MSEK for 2019. The distribution of DDD funding (12,5% of total funding) and SFO funding (37% of total funding) is further detailed in other parts of this report (Appendix F and section Interactions with host universities). How the national funds are distributed in the budget is illustrated in Figure 4a. Allocated national funds to host and non-host universities is shown in Figure 4b.

Table 1. Overview of SciLifeLab funding: National, DDD, and SFO research support to host universities (Millions of SEK). The total direct government funding for 2019 is 428 MSEK (about 42 MEuro, 48 MUSD). This figure does not include direct host university contributions (e.g. partial salaries of group leaders), other research infrastructure funding from VR and KAW, user fees, nor external grant funding. Taken together, the total SciLifeLab funding is over 1500 MSEK/yr (about 150 MEuro/yr).

	2017	2018	2019
National	209	213	215
DDD	52	53	54
SFO	154	157	159
Total (MSEK)	415	423	428

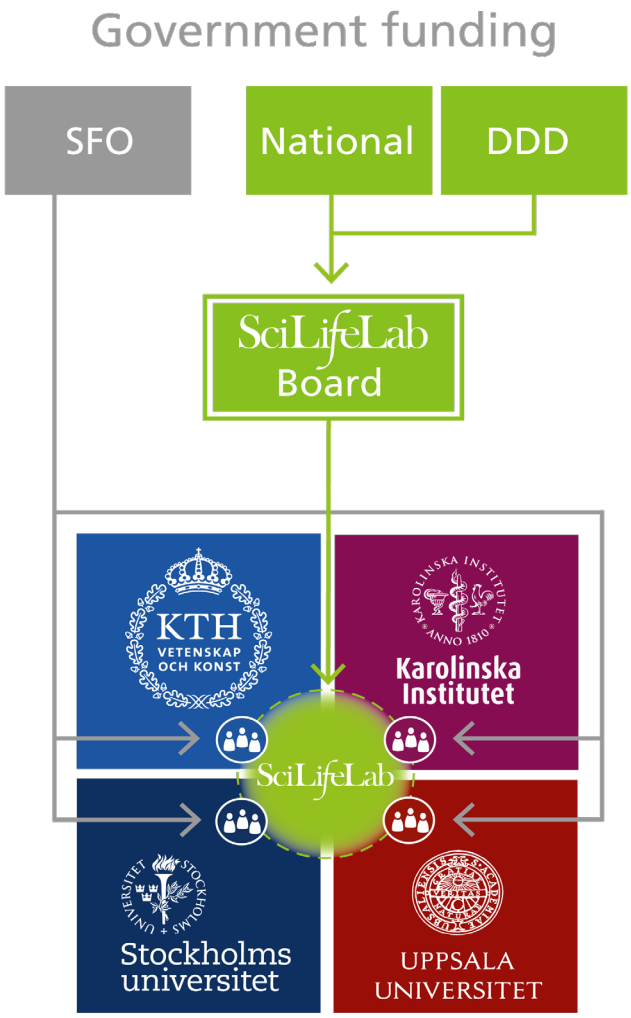


Figure 3. An overview on SciLifeLab's national mission as a collaborative center across the host universities. The three major funding streams, National, DDD and SFO, supporting the operations are illustrated.

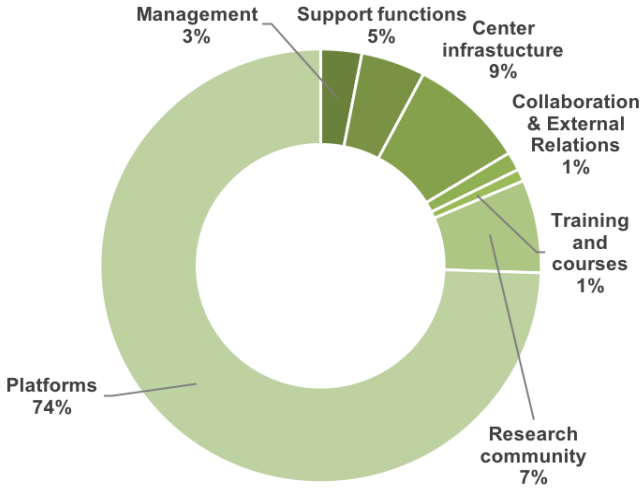


Figure 4a. Distribution of national funding for 2018.

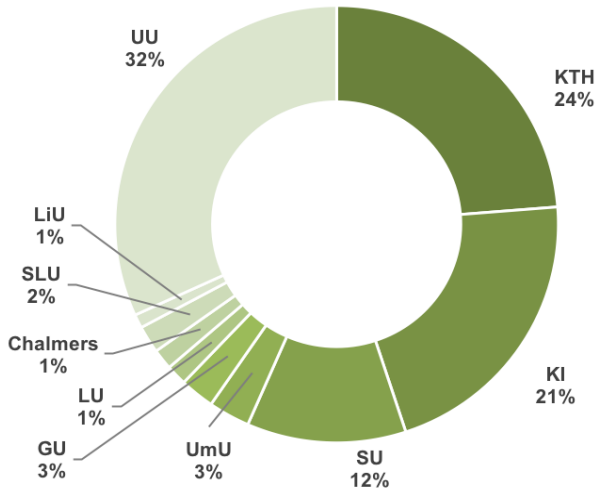


Figure 4b. Distribution of national funding for 2018.

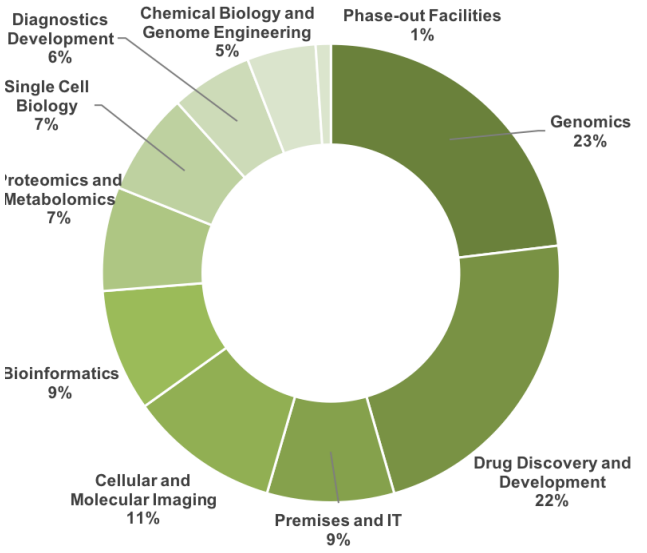


Figure 5. Distribution of national and DDD funding to the infrastructure platforms in 2018.

The majority (84%) of national and DDD funding is allocated to support the SciLifeLab infrastructure facilities, including equipment and staff. The distribution of funds between the different platforms within SciLifeLab infrastructure is shown in Figure 5. In 2018, national and DDD funding supported 168 FTEs working at the facilities. The remaining 16% funds coordination of e.g. research activities and support to the SciLifeLab Operations Office. For SciLifeLab to operate seamlessly, these independent funding streams need to be closely coordinated. This has been partially enabled by implementation of the new governance model (described in section SciLifeLab National Management). We have achieved improved integration of SciLifeLab operations and funding priorities, and in several cases during 2018, SciLifeLab efforts have been jointly funded by both National and SFO funding. The first such initiative was the Research Community Programs (RCPs), where 2,6 MSEK of national funding together with 4,4 MSEK SFO funds from each of the host universities enabled the coordinative support of seven novel research programs. In 2018, 16 Technology Development Programs (TDPs) were also funded through combining national funds, 7 MSEK in 2019 and 7 MSEK in 2020, with 3 MSEK of SFO funds from each host university per year.

In addition to the three core funding streams described above, SciLifeLab is supported by considerable funding from additional sources. The total external funding to SciLifeLab has since 2017 exceeded 1 BSEK annually, and this figure includes external research grants supporting SciLifeLab affiliated researchers. In 2018, the facilities reported external funding directly connected to the infrastructure to be 366 MSEK. This figure includes direct university funding of 53 MSEK (non-SFO funds, e.g. core facility support grants), and 141 MSEK from external funding sources (mainly from KAW and VR). Notably, over the past few years the relative level of external funding support to SciLifeLab has increased more than the core funding to SciLifeLab, indicating the capacity SciLifeLab has for attracting external funding.

Leadership, Management and Operations of SciLifeLab

SciLifeLab is formally represented by KTH, but as a joint effort with the other host universities. The SciLifeLab Board carries the overall responsibility for national coordination and infrastructure funding, while SFO funding is governed by the host university SciLifeLab Committees (Figure 6). The IAB is advisory to the SciLifeLab Board and provides scientific and operational support to the overall strategic development of SciLifeLab. The Management Group (MG) is the executive national leadership of SciLifeLab and prepares actions for SciLifeLab Board consideration. In doing so, MG also has close links with the host university SciLifeLab Committees (including shared members). SciLifeLab Operations Office supports MG, the research community and infrastructure in administration and execution of proposed actions. The SciLifeLab Data Centre (DC) works closely with MG, Operations Office and all platforms with data management and as a central support function to the infrastructure. DC is described in more detail in section *Infrastructure, SciLifeLab Data Centre (DC).*

To further strengthen the national role of SciLifeLab, a deeper involvement of non-host universities was established during 2018 through the formation of the National SciLifeLab Committee (NSC). The role of the NSC is to advise the MG on matters relating to the national scope of SciLifeLab and will be an important voice for the non-host universities in Sweden.

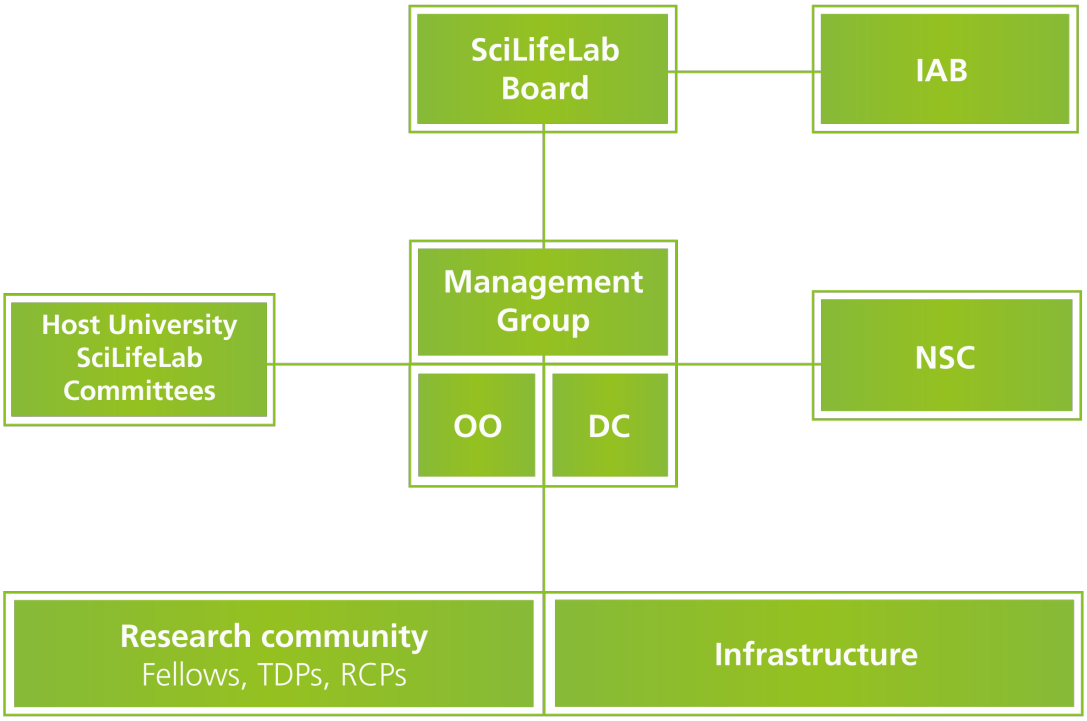


Figure 6. The SciLifeLab governance. Abbreviations: National SciLifeLab Committee (NSC), SciLifeLab Operations Office (OO), and SciLifeLab Data Centre (DC)

SciLifeLab National Management

A new unified management organization (Figure 6), fully integrated between Stockholm and Uppsala, was launched in 2017. This new governance model forms the foundation for operations and communication between the host universities and the SciLifeLab management.

Management Group: MG consists of the Director, Co-Director and Infrastructure Director, together with four Scientific Directors (SDs) representing each of the four host universities. MG typically meets bi-weekly, has two dedicated retreats annually, and multiple additional extended meetings for extraordinary issues, such as preparing funding decisions. Four Integration Directors (IDs), each representing one of the host universities, have the important role of linking the activities of the MG with the host university SciLifeLab Committees, as well as the host university leadership. The IDs take part in several strategic MG meetings during the year, and ad hoc as needed.

Host-university SciLifeLab Committees: At each host university, a local SciLifeLab Committee is responsible for allocation and steering of SFO funds. The host university SciLifeLab Committees are chaired by the IDs, linking the activities of SciLifeLab into the local environment (the many schools, faculties and departments involved) at their respective university. The members of SciLifeLab committees also represent different faculties, departments and stakeholders of SciLifeLab at that university, as well as the SDs (in most of the universities). SciLifeLab Fellows are represented in the SciLifeLab committees at KTH and KI. In the section *Interactions with the host universities* the work of the host university SciLifeLab Committees is described in more detail.

Campus Solna Committee: The Campus Solna Committee (CSC) was formed to coordinate strategic plans and decisions related to the Campus Solna research site in Stockholm, where SciLifeLab facilities and personnel from the three Stockholm universities are co-localized. The CSC consists of the SDs and IDs from the three Stockholm host universities, and the Infrastructure Director. The Campus Solna Manager (who is also the Head of Operations), a secretary, and the SciLifeLab Director are also present at CSC meetings. The CSC deals with e.g. strategic decisions on space usage and decides on the Campus Solna budget, including joint activities to promote the local research environment. CSC has a working group, which is responsible for implementing decisions formed by CSC and suggests processes and plans for CSC to decide upon. The Campus Solna Manager is responsible for the local administration, lab safety regulations and local core facility services.

Rectors Council: The Rectors Council, consisting of the four host university rectors (vice-chancellors), is not a formal part of SciLifeLab governance but holds regular meetings (three to four times annually) with the chair of the SciLifeLab Board, the Director, Co-Director, and the Head of Operations. The purpose of these meetings is to discuss and harmonize the collaboration between the host universities and the national SciLifeLab organization and to work towards a unified vision for SciLifeLab.

Further organizational, management and operational principles are continually being discussed, with the ambition of persistently increasing transparency, alignment, inclusion and clarity for all stakeholders.

Table 2. SciLifeLab leadership 2018

SciLifeLab Board	Name	Affiliation
Chair	Carl-Henrik Heldin	Uppsala University*
Industry representative	Margareta Olsson Birgersson	Roche Sweden
KTH representative	Sophia Hober	KTH
KI representative	Karin Dahlman-Wright	Karolinska Institutet
SU representative	Anders Karlhede	Stockholm University
UU representative	Stellan Sandler	Uppsala University
External university representative	Gunilla Westergren-Thorsson	Lund University
External university representative	Fredrik Elinder	Linköping University
External university representative	Marianne Sommarin	Umeå University

SciLifeLab Management Group (MG)	Name	Affiliation
Director	Olli Kallioniemi	Karolinska Institutet*
Co-Director	Siv Andersson	Uppsala University*
Infrastructure Director	Annika Jenmalm Jensen	Karolinska Institutet*
Scientific Director (SD)	Peter Nilsson	KTH
Scientific Director (SD)	Janne Lehtiö	Karolinska Institutet
Scientific Director (SD)	Mats Nilsson	Stockholm University
Scientific Director (SD	Ulf Gyllensten	Uppsala University

SciLifeLab Integration Directors (IDs)	Name	Affiliation
Integration Director (ID), *until December 31, 2018*	Mathias Uhlén	KTH
Integration Director (ID), *from January 1, 2019*	Amelie Eriksson Karlström	KTH
Integration Director (ID)	Ylva Engström	Stockholm University
Integration Director (ID)	Mats Larhed	Uppsala University
Integration Director (ID)	Stefan Eriksson	Karolinska Institutet

SciLifeLab Operations Office	Name	Affiliation
Head of Operations	Fredrik Sterky	KTH
Vice Head of Operations	Jenny Alfredsson	Uppsala University

Campus Solna Committee (CSC)	Name	Affiliation
Infrastructure Director	Annika Jenmalm Jensen	Karolinska Institutet*
Scientific Director (SD)	Peter Nilsson	KTH
Integration Director (ID), *until December 31, 2018*	Mathias Uhlén	KTH
Integration Director (ID), *from January 1, 2019*	Amelie Eriksson Karlström	KTH
Scientific Director (SD)	Janne Lehtiö	Karolinska Institutet
Integration Director (ID)	Stefan Eriksson	Karolinska Institutet
Scientific Director (SD) and Chair	Mats Nilsson	Stockholm University,
Integration Director (ID)	Ylva Engström	Stockholm University
Campus Solna Manager and Head of Operations	Fredrik Sterky	KTH

* The chair of the SciLifeLab Board, the Director, Co-Director and Infrastructure Director have key roles at the national level even though they also have a position at one of the host universities. The primary host university representatives in the MG are the SDs and IDs who have a primary role in representing their host universities. Not listed here, but included in the Appendix B are members of the host university SciLifeLab Committees as well as the members of the NSC.

Administration – SciLifeLab Operations Office

The SciLifeLab Operations Office supports MG, the SciLifeLab Board, as well as the host universities in fulfilling the national and the local missions of SciLifeLab. Operations Office consists of both the national administration and the local administration for Campus Solna and comprises all together 26 people. Operations Office staff are employed either at KTH or UU and are physically located at Campus Solna or Navet in Uppsala.

The main responsibility for the Operations Office is to assist MG with forming processes, administering and coordinating executive activities. Thus, the Operations Office works in close association with MG and is responsible for: communication, reporting, infrastructure coordination and evaluation, coordination of visits, guidelines, safety issues, IT and facility coordination, finance, training and events, as well as branding and external relations. Operations Office is run by the Head of Operations (employed at KTH) and the vice Head of Operations (employed at UU).

SciLifeLab Legal Representation

SciLifeLab formally consists of four host universities that themselves are autonomous public authorities reporting directly to the government. Thus, as an organization, SciLifeLab cannot independently engage in legal agreements with other parties and it is difficult for any of the individual universities to represent SciLifeLab in its entirety. Daily operations in terms of collaborations, procuring and operation of equipment, IT, licenses, software, MTAs, CDAs, GDPR etc. are complicated by this multi-university setting.

A process to resolve this issue is being developed, in very close dialog with the host university rectors and legal departments. In parallel, a focused effort to consolidate the DDD platform under a single legal framework was recently finalized. Under this arrangement, Uppsala University (UU) is now acting as a centralized legal proxy organization, granted power of attorney by the other participating universities, enabling them to act as a legal representative for the entire DDD platform (Appendix F). SciLifeLab Bioinformatics, National Bioinformatics Infrastructure (NBIS) is looking into a similar national arrangement, also under UU. This type of arrangement will serve as useful in developing a general process for handling legal issues within SciLifeLab.

SciLifeLab Campus Solna and Uppsala Campus Navet

Campus Solna is the largest research site for SciLifeLab and hosts the vast majority of researchers and facilities from the three Stockholm universities. Activities, strategic decisions and space allocation, budget and investments at Campus Solna are coordinated by the CSC in accordance with the Campus Solna Agreement that regulates how Campus Solna is managed (Appendix G).

About 600 people from the three Stockholm host universities work in the 15,000 square meters of total space in the Alpha and Gamma buildings at Campus Solna (including 50% of all SciLifeLab facility staff), and about the same number of people have access to the labs as frequent visitors, or as students or guest researchers on shorter periods. Day-to-day operations are overseen by the Campus Solna Manager while strategic developments, such as the entry and exit of groups to or from Campus Solna are governed by CSC in close coordination with the host universities.

The capacity for SciLifeLab to expand within Campus Solna is limited as about 90% of the areas are currently at maximum capacity. Expansion beyond the present buildings would not only be risky but would also compromise community-building and jeopardize the synergistic common research environment at Campus Solna. When capacity is reached, it will become critically important to establish a fair, transparent and yet rapid distribution of space amongst the three Stockholm universities and the national infrastructure. Furthermore, there needs to be a balance between different research fields, as well as between young and established group leaders. For example, we are currently making space arrangements to accommodate a larger Cryo-EM facility and the new Spatial Omics infrastructure. In addition, the host universities are in the process of recruiting new SciLifeLab Fellows while the current SciLifeLab Fellows have not yet come to the end of their appointments (typically four plus two years). Thus, there are many urgent issues to address in regards to managing Campus Solna, most of which require close interactions between the host universities because any increase or decrease of space at Campus Solna for a given function requires a reciprocal change at the respective host university's other locations.

Unlike Campus Solna, SciLifeLab in Uppsala is located at five campus areas across UU engaging researchers from nine different departments. There are currently 127 group leaders and scientists associated with SciLifeLab at UU, more than Stockholm SciLifeLab combined. Due to the physical distribution of SciLifeLab activities in Uppsala, there is a demand for a physical meeting place, filled by the SciLifeLab building Navet (the hub) located at the Biomedical Center (BMC) in Uppsala. The large majority of the SciLifeLab facilities in Uppsala are located at BMC, including genomics, bioinformatics, single cell, proteomics and DDD. Navet hosts 3 000 square meters of meeting rooms, guestrooms and offices, as well as houses part of the Operations Office, with an additional 8 000 square meters of laboratories in the surrounding area. Most importantly, Navet serves as a place where scientists, facility staff and visitors from either within and outside the SciLifeLab environment can meet. In addition, Navet has become a strategically important venue for community building efforts at SciLifeLab and has an enormous potential for further development in the future. Plans for developing Navet and Campus Solna further are described in the SciLifeLab strategy and future plans section below.

Infrastructure

Mission statement: Provide a unique and enabling infrastructure for high-impact research

When SciLifeLab was granted funding as a national research infrastructure in 2013, the major motivation was to provide cutting-edge, unique and enabling infrastructure covering a broad spectrum of molecular technologies to the life science research community in Sweden. The increasingly complex and costly array of instrumentation, technologies and expertise critical for cutting-edge life science research cannot be established and sustainably maintained at every university in Sweden.

The SciLifeLab infrastructure provides complementary technologies and services for assisting users in projects ranging from basic to translational research, and the potential to serve large-scale projects and grand challenges. The infrastructure facilities are evaluated every four years with a midterm check-up in between in order to ensure that SciLifeLab provides a dynamic and up-to-date infrastructure that meets user needs. This life cycle enables upgrading, further development and incorporation of new technologies and services, as well as phasing-out or reorganizing old ones. Phased-out facilities and technologies may be returned to university-level core facilities if they fill local/regional functions, or spun-out as commercial endeavors if appropriate.

The SciLifeLab infrastructure has a clear national mission: all facilities should offer their services to Swedish researchers on equal terms, regardless of affiliation. As specifically emphasized in the last governmental research proposition, the infrastructure should also be accessible to research in sectors outside of academia, including industry and healthcare.

Organization

The SciLifeLab infrastructure spans a broad range of service areas, and is organized into seven *platforms*. The actual service is conducted by 40 financially independent *facilities* providing specialized technologies, instrumentation and dedicated expert resources (Figure 7a-c). Many of the facilities comprise technologies that can be categorized under more than one service area, whereby the SciLifeLab infrastructure on the web site is no longer organized by the administrative units, but based on the service areas that the users are interested in. [1]

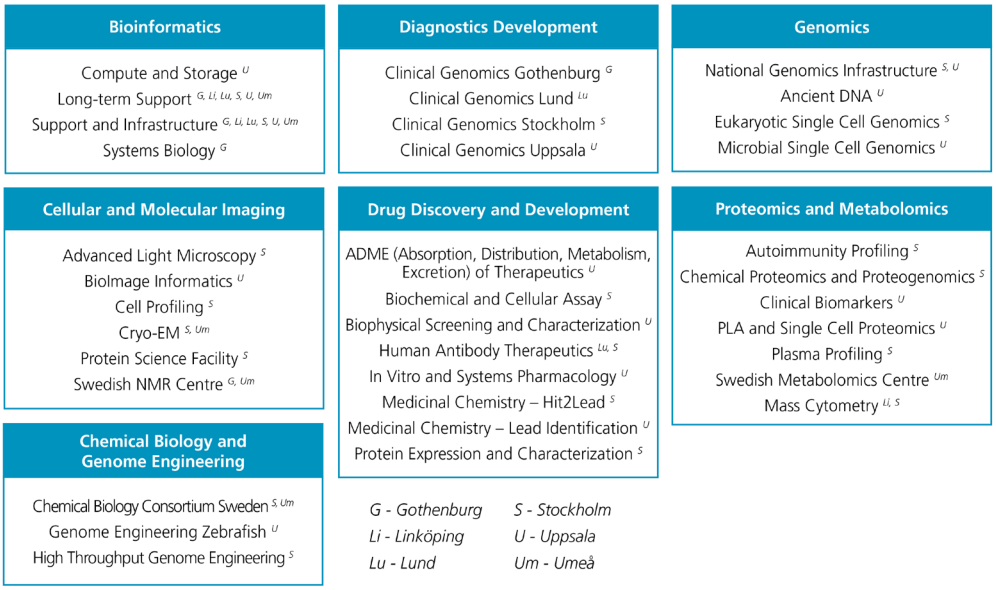


Figure 7a. Organization of platforms and facilities.

[1] www.scilifelab.se/infrastructure/

Platforms	Universities									
	Chalmers	GU	KI	KTH	LiU	LU	SLU	SU	UmU	UU
Bioinformatics	●	●	●	●	●	●	●	●	●	●
Cellular and Molecular Imaging		●	●	●				●	●	●
Chemical Biology and Genome Engineering			●						●	●
Diagnostics Development		●	●			●				●
Drug Discovery and Development			●	●		●		●		●
Genomics			●	●				●		●
Proteomics and Metabolomics			●	●	●		●		●	●

Figure 7b. Distribution of physical platform operations across Swedish universities.

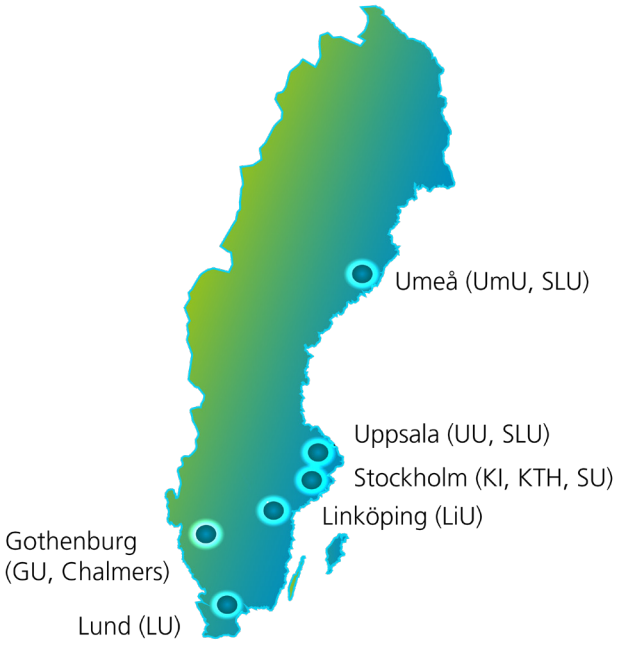


Figure 7c. Physical location of the universities where SciLifeLab platforms operate.

Governance and steering

Each platform is managed by a Platform Director (PD), who has a coordinating function and represents all the facilities within the platform. The PD has no budget authority since SciLifeLab funding is provided directly to the facilities. An exception is the DDD platform, whose governance and organization are platform-centric (described in more details in Appendix E). The individual facilities are managed by a Facility Director (FD) and a Head of Facility (HF). The FD is responsible for the scientific leadership and the strategic development of the facility, while the HF is responsible for the everyday operations at the facility, including project management and allocation of facility resources. The HF is usually also responsible for managing the facility staff. The platforms are encouraged to appoint a Platform Advisory Board to advise on long-term scientific development and strategic issues on the platform level. For a more detailed description about the platform and facility governance, see Terms and Conditions for Funding document (Appendix H).

Characteristics of the infrastructure facilities

Currently, 425 people are working full- or part time at the infrastructure facilities, and the gender distribution is even between males (53%) and females (47%). About 70% of the staff hold a PhD degree which demonstrates the high scientific level of the staff.

Many of the facilities have considerable additional funding on top of the SciLifeLab funding (Figures 8–10). The annual reporting from the facilities provide important metrics that are summarized as one-page descriptions of all facilities including funding sources, number of staff scientists, user statistics, main services provided, and deliverables for 2018 (see Appendix H. SciLifeLab infrastructure report).

SciLifeLab is continuously monitoring the infrastructure operations and performance with the help of the capabilities created by the DC. The visualization of the detailed and deep data on all facilities helps the MG and the SciLifeLab Board in their strategic decisions regarding funding, equipment etc.

The comparison of facilities with each other is important and informative, although it is also difficult as facilities are so different in terms of the types of services they provide. As the plots indicate (Figures 8–10), the infrastructure can be roughly categorized into three types of units:

1. Small facilities in terms of FTEs and user base, many of which have also been established quite recently. Their main funding comes from SciLifeLab and the user fee income is modest.

2. Mid-sized, established facilities, often co-funded from other sources, with a solid user base and good user fee income.
3. A few large facilities with a strong nation-wide user base, typically co-funded by the Swedish research council or KAW, with established user fee models, and a strong publication output.

We will continue to develop the visualization of the infrastructure performance, and time-trends will be more informative than static views of the facilities at any given time. Ideally, we would like to see development over time so that the small facilities become mid-sized and the mid-sized ones thrive and develop further. These statistics will be key in evaluating the performance of the facilities and for considerations on fusing some of the smallest facilities making them stronger together.

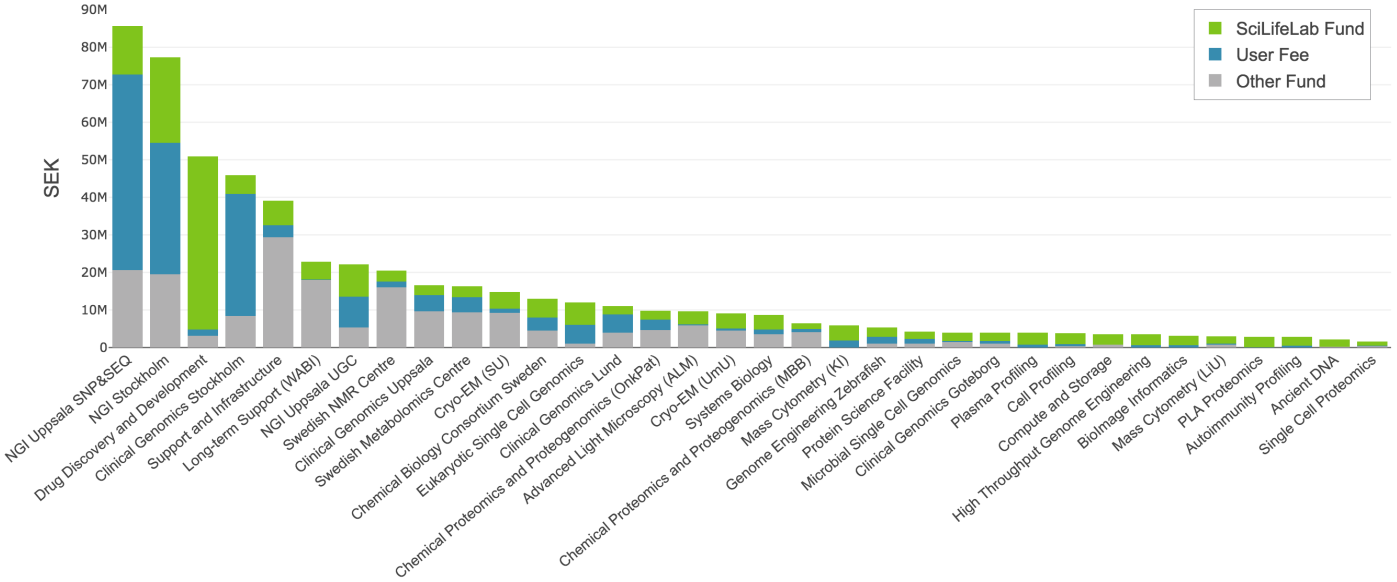


Figure 8. Distribution of funding and user fees across SciLifeLab facilities in 2018

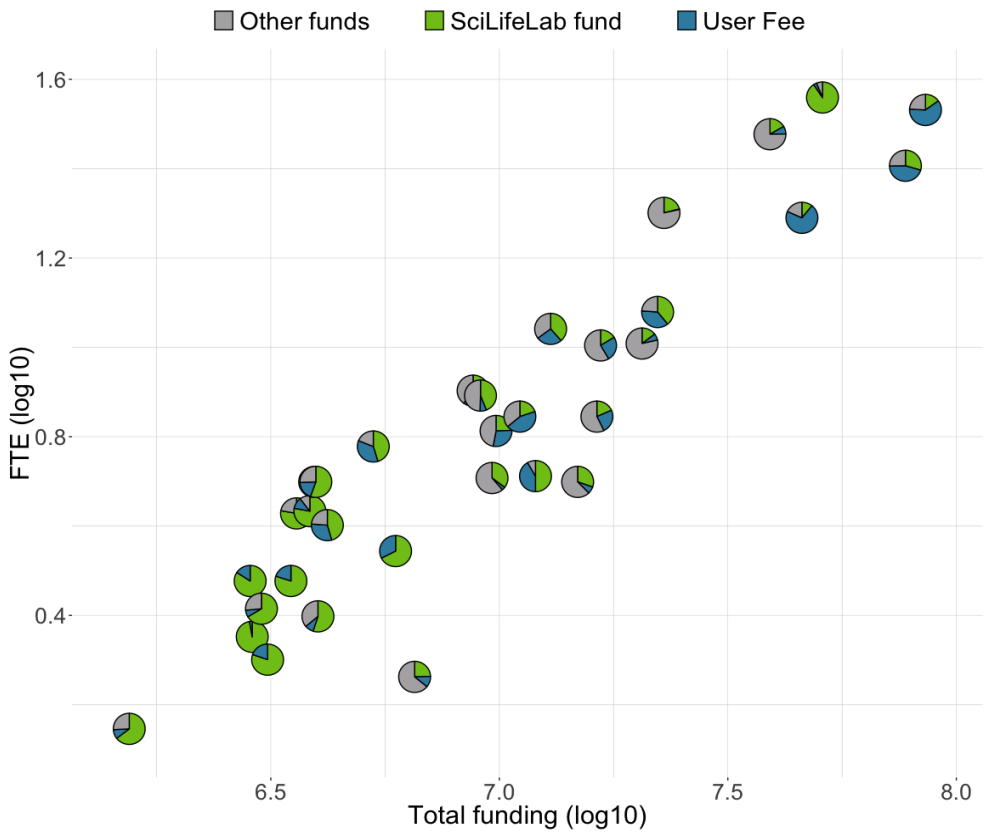


Figure 9. Total funding vs FTEs for the SciLifeLab facilities in 2018 with pies showing the distribution of funding and user fees.

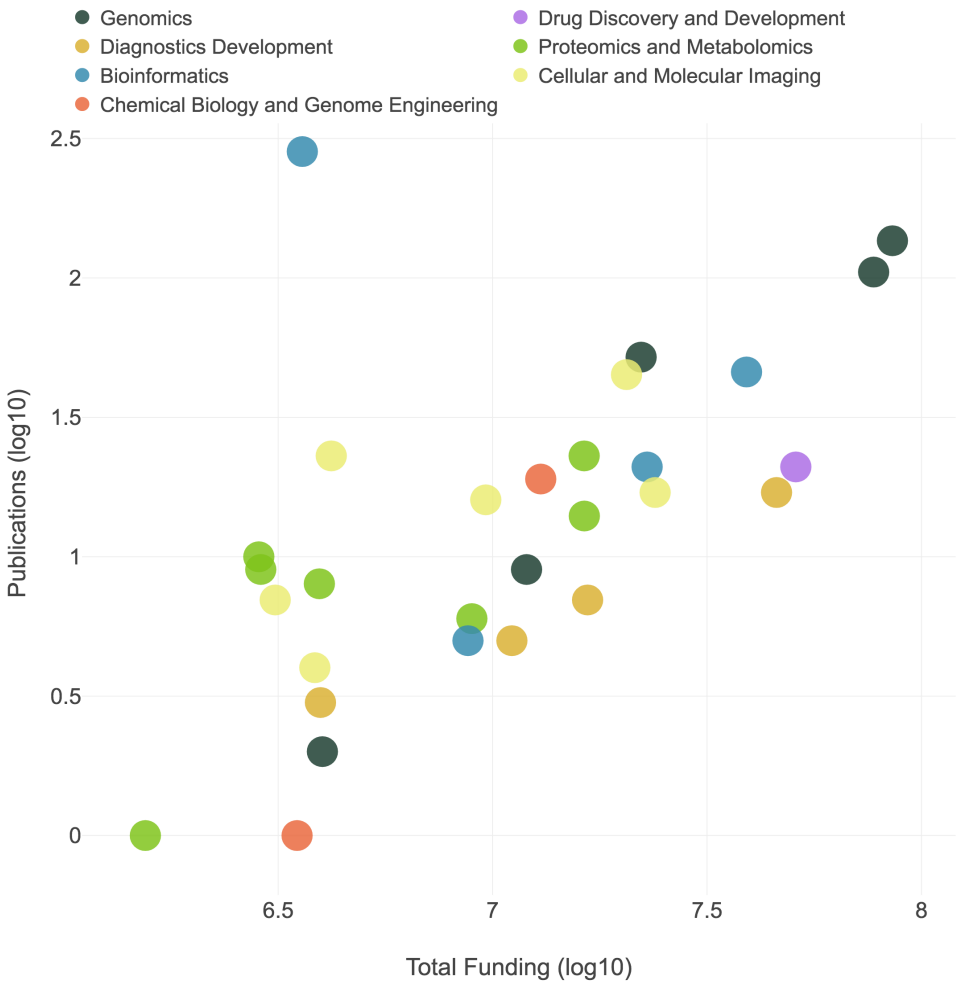


Figure 10. Total funding vs publications output for the SciLifeLab facilities 2018. Each of the colors of the circles correspond to a specific platform.

User base

The volume and geographical distribution of infrastructure users are key parameters that SciLifeLab monitors for each facility as well as for the national infrastructure as a whole. In 2018, there were about 1200 individual academic users of the SciLifeLab infrastructure, totaling over 3000 projects. The distribution of users based on the affiliation of the PI is shown in Figure 11. Notably, in 2018 48% of the users were from universities or institutions outside the SciLifeLab host universities, and 4% of the users originated from international universities. In addition to the about 1200 individual users included in Figure 11, the bioinformatics facility Compute and Storage in Uppsala reported 475 user accounts for 2018 representing researchers across Sweden that have utilized the data storage and computing capacities that the facility offers.

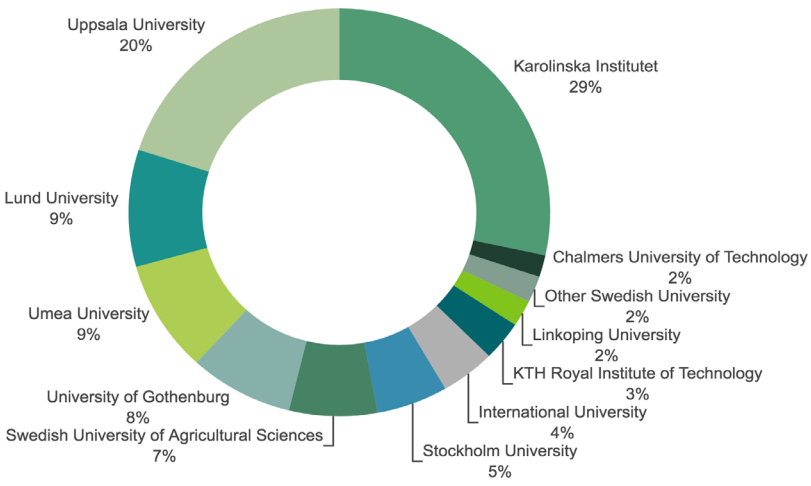


Figure 11. Academic user distribution 2018 based on PI. Total number of academic users was n=1201. The total number of individual service projects was >3000.

The distribution of users´ affiliation (Y-axis) across facilities (X-axis) is further illustrating the infrastructure usage (Figure 12). These types of plots help not only the facilities

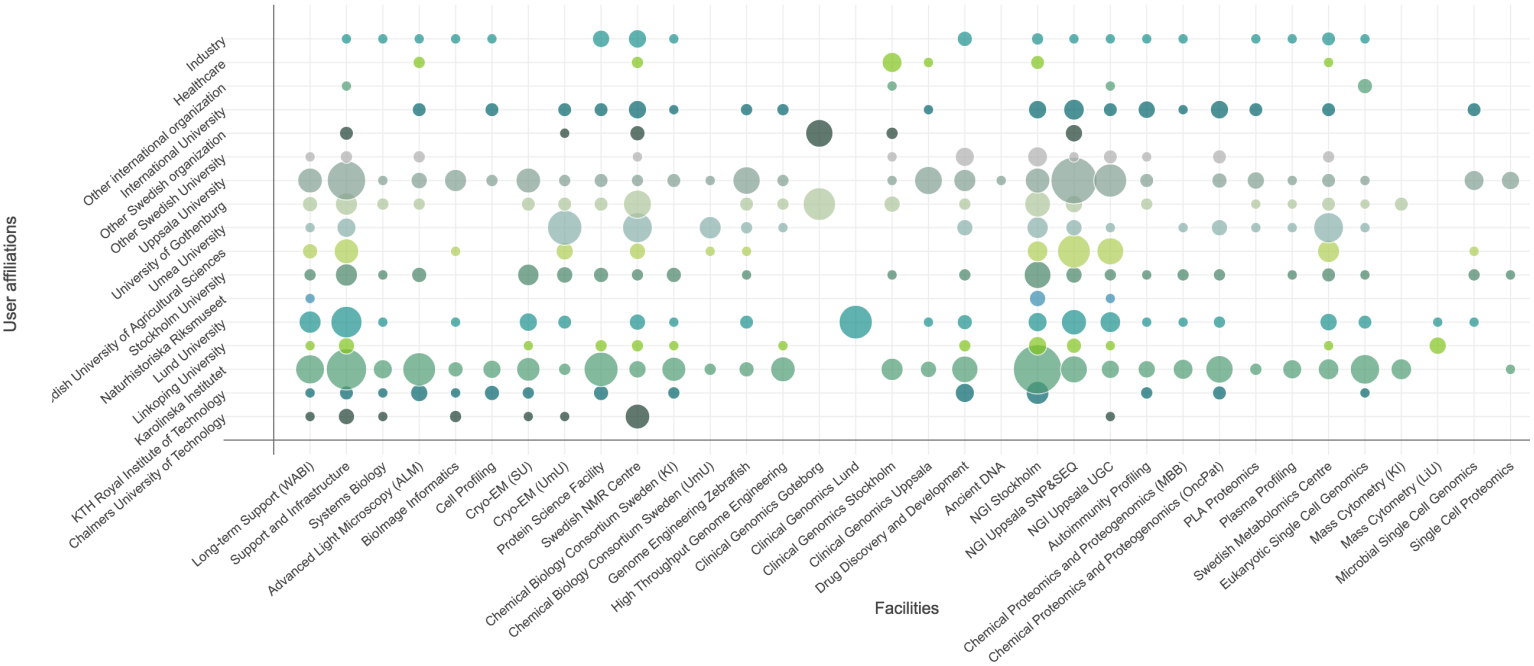


Figure 12. Distribution of users 2018 from all universities, healthcare and industry across all SciLifeLab facilities. The size of the circles corresponds to the number of users.

themselves, the management and the SciLifeLab Board, but also the user community, the universities and the government, to evaluate the performance and trends of SciLifeLab in a transparent fashion. Again, these statistics and plots have been enabled by the DC.

The SciLifeLab infrastructure is also open to non-academic researchers, and we have an overall ambition that up to 15% of the infrastructure services should be devoted to non-academic users from healthcare, industry and other sectors. Based on the total infrastructure FTE resources during 2018, 8% were spent on healthcare, 3% on industry and 1% on other governmental organization projects. In some facilities, such as Clinical Genomics within the DD platform, healthcare use is predominating.

Publications and cross-facility use

The number and impact of scientific papers published by both facility users or the facilities themselves are important metrics to determine infrastructure performance. The SciLifeLab Publication Database [1] was launched in 2017, allowing a convenient way for platforms and facilities to regularly upload relevant publications. In the database, publications are labelled as *service* (facility mentioned in acknowledgement), *collaborative* (facility staff in author's list) or *technology development* (facility member as main author). From 2010 the number of publications from the SciLifeLab infrastructure has more than tripled, to reach what we believe is a steady-state of around 500–600 publications annually (Figure 13). Bibliometric analysis on infrastructure publications (2010–2016) shows that the publications have been cited 40% more often than the world average for the same scientific field and publication year. [2] Prediction for recent years, 2017 and 2018, when citation score indicators are not fully reliable, e.g. due to the lag in updates to the databases used for the analysis, show a similar trend. For more details about the bibliometric analysis, see Appendix I.

During its last site visit, the IAB suggested that we should pay attention to multi-platform users (suggestion no. 10 in Appendix A), which is in line with our long-term ambition to promote multidisciplinary research through the use of several of the SciLifeLab platforms and/or facilities. We plan and are already promoting this in a number of ways, for example by:

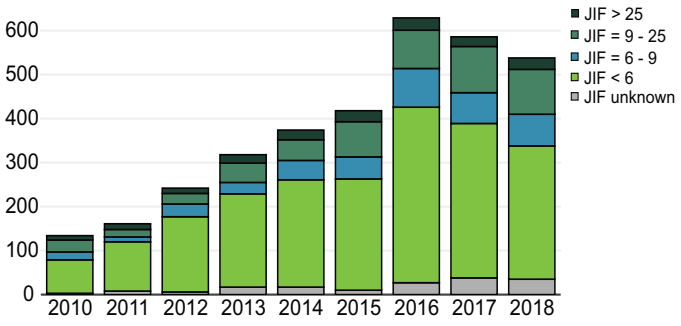


Figure 13. Infrastructure publications 2010–2018 with Journal Impact Factor distribution.

[1] https://publications.scilifelab.se

[2] The advanced bibliometric indicator mean normalized citation score (MNCS) between 2010 and 2016 showed an average value of 1,4 +/- 0,1. Bibliometric analysis on publications derived from SciLifeLab facilities has been performed by CWTS at Leiden University.

- offering sample preparation services and advice to enable multiplex data generation and analysis.
- offering advice on e.g. systems biology studies and biomarker discovery studies as to which combination of technologies would be most important.
- introducing a universal sample code, so that data from e.g. the same patient can be readily combined across platforms.
- offering systematic data integration services (almost non-existent today).

In addition, we are now for the second time organizing an infrastructure day (Facility Forum) where one important goal is to educate infrastructure staff scientists to be ambassadors of the full spectra of capabilities offered through SciLifeLab enabling them to guide users to different facilities. We are now busy preparing for the next Facility Forum that will be held in September 2019. Another way is through the newly initiated programs, TDPs (described in the *Technology Development* section below) and RCPs (described in detail in the *Research Community* chapter below), both programs which have successfully created not only new cross-facility interactions, but also important new interactions between the research community and infrastructure facilities.

Indeed, SciLifeLab infrastructure users are able to use multiple facilities and techniques within the SciLifeLab organization for their biological questions. In this respect SciLifeLab is unique, even in global terms, in being able to provide complementary world-class capabilities covering such a broad range of fields. SciLifeLab monitors the cross-facility usage based on the papers published by the infrastructure users. For 2017 and 2018, the share of infrastructure publications resulting from cross-facility use were 10 % and 13 %, respectively. A visualization of the cross-facility usage for publications 2017–2018 is given in the form of a Circos plot in Figure 14.

While the publication statistics are slightly lagging and not taking into account recently started facilities, there are a few patterns emerging from the cross-facility usage analysis. First, joint publications are common among genomics and bioinformatics facilities, as well as between CBCS and DDD, and in between proteomics facilities, and these cross-facility usage publications are to some extent expected. Some of the large facilities have very few collaborative publications (e.g. Swedish NMR Centre and Swedish Metabolomics Centre), indicating that these technologies are being applied in very specific but different projects and contexts. One could also hope to see more joint activities in the future, and which is something we are actively promoting, between e.g. DDD and other SciLifeLab facilities, and between BioImage Informatics and SciLifeLab imaging facilities. Thus, future analysis of co-publication trends will be interesting and important.

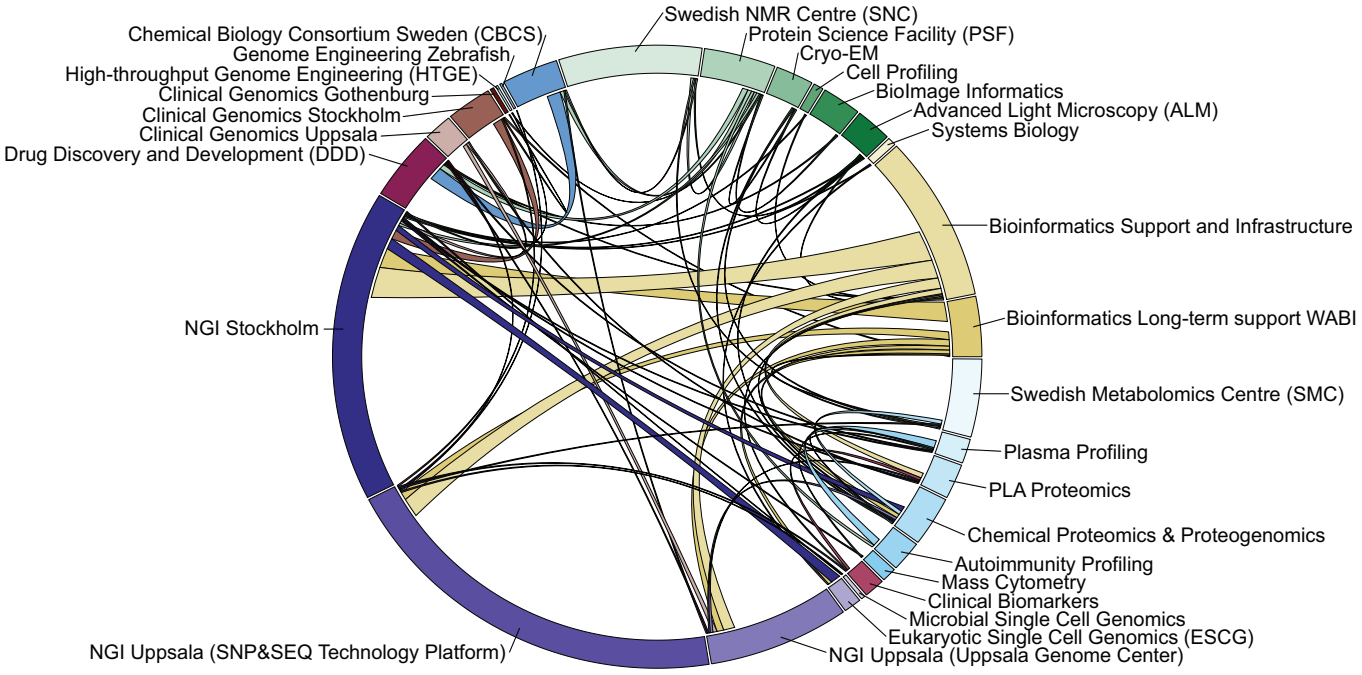


Figure 14. Circos plot illustrating cross-facility use based on infrastructure publications 2017–2018. Facilities are clustered platform-wise, and the length of the circle segments corresponds to the total number of publications for each respective facility. The ribbons represent publications where both the connected facilities contributed with service, data or analysis. The plot show that the major part of cross-facility publications is a result of collaboration between bioinformatics and genomics facilities. Other frequent collaborations are also apparent from the plot, e.g. CBCS–DDD and Plasma Profiling–Autoimmunity Profiling.

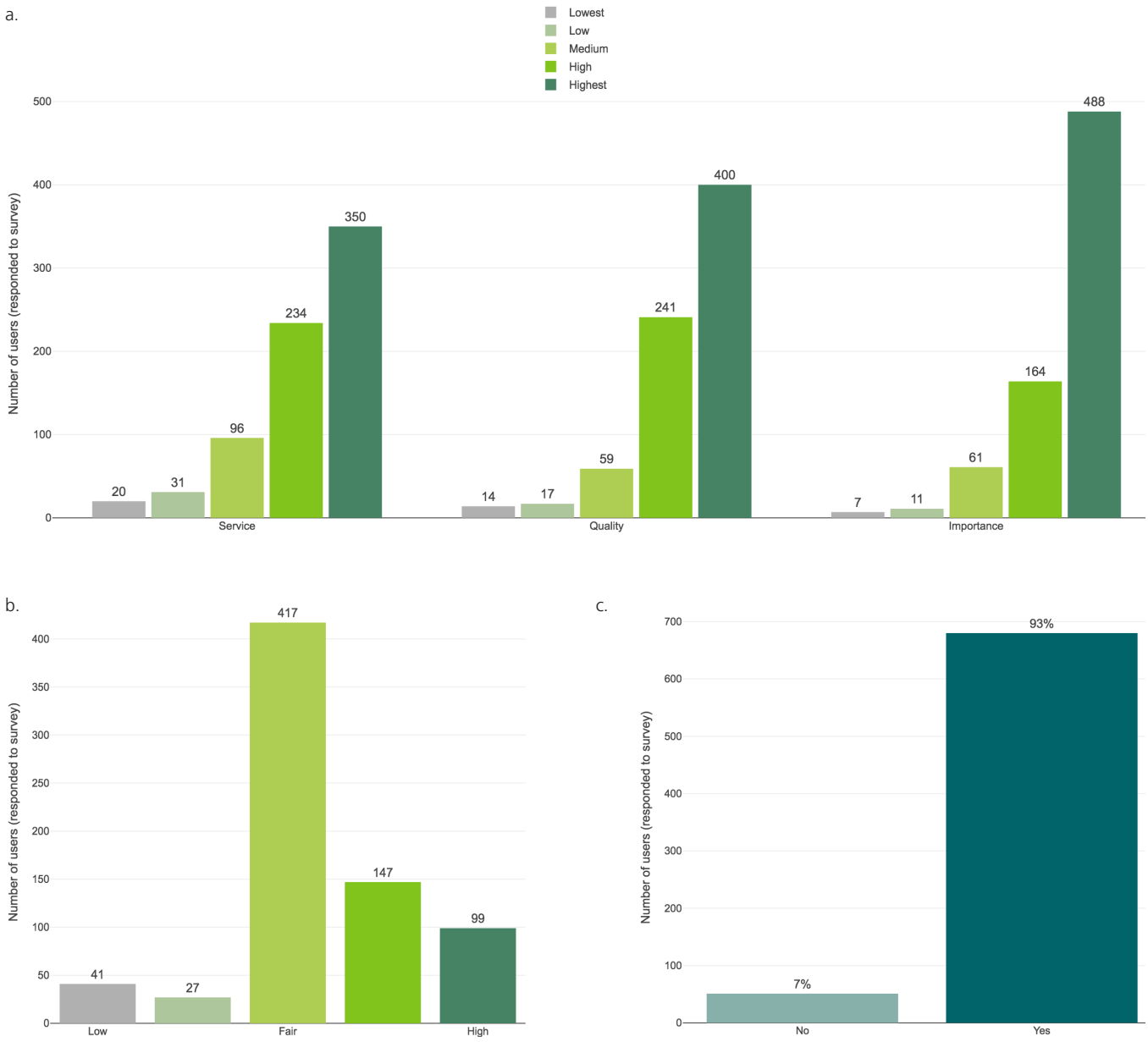


Figure 15 a–c. A facility user survey was conducted including 424 users from 2016–2018 rating their use of SciLifeLab services. Multiple facility use resulted in 731 facility-specific responses, overall very satisfied with SciLifeLab services. a) On a five level scale, 80% of responses express "high" or "highest" satisfaction, on a five-level scale, with the service level of SciLifeLab facilities. The quality of the service was regarded as "high" or "highest" in 88% of received responses, and the importance of the service to the user project was rated as "high" or "highest" in 89% of the cases. b) 81% of users believe the level of user fees are fair or near fair. c) 93% of users would use the services of the SciLifeLab facility again.

User satisfaction

The IAB previously requested user service statistics that has previously been provided at the level of individual platforms. Therefore, a user satisfaction survey was conducted in the fall of 2018, with 424 responses from users of SciLifeLab facilities between 2016–2018. A number of questions addressed the satisfaction and different aspects of impact of facility specific SciLifeLab services for the supported projects. Users were also asked if they would use the services again, and whether they perceived the level of use fees as appropriate.

The majority of the users' responses indicate an overall high user satisfaction with the infrastructure services and the quality, as well as valuing access to infrastructure services highly (Figure 15 a). The results also show users believe the levels of use fees are fair (Figure 15b), and 93% of the users would use the services again (Figure 15c). We will also try to collect these types of statistics more systematically in the future, and provide annual, and eventually real-time, user-satisfaction data.

Technology development

To maintain the SciLifeLabs infrastructure at the forefront, it is a necessary to continuously update the technologies and services. This is challenging due to the wide spectrum of services, the complexity of operations across universities and the country, and the frequency of required upgrades to expensive instrumentation. To facilitate all this SciLifeLab has developed four "cornerstones" for enabling infrastructure development and equipment upgrades.

1. Facilities are encouraged to use up to 20% of their national funding for internal technology development, identifying opportunities for new relevant technologies, upgrades and protocols, to complement existing capabilities.
2. As a new initiative in 2018, SciLifeLab launched a national call for Technology Development Projects (TDPs), [1] open to all researchers in Sweden. The purpose is to develop, or bring in and optimize, novel, relevant and cutting-edge technologies for incorporation as services within existing SciLifeLab facilities. In total, 51 applications were submitted and 16 were approved for funding with up to 1.5 MSEK per year for 2019–2020 (Table 3). In the future SciLifeLab intends to arrange these calls biennially.
3. A first internal call for funding of expensive instruments (in the range of 3 MSEK and above) for the infrastructure was arranged in 2018. The facilities submitted 20 applications in total as part of the call, of which 11 where approved for funding. This call will be repeated annually, and will also include a platform-wide inventory of expensive instruments currently in place and needs for the future years.
4. Perhaps the most important contribution to infrastructure technology development is generated by the closely associated research community within SciLifeLab. Research in these groups are often conducted in collaboration with facilities and will in many cases give rise to new technology that can be implemented as service at the facilities.

Table 3. Approved Technology Development Projects (TDPs) 2019–2020.

Title of Technology Development Project (TDP)	PI	Affiliation
High-throughput screening in live zebrafish	Amin Allalou	UU
Bifunctional Protein Degrader (BIPOD) - Towards tissue selective PROTACs	Mikael Altun	KI
Eukaryotic protein production for biomedical research	Alexey Amunts	SU
Mass Spectrometry Imaging in Neuroscience (Neuro-MSI)	Per Andren	UU
MF-SIM: Live Cell Super-Resolution 4D-Microscopy	Hjalmar Brismar	KTH
High-dimensional secretomic analysis of single cells for systems-level immunomonitoring	Petter Brodin	KI
Production of proteins and glycoproteins in mammalian cells	Malin Bäckström	GU
Ultra-sensitive monitoring of tumor DNA in plasma from cancer patients	Lucia Cavalier	UU
Novel method for identifying the effect of DNA sequence variants on common diseases	Åsa Johansson	UU
Multiplexed imaging tools for high-dimensional protein maps of human cells and tissues	Emma Lundberg	KTH
Spatial Genomics	Joakim Lundeberg	KTH
Deep and quantitative phosphoproteomic profiling of biological samples	Filip Mundt	KI
RIF-Seq: RNA isolation free RNA sequencing	Mats Nilsson	SU
CRISPR Screening 2.0	Bernhard Schmierer	KI
Improved drug discovery using single-cell resolution target-engagement profiling	Brinton Seashore-Ludlow	KI
Artificial Intelligence and Image Analysis for Whole Slide Imaging (AIIA-WSI)	Carolina Wählby	UU

[1] https://www.scilifelab.se/call-for-tdps/

Training

In order for users to optimally utilize the SciLifeLab resources the SciLifeLab infrastructure actively engages in education and training of researchers nationally. Technology-focused SciLifeLab training is currently being offered at: UU, KI, UmU, SU and LiU, and next year extending also to GU and LU. During 2016–2018, SciLifeLab coordinated, or contributed to, a total of 131 educational activities targeting participants, at educational levels ranging from undergraduate to post-graduate levels, from numerous Swedish universities (Figure 16). SciLifeLab increased its central support for infrastructure-related courses and trainings in an open call during 2017, resulting in a new course-package covering spatial proteomics, chemical proteomics, cryo-electron microscopy, drug development, and single cell genomics. In addition, as the need for analytical support with increasing data volume growth, SciLifeLab has since 2013 offered a centrally supported course package focusing specifically on bioinformatics.

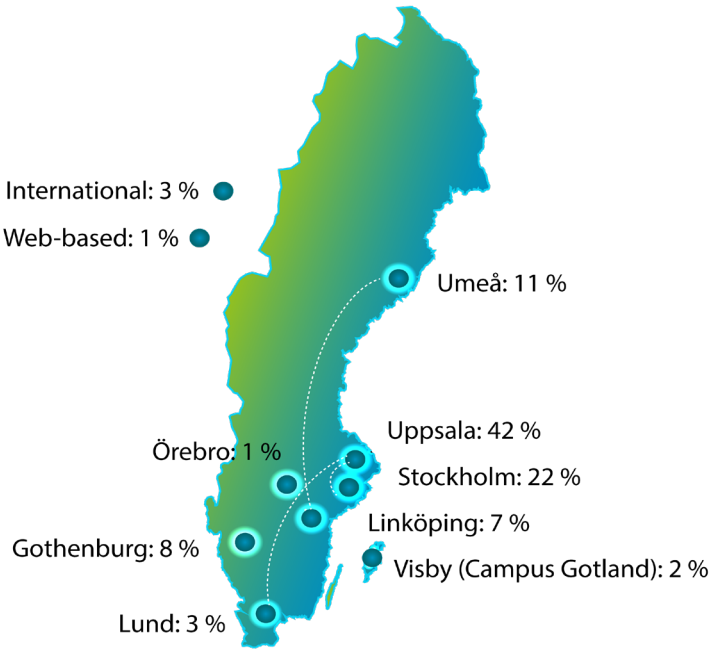


Figure 16. Geographical distribution of training organized by SciLifeLab. Dotted lines show co-organized courses at different sites.

SciLifeLab infrastructure – Criteria and evaluations

The infrastructure facilities, technologies and operations are evaluated on a regular basis, guided by key infrastructure criteria defined in 2016. A SciLifeLab facility should ideally:

- facilitate world-leading research in molecular life sciences.
- enable research that otherwise would not be possible in Sweden.
- provide high-quality services to academic researchers, industry, healthcare and other organizations in Sweden.
- be utilized by multiple research groups for high-quality research projects across the nation.
- be associated with a high-quality research environment.
- provide internationally competitive services.
- have a long-term plan for instrumentation renewal, technology development, data management and sharing, scientific domains and user communities being served, as well as for a sustainable and versatile funding base.
- have complementary and synergistic capabilities within and across SciLifeLab platforms.
- participate in national coordination of similar facilities at other universities in Sweden.
- promote translational implementation of research findings into healthcare and industry.

The first international evaluation of the SciLifeLab infrastructure was conducted in 2016, and evaluations will be held every four years, i.e. 2020, 2024 etc. The evaluations will engage internationally leading experts covering the research fields of the infrastructure. Guided by recommendations from these evaluations, SciLifeLab may then decide on implementation of new facilities or technology areas, and in parallel phase-out facilities or technologies that are regarded as out-of-date or common-place, or if they otherwise no longer fulfil the criteria to serve as national SciLifeLab facilities in competition with new facilities entering.

In between international evaluations, a Midterm Checkup of each facility is performed by the MG. The first Midterm Checkup was conducted in 2018, and was based on brief

reports from the facilities about: current status, future plans, and analyses of collected data on users and publications (an update of these analyses is given in the Facility Report, see Appendix H). The main purpose of this evaluation was to follow-up the terms and conditions for funding, to provide feedback to the facilities on their performance, and to give recommendations for future operations. Minor adjustments in the facility budgets were also done at this time. In the future, SciLifeLab will increasingly engage the recently formed NSC in this process to obtain input from a national perspective for future infrastructure decisions.

Next full infrastructure evaluation is planned to take place in 2020. The way by which this will be carried out is a critical question that we would like to get input on from the IAB. In brief, our plan is to engage in a lot of proactive strategic planning by the platforms at the national level. A platform-based planning process and coordination, (4 FTEs for all platforms, providing each platform entity about 0,5 FTE for 2019), as well as travels, meetings etc. will be supported, and has been approved by the SciLifeLab Board. The platform planning process will be carried out during 2019 and will engage all relevant national stakeholders and external international experts. The task will be to evaluate the existing state of the infrastructure, in addition to and identifying novel technologies and national services to be launched, developed, maintained, or phased out within each area. The outcome of this planning will form the key material for the next international evaluation of all SciLifeLab platforms in 2020. The evaluation will be done at platform level and will suggest a funding scheme that can be adjusted over the four-year period in a more flexible fashion than today and will put much more emphasis on the PD as a nationally responsible person for a given technology area.

SciLifeLab Data Centre (DC)

Research data is one of the most definitive and lasting products of SciLifeLab's operations and is key to securing a high scientific impact of our services. With this in mind, the DC was established in 2016 as a central support function to the infrastructure (Figure 17). The primary goal of the DC is to maximize the scientific impact of SciLifeLab generated data, through providing expertise and services for facility needs on IT and research data management, and by promoting Open Science, responsible data sharing, and facilitating that SciLifeLab data follows the FAIR principles (Findable, Accessible, Interoperable, and Reusable).

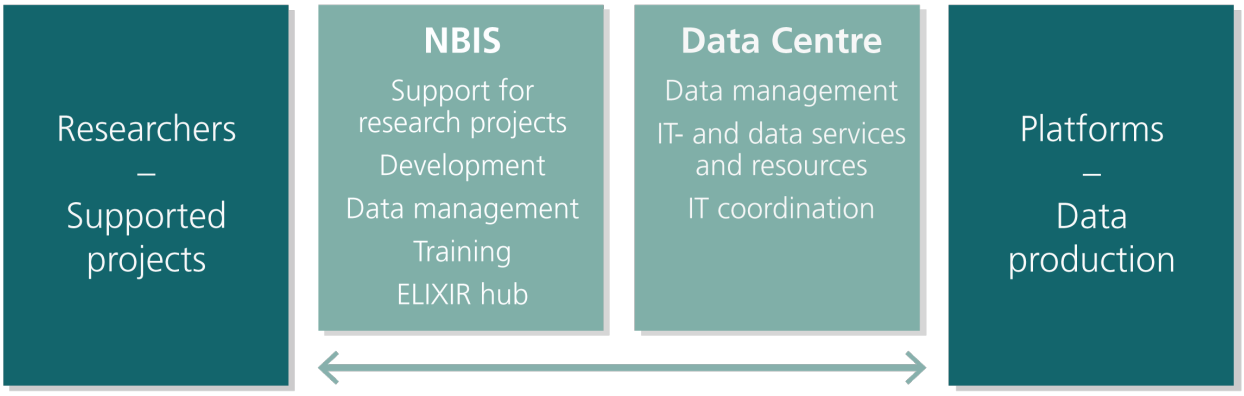


Figure 17. The SciLifeLab Data Centre (DC) provides services primarily to the technology facilities, which in turn supports user projects. In particular, DC supports data generating facilities, whereas for example NBIS, the Bioinformatics platform, primarily supports individual user projects.

SciLifeLab DC resources and services

The DC works to increase the visibility and to capture the impact of supported projects and data generated by SciLifeLab. In the future, it could serve a major role as a hub for molecular life science open data generated at SciLifeLab and across Sweden. To do so, it develops and operates services and resources for research data, as well as various supporting IT services for the facilities. Some examples of services provided today include:

- **SciLifeLab Order Portal:** The Order Portal is a web-based management system configured for the facilities to handle both contact and interaction with their users. The system is currently used by a number of facilities, including the SciLifeLab Genomics platform - National Genomics Infrastructure (NGI), and has recently been adapted for Operations Office to collect annual reporting data. [1]
- **Publication Database:** This resource stores publications that result from supported projects, and publications from researchers. The database is used for reporting, where facilities directly report publications into the database, and it provides a search and browse interface as well as an Application Programming Interface (API). Today, publications from facility users and SciLifeLab affiliated researchers are located in two places, https://publications.scilifelab.se and https://publications-affiliated.scilifelab.se.
- **Project Database:** This system is under development and will keep track of supported projects, resulting publications, and data depositions in public repositories. We are also bringing in a data repository software system to provide our facilities, affiliated researchers, administration and management with data storage capacity, meta data services, and a way to publish datasets that are not well suited for public raw data repositories. These services will be available during 2019.
- **Data Delivery Portal:** The DC is piloting a cloud-based object storage system as a data delivery platform for the facilities, and is currently developing interfaces towards both facilities and users in a project where several facilities contribute with both development staff and specifications. The data delivery portal will also be able assist facilities in provides certain other services to their users during the course of the project, such as meta-data generation, data management plans and feedback forms.
- **Data management plans:** Structured plans for data management in research projects are becoming increasingly important and the Swedish Science Council, VR, are requiring that supported projects maintain DMPs already from 2019. The DC works closely with NBIS and research data offices at other Swedish universities to provide templates for DMPs, and a web-based tool for storing and maintaining these will be established during 2019, and through communication with VR we will guarantee that SciLifeLab supported projects that use our DMP templates fulfil VR's requirements.

DC also provides a number of scientific resources of national interest that are openly accessible to anyone. Among these are the Swedish allele frequency database, SweFreq, [2] and data access services for large scale genomic data from SciLifeLab supported sequencing projects. We are also currently developing a whole genome imputation server in a Nordic collaborative project, with a target reference dataset of 10,000 Nordic whole genome sequences in addition to large international reference datasets. We aim to increasingly host data resources.

The DC also supports facilities and administration to increase compliance with the new EU General Data Protection Regulation (GDPR) coming into effect in May 2018, specifically in issues relating to sensitive data handling. A service is also provided to handle data access requests and the corresponding legal processes for PIs that want to share genomic datasets. This work is done in collaboration with the Centre for Research Ethics and Bioethics in Uppsala and with legal departments at the host universities.

SciLifeLab facilities need strengthened support for IT and data related issues, and DC has set up processes to meet facilities regularly and receive such needs in a structured format that can be processed and acted upon in a coordinated way across the whole infrastructure. Special attention is given to high performance computing and storage needs, reported by SciLifeLab users at SNIC systems. These requirements are followed up through regular meetings with SNIC management.

[1] https://ngisweden.scilifelab.se
[2] https://swefreq.nbis.se

Summaries of platforms

In this section, a brief presentation of the seven infrastructure platforms is given by the platform directors.

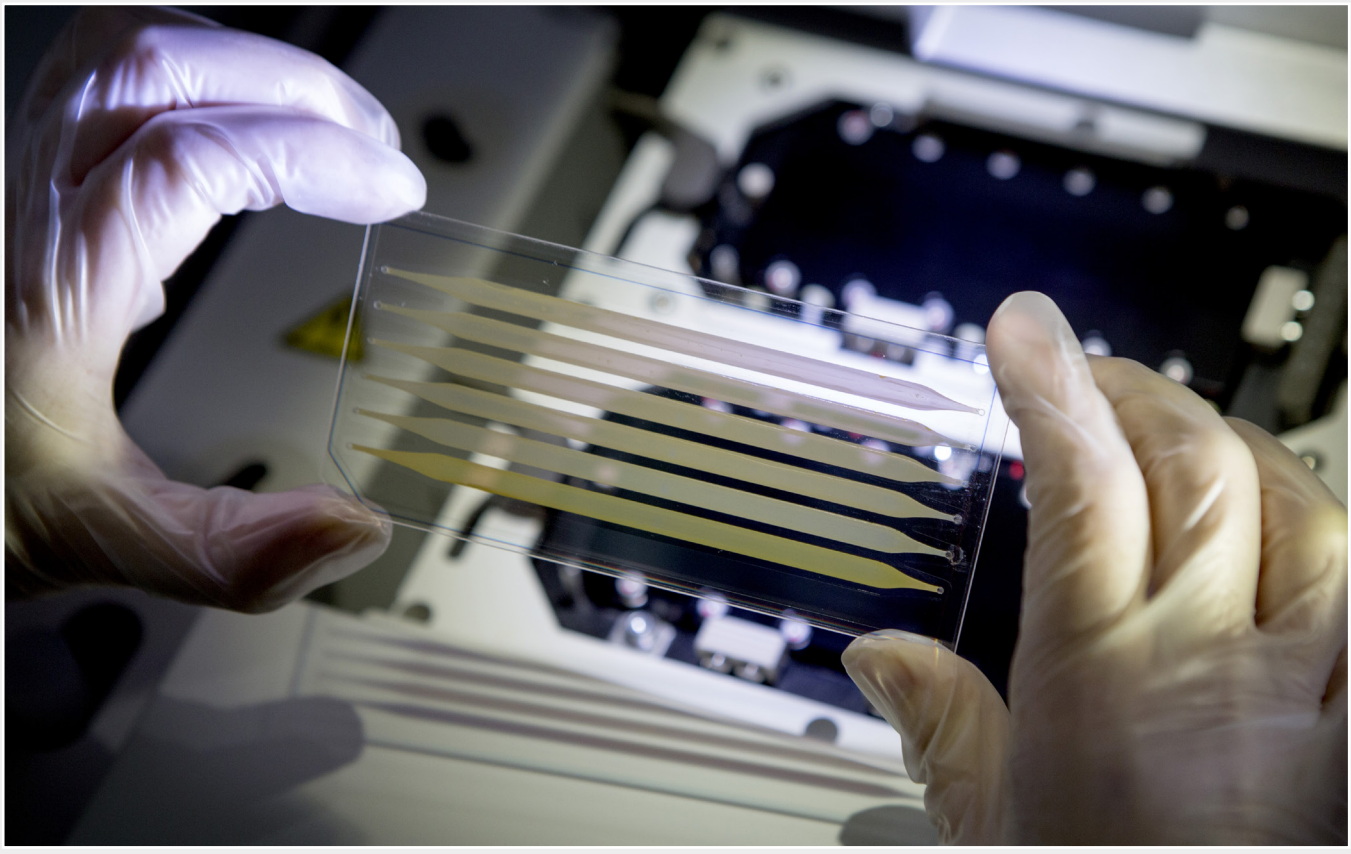
Genomics platform

Platform Director Ulf Gyllensten

The SciLifeLab Genomics Platform today provide service and expert guidance in:

- Technologies for extraction and preparation of DNA sequencing libraries from ancient DNA samples.
- Isolation of eukaryotic single cells and single prokaryotic organisms and sequence library preparation.
- DNA preparation for long-and short-read next generation DNA sequencing.
- Generation of short-read DNA sequence information using Illumina and Ion Torrent technologies.
- Generation of long-read DNA sequence information using PacBio, Oxford NanoPore and 10X Genomics technologies.
- High-throughput SNP genotyping using Illumina arrays and microsatellite genotyping using capillary systems.
- Bioinformatics analysis (QC of data, assembly of short-read data against reference genomes and variant calling, de novo assembly of and variant/mutation calling from long-read data).
- Spatial analysis of gene expression in tissue sections.

These services are provided through technology experts in the four facilities; NGI, Eukaryotic Single Cell Genomics, Microbial Single Cell Genomics and Ancient DNA. Since the last IAB site visit the platform has dramatically expanded its production capacity by acquiring and incorporated four NovaSeq instruments from Illumina into its service, an additional Sequel from PacBio, and one PromethION from Oxford NanoPore. The NovaSeq is used for a variety of projects and has increased the ability to perform large projects ranging from RNA-Seq to whole human genome sequencing. The additional Sequel has doubled the capacity for long-read whole genome sequencing and de novo assembly. The PromethION is being used for whole genome, long-read, DNA sequencing of large (human, forest trees) as well as smaller genomes. The emerging trends and technologies within the genomics fields that we are carefully considering in the platform are first alternative technologies for short-read sequencing, thus we are planning to evaluate the novel short-read technology and instrumentation from BGI. In term of long-read technology, PacBio has novel developments that increases the read length to over 100 kbp, which we will explore.



Proteomics and Metabolomics platform

Platform Director Jochen Schwenk

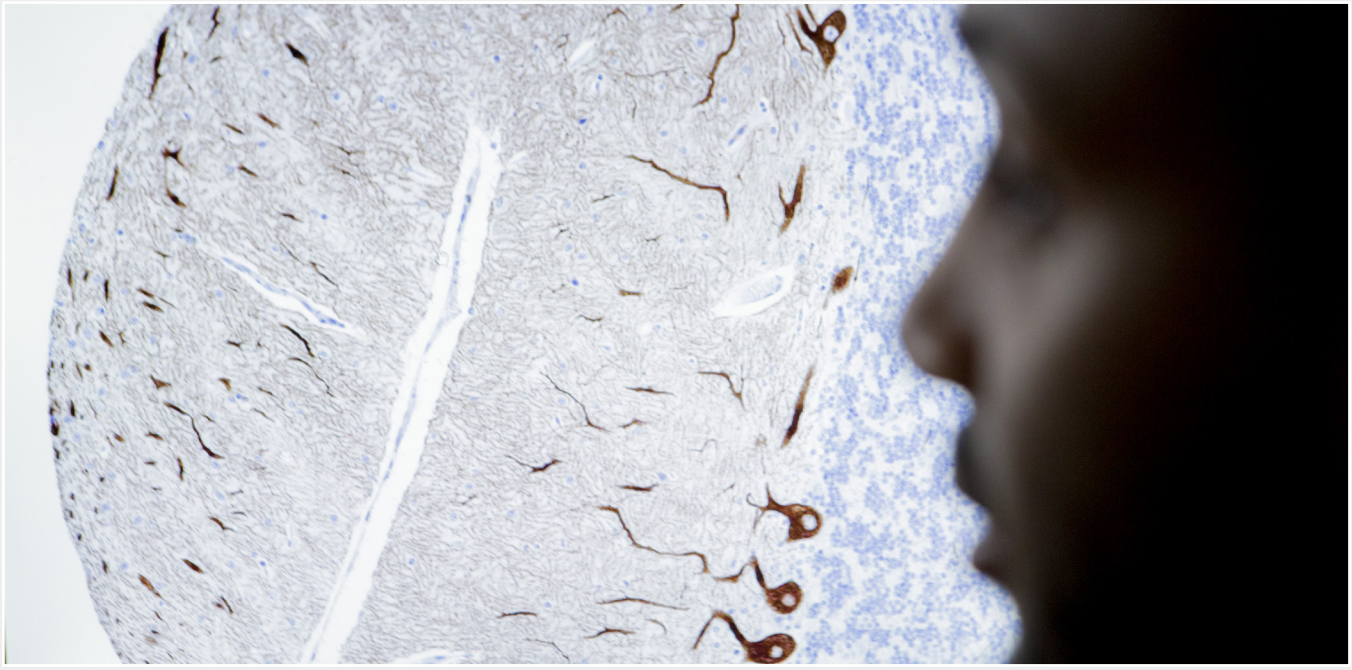
The SciLifeLab Proteomics and Metabolomics Platform provides service and expert guidance for identification, detection, imaging and quantification of proteins, peptides and metabolites using mass spectrometry and several multiplexed affinity-based assay systems. The services are provided through nine facilities: Autoimmunity Profiling (Nilsson, KTH), Chemical Proteomics and Proteogenomics (Lehtiö, KI), Chemical Proteomics & Proteogenomics (Zubarev, KI), Clinical Biomarkers (Landegren, UU), Mass Cytometry (new member 2019, Brodin, KI), Mass Cytometry (new member 2019, Jönsson, LiU), Plasma Profiling (Schwenk, KTH), PLA and Single-cell Proteomics (Kamali-Moghaddam, UU), and Swedish Metabolomics Centre (Moritz and Nordström, UmU).

Since the previous IAB visit the line-up of facilities at the platform has been restructured to focus on technologies tailored for parallel precision analysis of analytes, and to enable large-scale investigations in different areas of mainly human biology. The core competence of the platform is the combination of personnel with in-depth expertise and state-of-the-art equipment, advising and offering users the best possible analytical solutions. Several of the technologies and reagents are uniquely made available at the world leading platform, as many have often been developed by the research groups affiliated to the facilities.

The platform offers an unmatched spectrum of techniques including single cell profiling by CyTOF, multiplexed precision PEA or in situ PLA assays, advanced protein and metabolite mass spectrometry, as well as affinity proteomics systems built on reagents from the Human Protein Atlas project. The trends of services offered at the Proteomics and Metabolomics platform are towards further increased precision, higher sample throughput through automation of workflows, improved depth and resolution of analytical capabilities and linkage to other data sources for integration. Through different infrastructure calls (public, private or host universities), emerging technologies (liquid handling, mass spectrometers, single- and multiplexed immunoassays) are continuously implemented into the facilities at the platform.

Technologies

The SciLifeLab Proteomics and Metabolomics Platform provides exquisite services through a unique portfolio of technologies and is approached by users wanting access to its services in quantitative precision biology. We offer access to methods for targeted and discovery-driven metabolomics, tailored solutions of biomarker discovery and validation (mass spectrometry, autoimmunity and affinity proteomics), a variety of ultra-sensitive and multiplexed plasma analysis systems (Olink, in situ PLA, Simoa, MesoScale, Luminex), possible clinical translation through automated ELISAs (ProteinSimple), in depth studies of systems immunology on single cell levels (CyTOF, PEA), high-throughput assessment of antibody binding properties (large protein or peptide arrays) as well as screening of drug binding in thermal proteomics (mass spectrometry, DNA-assisted proximity-based assays). These services are supported by resources such as the Human Protein Atlas, aligned with statistical and bioinformatics analysis pipelines that ensure data quality from biomarker identification to multi-omics integration.



Bioimaging and Molecular Structure platform

Platform Director Hjalmar Brismar

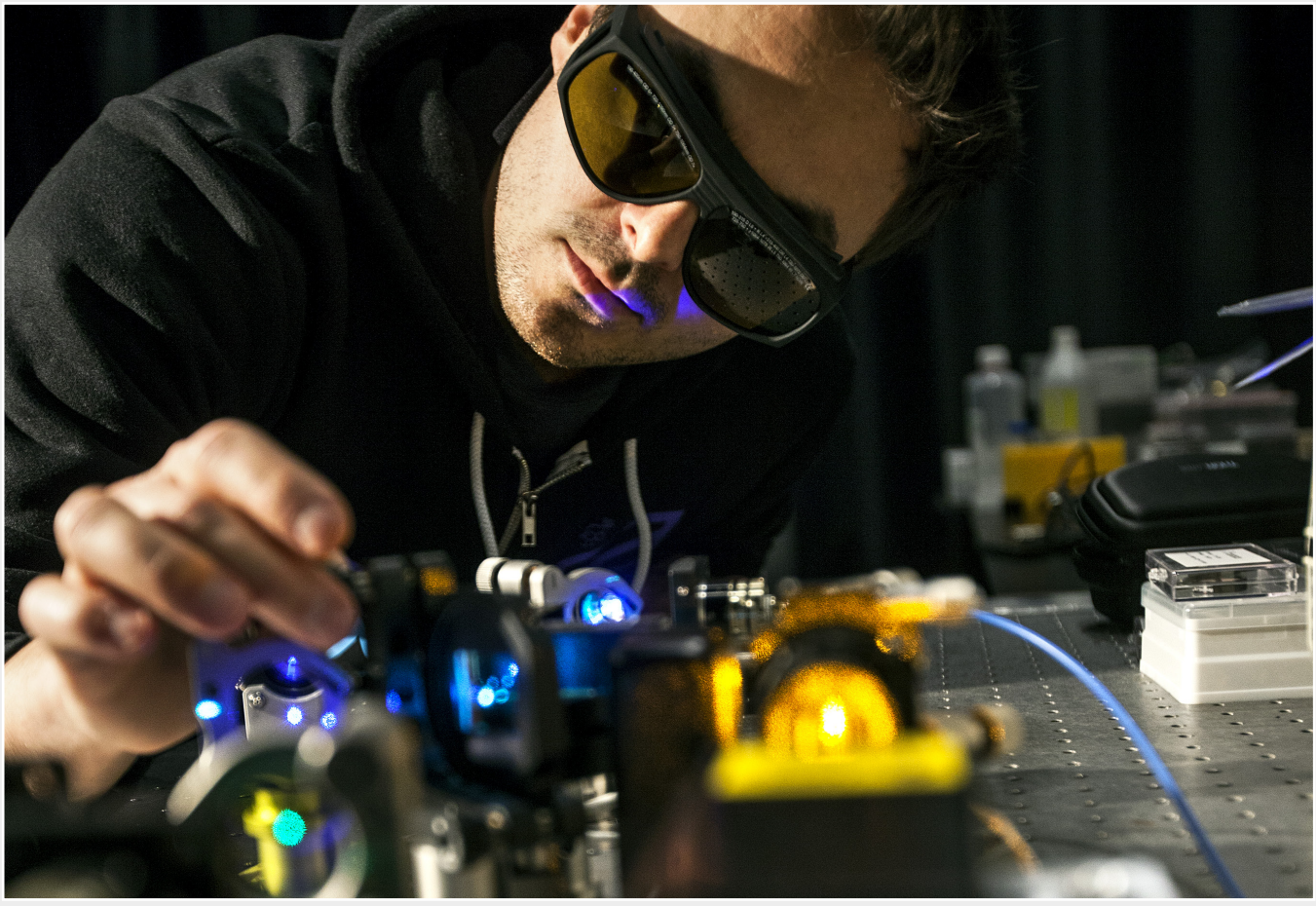
The Cellular and Molecular Imaging Platform was formed 2017 by combining existing facilities from the Bioimaging and Proteomics platforms with a number of newly formed national facilities. The platform is an administrative umbrella giving the facilities a high degree of autonomy. The platform has a wide range of technologies spanning from image analysis via electron and light microscopy to NMR spectroscopy. Microscopy and NMR are complementary technologies for analysis of protein structure.

The Cellular and Molecular imaging platform today provide service and expert guidance in:

- Super-resolution fluorescence microscopy using SIM, STED, PALM/STORM. Single molecule dynamic analysis with FCS. 4D fast volumetric imaging with light-sheet microscopy.
- Spatial proteomics with subcellular resolution. siRNA knockdown. Target protein analysis using automated immunostaining and automated confocal microscopy with unique HPA antibody libraries in a broad panel of cell lines.
- Automated and manual image analysis. Development of user-specific methods, education and advice on best-practice in biological image analysis.
- Protein production services.
- Single particle cryo-EM and cryo-tomography.
- NMR for structure determination and dynamic characterization of proteins including their interactions with ligands and other biomolecules.

The present services are provided through technology experts at seven facilities; Advanced Light Microscopy, Bioimage informatics, Cell Profiling, Cryo-EM in Stockholm, Cryo-EM in Umeå, Protein Science Facility, and the Swedish NMR Centre. Since the last IAB visit, all facilities have developed their service offerings both by new instruments and by development of new methods.

All technologies within the platform generate large amounts of multidimensional data. In order to exploit the full value of this data we aim to make a focused effort on integration of artificial intelligence, in particular deep learning with convolutional neural networks for analysis. A key factor for multidimensional analysis is the quality of data. Optimized sample preparation techniques and high-quality microscopic and spectroscopic recordings therefore go hand in hand with development of automated analysis.



Chemical Biology and Genome Engineering platform

Platform Director Anna-Lena Gustavsson

The Chemical Biology and Genome Engineering platform provides a range of services in chemical biology, CRISPR/Cas genetic screening, and creation of transgenic zebrafish lines. Platform services are provided by three facilities: Chemical Biology Consortium Sweden (CBCS, Stockholm and Umeå); High Throughput Genome Engineering (HTGE, Stockholm); and Genome Engineering Zebrafish (GEZ, Uppsala). As a platform, the three constituent facilities aim to establish a virtuous cycle between chemical biology, genetic screening, and organismal biology. Our combined mission is to identify and further develop small compounds as chemical tools, apply genetic screening to study modes of compound action as well as resistance mechanisms, and validate results obtained in cells in an intact organism.

Services provided by CBCS

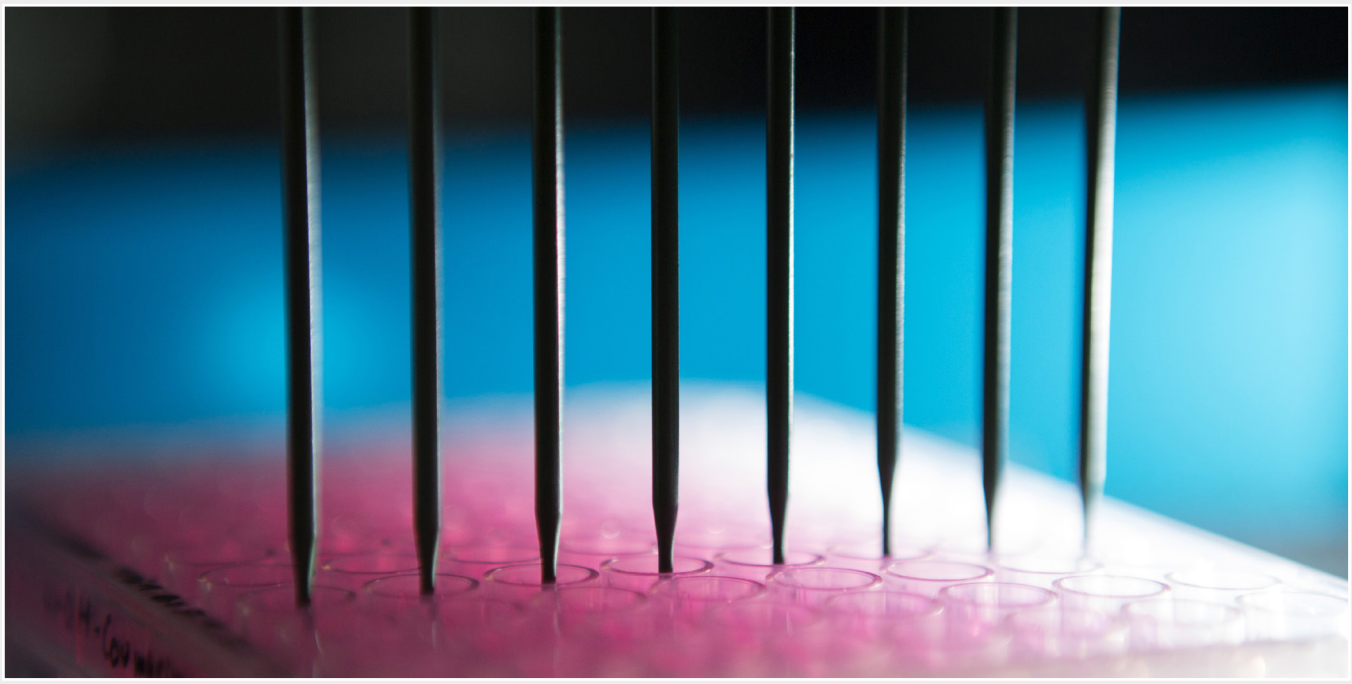
CBCS's mission is to develop and utilize high-quality small molecular tools together with research groups to address important biological questions within all areas of life sciences. CBCS provides expertise, experimental resources, and instrumentation for assay development and small molecule screening, computational chemistry, as well as cheminformatics, enabling chemistry developments and target identification efforts. CBCS and the Compound Center at SciLifeLab provide access to more than 200,000 small molecules for biological screening in assay-ready plates in an acoustic nanoliter scale liquid dispensing format. Screening formats range from isolated targets, via phenotypic cell-based assays, to whole organisms. Chemical tools give valuable information about "ligandability" and "drugability" of a particular target or pathway.

Services provided by HTGE

HTGE is a new facility established in 2017 and specializing in pooled genetic loss- and gain-of-function screening using CRISPR/Cas9 technology. HTGE carries out both small-scale and genome-wide screens with home-made lentiviral guide-libraries offering CRISPR-knockout, CRISPR-inhibition and CRISPR-activation screening – from library creation to data analysis. HTGE can complement CBCS's service with genetic screens for drug sensitivity, drug resistance, and drug targets. HTGE's R&D currently focuses on establishing a method for the characterization of drug-target interactions (CRISPR-X; saturating mutagenesis of protein domains by a base-editing enzyme fused to Cas9). CRISPR-X will be an important step towards further platform integration.

Services provided by GEZ

GEZ's main service is CRISPR/Cas9 and Tol2 based production of genome engineered zebrafish for disease modelling and investigation of gene function. Mutants are often generated in fluorescent reporter zebrafish lines and phenotype/genotype correlation is achieved by high-resolution fluorescence imaging of zebrafish larvae. GEZ has recently developed a multiplex CRISPR/Cas9 service, with combinatorial targeting of 2-8 genes, enabling the user to study the genetic basis of complex phenotypes involving multiple loci. In spring 2019, GEZ will launch an automated screening service in collaboration with the SciLifeLab BioImage Informatics Facility. We aim to develop an integrated service, spanning from the generation of genome engineered zebrafish to state-of-the-art, high-throughput quantification of distinct phenotypes.



Drug Discovery and Development platform

Platform Director Per Arvidssown and Kristian Sandberg

The SciLifeLab Drug Discovery and Development platform (DDD) provides service and expert guidance to:

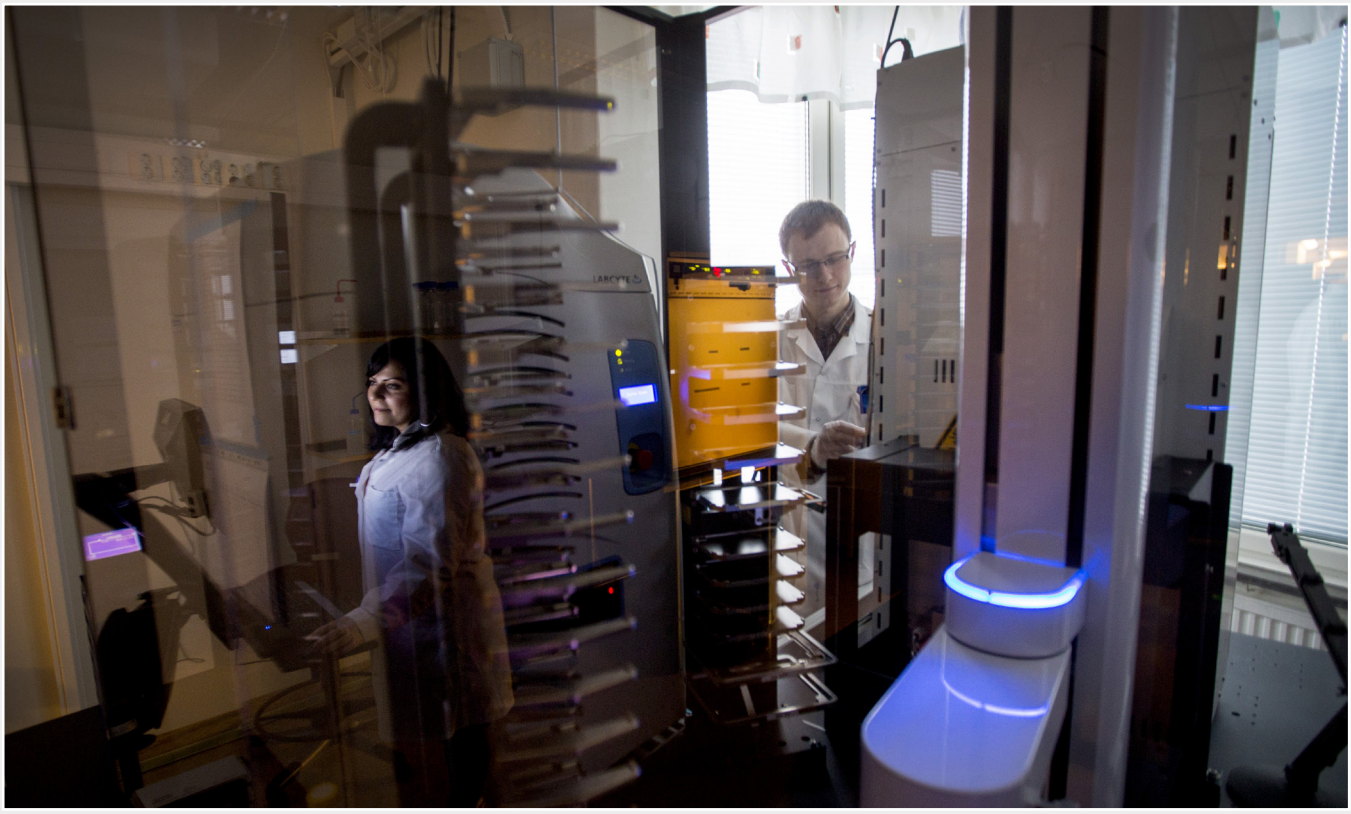
- design preclinical pharmacological studies for the development of novel therapeutics into clinical practice, including bioanalysis, PKPD modelling and safety assessment.
- design and produce recombinant proteins and human antibodies to build assays, to serve as antigens for selection in phage display libraries or to be therapeutic proteins.
- set up and run assays to characterize functional activity of molecules, to determine biophysical properties, to understand MoA of drug and to identify putative biomarkers.
- provide the expertise and resources required in synthetic and computational medicinal chemistry to develop drug like molecules supported by industry standard ADME data.

These services are provided through technology experts in the ten facilities: Target Product Profiling & Drug Safety Assessment; ADME of Therapeutics; Protein Expression & Characterization; Human Antibody Therapeutics; Biochemical and Cellular Assays; In Vitro & Systems Pharmacology; Biophysical Screening & Characterization; SciLifeLab Compound Center; Medicinal Chemistry Hit to Lead; and Medicinal Chemistry Lead Identification. The DDD project model relies on: a) focus on how the future drug will be used in the clinic; b) a project portfolio that is prioritized biannually; c) continuous feedback to the principal investigator (PI).

Since the last IAB visit the DDD project model has resulted in two programs that have reached phase 1 clinical studies; two programs that have been licensed by international pharmaceutical companies, and two programs that have contributed to the foundation of new companies. Ongoing programs are also competitive in grant applications as exemplified by the principal scientist Susanne Lindquist, Umeå University and her team who successfully secured a Horizon 2020 grant to build her company. DDD has also initiated work on potential therapeutics acting via new modalities to meet the future demands of medicines. The platform currently supports a portfolio of 18 programs, two technology development projects and >30 service projects per year.

In the platform, we are considering how emerging trends and technologies within drug discovery, e.g. new modalities and cell therapies like CAR-T, will impact on clinical practice in the future. A key technology for hit identification that is currently not freely available to academic scientists is DNA Encoded Chemical Libraries (DECL). DDD has therefore initiated a project with the aim to give academic scientists free access to a large DECL (>106 compounds) by the year 2020. Another key technology for the future is proteolysis-targeting chimeric molecules (Protacs). DDD is exploring the potential to refine Protacs by exploiting the large pool of different E3 ligases to achieve improved efficacy for this type of new modality drugs.

Read more about the DDD platform in Appendix F.



Diagnostics Development platform

Platform Director Richard Rosenquist Brandell

The SciLifeLab Diagnostics Development (DD) platform provides service and expert guidance in development, validation and implementation of high-throughput genomics technologies, including next-generation sequencing (NGS), for translational and clinical research projects, clinical trials and clinical diagnostics. This end-to-end service is provided through technology and medical experts in four facilities; Clinical Genomics Gothenburg, Clinical Genomics Lund, Clinical Genomic Stockholm and Clinical Genomics Uppsala. Each facility is closely connected to the university hospitals and medical faculty at each site. An extension of the platform to include all remaining university hospitals in Sweden is planned for 2019.

Since the last IAB visit the platform has continued developing high-throughput genomics technologies within the focus areas of rare inherited diseases, hematology, solid tumors and microbiology. A high number of applications have been successfully developed ranging from smaller NGS-based gene panels to whole-genome sequencing. During 2018, the facilities have made a joint procurement of 3 NovaSeq instruments to further increase the sequencing capacity in order to meet the rapidly increasing demand of NGS-tests for clinical research and diagnostics. As one of the few centers worldwide, we are offering clinical whole-genome sequencing since 2015; initially this was set up for rare diseases but we are now extending this service into leukemia diagnostics. We are currently also developing broad gene panel cancer diagnostics and clinical RNA-sequencing.

In 2017, the platform-initiated Genomics Medicine Sweden (GMS) has the ambition to secure access to NGS-based diagnostics for all patients in Sweden in order to introduce individually adapted therapies and follow-up strategies within healthcare. Regional Genomic Medicine Centers will be established at each university hospital, which together with the Clinical Genomics Facilities, will constitute the operative basis of GMS. GMS will be implemented as a broad collaborative project between different societal stakeholders including healthcare providers, universities with medical faculty, SciLifeLab, industry and patient organizations. A pre-study was approved in 2017 and earlier this year GMS received a two-year implementation grant from Vinnova, the Swedish Innovation Agency. Focus areas include setting up the national organization, building a national informatic platform and performing pilot studies in cancer, rare disease, microbiology and pharmacogenomics. Within this effort, the DD and its Clinical Genomics facilities will provide the technological basis and serve as a 'test bed' for new technologies. All in all, this initiative has the potential to deliver improved healthcare, strengthened Swedish research in the area of precision medicine, and will provide a foundation for innovation and collaboration with industry. More on GMS is presented in Appendix E.

Finally, considering that genomics is only one part of the precision medicine landscape, SciLifeLab should consider to extend the DD platform and include other omics technologies that are relevant for clinical/translational research and clinical diagnostics beyond genomics and are mature enough for validation and implementation.

Bioinformatics platform

Platform Director Bengt Persson

NBIS – the SciLifeLab Bioinformatics Platform provides support, infrastructure and training in most areas of bioinformatics enabling functional interpretation of data from genomics, metagenomics, proteomics, metabolomics and other large-scale analyses. We also provide expert knowledge in biostatistics, genome assembly and annotation, systems development, and data publication, and we are truly national with staff at six sites in Sweden.

Since the last IAB site visit NBIS has increased activities within our three main areas: Support, Infrastructure and Training. Furthermore, we are proud of receiving full support from VR for 2018–2020 where our application was given the highest score. We have expanded in number of staff (77 FTE at end of 2018 compared to 64 FTE at end of 2016) to meet the demands from our users and we have also increased our international collaborations (mainly Elixir and Tryggve).

Support: We provide bioinformatics support to ~300 PIs. The weekly drop-in sessions at all six sites across Sweden are very successful. Here, researchers get bioinformatics consultations for free in the initial phase of a project before data are generated. NBIS has recently launched a new support track – Partner Projects – for large projects (≥0.5 FTE over ≥2 years), where we also may participate as co-applicants. In recent years, the revenues from user fees have increased, indicating willingness to pay for bioinformatics support.

Infrastructure: The NBIS infrastructure services aim at facilitating large-scale analyses and making bioinformatics tools easily accessible for researchers. Our Tryggve funding from NordForsk has doubled, and we have increased EU financing. A major effort is the construction of local/federated EGA, where Sweden has taken a central role in the European development, since this is instrumental for secure storage of human data in the future. Systems development prioritization is done systematically and involves both national and international large projects and user-driven support cases.

Training: We have expanded our portfolio of national training, and in 2018 NBIS had over 430 participants at our training activities. We have also increased our international collaboration on training, and launched a very successful R summer school in 2018 (RaukR on Gotland). Most trainings are now administrated by NBIS – only five trainings have administrative support from SciLifeLab. NBIS runs an appreciated national mentoring program for PhD students. We have also initiated a high-profile seminar series in bioinformatics and genomics (BiG Talks) which we run together with three other platforms.

NBIS strives at mutually fruitful inter-platform interactions at SciLifeLab, and during 2018 we have intensified our collaborations with NGI and Clinical Diagnostics, as well as the national mass spectrometry infrastructure Bio-MS. In line with this, we aim at increased collaboration with the bioimaging platform during 2019.

Among emerging trends and technologies within bioinformatics that we are carefully considering in the platform, we observe an increased diversity of support projects and many of these have data of multiple types. We see needs for support in data management and data publication, including making data FAIR with appropriate meta-data assignment and enabling interoperability. We also expect single cell transcriptomics and ancient DNA to expand in the future. Furthermore, developments in AI/deep learning will have impact on analytical methods and infrastructure requirements. In line with this, we have currently an open announcement where scientists can suggest new support areas to be tested during 2 years.

Research community

Mission statement: Facilitate internationally leading collaborative research in a community of excellent scientists.

In addition to providing research infrastructure, SciLifeLab has the unique capability to promote collaborative research regionally in Stockholm and Uppsala, also nationally in the form of nation-wide communities and programs.

As advocated previously by the IAB, one of the founding principles of SciLifeLab has been the close link of excellent research with the infrastructure facilities as a precondition for the platforms to stay cutting-edge and to continually evolve. Thus, the joint research and infrastructure role of SciLifeLab is at the heart of its plans for the future. Today, we define the SciLifeLab research community as consisting of several parts. The first two form the "internal" community of group leaders and SciLifeLab-affiliated scientists at the host universities, while the "external" national user community reflects the user base of the infrastructure and provides an important extension to the internal resources. Interactions and bridges between the internal and external groups are now being promoted by a number of dedicated programs and initiatives, described in this chapter.

1. SciLifeLab-affiliated researchers from the host universities. SciLifeLab hosts nearly 200 affiliated research groups at its primary research centers in Stockholm and Uppsala, and provides a collaborative research community in close connection to the infrastructure, including the current 22 SciLifeLab Fellows. These researchers possess deep, often world-leading, knowledge in their area of interest, often co-developing technologies and applications with the SciLifeLab infrastructure, or representing early adopters of these technologies. Despite this key role, it is important to state that this group of scientists today has no favored access to the national infrastructure services.

2. Staff operating and developing SciLifeLab infrastructure (425 people corresponding to 313 FTEs). Unlike many local core facilities at Swedish universities that often requires users themselves to learn and operate the technologies, SciLifeLab has a broad community of talented and experienced staff scientists that guide the users through technologies, capabilities and services of specific applications. These individuals are the most valuable assets of SciLifeLab's research infrastructure and provide complementary and interdisciplinary expertise to any given project. They also contribute to, and on many occasions also pioneer technology development projects, and the evolution of a facility's capabilities.

3. National users of the SciLifeLab infrastructure services (About 1300 users each year). The wide community of users of the SciLifeLab infrastructure represents researchers covering a broad range of life science disciplines from all universities in Sweden and other research organizations. This community has a critical role in the national mandate of the infrastructure and provides a supplementary asset to SciLifeLab through providing additional expertise. SciLifeLab actively monitors publications resulting from the user community's utilization of the SciLifeLab infrastructure. However, as most of these publications do not have author contributions from SciLifeLab, monitoring them is difficult thus the number is likely to be underestimated. Today, scientists apply individually for access and service at the facilities, but through the RCP program described below, and other ways, the intention is to help user groups and networks of researchers from across the country to share their experience and link them with technological expertise of the "internal" SciLifeLab environment. Thus, while the user community has few formal

connections to SciLifeLab, they form a wider base of expertise to build on and act ambassadors for SciLifeLab beyond the host universities.

Publication profile of SciLifeLab: Interaction of research with infrastructure

DC maintains a continuously updated publication database of all SciLifeLab publications, categorized as i) co-authored by SciLifeLab associated group leaders and infrastructure staff ("affiliated") and ii) publications from the users of the national facilities where SciLifeLab is acknowledged ("facility users"). SciLifeLab-affiliated publications are defined as those where the authors have indicated their affiliation with SciLifeLab (keywords "Science for Life Laboratory" or "SciLifeLab" in the affiliation or address fields). As SciLifeLab is a secondary affiliation for associated scientists, these publications are also credited to the host universities.

Currently there are on average around 600 publications produced annually from each of the two groups mentioned above, though with some important overlaps. Analysis indicates that about 20% of 2017-2018 publications fall into both categories (Figure 18). In other words, one third of the total facility user publications are co-authored by SciLifeLab-affiliated scientists. Similarly, one-third of the publications from SciLifeLab-affiliated scientists are also listed as facility user publications, indicating that roughly every third paper from the internal SciLifeLab community is based on a collaboration with the infrastructure. This indicates the important added value the staff of SciLifeLab facilities bring to the science developed within the broader SciLifeLab community. While not surprising, it is also satisfying to see data supporting the expected key role of the "internal" user community in supporting the technology base at SciLifeLab.

SciLifeLab publication databases can be viewed at:

- Publication database (Reported from SciLifeLab-affiliated researchers) https://publications-affiliated.scilifelab.se
- Publication database (Reported from SciLifeLab infrastructure) https://publications.scilifelab.se

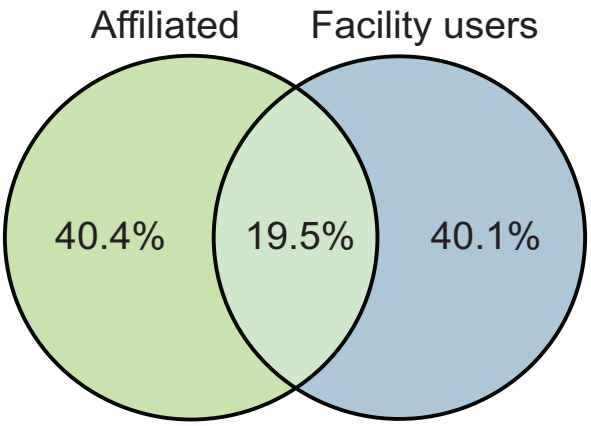


Figure 18. Scientific publications produced by SciLifeLab research community during 2017–2018. The diagram shows the percentage of all SciLifeLab associated publications derived from Affiliated (= SciLifeLab-affiliated researchers from the host universities including staff at the SciLifeLab infrastructure) and Facility users (All users of the SciLifeLab infrastructure nationally).

Publication profile of SciLifeLab: Strength areas based on publications

Different methods for analyzing and visualizing the strengths and focus-areas of SciLifeLab "affiliated" (or internal) publications have by applied, utilizing both quantitative and qualitative indicators. Word cloud illustration of publication keywords in PubMed shows the range of biological research topics of these publications, but also a strong focus on specific technologies, indicating that these are being applied in various research fields (Figure 19). The publication profile of SciLifeLab-affiliated group leaders is strong in e.g. cancer, proteomics, autoimmunity, inflammation, metabolism, obesity, evolution, phylogeny, and biomarkers. These analyses provide useful information for inferring core research areas for further study, or potential communities to build upon further. They also illustrate under-represented areas for further development.

The scientific production from the SciLifeLab affiliated "internal" research community was analyzed by the Centre for Science and Technology Studies (CWTS) at Leiden University and their advanced bibliometric indicators (Appendix I). SciLifeLab-affiliated researchers publish with a high relative impact in a wide range of molecular bioscience fields, with particular strong impact arising from publications in mathematical and computational biology and multidisciplinary sciences. Other scientific fields with high publication frequency and impact are biochemistry & molecular biology, genetics & heredity, biochemical research methods and biotechnology & applied microbiology (Figure 20 and Appendix I).

Publication profile of SciLifeLab: national and international collaborations

CWTS at Leiden University data also provides the institutional affiliation of SciLifeLab publication co-authors. Analysis of this data allows for visualization of the multitude of joint affiliations and collaborative interactions between SciLifeLab affiliated scientists. The impact of these collaborative publications is indicated in color, which denotes the field-normalized citation score.

Nationally, this type of analysis highlights the expected key role of the host universities. In addition, strong links to Lund University (LU) are apparent, along with University of Gothenburg (GU), Umeå University (UmU), and Swedish University of Agricultural Sciences (SLU). Co-publication with international researchers is highlighted, not by quantity but by the high citation impact of these publications, and they are on average higher than the national collaborations. High-impact collaborations with Oxford, Sanger, Boston area institutions (Harvard, MGH, Brigham, MIT) and Helsinki can be identified. Other notable high-impact collaborative sites are Copenhagen, NIH, and Tartu (Figure 21).

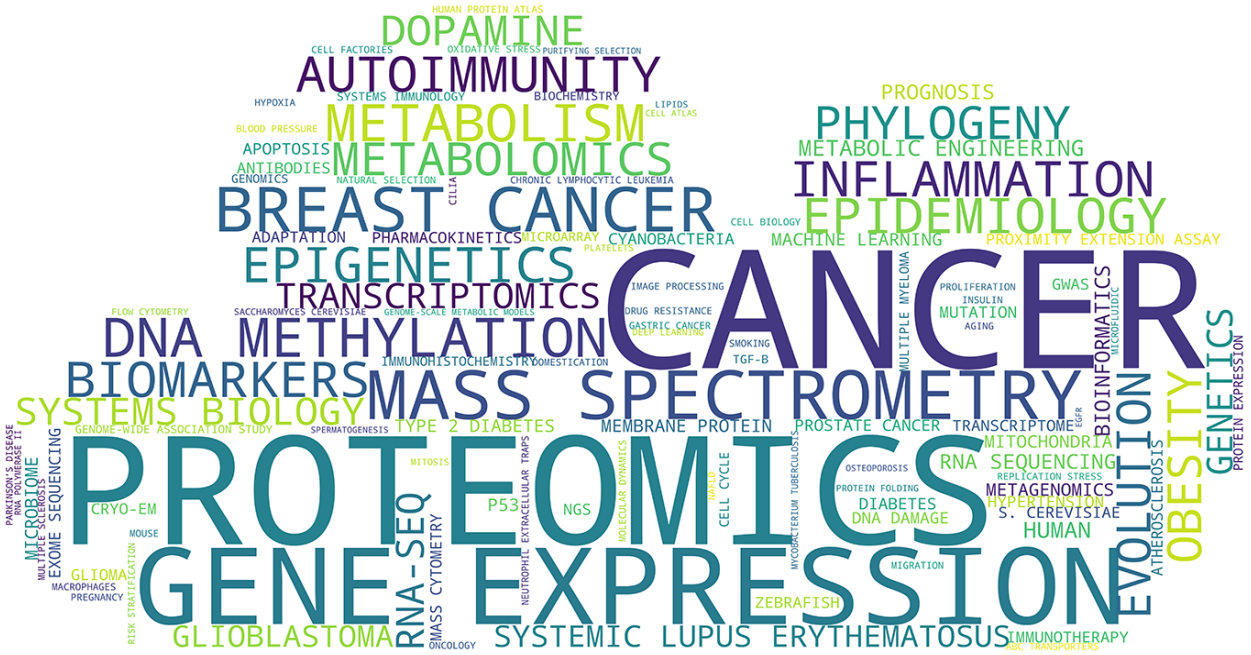


Figure 19. Wordcloud visualization of PubMed keywords from SciLifeLab-affiliated publications during 2017-2018 as listed in the SciLifeLab publications database (https://publications-affiliated.scilifelab.se)

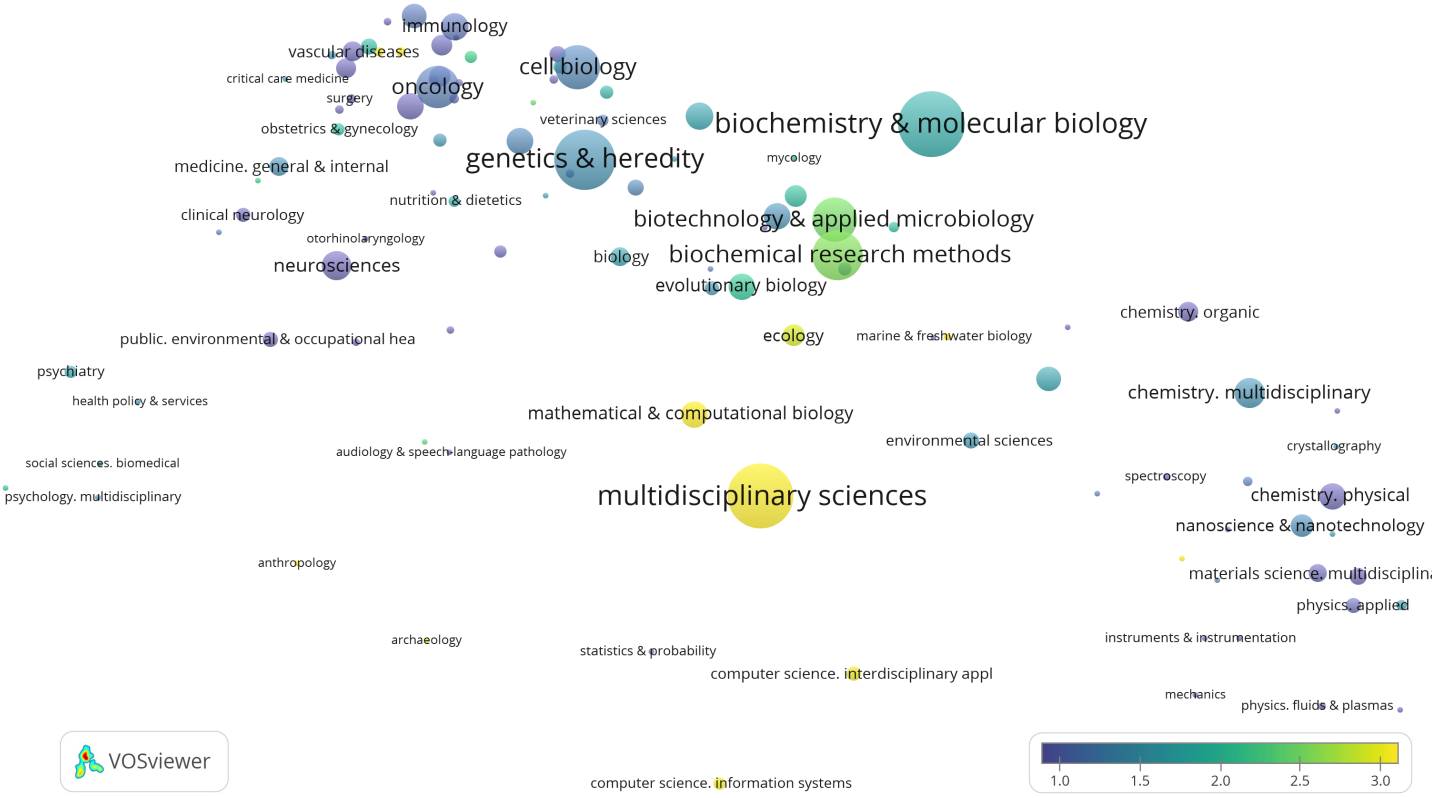


Figure 20. Research profile for publications from SciLifeLab-affiliated researchers during 2012–2016. The size of the circles indicates publication frequency for that particular research area, while the color of the circles indicates the impact measured as Mean Normalized Citation Score, MNCS. Analysis was performed by the CWTS at Leiden University. The top 20 scientific areas are listed in Appendix I.

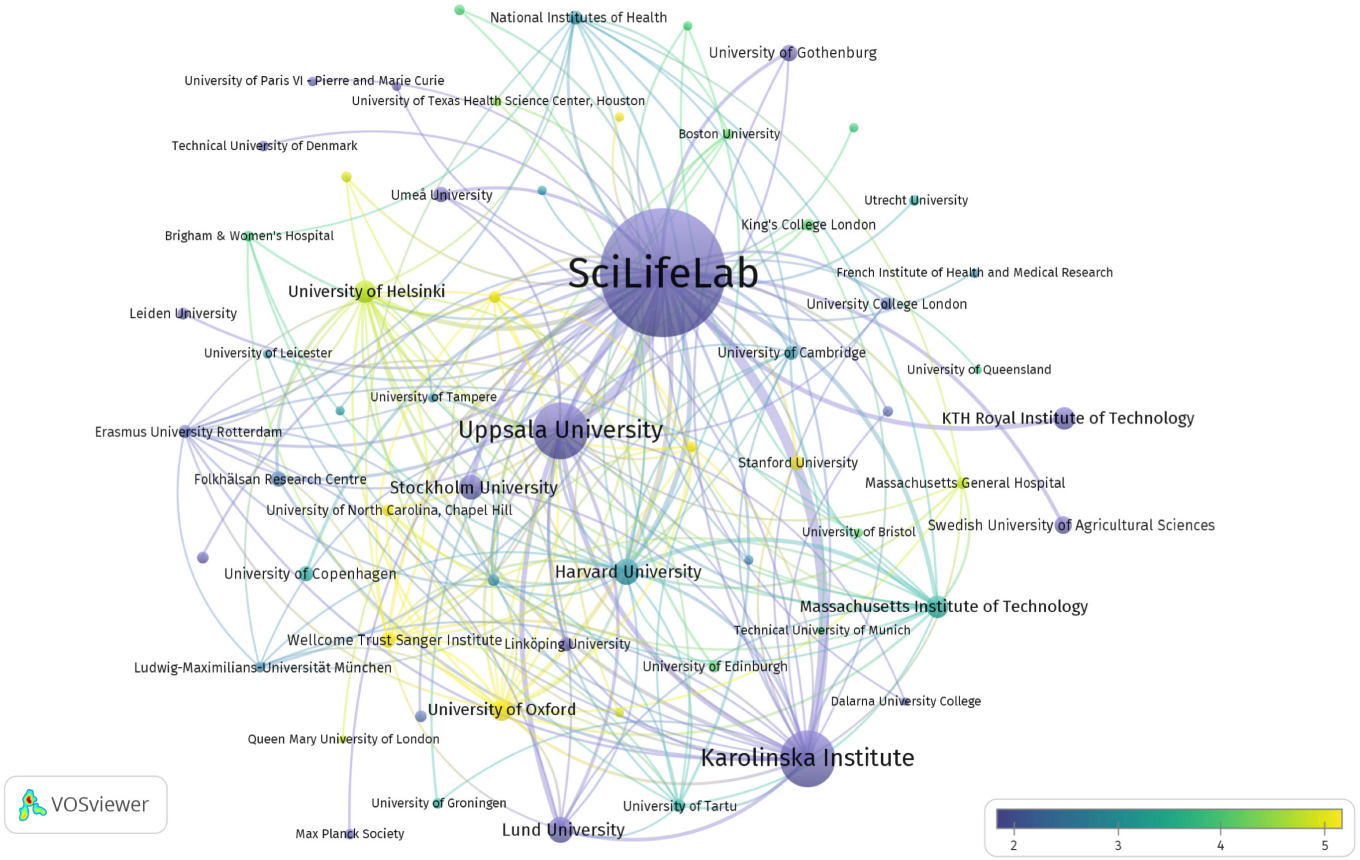


Figure 21. Network of SciLifeLab collaborations visualized based on joint authorships. The size of the circles indicates the publication frequency with a site or institution, while the color indicates the impact of these publication (MNCS). Analysis was performed by the CWTS at Leiden University. The national collaborators and top 20 international collaborators are listed in Appendix I

Table 4. Approved RCPs 2018.

Name of RCP	Coordinating PIs	Number of PI´s	Affiliation of key participants
Biology of Molecular Interactions	Alexey Amunts, Ilaria Testa	8	SU, KTH, GU, KI, LU, UmU, UU
The Human Protein Atlas	Mathias Uhlén, Cecilia Lindskog	9	KTH, UU, Chalmers, KI, LU
Large-scale clinical genomics and complex diseases	Richard Rosenquist Brandell, Sarah Bergen	11	KI, GU, KTH, LiU, LU, UmU, UU, ÖRU, as well as University hospitals at Karolinska, Lund, Umeå, Uppsala and Örebro
The Human Developmental Cell Atlas	Joakim Lundeberg, Emma Lundberg	5	KTH, KI, SU, UU
Aquatic Microbiome Research Initiative	Stefan Bertilsson, Rachel A Foster	6	UU, SU, Chalmers, GU, KTH, Linneaus University, SLU, UU
Phenotypic Drug Discovery in Human Disease	Oscar Fernández-Capetillo, Karin Forsberg Nilsson	8	LU, UU, GU, KI, KTH
Swedish Tumor Microenvironment (STorM) Program	Kristian Pietras, Anna Dimberg	5	LU, UU, KI, KTH, SU, Linköping University Hospital, Norrland University Hospital

Research Community Programs (RCPs)

Following recommendations from the previous IAB site visit, SciLifeLab launched the Research Community Program (RCP) concept – a totally new national community-building and research networking initiative. The RCPs aim to facilitate internationally competitive, cutting-edge collaborative research with broad participation from the entire country. In addition, the RCPs will promote networks and novel collaborations thus branding SciLifeLab research, as well as facilitate links between the national research community and the SciLifeLab infrastructure. The RCP call received a total of 32 applications, and seven RCPs were approved for 1 MSEK funding per year for three years (Table 4). Detailed information of the RCP call such as aim, description of program and how the SciLifeLab infrastructure is critical to the RCP and how the RCP is critical to the infrastructure is found in Appendix J. The RCPs represent a new way to connect the best scientists in the country with each other and with the SciLifeLab infrastructure. Funding of the seven RCPs was enabled by using both National SciLifeLab funding and an equal contribution of co-funding from the four host universities (SFO funding).

National sequencing projects

In 2014, SciLifeLab launched a national initiative to advance large-scale genomic research in Sweden, coordinated by the Genomics platform. The project, which is co-funded by the KAW, focuses on whole-genome human sequencing and genomics-based biodiversity studies. KAW is the largest private foundation in Sweden supporting long-term basic research beneficial to Sweden. [1] Applications are reviewed by an international panel of experts based on scientific impact, societal benefit, and technical feasibility, and the projects are granted funding by the SciLifeLab Board. The initiative is divided into two programs: 1) Swedish Genomes and 2) Biodiversity. The first and second calls have been completed and 41 projects have been granted a total of 44,9 MSEK. The third and final call for proposals funded 14 projects with 33 MSEK in 2017.

A full list of funded projects and more information about the National sequencing projects, is found here: https://www.scilifelab.se/infrastructure/national-projects/.

SciLifeLab Fellows Program

The SciLifeLab Fellows program is a recruitment and career development initiative designed for excellent young scientists at the beginning of their academic careers as group leaders. Ultimately, the program aims to strengthen Swedish research by recruiting and keeping top talents in Sweden. SciLifeLab Fellows are recruited by one of the host universities as independent group leaders and are supported by a generous starting package of around 3 MSEK/yr for four years. The funding comes from SFO funds from the host university to which the SciLifeLab Fellow is recruited. Two years of additional funding is granted following an evaluation, and the SciLifeLab Fellows may then be tenured at one of the four host universities, or move elsewhere to further their careers. Regardless of their future career steps we wish these young researchers remain strongly connected to SciLifeLab as adjunct researchers or alumni and serve as important future ambassadors for SciLifeLab and life science research in Sweden.

[1] https://kaw.wallenberg.org/en.

Currently, the SciLifeLab Fellows program includes 22 young group leaders (Figure 22) at various stages in their six-year program (see Appendix K). In their research groups, there are currently 148 active researchers, of which 34% are postdocs and 38% are doctoral students. During 2018, 10 of the PhD students in the fellow's groups have successfully graduated. Currently eight new SciLifeLab Fellows have been recruited with an estimated start during 2019, in addition two additional positions are being announced during 2019.

The current group of SciLifeLab Fellows have been exceptionally successful in attracting external research funding. Just in 2018, they have been granted one US grant from JDRF and six major EU grants, including four European Research Council (ERC) Starting Grants. In total thus far, nine out of the 22 SciLifeLab Fellows (41%) have obtained an ERC grant as a SciLifeLab Fellow. In addition, the fellows have received 28 national research grants from e.g. the KAW, the Swedish Cancer Society (Cancerfonden), the Carl-Tryggers Foundation, Göran Gustafsson Foundations, KI, the Swedish Society of Medicine, the Swedish Research Council (VR) and The Swedish Research Council for Environment, Agricultural Sciences and Spatial Planning (FORMAS). Fellows participated actively in internal SciLifeLab calls in 2018 such as: RCPs, TDPs, Expensive Instrument calls, SFO funded SciLifeLab Postdoctoral Grants and the Swedish Biodiversity program (part of the SciLifeLab National Sequencing Projects).

Seven of the SciLifeLab Fellows have received either a permanent position or have been promoted to a formal tenured position at one of the host universities (see below and Appendix K). This indicates, despite the many practical difficulties, their significant career progressions. The SciLifeLab Fellows program is critical for the SciLifeLab profile, and we want to promote and advance this program further with the host universities. There are still some practical challenges remaining, especially with Campus Solna, in accommodating some of the practical concerns of the SciLifeLab Fellows. Moreover, the future of the program is completely dependent on the continuation of SFO funding from the Swedish government to the host universities. With the uncertainty regarding the future funding, the host universities may soon pause new SciLifeLab Fellow recruitments until a sustainable funding situation have been clarified.

SciLifeLab Fellows (9/22 received ERC grants)

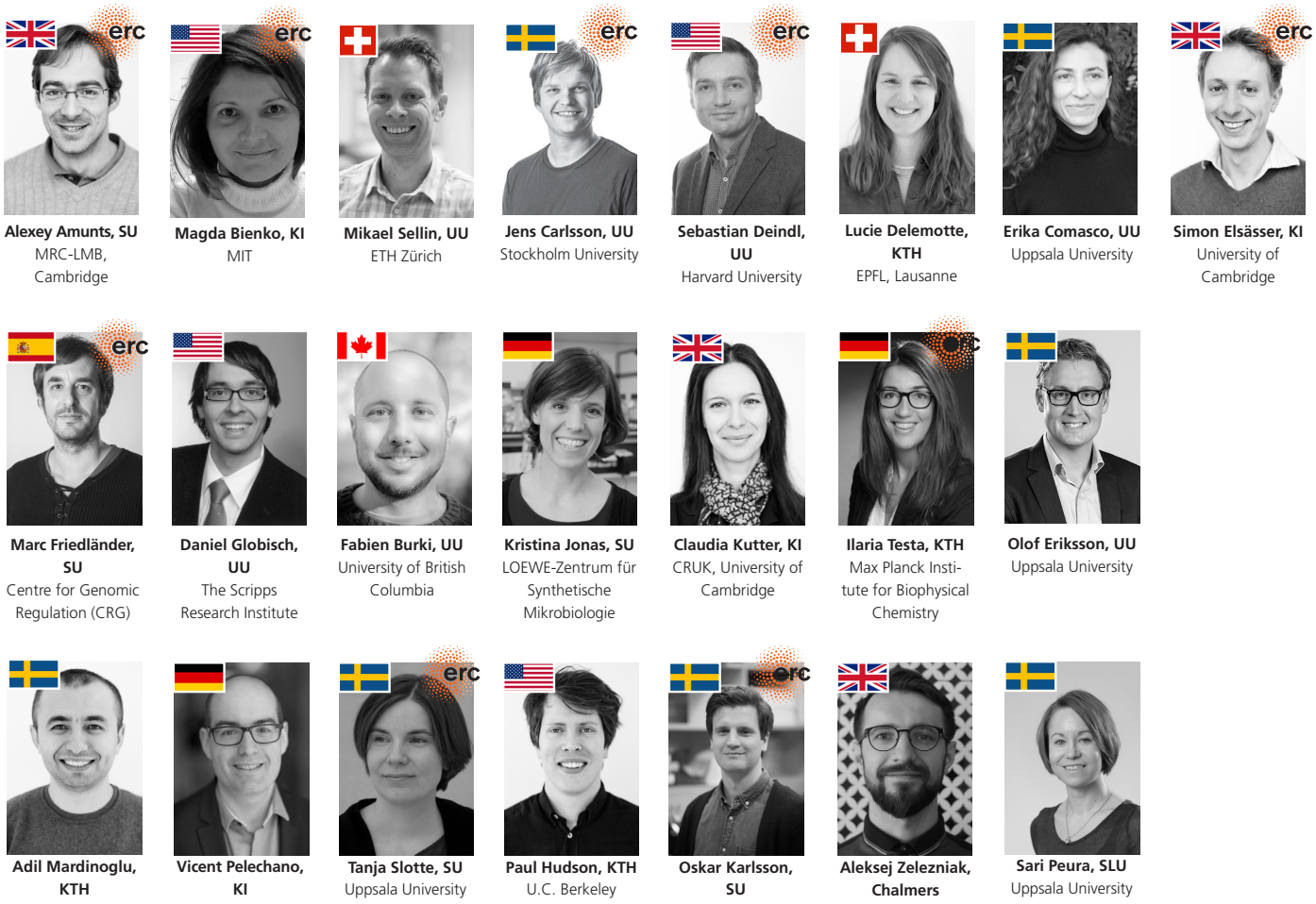


Figure 22. Overview of current SciLifeLab Fellows showing present affiliation, institute of origin, and European Research Council (ERC) grant funding.

Promoted SciLifeLab Fellows

During the 2017 IAB site visit, several critical comments in regards to the SciLifeLab Fellows program were expressed, criticism which we have taken seriously and worked with in a number of ways to improve the program. Calls for new SciLifeLab Fellows are now better coordinated between the host universities and SciLifeLab management in terms of both timing and research themes. The host universities have also agreed upon common basic guidelines, introductory procedures and agreements that stipulate terms, conditions and expectations of the program (Appendix K). Thus, the conditions and prerequisites for SciLifeLab Fellows are now more comparable across the host universities. However, common principles for the length of appointments and joint evaluation guidelines for tenure cannot been achieved as either university-, or department-specific regulations dictate these procedures. As a consequence, the SciLifeLab Fellow conditions at the host universities still differ somewhat.

An annual retreat is organized for the SciLifeLab Fellows both to highlight their specific challenges and opportunities, but also to build a stronger internal community and support for this group of young scientists. To facilitate further collaborations, a new national networking activity was recently launched that links the SciLifeLab Fellows program with the national Wallenberg Centers for Molecular Medicine (WCMM) Fellows, the National Molecular Medicine Fellows Program (NMMP). The aim of the NMMP is to bring the future leaders of life science and molecular medicine in Sweden together. This collaboration between SciLifeLab and WCMM is co-funded by a 9 MSEK grant from KAW. Altogether, the NMMP will encompass more than 100 young group leaders (including SciLifeLab and the four WCMM centers) that have been, or are being recruited, to the various centers. This collaboration includes joint annual meetings, career development events and research collaborations.

Illaria Testa

Recruited from Max Planck Institute for Biophysical Chemistry, Germany, by KTH Royal Institute of Technology in 2014

Marc Friedländer

Recruited from Centre for Genomic Regulation (CRG), Spain, by Stockholm University in 2014

Adil Mardinoglu

Recruited from Chalmers, Göteborg, by KTH Royal Institute of Technology in 2015

Sebastian Deindl

Recruited from Harvard University, USA, by Uppsala University in 2014

Tanja Slotte

Recruited from Uppsala University, Sweden, by Stockholm University in 2014

Sari Peura

Recruited from Uppsala University by Swedish University of Agricultural Sciences, Uppsala in 2016

Paul Hudson

Recruited from U.C Berkeley, US by KTH Royal Institute of Technology in 2014

Community building efforts within SciLifeLab

An important part of SciLifeLab's mission is to promote interaction, collaboration and a sense of community for researchers from different universities, scientific areas and backgrounds. For this purpose, SciLifeLab provides event support for activities focused around SciLifeLab core research areas and/or technologies. Examples of recurring events are scientific seminars, such as the SciLifeLab Mini-Symposia series which covers the four core scientific areas of SciLifeLab: medical and population genetics and genomics, biodiversity and evolution, cancer research, and drug discovery, as well as the SciLifeLab Seminar Series, broad-themed seminars with invited international and national speakers arranged at both campuses. [1]

A major annual scientific event is the SciLifeLab Science Summit. This one-day symposium is arranged around a specific scientific topic with high relevance to SciLifeLab. The event alternates between Stockholm (2016: Single Cell Analyses – from Microbes to Human Brain, 2018: Chemical and Genetic Screening – Exploring the Future Frontiers of Human Health) and Uppsala (2017: Imaging the Complexity of Life). In 2019 the SciLifeLab Science Summit will thus be arranged in Uppsala and will cover the topic - Artificial Intelligence for Life Sciences. Examples of other relevant community-building and outreach activities performed during 2017-2018 are summarized in Table 5.

Table 5. SciLifeLab events arranged during 2017-2018, location and number of participants. Full list of present and previous events at https://www.scilifelab.se/events/.

Events during 2017-2018	Date	Site	No of participants
Minisymposium: Medical and Population Genetics and Genomics	2017-04-21	Stockholm	60
Imaging the Complexity of Life – Science Summit 2017	2017-05-03	Uppsala	300
Mini-Symposium: Patterns in genomes and the evolution of novel genes	2017-05-04	Uppsala	80
Keystone Symposium – Single Cell Omics	2017-05-26	Stockholm	300
Minisymposium: Clinical and Regulatory Perspective on Drug Development	2017-06-12	Uppsala	70
Almedalen: Infrastructure resources for Swedish life science	2017-07-05	Visby	150
Minisymposium: Biologics – making it your business	2017-09-12	Stockholm	50
SciLifeLab Data Centre Workshop: Open Science in Swedish Life Science	2017-09-20	Uppsala	70
Mini-symposium: DNA repair in Cancer	2017-10-19	Stockholm	90
Minisymposium: Medical and Population Genetics and Genomics	2017-11-10	Uppsala	60
Mini-symposium on Symbiosis	2017-11-23	Stockholm	45
Finding Your Way in Science – Science & SciLifeLab Prize Scientific Symposium	2017-12-11	Stockholm	400
Uppsala-Stockholm Workshop on Biomolecular Simulation	2017-12-15	Stockholm	70
Minisymposium: Medical and Population Genetics and Genomics	2018-04-20	Stockholm	60
Chemical and Genetic Screening – SciLifeLab Science Summit 2018	2018-04-25	Stockholm	300
Keystone Symposium – Precision Medicine in Cancer	2018-05-06	Stockholm	300
Minisymposium: Covalent inhibitors in Drug Discovery	2018-05-18	Stockholm	100
Minisymposium: SciLifeLab Biomolecular Simulation Workshop	2018-05-24	Uppsala	70
Minisymposium: Biodiversity – Ecology and evolution of new species and phyla	2018-05-31	Uppsala	50
Minisymposium: The tumor microenvironment as a target for therapy	2018-06-01	Uppsala	85

[1] https://www.scilifelab.se/research/the-scilifelab-seminar-series/

Almedalen: Increased access to national research infrastructures	2018-07-03	Visby	70
SciLifeLab – A National Resource for Life Science, part of the Nordic Life Science Days	2018-09-10	Stockholm	150
Data Centre-Symposium- Data Management for Human Genomics	2018-09-19	Uppsala	70
Artificial Intelligence Meets Life Sciences – 5th RIKEN-KI/SciLifeLab Symposium	2018-09-20	Stockholm	120
Minisymposium: Medical and Population Genetics and Genomics	2018-10-26	Uppsala	60
Minisymposium: Functional precision cancer medicine – moving beyond genomics	2018-11-02	Stockholm	100
Minisymposium: Biomarkers in Drug Discovery – How to Predict for Success in the Clinic	2018-11-08	Uppsala	100
Science & SciLifeLab Prize Symposium	2018-12-12	Stockholm	250

The Science & SciLifeLab Prize for Young Scientists, established in 2013, is a global award aimed at rewarding scientists in four categories of high relevance to SciLifeLab at an early stage of their careers. [1] Each prize winner receives a grant of 10–30,000 USD and their essays are published in Science. The editors of Science assemble a team of reviewers who selected the winner for each category, of which one is a Grand Prize winner. In 2018 the four Prize winners were (Figure 23): Christoph Thaiss (University of Pennsylvania, Translational Medicine), Tim Wang (Janelia Research Center, Genomics and Proteomics), Matthew Savoca (Stanford University, Ecology and Environment) and Ruixue Wan (Tsinghua University, Cell and Molecular Biology). The Prize is a significant branding event for SciLifeLab and the prize gala dinner is also a way to reward and celebrate the SciLifeLab community. The Prize has continued to receive international recognition over the years with a steady increase in the number of applications from top universities all over the world.

Figure 23. Photo of the 2018 Prize winners (from the left): Christoph Thaiss (Grand Prize Winner, Translational Medicine), Tim Wang (Genomics and Proteomics), Mathew Savoca (Ecology and Environment) and Ruixue Wan (Cell and Molecular Biology).

[1] http://www.sciencemag.org/prizes/science-scilifelab-prize-young-scientists.

Scientific output and highlights from the past 2 years

Strengths and focus-areas of SciLifeLab "affiliated" (or internal) publications [1] were described were described previously in the section on research community. Also, quantitative and qualitative analyses of these publications have been performed based on the data received from CWTS Leiden University bibliometric database. The analysis show the number of papers per year (Figure 24a), and the total number of citations (Figure 24b). Because of the delay in data reporting to CWTS Leiden University bibliometric database, the cut-off date for publications used in the analysis was October 2018. Therefore, the publication output shows a downward trend in 2018.

Since the start of SciLifeLab in 2010, over 3700 publications been published by authors indicated their affiliation with SciLifeLab. A complete list of these publications is available in the SciLifeLab publication database. [2] Citation metrics show a strong increase in citations over time, and in 2017 SciLifeLab publications received almost 20,000 citations and for 2018 this figure is likely to be more than 20,000 citations (Figure 24b).

The research profile areas analysis shows that SciLifeLab publications for three of SciLifeLab's key research areas: Biomedical & Health Sciences, Life & Earth Sciences, and Physical & Engineering Sciences, have a citation impact well above the worldwide average for their areas during 2012–2016 (Figure 25). This means that SciLifeLab "affiliated" publications in biomedicine and health receive on average 76% more citations than field-normalized publications globally. Comparing these citation metrics (data not shown) with published data from universities globally indicates that publications from the SciLifeLab community have an impact similar to the top 10–30 universities in the world, depending on which parameters used. Obviously, as a research center, direct comparisons with integrated broad-faculty universities are not fair, but the data is still impressive.

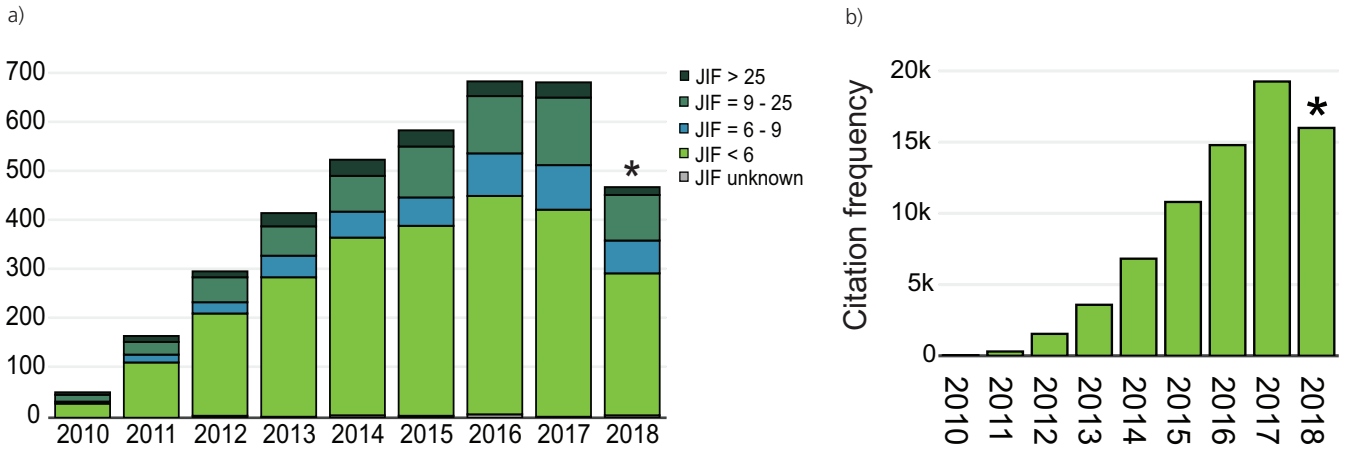


Figure 24. a) SciLifeLab "affiliated" (or internal) publications output and **b)** Publication citations frequency. Due to the delay in data reporting to CWTS Leiden University bibliometric database, the publication frequency is incomplete for 2018. (*publication cut-off date October 2018).

[1] SciLifeLab-affiliated publications are defined as those where the authors have indicated their affiliation with SciLifeLab (keywords "Science for Life Laboratory" or "SciLifeLab" in the affiliation or address fields). As SciLifeLab is a secondary affiliation for associated scientists, these publications are also credited to the host universities.

[2] https://publications-affiliated.scilifelab.se

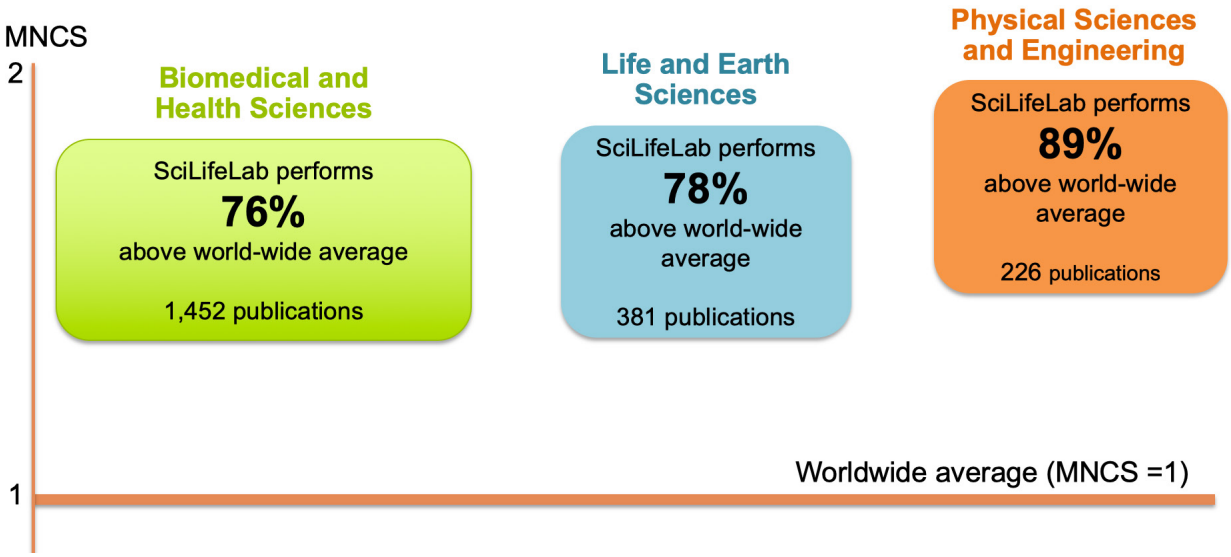


Figure 25. Bibliometric analysis of SciLifeLab "affiliated" (or internal) publications (2012-2016). SciLifeLab citation-based impact based on the Leiden CWTS bibliometric database ranking methodology shows that SciLifeLab performs (from the left): 76% above worldwide average in the same microfield and year for Biomolecular and Health sciences, 78% above average for Life and Earth sciences, and 89% above average for Physical sciences and engineering, MNCS is 1.76, 1.78 and 1.89 respectively.

In Table 6, we have extracted a set of high-impact publications representative of SciLifeLab-affiliated researchers, exemplified by numerous Science, Nature and Cell papers from all host universities covering different research fields (e.g. biomedicine, evolution etc.). For this selection we focused on publications with a strong link to SciLifeLab, i.e. where the first and/or last authors are SciLifeLab-affiliated researchers and SciLifeLab technologies have been used (marked in italics). Many more could have been selected, so the list below should be considered as examples only.

Each publication is labeled based on their connection to SciLifeLab:

- R = Publication from SciLifeLab-affiliated researchers from the host universities
- I = Publication from staff operating and developing SciLifeLab infrastructure
- F = Publication from SciLifeLab Fellow

Table 6. List of SciLifeLab high-level publications 2017-2019. Italics marks SciLifeLab affiliation

R	Deep mitochondrial origin outside the sampled alphaproteobacteria. *Martijn J, Vosseberg J,* Guy L, Offre P, *Ettema TJG*. Nature. 2018 May;557(7703):101-105
R	RNA velocity of single cells. *La Manno G,* Soldatov R, *Zeisel A, Braun E, Hochgerner H,* Petukhov V, Lidschreiber K, Kastriti ME, *Lönnerberg P,* Furlan A, Fan J, *Borm LE,* Liu Z, van Bruggen D, Guo J, He X, Barker R, Sundström E, Castelo-Branco G, Cramer P, Adameyko I, *Linnarsson S,* Kharchenko PV. Nature. 2018 Aug;560(7719):494-498.
R	Small-molecule inhibitor of OGG1 suppresses proinflammatory gene expression and inflammation. *Visnes T, Cázares-Körner A,* Hao W, *Wallner O,* Masuyer G, *Loseva O, Mortusewicz O, Wiita E,* Sarno A, Manoilov A, Astorga-Wells J, *Jemth AS,* Pan L, *Sanjiv K, Karsten S, Gokturk C, Grube M, Homan EJ, Hanna BMF, Paulin CBJ, Pham T, Rasti A, Berglund UW, von Nicolai C, Benitez-Buelga C, Koolmeister T, Ivanic D, Iliev P, Scobie M,* Krokan HE, *Baranczewski P, Artursson P, Altun M, Jensen AJ, Kalderén C,* Ba X, *Zubarev RA,* Stenmark P, Boldogh I, *Helleday T.* Science. 2018 Nov 16;362(6416):834-839.
R	Stereotypic Immune System Development in Newborn Children. *Olin A,* Henckel E, *Chen Y, Lakshmikanth T, Pou C, Mikes J,* Gustafsson A, *Bernhardsson AK, Zhang C, Bohlin K, Brodin P.* Cell. 2018 Aug 23;174(5):1277-1292.
R I F	Structure of the chloroplast ribosome with chl-RRF and hibernation-promoting factor. *Perez Boerema A, Aibara S, Paul B, Tobiasson V, Kimanius D, Forsberg BO, Wallden K, Lindahl E, Amunts A.* Nat Plants. 2018 Apr;4(4):212-217.

R	Enhanced validation of antibodies for research applications. *Edfors F, Hober A,* Linderbäck K, *Maddalo G,* Azimi A, *Sivertsson Å, Tegel H, Hober S, Szigyarto CA, Fagerberg L, von Feilitzen K, Oksvold P,* Lindskog C, *Forsström B, Uhlen M.* Nat Commun. 2018 Oct 8;9(1):4130.
R	Targeting PFKFB3 radiosensitizes cancer cells and suppresses homologous recombination. *Gustafsson NMS, Färnegårdh K, Bonagas N, Ninou AH, Groth P, Wiita E, Jönsson M, Hallberg K, Lehto J,* Pennisi R, Martinsson J, Norström C, Hollers J, Schultz J, Andersson M, Markova N, *Marttila P,* Kim B, Norin M, Olin T, *Helleday T.* Nat Commun. 2018 Sep 24;9(1):3872.
R	Spatial maps of prostate cancer transcriptomes reveal an unexplored landscape of heterogeneity. *Berglund E, Maaskola J, Schultz N, Friedrich S, Marklund M, Bergenstråhle J, Tarish F,* Tanoglidi A, *Vickovic S, Larsson L, Salmén F, Ogris C,* Wallenborg K, *Lagergren J, Ståhl P, Sonnhammer E, Helleday T, Lundeberg J.* Nat Commun. 2018 Jun 20;9(1):2419.
R	Discovery of coding regions in the human genome by integrated proteogenomics analysis workflow. *Zhu Y, Orre LM, Johansson HJ, Huss M, Boekel J, Vesterlund M, Fernandez-Woodbridge A, Branca RMM, Lehtiö J.* Nat Commun. 2018 Mar 2;9(1):903.
R I	Targeted NUDT5 inhibitors block hormone signaling in breast cancer cells. *Page BDG, Valerie NCK,* Wright RHG, Wallner O, Isaksson R, Carter M, *Rudd SG, Loseva O, Jemth AS, Almlöf I,* Font-Mateu J, *Llona-Minguez S,* Baranczewski P, *Jeppsson F, Homan E, Almqvist H, Axelsson H, Regmi S, Gustavsson AL, Lundbäck T, Scobie M, Strömberg K,* Stenmark P, Beato M, *Helleday T.* Nat Commun. 2018 Jan 17;9(1):250.
R I F	A DHODH inhibitor increases p53 synthesis and enhances tumor cell killing by p53 degradation blockage. *Ladds MJGW, van Leeuwen IMM, Drummond CJ,* Chu S, Healy AR, *Popova G, Pastor Fernández A, Mollick T, Darekar S, Sedimbi SK, Nekulova M, Sachweh MCC,* Campbell J, Higgins M, *Tuck C,* Popa M, Safont MM, Gelebart P, Fandalyuk Z, Thompson AM, Svensson R, *Gustavsson AL, Johansson L, Färnegårdh K, Yngve U, Saleh A, Haraldsson M,* D'Hollander ACA, *Franco M,* Zhao Y, Håkansson M, Walse B, *Larsson K,* Peat EM, *Pelechano V,* Lunec J, Vojtesek B, Carmena M, Earnshaw WC, *McCarthy AR,* Westwood NJ, *Arsenian-Henriksson M, Lane DP,* Bhatia R, McCormack E, *Laín S.* Nat Commun. 2018 Mar 16;9(1):1107
R	Wing bone geometry reveals active flight in Archaeopteryx. Voeten DFAE, Cubo J, de Margerie E, Röper M, Beyrand V, Bureš S, Tafforeau P, *Sanchez S.* Nat Commun. 2018 Mar 13;9(1):923.
R	A protein activity assay to measure global transcription factor activity reveals determinants of chromatin accessibility. Wei B, Jolma A, Sahu B, *Orre L,* Zhong F, Zhu F, Kivioja T, Sur I, *Lehtiö J,* Taipale M, Taipale J. Nat Biotechnol. 2018 Jul;36(6):521-529.
R	Subcellbarcode: Proteome-wide Mapping of Protein Localization and Relocalization. *Orre LM, Vesterlund M, Pan Y, Arslan T, Zhu Y, Fernandez Woodbridge A, Frings O, Fredlund E, Lehtiö J.* Mol Cell. 2019 Jan 3;73(1):166-182.e7.
R I	Conserved properties of dentate gyrus neurogenesis across postnatal development revealed by single-cell RNA sequencing. *Hochgerner H, Zeisel A, Lönnerberg P, Linnarsson S.* Nat Neurosci. 2018 Feb;21(2):290-299.
R	Ancient genomes suggest the eastern Pontic-Caspian steppe as the source of western Iron Age nomads. Krzewińska M, Kılınç GM, Juras A, Koptekin D, Chyleński M, Nikitin AG, Shcherbakov N, Shuteleva I, Leonova T, Kraeva L, Sungatov FA, Sultanova AN, Potekhina I, Łukasik S, Krenz-Niedbała M, Dalén L, Sinika V, *Jakobsson M,* Storå J, Götherström A. Sci Adv. 2018 Oct 3;4(10):4457.
R I	Asgard archaea illuminate the origin of eukaryotic cellular complexity. *Zaremba-Niedzwiedzka K, Caceres EF, Saw JH, Bäckström D, Juzokaite L, Vancaester E,* Seitz KW, Anantharaman K, Starnawski P, Kjeldsen KU, Stott MB, Nunoura T, Banfield JF, Schramm A, Baker BJ, *Spang A, Ettema TJ.* Nature. 2017 Jan 19;541(7637):353-358.
R	Alcohol-abuse drug disulfiram targets cancer via p97 segregase adaptor NPL4. Skrott Z, Mistrik M, Andersen KK, Friis S, Majera D, Gursky J, Ozdian T, *Bartkova J,* Turi Z, Moudry P, Kraus M, Michalova M, Vaclavkova J, Dzubak P, Vrobel I, Pouckova P, Sedlacek J, Miklovicova A, Kutt A, Li J, Mattova J, Driessen C, Dou QP, Olsen J, Hajduch M, Cvek B, Deshaies RJ, *Bartek J.* Nature. 2017 Dec 14;552(7684):194-199.
R	Kinetics of dCas9 target search in Escherichia coli. *Jones DL, Leroy P, Unoson C, Fange D, Ćurić V, Lawson MJ, Elf J.* Science. 2017 Sep 29;357(6358):1420-1424.

R I F	A pathology atlas of the human cancer transcriptome. *Uhlen M, Zhang C, Lee S, Sjöstedt E, Fagerberg L, Bidkhori G, Benfeitas R, Arif M, Liu Z, Edfors F, Sanli K, von Feilitzen K, Oksvold P, Lundberg E,* Hober S, *Nilsson P, Mattsson J, Schwenk JM,* Brunnström H, Glimelius B, Sjöblom T, Edqvist PH, Djureinovic D, Micke P, *Lindskog C, Mardinoglu A, Ponten F.* Science. 2017 Aug 18;357(6352).
R I F	A subcellular map of the human proteome. *Thul PJ, Åkesson L, Wiking M, Mahdessian D,* Geladaki A, *Ait Blal H, Alm T, Asplund A, Björk L,* Breckels LM, *Bäckström A, Danielsson F, Fagerberg L, Fall J,* Gatto L, *Gnann C,* Hober S, *Hjelmare M, Johansson F, Lee S, Lindskog C, Mulder J, Mulvey CM, Nilsson P, Oksvold P,* Rockberg J, *Schutten R, Schwenk JM, Sivertsson Å, Sjöstedt E, Skogs M, Stadler C, Sullivan DP,* Tegel H, *Winsnes C, Zhang C, Zwahlen M, Mardinoglu A, Pontén F, von Feilitzen K,* Lilley KS, *Uhlén M, Lundberg E.* Science. 2017 May 26;356(6340).
R I	Southern African ancient genomes estimate modern human divergence to 350,000 to 260,000 years ago. Schlebusch CM, Malmström H, Günther T, Sjödin P, Coutinho A, Edlund H, Munters AR, Vicente M, Steyn M, Soodyall H, Lombard M, *Jakobsson M.* Science. 2017 Nov 3;358(6363):652-655.
R I	Spatially resolved transcriptome profiling in model plant species. *Giacomello S, Salmén F,* Terebieniec BK, *Vickovic S,* Navarro JF, *Alexeyenko A, Reimegård J,* McKee LS, Mannapperuma C, Bulone V, Ståhl PL, Sundström JF, Street NR, *Lundeberg J.* Nat Plants. 2017 May 8;3:17061.
R I F	Mechanistic Insights into Autoinhibition of the Oncogenic Chromatin Remodeler ALC1. *Lehmann LC,* Hewitt G, *Aibara S,* Leitner A, *Marklund E,* Maslen SL, Maturi V, *Chen Y,* van der Spoel D, Skehel JM, *Moustakas A,* Boulton SJ, *Deindl S.* Mol Cell. 2017 Dec 7;68(5):847-859.e7.
R	Synthetic lethality between androgen receptor signalling and the PARP pathway in prostate cancer. Asim M, *Tarish F,* Zecchini HI, *Sanjiv K, Gelali E,* Massie CE, Baridi A, Warren AY, Zhao W, *Ogris C,* McDuffus LA, Mascalchi P, Shaw G, Dev H, Wadhwa K, Wijnhoven P, Forment JV, Lyons SR, Lynch AG, O'Neill C, Zecchini VR, Rennie PS, Baniahmad A, Tavaré S, Mills IG, Galanty Y, Crosetto N, *Schultz N,* Neal D, *Helleday T.* Nat Commun. 2017 Aug 29;8(1):374.
R	Targeted DNA sequencing and in situ mutation analysis using mobile phone microscopy. *Kühnemund M,* Wei Q, *Darai E,* Wang Y, *Hernández-Neuta I,* Yang Z, Tseng D, Ahlford A, *Mathot L, Sjöblom T,* Ozcan A, *Nilsson M.* Nat Commun. 2017 Jan 17;8:13913
R I	Efficient protein production by yeast requires global tuning of metabolism. Huang M, Bao J, *Hallström BM,* Petranovic D, *Nielsen J.* Nat Commun. 2017 Oct 25;8(1):1131.
R	Integrating evolutionary and regulatory information with a multispecies approach implicates genes and pathways in obsessive-compulsive disorder. Noh HJ, Tang R, Flannick J, O'Dushlaine C, Swofford R, Howrigan D, Genereux DP, Johnson J, van Grootheest G, Grünblatt E, Andersson E, Djurfeldt DR, Patel PD, Koltookian M, M Hultman C, Pato MT, Pato CN, Rasmussen SA, Jenike MA, Hanna GL, Stewart SE, Knowles JA, Ruhrmann S, Grabe HJ, Wagner M, Rück C, Mathews CA, Walitza S, Cath DC, Feng G, Karlsson EK, *Lindblad-Toh K.* Nat Commun. 2017 Oct 17;8(1):774.
R F	BLISS is a versatile and quantitative method for genome-wide profiling of DNA double-strand breaks. Yan WX, *Mirzazadeh R, Garnerone S,* Scott D, Schneider MW, *Kallas T, Custodio J, Wernersson E,* Li Y, Gao L, Federova Y, Zetsche B, Zhang F, *Bienko M, Crosetto N.* Nat Commun. 2017 May 12;8:15058.
R	Molecular composition of organic matter controls methylmercury formation in boreal lakes. *Bravo AG,* Bouchet S, Tolu J, Björn E, *Mateos-Rivera A, Bertilsson S.* Nat Commun. 2017 Feb 9;8:14255.
R	Insufficient antibody validation challenges oestrogen receptor beta research. *Andersson S, Sundberg M, Pristovsek N,* Ibrahim A, Jonsson P, *Katona B, Clausson CM, Zieba A, Ramström M, Söderberg O, Williams C, Asplund A.* Nat Commun. 2017 Jun 15;8:15840.
R I	Continuous immunotypes describe human immune variation and predict diverse responses. Kaczorowski KJ, Shekhar K, *Nkulikiyimfura D,* Dekker CL, Maecker H, Davis MM, Chakraborty AK, *Brodin P.* Proc Natl Acad Sci USA. 2017 Jul 25;114(30):E6097-E6106.
R	Expanding the product portfolio of fungal type I fatty acid synthases. Zhu Z, Zhou YJ, Krivoruchko A, Grininger M, Zhao ZK, *Nielsen J.* Nat Chem Biol. 2017 Apr;13(4):360-362.

Major initiatives enabled by SciLifeLab

The IAB has on a number of occasions pointed out the need for SciLifeLab to focus on identifying grand challenges for science and society that should be addressed. At SciLifeLab many research efforts are already underway that could be classified either as grand challenges, or that could be developed further into grand challenge projects. We have asked the IDs and SDs from the host universities to nominate a few such research topics, and in some cases specific researchers, publications, or projects. Many of these nominations also have extensive health care and industrial involvement. A selection of these nominations is listed below, though this list of potential future grand challenge and high-impact research efforts below is by no means all-inclusive. The SciLifeLab community, including the host universities and the SciLifeLab national organization, comprising the infrastructure facilities and the data center, will together consider how these and similar initiatives could be promoted further in the future.

- Deep learning and citizen science for large-scale image classification
- Stereotypic Immune System Development in Newborn Children
- 1000 tree genomes project
- Palaeogenetic research environment
- The Swedish SCAPIS SciLifeLab Wellness Profiling (S3WP) Program
- The Human Microbiome Translational Research Programme
- The use of systems biology in treatment of liver diseases.
- SubCellBarCode: Proteome-wide Mapping of Protein Localization and Relocalization
- The Human Secretome Program

Deep learning and citizen science for large-scale image classification

Principal investigator

Emma Lundberg, KTH

Short summary

Pattern recognition and classification of images are key challenges throughout the life sciences. We combined two approaches for large-scale classification of fluorescence microscopy images. First, using the publicly available data set from the Cell Atlas of the Human Protein Atlas (HPA), we integrated an image-classification task into a mainstream video game (EVE Online) as a mini-game, named Project Discovery, that engaged 322,006 gamers over 1 year. Second, we used deep learning to build an automated Localization Cellular Annotation Tool (Loc-CAT). We found that engaging players of commercial computer games provided data that augmented deep learning and enabled scalable and readily improved image classification.

Collaborations with universities/industrial and healthcare partners/research networks

This was a highly collaborative and interdisciplinary project, and was a partnership between Academia, KTH/SciLifeLab, and the gaming industry represented by both the Swiss start-up MMOS and the established Icelandic gaming company CCP games.

Cross-platform interactions

None

Motivation of highlight in terms of the contribution from SciLifeLab

This is the first project ever, where a scientific question has been integrated into a mainstream computer game, work often described citizen science This project, named Project Discovery, was a milestone in citizen science in that it resulted in participation by approximately 320,000 gamers over a one-year provided and nearly 33 million classifications of subcellular localization patterns, including patterns that were not previously annotated by the HPA. The scientific work was conducted by the Lundberg Lab at SciLifeLab.

Link to publication

https://www.nature.com/articles/nbt.4225

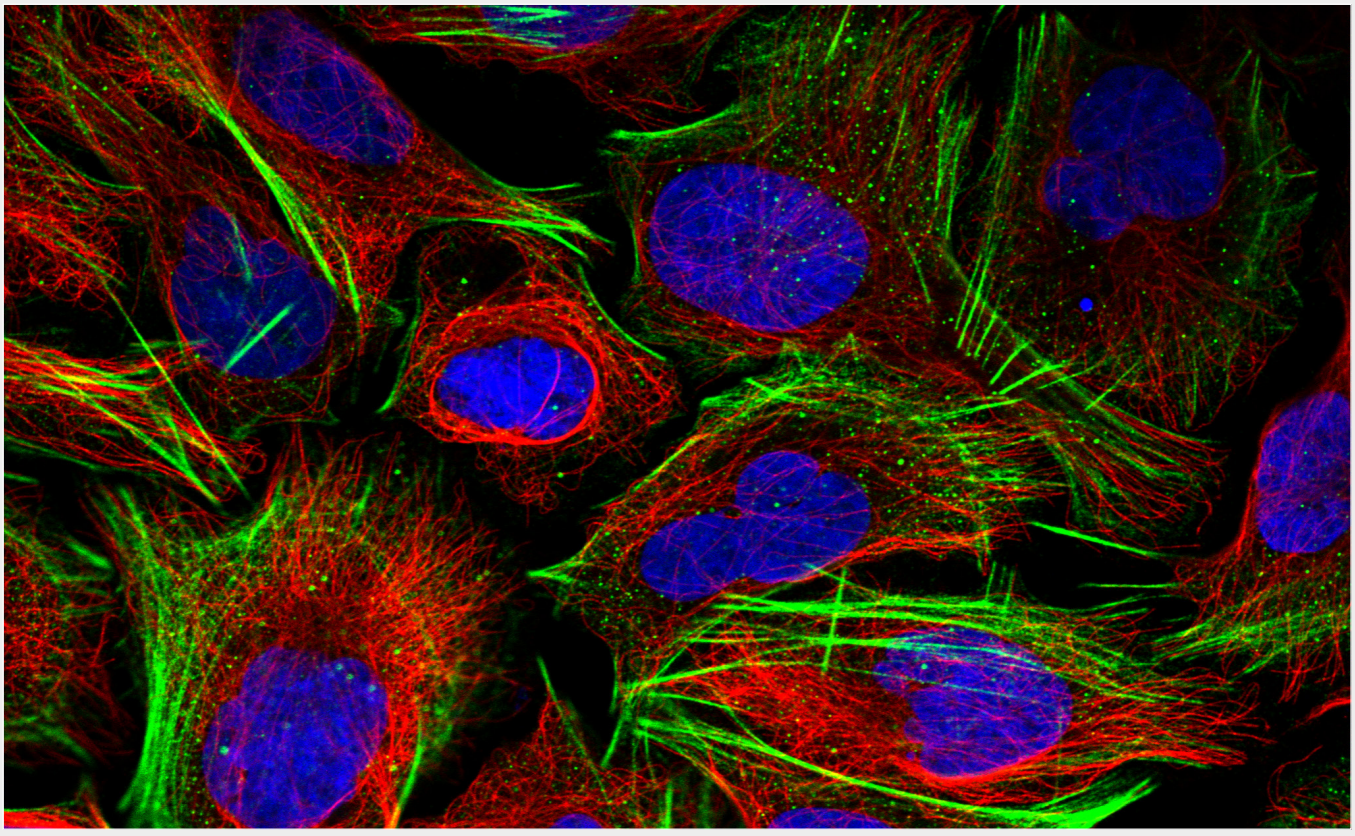


Figure 26. In the citizen science project Project Discovery, fluorescencent images of cellular compartments and proteins such as this, were intergrated into a mainstream computer game. The gamers then helpt with classifications of subcellular localization patterns of proteins.

Stereotypic Immune System Development in Newborn Children

Principal investigator

Petter Brodin, KI; Kajsa Bohlin, KI; Jochen Schwenk, KTH; Lars Engstrand, KI

Short summary

We performed comprehensive immune profiling of 50 preterm and 50 term newborn children, during their first six months of life. This was the first such systems-wide longitudinal immune profiling study of its kind. While preterm and term children exhibited large immunological differences at birth, these differences disappeared after a few months of life. We could see stereotypic immunological changes in both preterm and term children and identified a possible cause for this in the gut microbiota.

Collaborations with universities/industrial and healthcare partners/research networks

This project was a collaboration between several research groups at KTH and KI together with the Neonatal Ward at the Karolinska University Hospital, Huddinge.

Cross-platform interactions

The project involved several SciLifeLab facilities, including the Facility for Mass Cytometry, Facility for Plasma Profiling, Clinical Genomics, and the National Genomics Infrastructure

Motivation of highlight in terms of the contribution from SciLifeLab

This study highlights the possibility of collecting extremely rare clinical samples in a variety of conditions coupled to data collection and analysis at four different SciLifeLab facilities. Such quick and effortless implementation of these high-throughput technologies on clinical samples would have been impossible without the SciLifeLab infrastructure. As clinicians have very little time for research, partnerships with SciLifeLab facilities can be a way of performing cutting-edge science while still having time for their clinical duties.

Link to publication

https://www.sciencedirect.com/science/article/pii/S0092867418308481

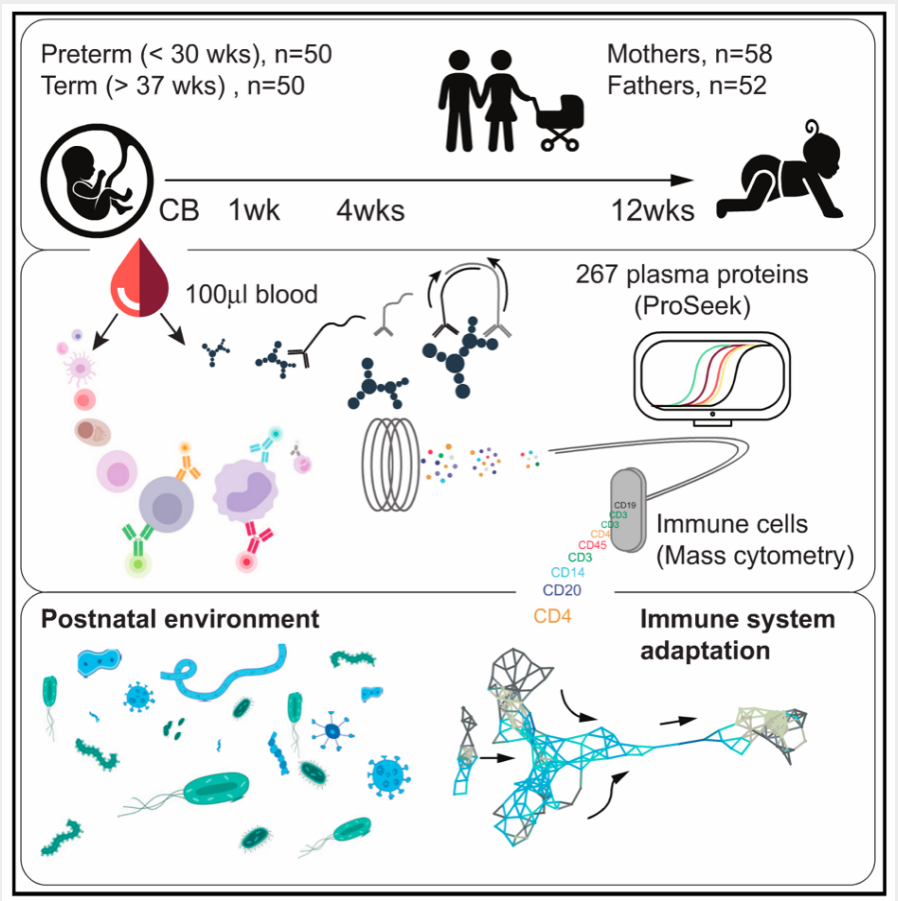


Figure 27. Graphical abstract of how this first ever systems-wide longitudinal comprehensive immune profiling study was perfomed.

The 1000 tree genomes project

Principal investigator

Ove Nilsson, UmU; Ulf Gyllensten, UU (Co-PI on behalf of SciLifeLab)

Short summary

The aim of the study is to combine genome sequencing, re-sequencing, phenotyping of diversity populations and breeding populations to (1) develop high quality reference genomes, haplotype maps, and genotyping platforms for Norway spruce and Scots pine; (2) discover genomic basis of phenotypic traits and climate adaptation, and (3) increase the genetic gain in Norway spruce and Scots pine breeding and deployment populations through genomic selection.

Project objectives: i) Improve the Norway spruce reference genome and produce a de novo high-quality Scots pine reference genome, ii) Study genome evolution and the genome-wide genetic basis of variation in economic and adaptive traits, iii) Examine the genetics of local adaptation in natural populations by combining genome-wide association study with data from multiple-site reciprocal transplanting experiments and controlled growth chamber experiments in order to identify loci suitable for adaptation to climate change, iv) Implement genomic selection in the Swedish national Norway spruce and Scots pine breeding and deployment programs.

Collaborations with universities/industrial and healthcare partners/research networks

Collaboration between: University Research in forest tree genomics and breeding at UmU, SLU and UU; SciLifeLab facilities in genomics and bioinformatics; and Forest Industry.

Cross-platform interactions

NGI, WABI (bioinformatics)

Motivation of highlight in terms of the contribution from SciLifeLab

This is the first large research project pioneering a novel relationship between the research community and SciLifeLab. SciLifeLab will act as co-PI in the project and receive funding not only to provide standard services from the facilities but also to act as a research partner and employ bioinformaticians and scientists in genomics whom will be part of the five-year timeline of the project. This model is very promising and could result in substantial additional funding to develop the SciLifeLab operations.

Link to webpage

None yet as the project is in the start-up phase.

Figure 28. Norway spruce forest.

Palaeogenetics research environment

Principal investigator

Anders Götherström, SU; Mattias Jakobsson, UU; Love Dalén, Swedish Museum of Natural History (NRM)

Short summary

Palaeogenetics, broadly described as the use of degraded DNA to retrieve chronological genetic data, has reached its full potential through the advent of next generation sequencing (NGS) and the computational strategies developed in parallel with NGS. Stockholm/Uppsala has several highly productive research-groups within the field, and through their activities, palaeogenetics has penetrated deep into archaeology, evolutionary biology, and ecology at both SU and UU, as well as at NRM.

Collaborations with universities/industrial and healthcare partners/research networks

The Swedish History Museum; Mehmet Somel's group at METU, Turkey; University of Johannesburg and University of Witwatersrand, South Africa; Beth Shapiro's group at University of California, Santa Cruz, USA.

Cross-platform interactions

The palaeogenetic work in Stockholm and Uppsala are heavily dependent upon the services provided by NGI. As a matter of fact, the three groups are every year among the top users in terms of DNA sequencing at NGI.

Motivation of highlight in terms of the contribution from SciLifeLab

There are a number of palaeogenetic publications with considerable impact from the region each year where all data was produced at NGI. Some examples: Sex Identification based on DNA of a female officer from the Viking period (Hedenstiern-Jonson et al. Am J Phys Anthropol. (2017) 164, 853) quickly became one of the most read scientific reports ever. Demographic analyses of ancient DNA (Kılınç et al. Curr Biol. (2016) 26, 2659; Skoglund et al. Science (2014) 344, 747) has settled the century-long debate on the role of migration during the Neolithisation. Sequencing of several Stone Age hunter-gatherers who lived in Scandinavia 10,000-6,000 years ago (Günther et al PLoS Biol. (2018) e2003703) revealed two early colonizations of Scandinavia. The existence of H. sapiens was extended from 200.000 to 300.000 years based on ancient DNA (Schlebusch et al Science (2017) 358, 652). Palaeogenomics of prehistoric animals: the woolly mammoth (Palkopoulou et al. Curr Biol. (2015) 25, 1395), the Pleistocene wolf (Skoglund et al. Curr Biol. (2015) 25, 1515) and the cave bear (Barlow et al. Nat Ecol Evol. (2018) 2, 1563). Genomic analyses of several additional extinct animals are currently being written up.

Link to webpages

https://ancientdnablog.wordpress.com/
http://theatlas.se/
http://JakobssonLab.iob.uu.se
http://palaeogenetics.com/LD

Figure 29. One of the Mammoth tusks Love Dalén collected in Siberia and extracted DNA from.

The Swedish SCAPIS SciLifeLab Wellness Profiling (S3WP) Program

Principal investigator

Linn Fagerberg, KTH; Göran Bergström, GU; Mathias Uhlén, KTH; Anders Gummesson, GU; Lars Engstrand, KI; Ina Schuppe Koistinen, KI; Valtteri Wirta, KI; Tomas Moritz, UmU; Fredrik Bäckhed, GU; Peter Nilsson, KTH; Jochen Schwenk, KTH; Adil Mardinoglu, KTH; Jens Nielsen, Chalmers; Kalle von Feilitzen, KTH; Petter Brodin, KI; Jacob Odeberg, KTH and KI; Björn Forsström, KTH ; Lena Jonasson, LiU

Short summary

The objective of the S3WP program is to profile healthy and disease individuals in a longitudinal manner using technology platforms available at SciLifeLab. The program involves integration of multi-omics analysis and systems biology to define the variability of molecular profiles between and within individuals over time. Samples are analyzed at several platforms using different techniques including: proximity extension assay, antibody bead arrays, autoimmunity profiling and MS-based proteomics, immune cell profiling, genomics transcriptomics, microbiome analyses and metabolomics.

Collaborations with universities/industrial and healthcare partners/research networks

The S3WP program is a collaboration between a large number of research groups at KTH, KI, U, Chalmers, UmU and LiU. Individuals from the analyzed cohorts have been sampled at Sahlgrenska University Hospital and Linköping University Hospital.

Cross-platform interactions

The S3WP program is highly multidisciplinary and involves many of the national facilities including: Mass Cytometry, Clinical Genomics, Systems Biology, Plasma Profiling, Autoimmunity Profiling, Swedish Metabolomics Centre, National Genomics Infrastructure, and the National Bioinformatics Infrastructure.

Motivation of highlight in terms of the contribution from SciLifeLab

The S3WP program is one of the most comprehensive programs in the world using integrative omics to study healthy and disease individuals. The program takes advantage of a large number of the facilities of the SciLifeLab national infrastructure.

Link to webpage

https://www.kth.se/kcap/research/research-program-1-wellness-profiling-1.639831

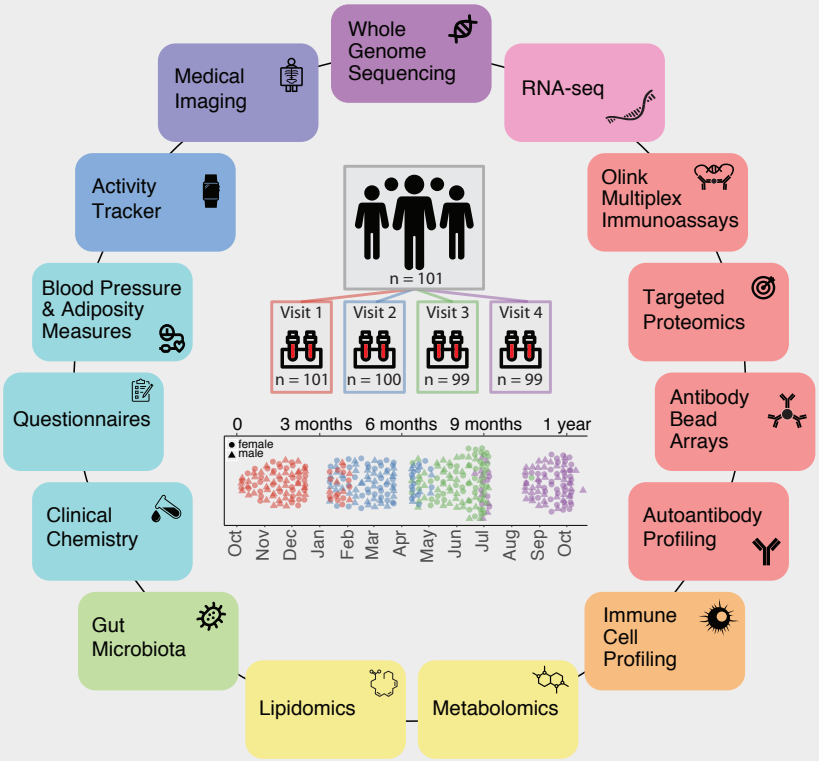


Figure 30. Overview of the studies involved in the S3WP program, one of the most comprehensive programs in the world using integrative omics to study healthy and disease individuals

The Human Microbiome Translational Research Program

Principal investigator

Lars Engstrand, KI

Short summary

The Centre for Translational Microbiome Research started in January 2016 as a collaboration between KI, SciLifeLab and Ferring Pharmaceuticals, and has established a broad technical, biological, clinical and epidemiological platform for studying complex microbiological communities in well-defined human materials. The collaboration forms a solid foundation for understanding the contribution of the microbiome to both normal physiology and pathophysiology, thus opens opportunities for development of novel therapies to address gastroenterology, reproductive medicine and cancer.

Collaborations with universities/industrial and healthcare partners/research networks

Ferring Pharmaceuticals and a number of hospitals in both Sweden and abroad.

Cross-platform interactions

Clinical Genomics, NGI, NBIS, and several facilities in the Proteomics platform.

Motivation of highlight in terms of the contribution from SciLifeLab

The project benefits from access to state-of-the-art sequencing, proteomic, metabolomic, while Immunology platforms provides value to a unique collection of clinical samples obtained at large hospital and from population-based studies.

Link to webpage

https://ki.se/en/research/centre-for-translational-microbiome-research-ctmr

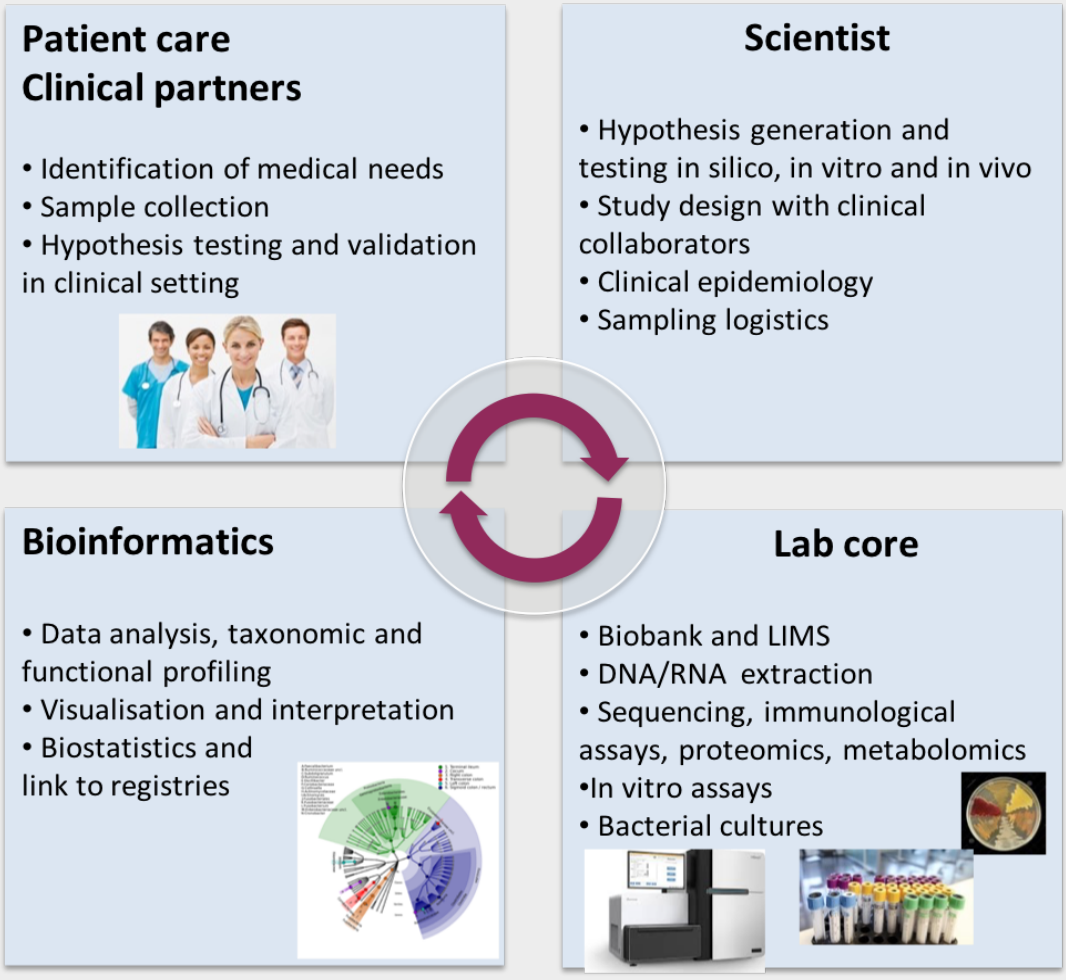


Figure 31. Translational microbiome research leading to innovative clinical applications.

The use of systems biology in treatment of liver diseases

Principal investigator

Adil Mardinoglu, KTH

Short summary

Using the systems biology-based tools developed in my group, we develop two different strategies for effective treatment of liver diseases including non-alcoholic fatty liver disease (NAFLD) and liver cancer. In the first project, we developed a metabolic cofactor-based formulation to boost the uptake and oxidation of the fat in the liver and currently running placebo-controlled multi-center phase 2 study for testing its effect in NAFLD patients. In the second project, we identified a liver-specific gene target that can be used in treatment of NAFLD and liver cancer patients and started to develop small molecules for selective inhibition of the drug target. We have already synthesized more than 500 novel compounds and started to test the compounds in pre-clinical mouse models.

Collaborations with universities/industrial and healthcare partners/research networks

Chalmers, GU, KI, Cambridge University, UK, King's College London, UK NIH, USA

Novo Nordisk, Denmark, Sanofi, France & Germany, GSK, USA, Pfizer, USA

Cross-platform interactions

Chemical Biology Consortium Sweden (CBCS) and Drug Discovery and Development Platform (DDD)

Motivation of highlight in terms of the contribution from SciLifeLab

SciLifeLab combines frontline technical expertise with advanced knowledge of translational medicine and molecular bioscience. In our interdisciplinary project, we take advantage of the technologies and expertise provided by SciLifeLab that are found within academia, industry, authorities and healthcare. We get the comments and suggestion from the DDD platform about the feasibility of our project, developed a biochemical assay for running the high throughput screening and identified small molecules that can inhibit and activate our protein.

Link to webpage

www.sysmedicine.com

Link to publication

https://scholar.google.com/citations?hl=en&user=WzjzuN-wAAAAJ&view_op=list_works&sortby=pubdate

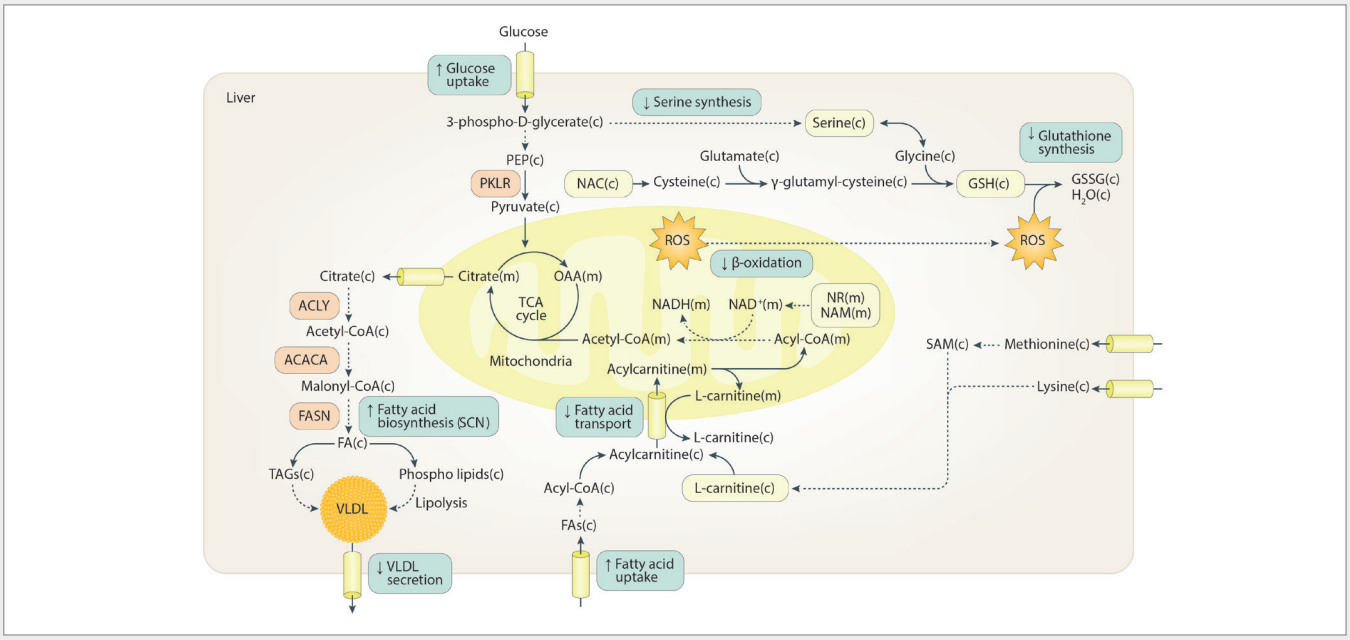


Figure 32. Hepatic steatosis is caused by one or a combination of the following: enhanced delivery of fatty acids to the liver; increased endogenous fatty acid synthesis; decreased mitochondrial fatty acid oxidation; and deficient incorporation or export of triglycerides as very low-density lipoproteins. New innovative approaches can be developed for effective treatment of hepatic steatosis by targeting one or multiple of these pathways. Natural substances including serine, glycine, N-acetylcysteine (NAC), l-carnitine or the precursors of NAD+ including Nicotinamide riboside (NR) and Nicotinamide MonoNucleotide (NMN) may also be supplemented to boost the mitochondrial fatty acid oxidation in liver that can decrease the level of the accumulated fat in the liver.

SubCellBarCode: Proteome-wide Mapping of Protein Localization and Relocalization

Principal investigator

Janne Lehtiö, KI; Lukas Orre, KI

Short summary

A proteome-wide resource was generated, by mass spectrometry analysis, on subcellular localization for proteins mapping to 12,418 genes across five cell lines. The data reveals: that the majority of proteins have a single main subcellular location, that alternative splicing rarely affects location, and that cell types are best distinguished by proteins exposed to the surrounding environment. Furthermore, the method can be used for proteome-wide relocalization analysis, enabling studies of protein dynamics after perturbation.

Collaborations with universities/industrial and healthcare partners/research networks

None

Cross-platform interactions

NGI

Motivation of highlight in terms of the contribution from SciLifeLab

The great value of SciLifeLab was demonstrated in this study as SciLifeLab has the efforts to capacitate large scale proteome analysis of the hundreds of MS analysis runs used in generating this proteome-wide resource. This resource forms an orthogonal dataset to single cell analysis by RNA sequencing and mass cytometry as well as antibody-based protein localization efforts at SciLifeLab, combined forming a unique view of cellular architecture.

Link to webpage

www.subcellbarcode.org

Link to publication

https://www.cell.com/molecular-cell/fulltext/S1097-2765(18)31005-0

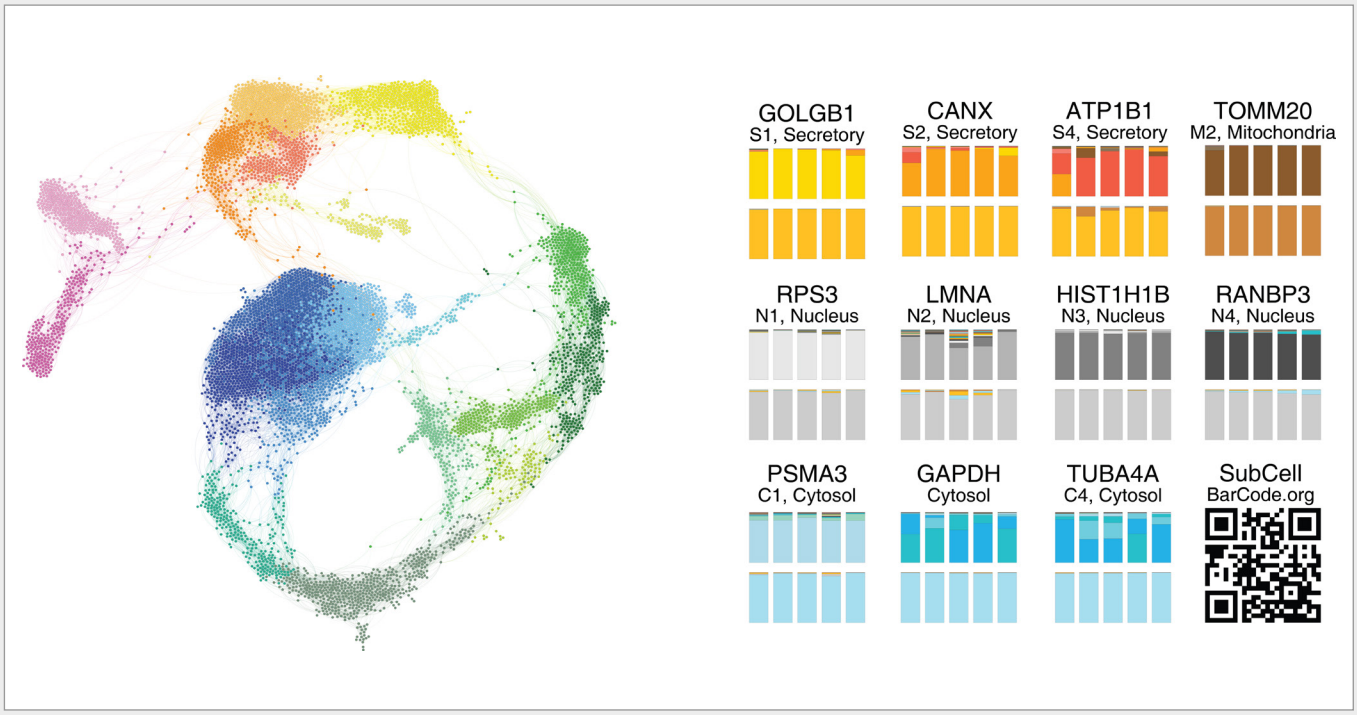


Figure 33. (Left) A protein correlation network based on the data generated in the SubCellBarCode project, illustrating the rich information and modularity of the data generated by subcellular fractionation coupled to quantitative MS-based proteomics. (Right) Examples of SubCellBarCodes for individual proteins together with classification of subcellular location.

The Human Secretome Program

Principal investigator

Mathias Uhlén, KTH and KI; Åsa Sievertsson, KTH; Jan Mulder, KI; Cecilia Lindskog, UU; Peter Nilsson, KTH; Jochen Schwenk, KTH; Paul Varley, MedImmune, Cambridge, UK; Lovisa Holmberg Sciavone, AstraZeneca; Björn Voldborg, Danish Technical University, Copenhagen, Denmark; Sophia Hober, KTH; Johan Rockberg, KTH; Hanna Tegel, KTH; Lorenz Mayer, GE Healthcare, Uppsala, Sweden; Adil Mardinoglu, KTH; Jens Nielsen, Chalmers; Linn Fagerberg, KTH; Kalle von Feilitzen, KTH; Björn Forsström, KTH

Short summary

The proteins secreted by human tissues (the secretome) are important for the basic understanding of human biology, but also for identification of potential targets for future diagnosis and therapy. A comprehensive program, The Human Secretome Program (HSP), has been initiated at SciLifeLab to annotate the human secretome and to create a resource of recombinant full-length proteins. More than 1500 proteins have been generated using CHO cell factories and these have been used in various drug development programs in collaboration both at SciLifeLab and with external partners to explore the human secretome.

Collaborations with universities/industrial and healthcare partners/research networks

The HSP program is a collaboration between a large number of SciLifeLab research groups at KTH Royal Institute of Technology, Karolinska Institute, Chalmers, Uppsala university and also external collaborators both in academia and industry.

Cross-platform interactions

The HSP program is highly multidisciplinary and involves many of the national facilities including: Mass Cytometry, Systems Biology, Plasma Profiling, Autoimmunity Profiling, NGI and NBIS.

Motivation of highlight in terms of the contribution from SciLifeLab

The HSP program is to our knowledge the world's largest program for protein expression in mammalian cell factories. The program takes advantage of a large number of the facilities of the SciLifeLab national infrastructure, thus benefitting from the platforms' expertise and competences whereby SciLifeLab involves a large number of researchers.

Link to publication

https://www.biorxiv.org/content/early/2018/11/27/465815

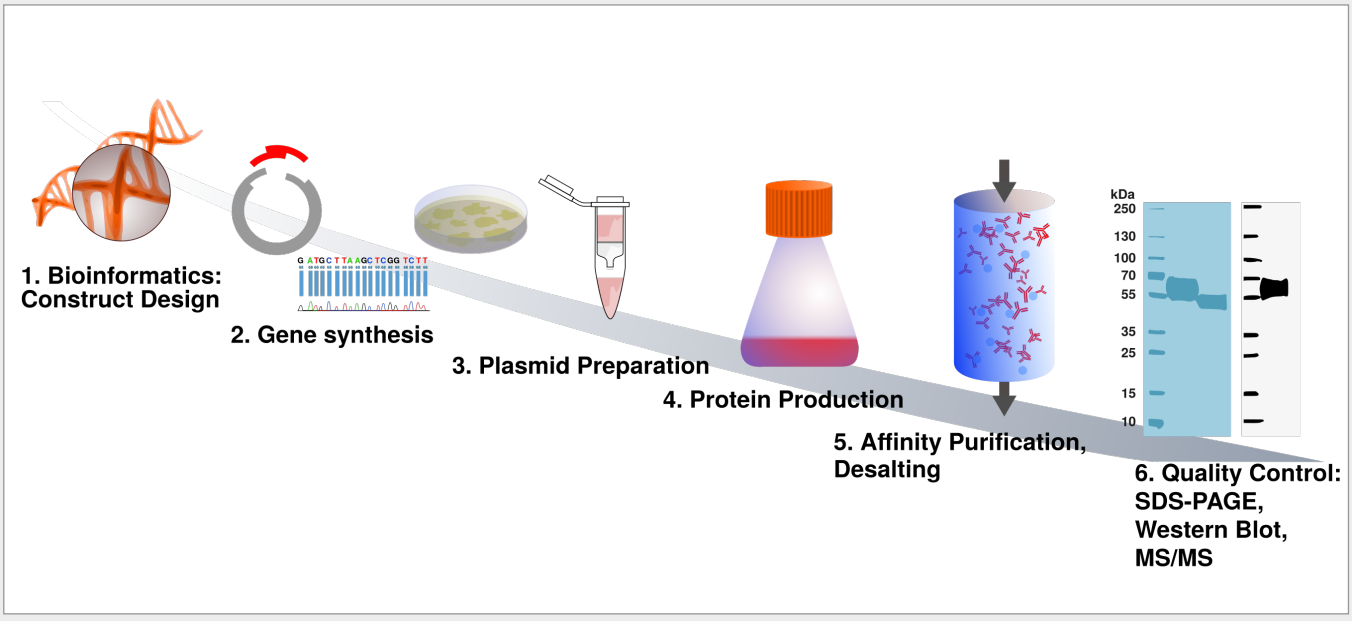


Figure 34. Overview of processes for annotating the human secretome to create a resource of recombinant full-length proteins for use in e.g. various drug development programs

Translation and societal benefit

Mission statement: Promote translation of research findings into lasting societal benefits

Introduction

Translating benefits to society within health, environment, internationalization and economic growth, often extend beyond the academic community to also include external parties. We will only briefly review these aims and connections here, as the IAB are also provided with white papers on industrial collaborations (Appendix D), clinical collaborations (Appendix E) and a special review of the DDD platform (Appendix F), all which have substantial translational and society impact coverage. SciLifeLab has over the years established an extensive network of interaction with organizations from all sectors of life science (Figure 35). These range from: technology development projects with industrial vendors of instrumentation, engagement in international research networks, to close collaborations with companies and healthcare organizations. Particular efforts have been made by SciLifeLab during 2017–2018 to expand and nurture its interactions within the external sector.

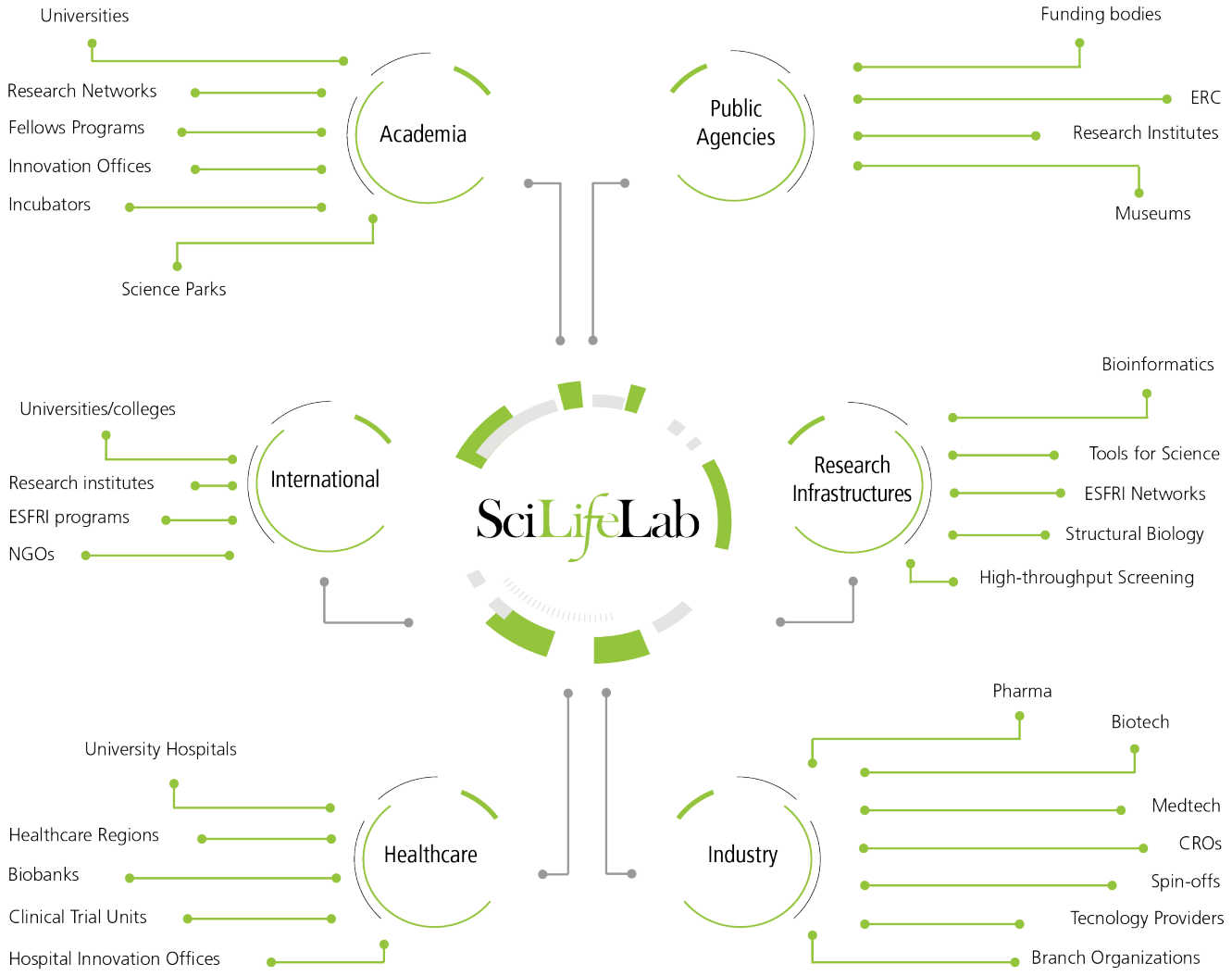


Figure 35. An illustration of the broad network SciLifeLab has with external collaborators and as well as interactions beyond academia.

Industry Relations and Collaboration

As part of the conditions for national funding from the government, the SciLifeLab mission is to support researchers in Sweden from all sectors, including industry. SciLifeLab is already heavily engaged with this sector by providing industries with: service through its infrastructure, technology development in collaboration with its facilities, collaborative research within its scientific community, and technology transfer to external parties. In addition, SciLifeLab has diverse categories of industry partners, including: i) providers/vendors of instrumentation, reagents, consumables and software, ii) industrial users of SciLifeLab infrastructure through its service areas, iii) basic/applied research collaborations with facilities and associated faculty, iv) joint technology development partners, and v) spin-offs, tech transfer, and commercial endeavors.

As an illustrative examples of industry interactions a few examples are provided below of a number of fruitful SciLifeLab-industrial collaborations, either initiated or extended during 2016–2018.

- The Centre for Translational Microbiome Research (CTMR), a collaboration between KI, SciLifeLab and the Swiss pharmaceutical company Ferring, continued during 2018 as a successful model of public-private partnership. The center translates understanding of how the microbiome contributes to human health and disease for improved therapies in gastroenterology and women's health.
- AstraZeneca continues to be an important collaborative partner to SciLifeLab and the AZ-SciLifeLab joint research program initiated in 2012 will progress until at least 2019. The program encompasses a dozen projects at the host universities and AstraZeneca provides 5–10 MUSD of funding annually to the program.
- The Cell Profiling facility at SciLifeLab recently became an official beta-testing site for a pre-market system called CODEX - Co-Detection by inDEXing, provided by the industry partner Akoya Biosciences. The system enables highly multiplex imaging of 32 proteins in tissue sections and will be available for facility users once robust workflows and analysis pipelines are set up.
- The National Mass cytometry facility in Stockholm and Petter Brodin's research team are working on a collaborative agreement with UCB Biopharma to implement its unique experimental and computational methods for immune-monitoring as an integral part of multiple clinical trials headed by UCB. Discussions are also ongoing with Janssen.
- The SciLifeLab Drug Discovery and Development, and Chemical Biology platforms, have both engaged in public-private partnership collaborations with industry, exemplified through collaborative projects currently funded by Vinnova, the Innovative Medicines Initiative (IMI) and European Lead Factory (ELF).

Although there are already vibrant and dynamic interactions between SciLifeLab and the industry, some challenges remain in providing the best pre-requisites for continued and expanded industrial engagement. These are discussed further in Appendix D.

Healthcare Relations and Collaboration

A major way in which SciLifeLab can directly contribute to societal benefit is by actively engaging in the translation of basic research findings into healthcare-related innovations and methods which directly benefits patients. The majority of translational research within SciLifeLab stems from researchers within our community who are affiliated as physicians at Stockholm or Uppsala-based hospitals, thus increasing the basic knowledge of diseases states and the molecular pathophysiology in areas such as: cardiovascular disease, inflammation, cancer, immunology, neurological and rare diseases.

Several collaborations with healthcare are already established on an organizational level linking the host university research centers with the university hospitals. The Karolinska University Laboratory is an important partner when it comes to identifying new possibilities for implementing novel technologies and services from SciLifeLab into clinical practice at the university hospitals. The already established Genomics Medicine Center Karolinska stemmed from such a collaboration, and resulted in the national GMS initiative.

GMS was initiated and launched from the SciLifeLab Diagnostics Development platform in 2017 and receives co-founding from the 14 university hospitals/health regions and universities in Sweden. The ultimate aim of GMS is to integrate findings from next-generation sequencing into individual patient electronic healthcare records and registries enabling personalized management and care, and to provide a unique resource for population-based, cross-disciplinary research projects within the field of precision medicine (Figure 36). GMS is discussed further in Appendix E.

International Relations and Collaborations

The most significant international exposure of SciLifeLab is facilitated through SciLifeLab-affiliated scientists, who present their research activities at international conferences and symposia, as well as engage in collaborations with international researchers. The co-publication graph of SciLifeLab with international organizations was presented earlier in the research community section (Figure 21). In 2018 SciLifeLab was featured in an article in Science as an example of how small countries can organize their infrastructure and research collaborations

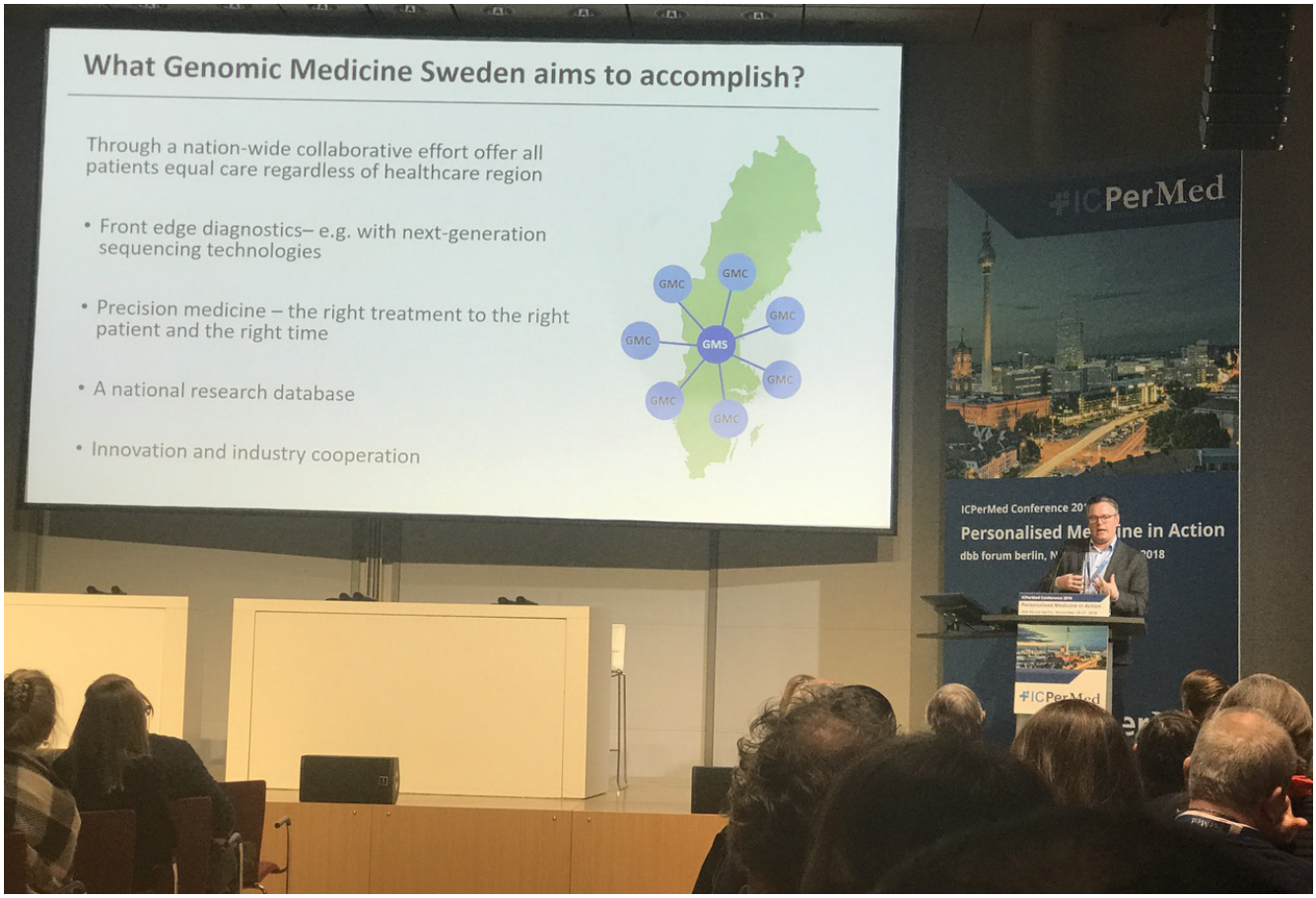


Figure 36. SciLifeLab's Diagnostics Development Director Richard Rosenquist Brandell presents Genomics Medicine Sweden at the 2nd annual International Consortium for Personalized Medicine Conference in Berlin, November 2018.

and there has been significant interest in the SciLifeLab model as such from many emerging life science regions globally. [1]

There is an increasing flow of international delegations requesting the possibility to visit SciLifeLab, with the aim to either learn from our organization or for discussing collaborations. During 2017–2018, SciLifeLab as an organization hosted high-level delegations from: Finland, Norway, Denmark, Estonia, Latvia, UK, France, Ukraine, Spain, USA, India, Saudi Arabia, China, Japan, South Korea, the Philippines, Colombia, Taiwan, and South Africa. In addition, the technology platforms and individual PIs are responsible for hosting 100s of international visitors per year.

There are several Nordic, EU- and international scientific networks where SciLifeLab and its facilities and researchers have become involved during 2017–2018. These include active participation in: several ESFRI programs (EU-ELIXIR, EU-EATRIS, and EU-OPENSCREEN), the Nordic Precision Medicine Forum, NordForsk, the Chan-Zuckerberg Cell Atlas initiative, and the Global Alliance for Genomics and Health.

Over the past five years SciLifeLab has also established dialogs and relationships with sister-organizations in other countries including: the Francis Crick Institute in London, Broad Institute in Boston, the Advanced Science Research Center in New York, EMBL in Heidelberg, FIMM in Helsinki, VIB in Ghent, and RIKEN in Japan which SciLifeLab also has an annual seminar and scientist exchange program with.

Although there is a considerable potential to develop the international role of SciLifeLab even further within the global life science sector, this development must be carefully coordinated between the SciLifeLab management and must also be in line with the strategic directives of our host universities. Since all four host universities have individual internationalization strategies covering a broad range of strategic areas, SciLifeLab must align itself with these in order to avoid any potential conflicts or redundancy. Although this has been a challenge historically, the host university international relations divisions are increasingly engaging SciLifeLab proactively in their international life science strategy development. Examples of such recent inclusions of SciLifeLab by the host universities include the China Strategy Forum at KI, and the proactive engagement of SciLifeLab in KTH's international policies and activities in South America. Although further developments remain, things are moving in the right direction.

[1] http://www.sciencemag.org/advertorials/scilifelab-model-explained

Commercialization and Innovation

The translation of basic research findings into societal benefits in terms of patents, innovations, commercial endeavors and economic growth, is clearly stated in the mission of SciLifeLab. However, due to the unique Swedish "teacher's exemption", also called "Professor's Privilege", whereby the right to develop intellectual property protection for basic discoveries lies with the individual researcher, and not the institution, SciLifeLab does not have a dedicated technology transfer function. All four host universities have their own well-resourced innovation offices to help individual researchers with both the commercialization and the innovation processes. In addition, since the data produced at SciLifeLab is the property of the host universities, it would not be appropriate for SciLifeLab to take this role. As patent applications and technology transfer activities are not coordinated by SciLifeLab, monitoring the metrics of these activities is difficult.

It is, however, crucial for SciLifeLab to create the best possible pre-requisites for innovations to take place, while not focusing on securing the innovations per se. Thus, SciLifeLab keep a close dialog with the innovation offices at the host universities and work closely with these, especially within the scope of translational facilities such as Drug Discovery & Development and Diagnostics Development. Ensuring that the innovation offices are onboard at an early stage increases both quality and opportunity.

During 2017, the SciLifeLab External Relations Forum (SERF) was created allowing for a continuous dialog between the SciLifeLab Operations Office and the host universities external relations and innovations offices. This has been greatly appreciated by all parties and is in line with the ongoing effort to better align the overall strategic objectives of SciLifeLab with those of the host universities.

Outreach, Branding and Exposure

SciLifeLab is increasingly consulted as an authority in national life science policy and strategy development, and is a trusted speaking partner for many branches of government, trade organizations and special interest groups. To better align the SciLifeLab mission with the aim of the government, public agencies and public interest, SciLifeLab has a continuous dialog with: the Ministries of Research & Education, the Ministry for Innovation and Enterprise, national public and private funding agencies, such as KAW, the Swedish Research Council and VINNOVA, and organizations such as Business Sweden and SwedenBIO. During 2017–2018 SciLifeLab has been an active participant at a number of events and workshops focusing on the greater research community, including: industry-specific events such as the Nordic Life Science Days, national research infrastructure seminars, international events profiling the strengths of Sweden as a strong life science community, and inter-sectorial workshops such as AIMDays (http://aimday.se) where basic researchers are connected with large companies and SMEs with specific research challenges. The funding and establishment of the SciLifeLab External Relations Office (see Appendix D) will significantly increase our capacity to more proactively reach out to external parties and stakeholders in the life science community.

In the summer of 2018, SciLifeLab organized and hosted its first discussion seminar at the annual Almedalen Week in Visby, which is considered the most important political forum in Sweden. Seminars and round-table discussions were held on the topic on how to increase the accessibility of SciLifeLab to researchers from outside of academia. The results of these discussions have since been a topic of lively debate from branch organizations aimed at the government and will be a key point for SciLifeLab to argue towards the next research proposition to be put forth to the government in 2020.

Interactions with host universities

In this section, we have asked the four host universities (KTH, SU, KI, UU) to express their specific contributions to SciLifeLab, the benefits that they have seen arising from SciLifeLab collaboration, as well as their future plans and expectations.

The host universities below describe both internal research prioritization and SFO funding, joint collaboration with other universities, as well as development of the national infrastructure. Host university strategies are therefore more strongly focusing on research contributions, including the SciLifeLab Fellows program. In addition, the Stockholm universities emphasize Campus Solna as a joint SciLifeLab research/infrastructure space.

The host universities have each independently written these descriptions by mid-December in a common format, but by the time of the deadline for the IAB report, these documents have not yet been systematically shared and exploited for collaborative and comparative purposes. These strategy documents form an excellent base to build joint research strategies and four-way and three-way (Stockholm Campus Solna) collaborations across the host universities. These documents will also enable planning of national infrastructure strategies. Integration of these strategies will take place in 2019, and we hope to present initial thoughts of this process during the IAB site visit in March 2019.

Table 6. Metrics summary of host university engagement in SciLifeLab

	KTH	KI	SU	UU
SciLifeLab staff from each host university	265	230	90	230
Number of PIs engaged in SciLifeLab[a]	39	20	12	127
Number of departments associated with SciLifeLab	5[b]	11	10	10
SciLifeLab Facilities hosted	7	12	7	16
SciLifeLab Fellows supported	4	4	5	9

[a] PI definition at UU: PIs in clinical or preclinical biomedicine and environmental sciences that are using the infrastructure facilities or otherwise benefit from SciLifeLab, and that contribute (committee consultation, teaching, recipients of post-doc grants or other research-oriented support) to the SciLifeLab activities. At KTH, SU and KI, PIs are defined as group leaders physically located in Campus Solna.

[b] Including KTH university administration (UF) as a department.

Introduction

Together accounting for over 50% of all academic life science research in Sweden, [1] the host universities that originally launched SciLifeLab are the scientific foundation upon which SciLifeLab is built. SciLifeLab provides the host universities with a common arena for strategic co-investment of key research infrastructure, increased attractivity for recruiting top talent, possibilities for increased collaboration and innovation in partnership with industry and healthcare, increased exposure to the greater national and international life science community, and a collaborative platform for developing great science to address global challenges in health and environment. The potential for SciLifeLab to strengthen the overall profile of Sweden as a strong and internationally competitive life science nation benefits the host universities both directly and indirectly, enabling research that had otherwise not been possible.

While SciLifeLab plays an important role for the host universities in their collective effort in life science, it is important to remember that SciLifeLab is a minute part of the host universities as a whole. The total annual base budget (i.e. excluding grants and externally sourced research funding) for the four host universities 2018 was 13.4 BSEK (KTH: 2707 MSEK, KI: 3043 MSEK, SU: 3435 MSEK, UU: 4195 MSEK). [2] SciLifeLab's annual base governmental funding for 2018 (including SFO funds) was 423 MSEK, thus accounting around 3% of the host universities' total investment in education and research annually.

[1] Based on reported funding for 2017 in the category "medicine and health" from the Swedish National Research Council (VR).

[2] Based on the allocated budget from 2018 government funding https://www.esv.se/statsliggaren/

KTH Royal Institute of Technology Strategy @ SciLifeLab

An innovative European technical university – Since its founding in 1827, KTH Royal Institute of Technology in Stockholm has grown to become one of Europe's leading technical and engineering universities, as well as a key centre of intellectual talent and innovation. KTH is Sweden's largest technical research and learning institution and home to students, researchers and faculty from around the world dedicated to advancing knowledge. KTH has more than 13000 students and 1700 PhD students and about 2200 scientists.

Role of SciLifeLab at KTH

Importance of SciLifeLab for KTH

Science for Life Laboratory is one of the largest and most important scientific initiatives in the history of KTH. Many research groups from KTH has moved to the Solna site to form a strong scientific base with an impressive scientific track record during the past years. Many of the facilities at SciLifeLab Solna are run by KTH personnel and these technical platforms are thus now available also for research groups outside KTH.

Importance of the national infrastructure at SciLifeLab to KTH

The fact that KTH is main responsible ("huvudman") for SciLifeLab makes it of particular importance for KTH. The fact that SciLifeLab is the only national infrastructure in life science in Sweden makes this responsibility even more important. The mission is to create a scientific hub in molecular bioscience in Sweden and provide cutting-edge research with state-of-the-art technology related to bioscience with a particular focus on technology- and data-driven research.

KTH´s engagements in SciLifeLab

The Founding Director for SciLifeLab Stockholm (2010–2013) and the national SciLifeLab Sweden (2013–2015) was from KTH. Three out of five schools have research groups at the Solna site and KTH participate on all levels in the organization and management of the center. KTH has funded four SciLifeLab Fellows and 16 post-doc positions. In addition, KTH have provided infrastructure and base funding to the KTH SciLifeLab faculty.

Staff

- PIs: 39, 30 in faculty positions (professors, associate professors, assistant professors)
  - KTH School of Engineering Sciences in Chemistry, Biotechnology and Health (CBH)
    - Dept of Protein Science: 120 persons, 19 PIs, 11 on faculty position
    - Dept of Gene Technology: 50 persons, 9 PIs, 8 on faculty positions
  - KTH School of Engineering Sciences (SCI):
    - Dept of Applied Physics: 55 persons, 7 PIs, 7 on faculty positions
  - KTH School of Electric Engineering and Computer Science (EECS)
    - Dept of Computational Science and Technology: 20 persons, 4 PIs, 4 on faculty positions
- SciLifeLab Fellows: 4 (2 more to be recruited)
- KTH University administration (UF): 20 persons
- **Total: 265 KTH employees (Nov 2018)**

Departments

The KTH groups at the Solna site comes from three out of the five KTH schools. These are:

- KTH School of Engineering Sciences in Chemistry, Biotechnology and Health (CBH)
- KTH School of Engineering Sciences (SCI)
- KTH School of Electric Engineering and Computer Science (EECS)

National infrastructure operated by KTH

- NGI Stockholm
- Advanced Light Microscopy
- Cell Profiling
- Plasma Profiling
- Autoimmunity Profiling
- Human Antibody Therapeutics (DDD)
- Protein Expression and Characterization (DDD)

KTH SciLifeLab committee

The KTH SciLifeLab committee consists of six persons. These persons have been appointed to represent the relevant schools at KTH and in addition the KTH Scientific and Integration Directors and the KTH representative of the national SciLifeLab Board. The committee meets four times a year and in addition when needed. The committee prepares all strategic issues related to SciLifeLab and KTH and the committee suggest the annual SFO-budget which is then finalized and decided by the KTH rector.

Key contributions from KTH to SciLifeLab – since the start

Infrastructure

Part of six of the current nine infrastructure thematic areas (Genomics, Proteomics, Single Cell Biology, Bioimaging, Diagnostics, Drug Discovery)

Research

KTH staff has contributed to more than 500 publications in the last four years and many of these as senior authors in papers published in high impact journals, such as Science and Nature. KTH hosts two of the newly selected Research Community Programs at SciLifeLab. The KTH researchers have been successful to obtain external grants both nationally, in Europe (i.e. ERC) and internationally (USA).

Education

KTH is heading a new master education program together with SU and KI with SciLifeLab as base. All scientific staff from KTH participate as teachers in under- and postgraduate training organized by KTH.

Collaboration/Impact on society

The KTH staff are present in numerous collaborations with research groups at all Swedish universities and abroad, the latter exemplified by Riken (Japan), BGI (China), KAIST (South Korea), EBI (UK), Broad (Boston), Stanford (California), UCSD (California), ETH (Switzerland) and Max Planck (Germany). KTH faculty has participated in many outreach activities, such as public lectures, presentations for young students (senior high-school), organization of numerous scientific workshops and conferences, participation in national TV programs and presentations in webinars. A large number of spin-out companies has been founded by SciLifeLab researchers from KTH during the last years and two such companies has done initial public offerings during this period. KTH personnel have also been responsible for the initiation of the annual SciLifeLab Prize together with the Science magazine and the American Association for Advancement of Science (AAAS).

The KTH SciLifeLab vision for the next five years

Ambitions for SciLifeLab within KTH

To continue to be a national scientific hub in molecular bioscience in Sweden and to provide cutting-edge research with state-of-the-art technology related to bioscience with a particular focus on technology- and data-driven research.

What are KTHs expectations on SciLifeLab?

See the answer above

How can integration and collaboration between host universities be strengthened through SciLifeLab?

The collaboration between the different host universities has increased dramatically since the inauguration of SciLifeLab and this positive development should be further encouraged by dedicated funding for research projects or post-docs shared by at least two of the host universities. Regarding integration, it is important to point out that the four host universities has different competences and focus in their research competence base and this should be considered as a strength for SciLifeLab. Integration of these different competences are therefore of great importance and especially at Campus Solna where physical presence of groups from three university hosts are encouraged on each floor of the 12 floors of the alfa and gamma buildings.

How can KTH work toward a uniformed national organization?

KTH will continue to strongly support the mission of SciLifeLab to be a valuable infrastructure for life science. Since the infrastructure funding is to provide a national resource, it is important to involve all relevant Swedish universities in the selection and prioritization of the of the national infrastructure.

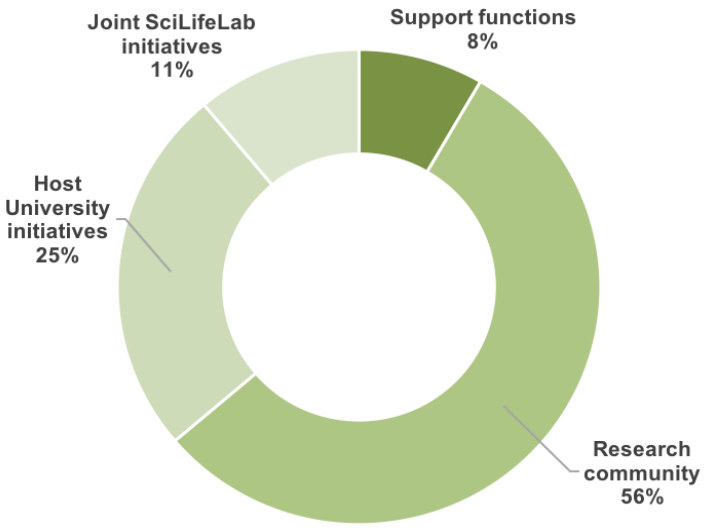


Figure 37. KTH distribution of SFO funding based on budget 2019.

Karolinska Institutet Strategy @ SciLifeLab

Karolinska Institutet's mission is to conduct research and education and to interact with the community. Our vision is to significantly contribute to the improvement of human health. Karolinska Institutet (KI) accounts for the single largest share of all academic medical research conducted in Sweden and offers the country's broadest range of education in medicine and health sciences. KI host more than 6000 students, 2100 PhD students and about 1700 scientists.

Role of SciLifeLab at Karolinska Institutet

Importance of SciLifeLab for Karolinska Institutet

Since the creation of SciLifeLab in 2010, the use of national infrastructures and collaborative projects have increased continuously. In 2017 26% of the national infrastructure users were from KI. The attractive milieu at SciLifeLab and the possibility to recruit scientists with SFO funding provides an opportunity to further increase the quality of research both at SciLifeLab and KI. Further, reducing the threshold for bringing technology advancements towards addressing novel scientific problems and precision medicine holds great promises for KI.

Importance of the national infrastructure at SciLifeLab to KI

KI recognizes that with the growing demand of advanced technologies to address scientific problems, there is a need for consolidation both to share the costs associated with running such facilities but also to maintain the expert knowledge and experience required for maintaining such advanced infrastructures. It is KIs opinion that SciLifeLab should focus on infrastructures that require national coordination. This should then be complemented with university and/or regional infrastructures. A national mission is also important in connecting KI facilities (e.g. Genome Medicine Karolinska as part of Genome Medicine Sweden) and research in national contexts; this includes projects where SciLifeLab can act as a national hub to coordinate larger projects that involve multiple groups from several associated universities.

KI engagements in SciLifeLab

KI is a one faculty university and the research is conducted within 22 departments. All KI scientists and facility staff associated with SciLifeLab are employed within a given department that also holds the responsibility for i.e. financial and Human Resources (HR) issues. Currently, eleven KI departments host SciLifeLab facilities, TDPs, RPCs, SciLifeLab Fellows, KI SciLifeLab PIs, or KI SciLifeLab committee funded strategic initiatives.

Number of staff

- PIs: 20
- SciLifeLab Fellows: 4 (2 additional currently being recruited)
- Facility staff: 63
- Total KI staff @ SciLifeLab: 230

National infrastructure operated by KI

Twelve facilities supported by national funding are operated by KI:

- Diagnostic Development (Clinical Genomics Stockholm)
- Genomics (Eukaryotic single cell genomics, NGI Stockholm)
- Proteomics and Metabolomics (Chemical proteomics, Proteogenomics, Mass cytometry Stockholm)
- Chemical Biology and Genome Engineering, (Chemical Biology Consortium Sweden – CBCS, Stockholm, High Throughput Genome Engineering)
- Cellular and Molecular Imaging (Protein Science Facility – PSF)
- Drug Discovery and Development (compound center and target product profiling & drug safety assessment)
- Fluorecence tissue profiling is being phased out 2018
- iPS Core has been a SciLifeLab pilot facility

Co-funding

KI and Stockholm county council (SCC) has a separate initiative for core-facilities that provides funding to CBCS, PSF and Eukaryotic single cell genomics. This initiative also supports regional core-facilities with synergy to SciLifeLab Facilities (Genomic Medicine Karolinska, regional facilities in proteomics, Genome engineering Karolinska). This funding adds up to 18.45 MSEK on a yearly basis. In addition, 22.25 MSEK is provided to support expensive equipment to PSF, proteomics and genomic medicine Karolinska.

KI SciLifeLab committee

From 2013, a KI SciLifeLab committee (SFO-PRIO) has been appointed by the board of research. The current group has a mandate until 2020 and the members are: Stefan Eriksson (chair, ID), Janne Lehtiö (SD), Katja Petzold, Anna Falk, Lars Engstrand, Vicente Pelechano Garcia (SciLifeLab Fellow representative). The three departments most involved in SciLifeLab activities are represented. The committee meets four to six times/year and decides on initiatives as well as a yearly budget and recruitments. The committee is supported by a scientific

administrator and a controller. The Vice-President (KI representative at the SciLifeLab national board) meets with the SD and ID on a regular basis to discuss SciLifeLab related issues.

Key contributions from Karolinska Institutet to SciLifeLab

Major research areas that have benefit from SciLifeLab

- Inherited disease and microbiome research have benefitted enormously from the introduction of SciLifeLab Clinical Genomics
- Proteogenomics
- Human Developmental Cell Atlas, a Swedish initiative within the Human Cell Atlas: launched in 2018 and hosted at SciLifeLab

Research environment

The SFO committee has supported the development of KI hosted facilities for advanced proteomics (BioMS), Clinical Genomics (Genomic Medicine Sweden), eukaryotic single cell genomics, mass cytometry and chemical biology, high-throughput analysis and tissue profiling. KI also provides a strategic research environment with excellent collaborative opportunities in medical research and provides samples derived from cell cultures, animal and human tissues with focus on translational research together with hospitals in primarily the Stockholm region.

SciLifeLab faculty

The establishment of a KI SciLifeLab faculty aims to create a multi-disciplinary research environment in the field of molecular bioscience. The PIs are selected in different ways: external recruitment of scientist to KI with competences specifically in the multidisciplinary goals of SciLifeLab, an internal relocation program of five PIs and PIs that are scientific responsible for facilities. The expectation is that these PIs will contribute to the development of the technology at SciLifeLab or that their research should significantly benefit from the close proximity to the platforms. In general, PIs should locate to SciLifeLab for a fixed time and the rotate back to the host department.

SciLifeLab Fellows

SciLifeLab Fellows have been recruited in an open process for a four-year fixed position as assistant professors with a possible extension of two years. A prolongment is associated with a permanent position at the host department. The four SciLifeLab Fellows recruited so far have been exceptionally successful in obtaining external grants and the two first recruited fellows have been granted prolongment after evaluation.

Education

A number of workshops and training are available for postdocs and PhD students working at SciLifeLab (also from other universities within the "SciLifeLab consortium").

Collaborations and impact on society

KI has been driving several clinically oriented projects at SciLifeLab (clinical sequencing, collaboration with molecular pathology, clinical chemistry, large projects on several major disease areas), and collaboration with biobank and clinical trial units at Stockholm County Council (SCC) and the Karolinska University Hospital (KUH). Several industrial agreements, notably with pharma (AstraZeneca, Ferring etc.) and technology vendors (Agilent, GE Heathcare, Thermo Fisher etc.) has supported research and development at SciLifeLab.

The Karolinska Institutet SciLifeLab vision for next five years

In the coming five years, SciLifeLab develops as a center that lowers the barrier for translational research, develop new and enhanced technologies, develops and expands IT platforms for high-throughput screening and other applications and provides access to powerful data clusters to introduce AI in cell and molecular biology research.

KI has the *ambition* to contribute to the development of SciLifeLab to remain one of the leading centers in technology driven life science, offering both unique services and driving world leading technology and biomedical research. KI has especially an ambition to continue the development of facilities and translational research important for advancing precision medicine and clinical implementation of research. KI *expects* that SciLifeLab maintains a constant evaluation and renewal of facilities, is recruiting and maintaining leading research groups developing technologies and provides a research environment that develops in synergy with facility services.

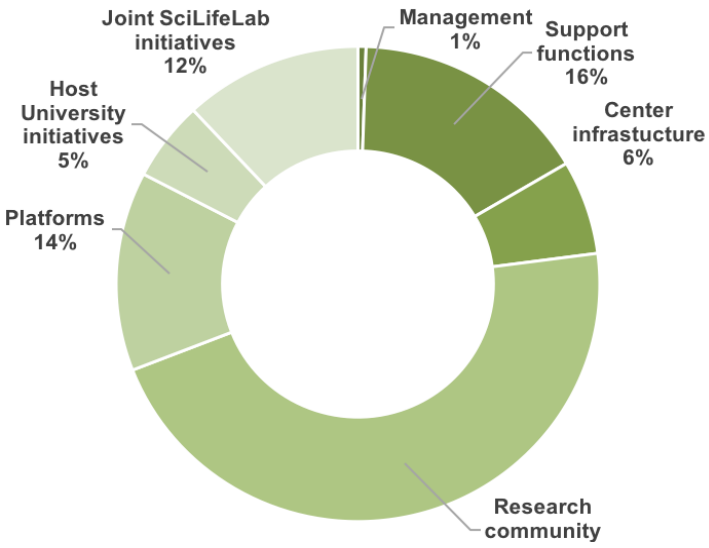


Figure 38. Karolinska institute distribution of SFO funding based on budget 2019.

Stockholm University Strategy @ SciLifeLab

Stockholm University (SU) is characterized by its strong focus on fundamental research, combined with applied research in environmental science and chemistry in particular. Education is closely linked to research. SU has 30,000 students (FTE), 1,600 doctoral students, and 5,500 members of staff active in total. SU has the largest science faculty in Sweden, which is reflected in the unusual breadth in natural sciences and mathematics in general, and also in the type of research that utilizes and interacts with SciLifeLab.

Role of SciLifeLab at SU

Importance of SciLifeLab for SU

- SciLifeLab provides excellent possibilities for **collaborations between scientists and research groups**. It is especially important that it offers an arena where scientists from different disciplines meet, formulate and address challenging research questions from different angles.
- One of the essential actions is the **recruitment of SciLifeLab Fellows**. This successful program enables SU to recruit young, talented scientists, who become crucial members of the SciLifeLab research community and of the Faculty of Science at SU. They contribute in building a dynamic and creative research environment at SciLifeLab. SciLifeLab Fellows also belong to a host department at SU and thereby participate in developing new research themes, and provide the local research and education programs with strong links to SciLifeLab. Two of our current Fellows have recently been tenured and promoted to Associate Professors.

Importance of the national infrastructure at SciLifeLab to SU

SciLifeLab creates **unique possibilities** for SU's scientists **to use cutting-edge technologies** in a user-friendly and cost-effective manner. Access to a broad range of technology platforms and facilities is especially valuable for small to middle-sized research groups. In addition, support by specially trained technical personnel in planning, execution and analyses of the data, including bioinformatics and data storage, is of great importance.

SU engagements in SciLifeLab

Departments

10 out of 15 departments within all four sections (Biology, Chemistry, Earth & Environment and Mathematics-Physics) of the Faculty of Science as well as one dept. within the Faculty of Humanities.

Number of staff

- PIs: 12
- SciLifeLab Fellows: 5 (+2 ongoing recruitments),
- Infrastructure staff: 45
- Total no. of staff at SciLifeLab: 90

Facilities and Platforms

- Bioinformatics platform (Long-term and Short-term bioinformatics)
- Bioimaging platform (Cryo-EM is founded and hosted by SU)
- DDD (Biochemical and Cellular Assays Facility and the Medicinal Chemistry/Hit2Lead Facility)
- Genomics (Ancient DNA facility with UU, and some role in NGI Stockholm)

SU SciLifeLab committee

The Board for the Faculty of Science decides on recruitments of SciLifeLab Fellows and senior PIs to SciLifeLab, and on the budget for the SFO-funding linked to SciLifeLab. The Science Faculty Board's Working Committee is the "SciLifeLab committee", it prepares the decisions for the board, discusses SciLifeLab strategic issues and takes other decisions on delegation from the board. The Working Committee consists of the Dean and Vice Dean, the four Section Deans, the chair for the Committee for Undergraduate Education and a student representative. The Vice Dean also acts as SciLifeLab Integration Director (ID). The Working Committee meets about four times per semester and SciLifeLab issues are included in the agenda for each meeting. The SciLifeLab Scientific Director is often present when SciLifeLab matters are discussed. Having the Working Committee of the Faculty Board as SciLifeLab committee ensures that SciLifeLab issues are well anchored within the leadership of SU and that staff on all levels is well informed.

Key contributions from SU to SciLifeLab – since the start

Infrastructure

- SU has been a major founder and developer of computing science and bioinformatics linked both to facilities and research.
- In Structural Biology, SU has built the very successful Cryo-EM facility with funding from KAW and SU.
- Scientists from SU actively develop new diagnostic tools and assays. This is reflected both in several of the Drug, Discovery and Development Platform (DDD) facilities

and in the initiation of a new "in situ-sequencing service" within the Eukaryotic Single Cell Genomics facility, co-funded by KAW.

Research

- Using the Cryo-EM facility, several breakthroughs have been made by SU scientists on the structure and function of ribosomes from bacteria, eukaryotic cells and mitochondria, and in the development of software for high-throughput image analysis and structure determination.
- A new laboratory for environmental contaminant toxicology purposes has recently been established at SciLifeLab by SU scientists to enable measurements of new chemical contaminants in air, water, tissues and biofluids. Collaboration with the SciLifeLab research community will advance the understanding of how exposures to these contaminants impact human and wildlife health.
- By using SciLifeLab and through the National Sequencing projects, SU groups have carried out whole genome sequencing of many non-model organisms. Subsequent extensive transcriptome and epigenetic analyses have promoted important discoveries of evolutionary mechanisms and of ecological biodiversity at many levels.
- In archaeogenetics several milestones have been reached, describing prehistorical migrations based on ancient DNA sequencing. The discovery of a female Viking warrior in a grave in the town of Birka rendered huge interest also among the general public. The archaeologists at SU are "super-users" of the DNA sequencing facilities at SciLifeLab.

Education

- Together with KTH and KI, SU runs the master program linked to SciLifeLab," Molecular Techniques in Life Sciences".

The Stockholm University SciLifeLab vision for the next five years

- The continued development of SciLifeLab as an integrated infrastructure and research center is of fundamental importance for science and education in molecular biosciences within Sweden.
- The national infrastructures of SciLifeLab should support excellent research at the universities in Sweden, by providing access to the advanced instrumentation and infrastructure service.
- The SciLifeLab Solna Campus should be developed into a world-class joint research environment.
- SciLifeLab should promote utilization and implementation of knowledge, technologies and research discoveries in education, in health care and for applied environmental sciences.

Ambitions for SciLifeLab within SU

- SU will foster and develop research and technologies at SciLifeLab, which reflect SU's strengths and breadth in biosciences and environmental sciences in particular. This includes strengthening current strong fundamental research areas (e.g. structural biology, bioinformatics and ancient DNA sequencing), further attracting novel environmental research to the SciLifeLab Solna campus, and supporting high quality research and teaching that benefits from the state-of-the-art technologies present there.
- To build a very strong research environment at Campus Solna, SU will strive to attract excellent researchers both at junior and senior levels who are dedicated to SciLifeLab and its research environment.
- SU and its leadership acknowledge both the possibility and a responsibility to actively develop and strengthen the "Environmental research profile" of SciLifeLab. As part of that, SU wishes to promote the use of the DDD platform for environmental exposome research and monitoring.
- SU has together with The Swedish Museum of Natural History created a joint Center for Paleo Genetics (CPG). This center will host the Stockholm node of the SciLifeLab Ancient DNA facility. The support given to ancient DNA research will not only be of great benefit for archaeology, but also for environmental sciences, involving research on marine and terrestrial sediments, and will require dedicated bioinformatics, all of which will feed-back to activities within SciLifeLab.
- SU is accomplishing several strategic investments in structural biology, neuroscience and brain research, by among other things building state-of-the-art imaging facilities both at SciLifeLab and at SU's main campus. These include the Cryo-EM facility, the intravital microscopy facility (IVMSU) and the non-clinical brain-imaging center (SUBIC). In close connection to these, computational biology and theoretical physics, such as aspects of artificial intelligence and deep learning, are also being reinforced. Together, these investments will enable novel collaborations and growing activities at SciLifeLab during the next five-year period and beyond.

SU's expectations on SciLifeLab

- The national infrastructures may consider programs/activities that improve competences both at facilities and at host universities, thus enabling more efficient use of the facilities for new research areas. This is especially important for environmental research where focus is on non-human, non-model organisms, metagenomics and other environmental samples in general.
- SciLifeLab should act together with the host universities to build an interactive and stimulating research

community within SciLifeLab as a whole. In particular, this means increasing the visibility of Campus Solna as a unique research and education center that provides excellent laboratory facilities and working conditions for an interactive and stimulating research community, and world-class training.

How can integration and collaboration between host universities be strengthened through SciLifeLab?

- Creating different types of programs, such as the newly started Research Community Program (RCP), can strengthen integration and collaboration between groups from the same or different host universities. It could also include joint postdoc or PhD programs, aimed at attracting the best candidates that can chose their projects with one or more groups located at Campus Solna, and collaborations with groups at the other campuses.
- SciLifeLab should be proactive in stimulating the host Universities to open up their local core facilities, PhD courses/work-shops and other local activities for the other host universities.

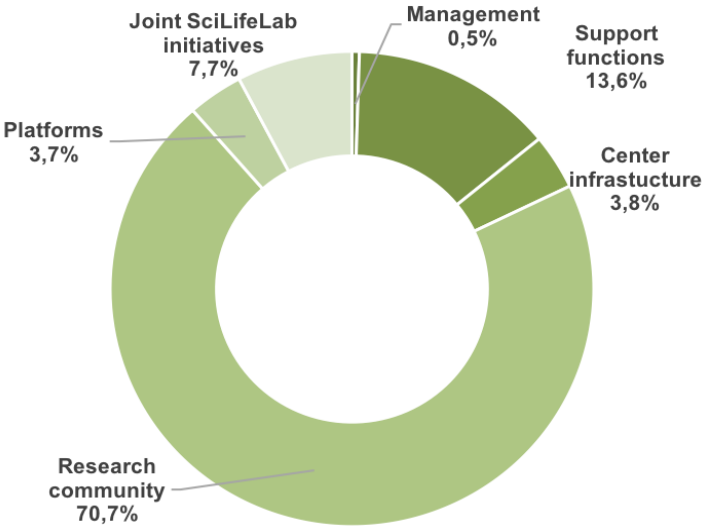


Figure 39. Stockholm University distribution of SFO funding based on budget 2019.

Uppsala University Strategy @ SciLifeLab

Uppsala University is the Nordic region's oldest university – founded in 1477 – and is ranked among the top 100 universities in the world. It has more than 40,000 students and 5,000 researchers which conduct world-leading research and give a number of courses.

Role of SciLifeLab at Uppsala University

Importance of SciLifeLab for Uppsala University

The focus of SciLifeLab aligns well with the objectives of Uppsala University (UU) to *strengthen its position as a leading international research university, attract the most qualified academic staff from all over the world* and *collaborate with the private, public and non-profit sectors* for the benefit of society at large. SciLifeLab provides an opportunity to engage in activities that are complementary to, while not competing with, UU's main activities. In this way SciLifeLab enriches and expands the activities of UU.

Importance of the national infrastructure at SciLifeLab to Uppsala University

SciLifeLab represents a forum for inter-disciplinary collaboration within UU and develops and delivers cutting-edge technology to scientists both across Sweden and internationally. The SciLifeLab Fellows program enables UU to recruit top performing young PIs, offers them outstanding starting conditions and a national network for young scientists to engage in.

Uppsala University engagements in SciLifeLab

Departments

A large number of departments from the Disciplinary Domains of Medicine and Pharmacy as well as Science and Technology are involved in SciLifeLab by hosting infrastructure facilities and their personnel, SciLifeLab Fellows and SciLifeLab Faculty.

Facilities/Platforms

- Many of the SciLifeLab infrastructure facilities are located at UU, including large parts of the platforms: **Bioinformatics** (Facilities: Compute and Storage, Long-term support, Support and Infrastructure, BioImage Informatics),
- **Genomics** (National Genomics Infrastructure, Ancient DNA),
- **Single cell biology** (Microbial Single Cell Genomics, Single Cell Proteomics),
- **Proteomics and Metabolomics** (PLA Proteomics, Clinical Biomarkers),
- **Chemical Biology and Genome Engineering** (Genome Engineering Zebrafish),
- **Diagnostics Development** (Clinical Genomics Uppsala), and
- **Drug Discovery and Development Platform** (ADME (Absorption, Distribution, Metabolism, Excretion) of Therapeutics, Biophysical Screening and Characterization, In Vitro and Systems Pharmacology, Medicinal Chemistry – Hit2Lead).

UU has co-funded these national facilities using SFO funds to increase their ability to provide services. National Genomics Infrastructure and Genomic Engineering Zebrafish have also received co-funding from UUs infrastructure funds. UU is presently using SFO funds towards four pilot facilities (Mass Spectrometry Imaging (NR-MSI), Preclinical PET-MRI, Pre-clinical cancer treatment (PCT) and Customized microfluidics).

Staff

At present, UU has nine SciLifeLab fellows and employs about 100 facility staff. In addition, UU has 127 SciLifeLab Faculty, i.e. PIs in clinical or preclinical biomedicine and environmental sciences that are using the infrastructure facilities or otherwise benefit from SciLifeLab, and that contribute (committee consultation, teaching, recipients of post-doc grants or other research-oriented support) to the SciLifeLab activities.

Uppsala University SciLifeLab committee

The committee is composed of the Scientific Director (SD), Integration Director (ID), the Vice head of Operations for SciLifeLab, and appointed representatives from the Disciplinary Domains of Medicine and Pharmacy and Science and Technology. The ID is the Chair of the committee. The committee meets once a month and the main responsibility of the committee is to decide on the use of the SFO funding, and to discuss future strategies for recruitment of SciLifeLab Fellows and development of new technologies. The committee operates by a cycle of: discussion of each topic on one meeting, followed by a decision on the topic in the coming meeting. Material for the committee meeting is prepared by the working group consisting of the SD, the Vice head of Operations, and one appointed representative from each Disciplinary Domain. The agenda for each meeting is sent out one week before the meeting, together with the necessary documentation. Given the structure of the committee and the formalized meeting procedure, all items on the agenda have been handled by the management group and each Disciplinary

Domain prior to any decision is taken by the SFO committee, leading to a well-structured process.

Key contributions from Uppsala University to SciLifeLab – since the start

Infrastructure

Many SciLifeLab facilities are located at UU and several of these are national research infrastructures and co-funded by the Swedish Research Council (VR).

Research

- Scientists from UU are among the largest userbase of the SciLifeLab facilities, and major contributor to the scientific output of in terms of publications, PhD students and post-docs.
- The SciLifeLab Fellows program has enabled UU to recruit excellent young scientists and offer them tenure track opportunities. Many of the Fellows actively choose SciLifeLab even though they had offers from prestigious institutes like ETH, MIT and CALTECH, or top industrial actors such as AstraZeneca.
- Uppsala applies an Embedded Fellows concept, according to which each Fellow has a host department from day one and a career plan and mentor. UU has a dedicated building for SciLifeLab (Navet) as the main meeting forum and the location of the SciLifeLab Operations Office in Uppsala, but Navet does not house the SciLifeLab Fellows.

Education

The Bioinformatics and Genomics facilities at UU has given many courses and workshops in genomics, bioimaging, bioimage informatics and proteomics technologies. Over 1,000 scientists from all over Sweden have taken courses in analysis of next-generation DNA sequencing data. UU also has offers a MSc program and a highly acclaimed seminar series.

Collaboration/Impact on society

- Facilities contributing to the societal benefits include Clinical Genomics at Uppsala University Hospital.
- Developed the AIM DayTM concept as a meeting forum for organizations/industry and academia.
- Host of the Uppsala Health Summit, for high-level interaction between industry, research and policy makers.
- Sponsor of SciFest; a science festival to spur the interest and curiosity in students ranging from pre-school to high-school level to engage in science.

The Uppsala University SciLifeLab vision for the next five years

- Continue to develop the research infrastructure platforms concept, and consider including facilities enabling rapid and efficient proof-of-concept in vivo studies making the translational research chain complete.
- Expand the SciLifeLab Fellows program,
- Develop SciLifeLab post-doc and PhD programs. The post-doc and PhD programs should focus on cross-disciplinary projects, requiring supervising PIs from different Departments, Disciplinary Domains or Universities to join forces. In the PhD program, two students from different fields would work together on a common scientific question, thereby approaching it from different angles. UU also recognizes the need facilities focusing on environmental monitoring, which is largely missing at the national level, and where the SciLifeLab single cell biology and genomics would be valuable.

Uppsala University's expectations on SciLifeLab

- Continue to develop and provide state-of-the-art research infrastructure.
- Provide funding for expensive and highly advanced cutting-edge infrastructure,
- Develop joint post-doc and PhD programs to encourage closer collaboration between host universities.

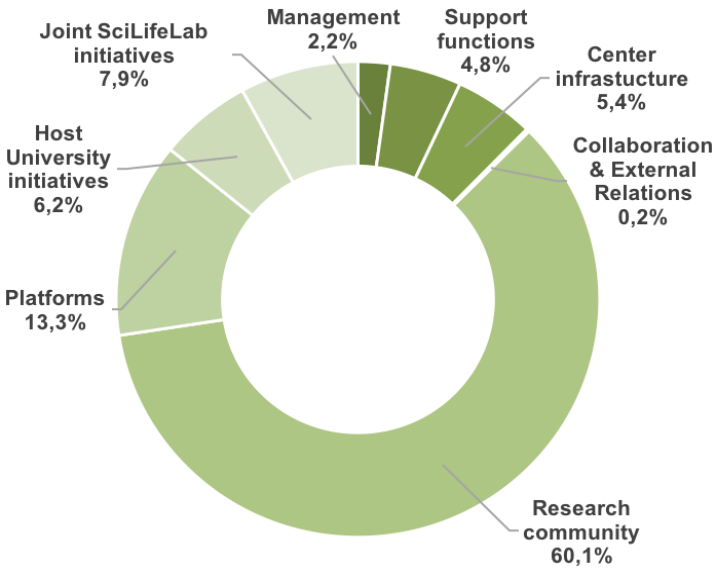


Figure 40. Uppsala University distribution of SFO funding based on budget 2019.

Comments from the National SciLifeLab Committee (NSC)

Here, the newly formed national SciLifeLab Committee (NSC) has been asked to present its role within SciLifeLab and the national view on future developments of the organization.

Introduction

To enable the SciLifeLab mission to be a national resource and to provide service and expertise to all researchers in Sweden, and to form synergies between SciLifeLab and non-host universities the National SciLifeLab Committee (NSC) was formed and formally elected by the SciLifeLab Board in 2018. The NSC consist of representatives from non-host universities and has the task to assist in making SciLifeLab visible on the national arena, as well as to provide input to the SciLifeLab management and the SciLifeLab Board on e.g. new initiatives to enable this mission. The NSC is described in more detail in the chapter *Development since 2017* above.

The NSC committee and how it works

An important goal for SciLifeLab is to formalize and strengthen the interactions between the four host universities and the other six universities in Sweden regarding infrastructures, training and research in the life science area. The SciLifeLab Board decided on February 8, 2018, to establish a National SciLifeLab Committee (NSC) consisting of eight members including; one member from each of the six universities outside the Uppsala-Stockholm region, one member that represents the Wallenberg Centres for Molecular Medicine, and one member representing the SciLifeLab Board also acting as the chairman of the committee. All members have a personal deputy member. Each appointment runs for 2018–2019.

Prof. Gunilla Westergren-Thorsson from Lund University is a member of the SciLifeLab Board, and was appointed chairman of the NSC. The other seven members were appointed based on suggestions from each of the six non-host universities and the Wallenberg Centre for Molecular Medicine (WCMM), respectively. The tasks given to the members of the NSC were to participate in joint NSC meetings, stay informed about the goals and availability of the SciLifeLab infrastructure, give advice on strategic issues regarding service, competence and support, and to be ambassadors for SciLifeLab at the home university.

The committee has had two meetings in 2018, where they have been informed about structures, economy, workflow and different platforms etc. **At the first meeting** the role of the Committee was intensely discussed and how SciLifeLab works in a national perspective. Several critical voices were raced, especially linked to transparencies and insight into application processes and how/if SciLifeLab promotes Swedish research outside the host universities. It was furthermore pointed out that it is difficult to understand the SciLifeLab organization, and the relation to the SFOs and thereby the role in Sweden as a national organization.

In the second meeting several good examples where a small support from SciLifeLab to some national platforms has allowed them to grow, were presented. These supports to specific platforms were reported to be important for their success in raising more money at the local level and allowing the platforms to succeed and further growth within larger national perspective. As example, the Clinical Diagnostics is now forming the SWEGENE initiative. More similar initiatives are upcoming in different areas and considered important for the interaction between SciLifeLab and different Swedish universities. The Committee was unanimous to see more of this type of **flagship projects**. Further discussions were connected to education at SciLifeLab such as in bioinformatics, which is positively engaging our younger generation of researchers and increases contact points on a national level in different interactive projects. Occasionally, the bioinformatics courses are also given locally at the different universities, which is highly encouraged and thereby support the national initiative of SciLifeLab.

Conclusively, all members of the committee were positive in strengthening Life Sciences in Sweden in a national perspective and they also found a name change from SciLifeLab to **SciLifeSweden** timely, as once suggested by a previous Minister of higher education, Jan Björklund.

A third meeting is planned to take place in February, 2019. Each university representative has been asked to select or visualize four to five important infrastructure platforms that open for use/service at their home university. The goal is to get an overview of key features of infrastructural resources within Life Sciences in Sweden and how all universities can connect in an efficient way to SciLifeLab with broader but also more specialized knowledge in different areas. Each university also got the task to suggest alterations in the interactions with their respective university and SciLifeLab regarding platforms that may not need further support or new platforms that could be included, as well as platforms that may be linked to different nodes in Sweden.

The NSC SciLifeLab vision for the next five years

How can interaction and collaboration between SciLifeLab and non-host universities be strengthened?

- Change the leadership of SciLifeLab by including representatives from the major universities in Sweden to form a national Life Science organization.
- Change the name from SciLifeLab to SciLifeSweden and make it a national organization similar to WCMM, see http://wcmm.se/.
- Increase the involvement of the different universities by developing joint strategies for advancement and development of Swedish Life Science infrastructure
- Excellence in platforms at different universities should be connected to SciLifeLab and those that are not of national interest should not be part of or be funded by the national infrastructure.
- The formation of new nodes or extension of existing nodes should be based on bottom up process together with the various universities and SciLifeLab
- Define the role of SciLifeLab in relation to the SFOs.
- Increase the accessibility of SciLifeLab facilities.
- Increase communication about SciLifeLab and transform SciLifeLab into a legal entity.

From your perspective, is SciLifeLab heading in the right direction?

It is very positive that the NSC is now formed and discussions for the future is taking place, which is a major step. Notably, there is a strong and positive engagement from the involved parts. However, there are also worries that the NSCs' task is just to be an advisory entity to SciLifeLab. The current role played by the NSCs' is vague and in a longer perspective may result in less motivation.

How can SciLifeLab continue to strengthen life science on a national level and to keep Sweden at a forefront position in molecular life science?

- To ensure engagement in a longer perspective, a future way could be to organize our universities similarly to Wallenberg Centers of Molecular Medicine (WCMMs), which today are situated at the Universities of Umeå, Linköping, Gothenburg and Lund. The WCMMs were partly started to improve the use of the SciLifeLab resources in a more efficient way. These structures are up and running, including yearly meetings with SciLifeLab, and could easily be implicated in the future organization of SciLifeLab/SciLifeSweden. Importantly, the WCMMs are situated in close vicinity to university hospitals, which greatly boosts the Life Science strategy in Sweden as well facilitating transfer of research results to the Health sector.
- Organize offices with a director at all major universities with the role of information, help and prioritization of applications to the various facilities. This approach could help to keep edge in a larger national perspective (see WCMM).
- Improve the education at all major universities, which has already had a good start with the bioinformatics courses in Uppsala. These courses are good models and should be further developed.
- Increase the number of flagship projects, which should be allocated a special "honor" tag.
- Increase the scientific edge of SciLifeLab/SciLifeSweden, by including already existing analytical facilities at all universities such as Life MR, Metabolomics, MAXIV and in a longer perspective, ESS.
- Define the interaction with the Swedish government, VR, Vinnova and other grant holders.
- Continue to organize analytical facilities such as Genetic Sweden, BioMS, NBIS, CryoEM between Umeå and Stockholm, and Cytof between Linköping and Stockholm.
- Increase interactions with the Health regions in Sweden and also interaction with industry.

SciLifeLab Strategy and Future Plans

This section describes the plans for strategic development of SciLifeLab over the next few years based on the ambitions of the SciLifeLab Board and SciLifeLab Management Group (MG). Some of these developments are currently under or near implementation and others are at this stage only conceptual in nature.

Introduction and Strategy Statement

SciLifeLab is approaching ten years of age and the national infrastructure mission of SciLifeLab is now entering its fifth year. Now we will need to develop a comprehensive and ambitious strategy for the future, while still considering the original regional and national motivations for the launch of SciLifeLab. Here, both milestones reached and the capabilities that SciLifeLab has developed over the past five to ten years, form the basis of the future plans, along with the evolving national and international life science scene.

Sweden is a small country defined by a strong academic and industrial life science track record, which can also boast with: high levels of public and private R&D investment, a highly educated community, strong research traditions, high technology and innovation capacity, a supportive government, and excellent public healthcare coupled with extensive medical registries and biobanks. In addition, Sweden has consistently held a leading position in the EU ranking of countries based on the overall investment into R&D as a fraction of GDP (3,33% in 2017). However, despite this fact, and with a 36% increase in R&D spend during the period 2007–2017, funding has been quoted as being scattered, leading to short-term project-based employments and truncated initiatives at universities with no organizational rejuvenation or long-term transformative results. [1]

Three Swedish universities (KI, UU and LU) rank among the top 30–100 globally, and five more are in the top 100–250 (SU, KTH, Chalmers, GU and SLU). [2] None of these universities can individually compete in life science research, funding or resources with world-leading institutions like Harvard, Stanford, Cambridge, Oxford or ETH. However, combining the expertise and resources from KTH, KI, SU and UU into a consolidated critical mass, creates a multidisciplinary capacity in molecular bioscience at the international forefront. Collaboration, not competition, is the key to sustaining long-term research excellence in Sweden. This collaborative approach is the historical motivation for the launch of SciLifeLab and will be the guiding principle also for its future development. By building on the base of the Stockholm-Uppsala universities, further coordination and inclusion will continue to strengthen the capacity and competitiveness of SciLifeLab, its affiliated universities, and ultimately the whole of Sweden.

Since its launch, SciLifeLab has made excellent progress in reaching, and in many aspects even exceeding, many of the goals originally envisioned. In order to continue this success, a new roadmap for the next decade is required, that also take into consideration the changes in academia and society over the past five to ten years that effect our operational environment, including:

- The funding available for research infrastructures will continue to be limited, further emphasizing SciLifeLab's national role to keep up with cutting-edge capabilities and rapidly evolving technologies.
- Sweden needs to act in a more nationally coordinated fashion and promote collaboration and strong national life science communities to achieve a critical mass internationally in any technology or research field.
- Understanding life in virtually every field will need integration of data from multiple technologies, leading to improved models for a systems-based understanding of the complexity of life.
- Increased collaborations between sectors and research disciplines will be required to address grand challenges in science and society. For example, human health is critically dependent on how we can measure and control the impact of the environment, life-style and the "exposome".
- Life science is increasingly dependent on e-infrastructure and processes for big data management, integration and analysis.

[1] https://www.universityworldnews.com/post.php?story=20190117082309111

[2] https://www.timeshighereducation.com/world-university-rankings/2019/world-ranking#!/page/0/length/25/sort_by/rank/sort_order/asc/cols/stats

SciLifeLab's national infrastructure network, broad research community and the strong collaborative research centers in Stockholm and Uppsala allow Sweden to better leverage its strong assets by enabling research, collaborations and impact that otherwise would not be possible. We aim to develop the SciLifeLab concept to the next level, for the benefit of not only the life science community but also for society in general through our key pillars of unique research infrastructure, world-class collaborative scientific community, and impact on society as reflected in our mission statements:

- to provide unique and enabling infrastructure for high-impact molecular life science research.
- to facilitate internationally leading collaborative research in a community of excellent scientists.
- to promote translation of biomolecular research findings into lasting societal benefits.

Infrastructure:

SciLifeLab's national research infrastructure has a significant track record of achievements, and its relevance to the Sweden's life science community as a whole is now better acknowledged than previously. Progress in life science today continues to be highly dependent on the cutting-edge research infrastructure capabilities, i.e. new technologies, equipment, data analytics and focused expertise that SciLifeLab offers. Moreover, equipment and key instruments will continue to become even more expensive, their operation more demanding, and their replacement/upgrade cycles even shorter. Therefore, it is not possible for a country the size of Sweden to otherwise maintain the spectrum of cutting-edge infrastructure and critical mass of technical expertise provided by SciLifeLab solely by all of its universities and across all life science disciplines.

SciLifeLab provides access to its cutting-edge and essential infrastructure in a coordinated fashion guaranteeing all users the same terms through its national facilities. Therefore, a single investment in life science infrastructure can benefit scientists broadly and in a far-reaching manner, across the universities, scientific disciplines and sectors. The infrastructure and capabilities at SciLifeLab are particularly important for smaller universities and organizations, narrow fields of research, and new research groups with limited funding, including young researchers who would not otherwise easily be able to afford or maintain such capabilities. However, continued and increased national engagement is necessary for developing SciLifeLab as a common national infrastructure platform. While researchers in e.g. basic biology, human health, evolution, ecology and agriculture already make extensive use of SciLifeLab services, we see significant not yet utilized opportunities also in environmental research, climate change, and biotechnology applications. Furthermore, SciLifeLab needs to continually evolve and develop to meet the challenges of the future. SciLifeLab has a particular edge to function as a test-bed for new technologies, facilitate major technology transitions and providing scalability for national needs in terms of new critical technologies. Thus, we will try to evolve SciLifeLab to become more agile in this respect.

Infrastructure vision 2025: SciLifeLab infrastructure will enable research that would not otherwise be possible in Sweden by: i) agile responsiveness to develop, adopt and scale-up of new technologies and services, ii) coordinated national funding, deployment and maintenance of infrastructure platforms and capabilities, iii) facilitating the use of multiple complementary technology platforms for comprehensive understanding of life and iv) promoting data-centric open-access life science practices. These capabilities build upon the inherent opportunities and advantages of the national SciLifeLab infrastructure model.

Research community:

The second key pillar for SciLifeLab is founded on its collaborative research community and the associated synergy between established research groups, new international recruits, research disciplines, and universities working in close collaboration with the research infrastructure. The scientific productivity of SciLifeLab in terms of publications and citations is excellent and many research projects are internationally leading. SciLifeLab began as research centers in Stockholm and Uppsala, facilitated by the dedicated support of the government strategic research area (SFO) funding program. Today, SciLifeLab research is supported by many sources, but the SFO funding still forms an important funding base for the Stockholm and Uppsala SciLifeLab research centers, including the SciLifeLab fellows' program. A central asset to the research environment at SciLifeLab is the recruitment of international young PIs through the SciLifeLab Fellows program supported by the SFO funding. SciLifeLab fellows' program has already been a success, despite early challenges and continued evolution. Funding of the research community programs (RCPs) and technology development projects (TDPs) represent the first steps to link up research and technology development with the national infrastructure, and to expand the SciLifeLab research sphere outside Stockholm and Uppsala to a national level. Further development of the collaborative research communities in Stockholm (Campus Solna) and Uppsala is needed, and an urgent source of uncertainty is whether the SFO funding program (which consists of 43 different programs in all fields of science) will continue as the SFO program was originally meant for term-limited strategic purposes. We will work with the host universities to assure that young scientist recruitments and career development programs, such as the SciLifeLab Fellows' program, and the related National Molecular Medicine Fellows (NMMP) program, will continue to receive priority nationwide.

Research community vision 2025: SciLifeLab will bring together multi-disciplinary research capabilities across Sweden and internationally, based on the cutting-edge infrastructure, to foster collaborative research and grand challenge opportunities that would not otherwise happen. SciLifeLab research environment attracts the best young group leaders to Sweden and promotes recruitment, training and career development of young scientists.

Societal impact:

The third pillar of SciLifeLab is the capacity for translating research and technologies into societal benefit, including impacts on health, environment and industry. SciLifeLab has already accomplished significantly in supporting the health care providers to incorporate novel technology, in particular pioneering the diagnostic implementation of clinical genome sequencing. The translational research initiatives in clinical genetics and genomics initiated within the realm of SciLifeLab are now being adopted by all medical universities and healthcare regions in Sweden, and being run as the major national program Genomic Medicine Sweden (see Appendix E). Concomitantly, the Drug Discovery and Development (DDD) platform has made major achievements in developing academic research findings into potential drug candidates and opportunities for economic growth, including two drugs that have reached clinical trial stage and several investment deals. The white papers on industrial and clinical collaboration (Appendix D and E) highlight some of these areas and the future plans that are of crucial importance to the next phase plans for SciLifeLab. We believe there are major opportunities to be realized for SciLifeLab in the health care and industrial collaborative interface.

Impact on Society vision 2025: The technologically advanced, interdisciplinary and multi-university research environment provides an attractive opportunity to promote collaborations with healthcare, environmental stakeholders, industry and the society at large. SciLifeLab will facilitate translation of new diagnostic and therapeutic opportunities that would not otherwise enter clinical testing or medical use. SciLifeLab will promote application of its technologies and expertise to monitor the environment, climate change and the impact of the environment and lifestyle on human health. We will leverage SciLifeLab technologies, expertise, collaborative research community and life science data to advance opportunities and innovation potential for the industry.

The future strategy for SciLifeLab is based on the three pillars described above and SciLifeLab has shown that by strategically invest into a coordinated national effort in molecular bioscience delivers great research and benefits for the whole country (Figure 41). While SciLifeLab is specifically tailored to Sweden's unique context, we believe this model could also provide inspiration for other countries and regions to follow in dealing with universal infrastructure challenges. [1]

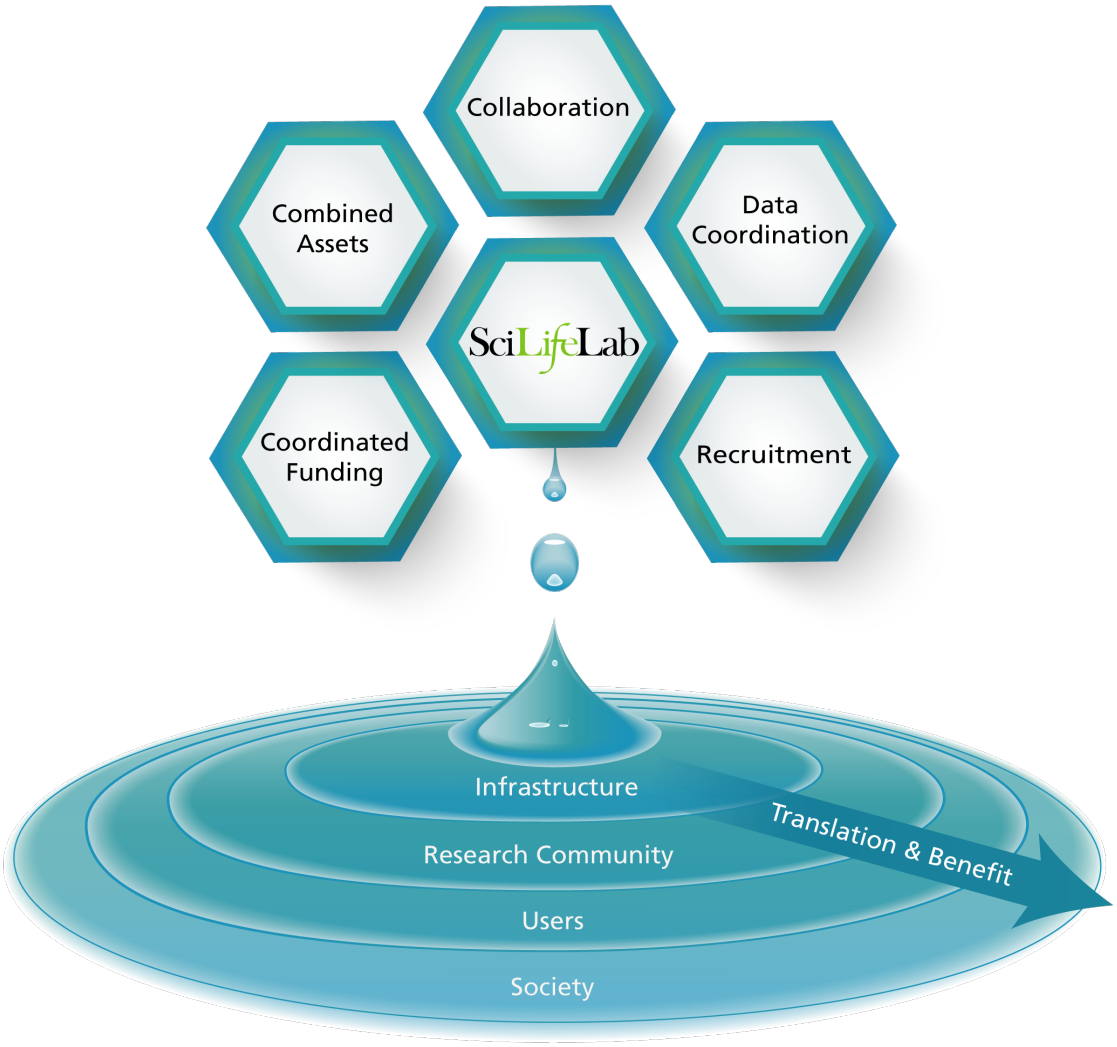


Figure 41. Illustration envisioning the ripple effects of SciLifeLab's coordination of national funding, assets, recruitment, data coordination and collaboration to create a central research infrastructure which together with a strong associated research community empowers users across Sweden to translate science into benefits for society.

[1] https://www.sciencemag.org/advertorials/scilifelab-model-explained

Future Plans for SciLifeLab

For the upcoming next four-year funding period (2021–2024), we aim to execute and evolve SciLifeLab's vision and mission to achieve the following goals:

- Provide capabilities enabling research that would not otherwise be feasible.
- Recruit and retain international young scientists who would not otherwise have chosen to come to Sweden.
- Catalyze research collaborations that would not otherwise happen.
- Create medical, industrial and societal benefits that would not otherwise be possible.

A summary detailing our strategies is outlined below:

1) Improve national coverage and impact:

We will develop towards a complete national model, which is key to the continued development, branding and impact of SciLifeLab. This goal will be supported through a number of action items:

a. SciLifeLab as a fully national research infrastructure: We will establish a relationship between SciLifeLab and non-host universities, engaging the relevant stakeholders across the country in decisions on how future infrastructure will be developed and how it will evolve (see point no. 2a below).

b. Promote capabilities for addressing national and global grand challenges: We will brand and develop SciLifeLab as a collaborative platform for catalyzing transformative, technology-based life science research, such as capabilities to solve grand challenges in life science (4d).

c. Develop SciLifeLab as the national hub for life science data: Through the SciLifeLab Data Centre (DC) and the SciLifeLab Bioinformatics Platform (NBIS), which is also the ELIXIR node of Sweden, we will establish services and resources for life science data that will strengthen SciLifeLab's role as a future data hub in Sweden.

d. Engage and impact on other sectors of Swedish society: We will proactively develop SciLifeLab towards a national collaborative hub and a community of stakeholders in health care, environment, industry and other societal sectors. The recently granted VR funding for the formation of a SciLifeLab External Relations Office is a key step in this direction (4a, b and c).

e. SciLifeLab as a hub and voice for the national life science community: We will further engage SciLifeLab in both national and international dialogs on life science research. This is an emerging role through: contributions to policy development, public engagement, interaction with the government life science office, and promotion of Sweden internationally. This is dependent on a clear and uniformly accepted profile and mandate for SciLifeLab.

2) Governance and Structure:

Delivering on our goals for development is dependent on SciLifeLab's ability and freedom to operate in a dynamic and efficient manner within our complex multi-stakeholder environment. The plans described below thus address SciLifeLab's operational capacity and ability to build a national community for life science.

a. Achieve improved integration across multiple decision bodies: SciLifeLab has evolved as a result of separate government funding decisions and steering of these major funding streams are different: SFO funds are controlled by the SciLifeLab committees at the host universities, and the National/DDD funding by the SciLifeLab Board. Overall, executive management and integration rests upon the MG and Operations Office at SciLifeLab, but are dependent on decisions, alignment, feedback and advice from a multitude of other parties including i) the SciLifeLab Board, ii) the International Advisory Board (IAB), iii) the Rectors' council, iv) the SciLifeLab committees at the host universities (SFO funding), v) the National SciLifeLab Committee (NSC) vi) the Campus Solna Committee (CSC), vii) University- and department – specific decisions on Human Resources (HR), legal, finance, purchasing etc. Therefore, SciLifeLab often has tasks at hand that it can only execute with the help and support of multiple other parties. Dozens of people are regularly engaged in discussing and steering the various aspects of SciLifeLab functions and the IAB will meet most of them. In the future, it is important to emphasize the role of the SciLifeLab Board as a key decision maker on national funding. Also, closer coordination is needed between SFO decisions from individual host universities and the SciLifeLab Board.

b. Explore legal challenges in operating SciLifeLab. SciLifeLab's role as a national research infrastructure is funded by the government and requires all facets of SciLifeLab to act in an integrated fashion in order to effectively serve the Swedish life science community. To fulfill its objectives and

maintain scientific excellence, SciLifeLab is highly dependent on close, committed contributions and interactions between the host universities. SciLifeLab also functions as a research community integrated with infrastructure and it is therefore responsible for a mission that may need to be executed as a distributed multi-university endeavor. SciLifeLab will need the capacity to formally connect and engage the community with healthcare, industry, international and other external entities not only for access to infrastructure, but also in research collaborations, joint technology development, society challenges and so forth. There are also many IT, data, IPR, confidentiality, HR, finance and related practical internal legal challenges. Designating a single host university for formal legal representation of specific platforms within SciLifeLab (such as the DDD platform in 2018 with UU as a legal host) has been adopted as a temporary solution to solve urgent practical problems. However, fragmenting SciLifeLab into separate platforms, under separate host universities and each with their own branding is not sustainable long-term either. Therefore, SciLifeLab is together with the host universities planning to identify sustainable and mutually beneficial solutions for the future. As the strength of SciLifeLab lies in its close and interconnected relationship with the host universities, the aim of this investigation will be to identify alternatives that do not compromise the SciLifeLab-host university relationship. Rather, we hope to identify solutions that will strengthen the roles and impact of all parties involved.

3) Next generation infrastructure development:

We need to carefully plan the development and next phase of SciLifeLab's national infrastructure. The national infrastructure is the mission-critical core engine of SciLifeLab and key to the success of all other SciLifeLab strategies.

a. Community engagement to plan the next phase of SciLifeLab infrastructure: We will engage the national community, including infrastructure committees of host and non-host universities, host university SciLifeLab Committees and the National SciLifeLab Committee (NSC) in the planning of the next phase of the SciLifeLab infrastructure. This will also include the SciLifeLab research community, the broader user community, and TDPs/RCPs. The universities also have their own reference groups for planning of research infrastructure, the Universities' Reference Group for Research Infrastructures (URFI). The URFI groups' work is also relevant to SciLifeLab in the life science area. These discussions will focus on the general principles of SciLifeLab facilities and platforms, criteria and expectations.

b. Define the infrastructure areas where SciLifeLab will be active: SciLifeLab infrastructure services cannot spread across all the different technology areas unless significantly more funding is made available. Since there will be more need for investments in equipment renewal, data management and new service areas in the future, the base funding to the present platforms is likely to decrease. We will therefore define through community interaction as to: i) which technology areas SciLifeLab will remain engaged in as a key player (e.g. omics, bioinformatics, cell imaging, chemical biology, DD and DDD), ii) which areas where SciLifeLab is unlikely to be engaged (e.g. biobanks, animal facilities and iii) which areas where SciLifeLab's role could be considered to expand (e.g. in vivo imaging, protein production, synthetic biology etc.).

c. Focus on platforms as a key way to structure to improve evolution: Previously, SciLifeLab has generally funded individual facilities directly, which then have been combined administratively under six platforms. Transitioning towards a platform-level funding approach could in the future enable more flexibility and autonomy to change course or create new openings. Platform-oriented funding is already performed in practice for DDD and to some extent in the DD platform, increasing the role and responsibility of the platform steering/advisory groups. In the future, we plan to progressively provide funding to platforms that in turn allocate funding to their facilities and/or infrastructure networks. This provides the opportunity to coordinate research and technology development projects at the platform level. Therefore, the unit to be assessed during the international evaluation will be primarily a technology area/platform. Planning of platform-based evaluation has been discussed with the SciLifeLab Board and funding has been allocated for this (section *Key challenges and opportunities to be discussed with the IAB question no. 2*). The task is to identify specific technologies and national services to be launched, developed, maintained, or phased out within each area. The outcome of this planning will then form the core material for the next international evaluation of SciLifeLab infrastructure taking place in early 2020.

d. Increase cross-platform projects: An important principle for SciLifeLab is the synergy across platforms and the ability to provide complementary multi-platform services and capabilities for e.g. systems biology, systems medicine, immunology, spatial molecular pathology, biomarker discovery or environmental research. Today, about 13% of user publications already make use of more than one SciLifeLab platform in their research. This is a major differentiating factor for SciLifeLab nationally (as compared to other funders and operators of infrastructure, such as VR networks) but also in international comparisons. Therefore, SciLifeLab should not change, add or delete technology capabilities without considering carefully how this will impact on the opportunity to launch comprehensive services and resources for research.

e. Continue work towards a data-centric SciLifeLab. A central aspect of the synergy and overall value of SciLifeLab

comes from the data produced. We will better integrate bioinformatics with laboratory services to ensure all SciLifeLab data will be delivered to users in ways that facilitate sustainable and responsible downstream bioinformatic analysis and data management. We will also continue to develop and enable the DC to build and host data resources and services, provide state-of-the-art IT capabilities to our service platforms and researchers, and provide expertise on data management, bioinformatics and IT processes concerning research data. The DC will be critically important towards establishing SciLifeLab as a data hub and promoting open data principles (FAIR) and dealing with sensitive data (GDPR).

f. Increase availability of data and results. We will, through our DC, track and host scientific data and results produced at SciLifeLab to maximize impact and availability. Data and results produced at SciLifeLab facilities are owned by the universities and the researchers that use our services, thus we have no mandate to take charge of the data. Instead, we will stimulate community building and data sharing/tracking by providing high quality services for data management to Swedish researchers. This includes i) the provision of a common data delivery portal for our service platforms, ii) requirement of data management plans from users, iii) provide access support and security for sensitive data, such as human genomics data, iv) establish meta-data services and supported pipelines for data submissions to public repositories, such as at the EBI, v) both develop large-scale data resources and, in some cases, provide the e-infrastructure to host them, and vi) consider research-developed data resources or bioinformatic toolboxes to be eligible for facility funding.

g. Strengthen IT services for our platforms. IT permeates the operation of our service platforms in every aspect. In order to produce research data with high quality and impact, the facilities need a robust and well-functioning IT environment. In cooperation with host universities, we will establish a central IT function that can facilitate their needs in a way that improves their operations, and coordinate services across all platforms in a cost-efficient way. IT needs to be a well-integrated core function at SciLifeLab, enabling the cross-platform state-of-the-art IT services required for a data centric SciLifeLab and good data-intensive research practices. Executing this ambition in the multi-university organization of SciLifeLab will be difficult and requires strong interaction with the host universities, mandates for IT and data representation, and the legal representation discussed in other parts of this report.

h. Alignment with other infrastructure funders: We will increase coordination of SciLifeLab funding in dialog with the other major infrastructure funders in Sweden, particularly with VR – the National Research Council, such that life science infrastructures as a whole are better coordinated on a national level. VR has seen its infrastructure funding budget decrease over the last 4-year period. In addition, KAW is also spending less on infrastructure funding than before. This emphasizes the continued importance of SciLifeLab as a national life science infrastructure and its national role in providing access to key cutting-edge infrastructure to the Swedish research community.

i. Integration with regional and local infrastructures: We will ensure links from our national facilities to regional infrastructure networks and local infrastructure services. For example, the Cryo-EM central facilities in Stockholm and Umeå are already closely collaborating with regional nodes with smaller Cryo-EM instruments. The DD network will ensure health care implementation nationally through local Clinical Genomics facilities in parallel to the GMS program nodes.

j. Links to other national infrastructures: We will continue our dialog, planning, and identification of synergies with the other two major national infrastructures in Sweden: MAX-IV and ESS. SciLifeLab's structural biology capabilities can be combined with those of MAX-IV and these two major national infrastructures can set up collaborative resources for the life science community. Other areas of interest include maximizing synergies with national initiatives on artificial intelligence and machine learning, as well as industrial initiatives on biologics manufacturing such as the Testa Center in Uppsala.

k. Relation of SciLifeLab with international infrastructures: While SciLifeLab is predominantly a national infrastructure organization, we will investigate the possibility to increase access to international academic users. One way to accomplish this is via the European Strategy Forum for Research Infrastructure (ESFRI) pan-European infrastructure networks, where the four SciLifeLab host universities are already partners. For example, the SciLifeLab bioinformatics network (NBIS) is the national coordinator of ELIXIR in Sweden. KI, KTH, LU, GU and UU are members of the EATRIS translational research network which could promote industrial application of SciLifeLab services. SciLifeLab Genomics platform – National Genomics Infrastructure (NGI) is providing international access via the EASI network.

l. Funding Strategy for major equipment: SciLifeLab currently provides an annual depreciation support of about 10 MSEK/year for major equipment within its national infrastructure based on annual applications. Increasing this to 20 MSEK (about 10% of the total SciLifeLab national funding) is likely to be needed to ensure the continued evolution of our platforms and their cutting-edge equipment. This will proportionally reduce the basic funding available for the facilities and platforms. The depreciation support will be front-heavy during the first two to three years to enable rapid entry of latest technologies and we thus expect the host universities and facilities to contribute more over the subsequent years as service

income from new investments will hopefully also increase.

m. Funding strategy for technology development: We will continue the RCP and TDP programs (co-funded with SFO funds from host universities) to build facility-associated research communities. SciLifeLab facilities can spend up to 20% of their SciLifeLab basic funding for internal R&D, preferably in collaboration with the research community, fellows, and RCPs. The future development of the infrastructure is critically dependent on a close collaboration between researchers and the infrastructure, and hence depends on both SFO and national funding.

n. Facility and platform agreements: The primary way by which SciLifeLab can control how its facilities and platforms function is through facility and platform agreements that set the criteria and expectations that facilities need to fulfill to be eligible for funding. The exact text in these agreements will be edited and the adherence to these agreements will be monitored. For example, we will emphasize the branding aspect and the good facility practice, data handling etc.

o. Branding of national SciLifeLab infrastructure: We expect all platforms, whether jointly funded or only SciLifeLab funded, to more systematically brand their activities under the SciLifeLab name in comparison to the platform-dominated branding that dominates today as a result of e.g. long-term VR funding decisions (e.g. NGI, NBIS, CBCS etc).

p. Career Development of infrastructure staff: The SciLifeLab infrastructure staff is one of the most valuable assets of SciLifeLab. Thus, attracting and maintaining this staff is key to SciLifeLab's continued success. We have now budgeted 2 MSEK/year to help with education, training and special skills development of infrastructure staff. We will also discuss with the host universities to facilitate more transparent career paths for staff within our national infrastructure and work with community building initiatives aimed at the infrastructure staff. Host universities are also engaged in relevant international efforts to improve career possibilities for infrastructure staff, such as implementing the HRS4R strategy of the European Commission to improve HR strategies (UU). [1]

4) Strengthening the SciLifeLab research community:

We will profile the research focus areas of the SciLifeLab community. Today SciLifeLab has a strong infrastructure, excellent research quality and a strong brand, but it is not a very strong and cohesive community with a clear focus and a strong sense of a community with a joint mission. Improving this will be a critical step requiring several strategies for Stockholm, for Uppsala, and for the broader national community.

a. Criteria, expectations and benefits of SciLifeLab group leaders: We are redefining the criteria, benefits, responsibilities and expectations for SciLifeLab group leaders and preparing a plan for a formal formation of the SciLifeLab community. This will be critical towards operational principles for the joint Campus Solna space in Stockholm, but also for the national SciLifeLab community at large. Status as a SciLifeLab affiliated group leader must be attractive to retain the best researchers but also involve the responsibility to support SciLifeLab's vision and mission.

b. Joint PhD and postdoc programs. There need to be tangible benefits to become a SciLifeLab group leader and to promote community formation. One such initiative (suggested by several host universities) is a plan to open a joint postdoc program. This could be launched in a way that only two SciLifeLab group leaders at different universities, or between a platform and a scientist can apply, as suggested by the IAB at their last visit. A graduate school with activity across SciLifeLab host universities, associated with the infrastructures, will also be considered.

c. Integration of host university research strategies: This IAB report contains detailed plans from our host universities in regard to their specific research activities at SciLifeLab in the future (section Interactions with host universities). These will be further discussed and joint areas of interest will be identified. This is particularly relevant for Campus Solna, where three host universities are co-located, in order to collaborate and to make use of the infrastructure.

d. Continued development of the SciLifeLab Fellows program: We hope the host universities will continue the SciLifeLab Fellows' program, even if SFO funding does not continue in the same format as today. Considerable efforts have been undertaken to align the SciLifeLab Fellows program across the host universities. However, the basic framework of the program is by necessity defined separately at each university. More attention has been given, but will still be needed, to facilitate a smooth start for new SciLifeLab Fellows. Integration of SciLifeLab Fellows to the Campus Solna environment continues to be a focus, where collaboration and access to the national facilities are a priority. We would also like to see that SciLifeLab Fellows at Campus Solna can continue to be affiliated group leaders at SciLifeLab ("alumni") after their transition back to their respective host departments.

e. Further development of SciLifeLab Fellows program with the Wallenberg Molecular Medicine Centers. Together with SciLifeLab and the Wallenberg Centers for Molecular Medicine (WCMM) we have formed the National Molecular Medicine Partnership (NMMP) with over 100 young group leaders at eight universities. This provides excellent possibilities for research interactions and ca-

[1] https://euraxess.ec.europa.eu/jobs/hrs4r.

reer development for young faculty and we will continue to actively support this interaction through seminars, collaborations, interactions and social events.

f. Next steps for Research Community Programs: SciLifeLab nominated seven RCPs for 2019-2021 with a combination of national and SFO funding by the four host universities. We will promote and expand membership in these new RCPs and will launch additional RCPs, particularly focusing on emerging research areas, and currently underserved areas. The hope is also for the RCPs to act as launching pads for grand challenge programs.

g. Other ways of fostering community engagement: Today SciLifeLab does not have a very strong sense of an inclusive research community. Promoting this in Stockholm, Uppsala and across the heterogeneous and geographically spread community of SciLifeLab will be a major task for the future. This will include symposia, seminar series and retreats, increased communication and branding efforts, as well as a complete re-design of a more interactive and engaging SciLifeLab webpage during 2019. We will look into international examples of community building (e.g. AAAS community engagement programs) and will create a SciLifeLab community engagement strategy in 2020.

5) Future plans for health care, industry and other society interactions:

Driving paradigm shifts in how healthcare is performed, or addressing major environmental challenges, requires the collective effort of researchers from the entire life science ecosystem. The Swedish government has expressed a clear ambition for increasing the access of national research infrastructures to all researchers in Sweden, also beyond academia. Thus, by increasing the capacity for SciLifeLab to engage with these sectors will be key to our future success and for securing the sustainability of SciLifeLab as a national research asset.

a. Expanding collaborations with health care beyond genomics: We will continue to develop SciLifeLab infrastructure services for healthcare through the DD platform on a national level, which will serve as a link from SciLifeLab to healthcare institutions in all regions of Sweden. Genomics is already rapidly progressing towards broad implementation of clinical diagnostics via the GMS program, involving all medical universities and health care regions in Sweden. There are, however, considerable untapped opportunities for diagnostic and clinical research also on e.g. plasma proteomics and metabolomics profiling, microbiome, single cells and spatial tissue analysis. This presents an opportunity for SciLifeLab in the years to come and is discussed further in Appendix E.

b. The DDD platform as a source of translation and innovation: The future of the DDD platform as an integral component of SciLifeLab that will be elaborated to achieve optimal synergy with other SciLifeLab capabilities. DDD will continue to address major unmet therapeutic needs and act as an engine for transforming academic discoveries into new drugs and new therapeutic modalities for clinical trials (Appendix F). By interacting with innovation offices, attracting external funding and driving public-private partnerships, DDD supports translation, innovation and entrepreneurship. DDD will in particular address rare diseases, or biomarker-defined subsets of rare- and common diseases, thereby also contributing to the future precision medicine strategy of SciLifeLab. DDD could evolve either towards industry and public-private initiatives, or towards public, not-for-profit, open science drug development capabilities.

c. Increasing capabilities for industrial collaboration: SciLifeLab will continue to increase accessibility of its infrastructure for industrial users by working with policy makers to develop a sustainable user fee framework, and legislative flexibility towards industry. We will also expand SciLifeLab interactions with industry in joint research efforts, technology co-development endeavors and adoption of new technologies from the industry. Many joint research projects have been launched over the past few years together with the industry on e.g. microbiome, the human secretome initiative and drug development. Beyond biomedical research, there could also be major opportunities in biotechnology, e.g. bioenergy, clean-tech and the paper and pulp industry which are massive unexploited resources. For example, SciLifeLab has recently engaged in the 1000 tree genomes project, which is co-funded by the KAW foundation and a consortia of Swedish paper industries. More details on the future strategies with industry are described in the white paper on industrial collaboration (Appendix D).

d. Branding SciLifeLab as a resource to address grand challenges in society: A core mission of SciLifeLab is to translate biomolecular discoveries into benefits for the society. Beyond this, SciLifeLab capabilities and the community can provide an asset to address major societal challenges in health care, environment and other global themes of national importance or connected to United Nations Agenda 2030 goals. One area of interest is environmental monitoring, particularly sequencing of environmental metagenomes and their associations with climate change. SciLifeLab has recently funded an RCP starting in 2019 on aquatic microbiome, but overall the area of environmental research needs to be further strengthened. Integration of health and environmental monitoring technologies makes SciLifeLab ideally positioned for mapping the exposome, an emerging area examining the health impact of life style and environmental factors.

6) SciLifeLab Campus Solna and Uppsala Navet: SciLifeLab Integrated Research Centers

SciLifeLab Campus Solna

About 600 individuals from the three Stockholm host universities work at Campus Solna including more than 50% of all SciLifeLab national facility staff. Campus Solna is therefore a unique and physically integrated research center spanning three universities, where infrastructure and research meet in a multidisciplinary setting. It is the aligned ambition of the host universities to maintain and develop Campus Solna as an internationally recognized life science center of the highest excellence standards.

The CSC is responsible for the SciLifeLab Campus Solna strategy in accordance with the three-party collaboration agreement between KTH, KI and SU. CSC is composed of the three Scientific and Integration Directors (SDs and IDs) from these universities, together with the Infrastructure Director of SciLifeLab. The Campus Solna Manager is the operational head of Campus Solna and reports to CSC. CSC needs to deal with many practical challenges to make Campus Solna work optimally across all universities, across different disciplines and between research and infrastructure. CSC has made a document detailing the principles of space utilization priorities. The following strategic and practical guidelines are being discussed:

a. Improve leadership functions at Campus Solna: The host universities (rectors and the host university SciLifeLab committees) need to ensure leadership, particularly research leadership for Campus Solna, and provide mandate for the leadership to have sufficient mandate across university boundaries. This would help to deal with the complex day-to-day operations and decisions needed at Campus Solna.

b. Implement processes for space review and allocation: After the initial years' continuous increase in available space in the Alpha and Gamma buildings of Campus Solna, the availability of space is now becoming limited. Several research groups have been in residence since the start of SciLifeLab in 2010. Therefore, processes for releasing space for accommodating new recruitments (e.g. SciLifeLab Fellows) and new facilities are required. Policies for moving in and out exist (Appendix G), but actual turn-over of personnel and groups needs to be coordinated between CSC in dialog with the host universities. This is a complex task, as the host universities also require a mobility strategy for groups moving to and from Campus Solna. For KTH, Campus Solna is a formal campus within the university and for some of its departments the sole location, which makes relocation to another campus complicated. In contrast, KI and SU are preferring a more dynamic space allocation and mobility between campuses within their universities. The Campus Solna Working Group has been given the mandate to work out processes related to implementation of the Campus Solna strategy document (Appendix G).

c. Undertake a scientific review of Campus Solna: According to the aforementioned Campus Solna agreement, the research performed at Campus Solna should be periodically evaluated. CSC and the host university rectors are considering to arrange the first dedicated scientific review of Campus Solna research to ensure that this center will continue to be internationally leading and discuss future research strategies and changes, including space allocations.

d. Improve scientific networking at Campus Solna: Stronger joint functions, activities, and community building activities for all Campus Solna residents (students, postdocs, senior investigators, administrators etc.) and more high-profile internal and external seminar series, retreats and workshops are now being initiated or planned. The SciLifeLab Fellows and RCPs are essential parts of this activity, but also local thematic research themes are now being developed for Campus Solna.

e. Establish better capabilities for visitors and the public: Being one of the two main sites of SciLifeLab, Campus Solna is also the primary physical interface for SciLifeLab towards the public. Campus Solna is a showroom targeting interested organizations and stakeholders, including numerous international visitors, politicians, industry representatives, university leaders and funding agencies. Recently, the conference center located adjacent to the receptions area was acquired by SciLifeLab and will serve this purpose well. Initiatives are being taken to reinvigorate both the conference area as well as the reception and lobby area (Delta) to make it more welcoming, representative and inspiring for visitors.

Plans for the Uppsala Navet campus

SciLifeLab campus Navet is located at the Uppsala Biomedical Centre (BMC) at Uppsala University, where three different faculties are gathered. Navet was built within one of the internal atria of BMC to create a physical meeting place, including offices for SciLifeLab Operations Office staff, conference rooms, as well as seminar/lunch rooms for researchers and staff that have laboratories in the surrounding buildings. We will continue to develop Campus Navet as a creative and inspiring meeting place to facilitate unique scientific questions to be addressed, and where collaborations can be initiated and developed, across both host and non-host universities. We will introduce the opportunity to arrange meetings and seminars at the internal rates of Uppsala University to the whole SciLifeLab community.

Key Challenges and Opportunities to be Discussed with the IAB

This section summarizes the two key areas the Management Group and the SciLifeLab Board wishes to discuss with the IAB during the site visit. The theme of the IAB visit 2019 is to discuss and prepare a new roadmap for the future of SciLifeLab. We would like to place particular emphasis on the overall profile and strategy of SciLifeLab and relate to many of our future plans as defined in the previous section.

Question 1: SciLifeLab plans for the next government budget and beyond, towards the next decade

Our additive value to the universities and overall life science community will justify continued national funding from the government beyond 2020. Along with the numerous stakeholder meetings during the IAB visit, we would like to hear comments and advice from the IAB regarding the plans that we have presented in this document. In order to emphasize the unique and additional value of SciLifeLab, we have developed the aforementioned add-on unique bullet points:

- Providing capabilities enabling research that would not otherwise be possible.
- Facilitating recruitments of international young scientist who would not have otherwise chosen to come to Sweden.
- Promoting research collaborations that would not otherwise happen.
- Creating health care, industrial and society benefits that would not otherwise be expected.

We wish to discuss with the IAB how our action items for the future will help to advance SciLifeLab towards these goals, and how the community of stakeholders is likely to see this as being possible.

Question 2: SciLifeLab plans for the next development of its infrastructure

In the Strategy and Future Plans section, we have detailed steps to plan and execute implementation of the next generation of research infrastructure, including a closer interaction with non-host universities. We hope to achieve a better prospecting of future technologies as well as incorporation and linking of key technology capabilities across the nation with SciLifeLab.

The next SciLifeLab infrastructure evaluation will take place in early 2020, aimed to evaluate the infrastructure funding strategy for the period 2021–2024. These discussions are intended to create a national SciLifeLab infrastructure roadmap and funding plan. As mentioned in the previous section, this is a mission-critical aspect for the future of SciLifeLab, and we must not fail in this process. Therefore, we like to seek advice from the IAB on the infrastructure planning, including:

- The process for ensuring national engagement and acceptance for SciLifeLab to maintain a continued and even increased mandate in developing life science infrastructure for Sweden.
- Platform-centric and data-centric plans for developing the SciLifeLab infrastructure.
- Self-assembly of technology platforms that will develop plans and a roadmap to be presented to the international evaluators/experts in 2020.
- Strategies to ensure that SciLifeLab funding is devoted to the right kind of infrastructure, including prospecting for new emerging technologies, and an approach to decrease investments in already fully developed infrastructure.
- The right balance in terms of achieving the best national infrastructure network for each individual infrastructure area, and the need to ensure multi-platform capabilities, and joint infrastructure for comprehensive life science research.
- Strategies to leverage SciLifeLab funding towards national initiatives for diagnostic development, precision medicine and drug discovery.
- Strategies to leverage the infrastructure and research expertise to create the capabilities needed to address complex research question or grand challenges.
- How should we interact more with national funding agencies such as VR, KAW, Vinnova and others to ensure that the research infrastructures in life sciences will optimally meet the future needs of the complete life science community in Sweden?

Notes


SciLifeLab

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