

May 2025

Evaluation of the Research Part of the University of Luxembourg: Evaluation Report

**Luxembourg Centre for Systems
Biomedicine (LCSB)**



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Prof. Maria Pia Abbracchio (Chair), Prof. Rudolf Aebersold, Prof. Edda Klipp, Prof. Daniel Scherman

Executive Summary

The Luxembourg Centre for Systems Biomedicine (LCSB) is building a position in the relatively new field of systems biology, tackling health and medical challenges, especially those related to neurodegenerative diseases and ageing. LCSB has grown to more than 220 staff members (excluding PhD students) having been successful in attracting strong researchers, despite slow recruitment practices.

Research quality is of an internationally excellent standard overall, with key international publications in the neurodegenerative and rare disease as well as systems ecology fields. While the LCSB has collaborations in other fields, it is not yet a leader in these projects. The Centre has successfully won international grants but needs to find more to meet its needs and further strengthen its international leadership. Research integrity and open science policies are well implemented. The LCSB is well connected to the national and international basic research landscapes, but less with R&D in industry. In line with its mission in research, LCSB makes a relatively modest but useful and focused contribution to the University of Luxembourg's teaching.

Research spans from basic to translational research, but the translational and societal output has the potential to be further developed. Societal impact in terms of outreach to the lay public, and especially high-school students, is particularly strong.

The LCSB is very well organised in terms of support teams covering logistics, infrastructures, operations, innovation, partnering, and grant applications. LCSB has seven very well equipped centralised scientific platforms. Expansion is planned in metabolomics/lipidomics/proteomics and the animal facility. The availability of *in vivo* imaging instruments could be expanded, given LCSB's scope and to foster translational research.

The strategy of conducting systems biology with focus on neurodegenerative diseases, while potentially risky initially, has proven to be successful in supporting basic research and developing some translational activities. However, the internal collaboration and synergy between the LCSB's groups is insufficient. LCSB's organisation and composition are suitable for conducting the research, but its development is hampered by the 5-year rule and time-consuming university processes. Except for salaries for full professors, employment conditions remain attractive in Luxembourg and the short-term human resource strategy is sound.

The Panel recommends LCSB to increase internal synergies among its research groups on the back of the new tandem funding mechanism introduced by the Centre's Director and to develop excellence in a few distinctive areas. LCSB is also encouraged to share its know-how in applying systems biology to complex diseases through collaborations with other University of Luxembourg scientists. Visibility should be improved by taking the lead in more international projects and publications. Gender balance also needs to be improved by applying European best practice.

At the national level, a funding vehicle big enough to address the need for large, integrated systemic projects (> €1million) is needed. To foster translational research, establishing a Medicinal Chemistry Department at the University of Luxembourg and a University Hospital covering neurology in Luxembourg should be looked into. The Panel recommends the University to develop longer-term human resource strategies, taking succession planning into account. Additionally, increasing the freedom of the Centre to make autonomous decisions may help to reduce some of the administrative bottlenecks.

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1 Introduction and background

1.1 Introduction to the evaluation

The Ministry of Research and Higher Education (MESR) of Luxembourg mandated Technopolis Group with the evaluation of the research part of the University of Luxembourg. This evaluation was conducted from May 2024 to June 2025. According to Art. 50/2 of the modified law on the organisation of the University of Luxembourg of June 27th, 2018, based on the original law of 2003, the University is subject to external evaluation every four years. The present evaluation assesses both the research and institutional aspects of the University.¹ The main time period to be covered by this exercise is 2018-2023. Next to a retrospective assessment of achievements, the evaluations' prospective elements include the evaluation of the strategies and plans of the University as well as the evaluators and the panel assessment of challenges and opportunities ahead.

The University's mission, as defined by law, is threefold: to offer higher education courses leading to degrees, diplomas and certificates; to conduct research; and to contribute to the social, cultural and economic development of Luxembourg.

This report is part of the assessment of the research performance of the Universities' 13 research departments and three interdisciplinary centres (ICs) and covers the Luxembourg Centre for Systems Biomedicine (LCSB). The evaluation is based on international external peer review and covers the performance of the IC, taking into account various aspects such as inputs (e.g., finances, human resources, infrastructure, strategy) and outputs/impacts (e.g., research outcomes, innovation activities, services). A separate report covers the assessment of organisation, management, and governance matters.

The observations and recommendations presented in this report are based on a peer review by the following experts working in the research entities' research fields: Prof. Maria Pia Abbracchio (Chair, University of Milan), Prof. Rudolf Aebersold (ETH Zurich), Prof. Edda Klipp (Humboldt-Universität zu Berlin), Prof. Daniel Scherman (CNRS -Inserm – Paris Cité University).

The assessment is based on a self-evaluation report submitted by the IC, background information on the Luxembourg research system information provided by Technopolis Group, and an on-site visit of the LCSB in January 2025. The hearing, which was organised and moderated by Technopolis, consisted of a self-presentation by the research unit and its research groups, as well as group interviews with external partners and clients.

The committee applied the following evaluation criteria and organised the present report accordingly: quality of the research, impact of the research (third mission), and future potential of the research in the IC.

The evaluation team would like to thank all those who helped us prepare the evaluation, those who provided information and those who were interviewed during the consultation.

¹ The external evaluation of the University covers teaching and research activities, central administration and internal organisation. The focus alternates between research and education. All evaluation reports are published by the Ministry. <https://mesr.gouvernement.lu/fr/dossiers/dossiers/rapports-d-evaluations.html>

1.2 The Luxembourg Centre for Systems Biomedicine (LCSB)

LCSB is one of four Interdisciplinary Centres at the University of Luxembourg. It has been founded in 2009 and has grown, at the date of the self-evaluation report, to >220 members, 18 research groups and 7 facilities and platforms which operate at cost recovery rate of 34% and are also accessible to outside users.

The central distinguishing feature of the LCSB is its research focus on a systems approach to study multifactorial diseases, in particular the neurological diseases Parkinson's disease (PD) and Alzheimer's disease (AD). The breadth of the PD research approach which includes exposome and metagenomics in addition to epidemiology, clinical assessment, medical imaging, genetics/biochemistry/cytology, histology, induced pluripotent stem cells (iPSCs) and organoids and typical tissue and cellular research represents a strength and unique feature of the research programme.

LCSB is mainly funded by the state endowment which has grown considerably between 2018 and 2023. Competitive funding is mainly from the National Research Fund (FNR) reaching €5.7m in 2023 with international funding close to €4.4m. LCSB is the first research institution in Luxembourg to employ a fundraiser (since 2013) and has actively acquired philanthropic funding from private donors and foundations in Luxembourg and beyond.

The academic staff of LCSB consists of 11 (9.2 FTE) full professors, 3 associate professors, 2 assistant professors, 71 postdocs and 17 research scientists. Between 2018 and 2023, the number of PhD students increased from 72 to 89, with an average number of 14 PhD graduates per year.

2 Research strategy and organisation

The LCSB operates as a well-integrated research centre consisting of 18 research groups (at the end of 2023, one affiliated professor and one junior principal investigator have since left) and 7 facilities. The Centre underwent a leadership change in 2022. The new director has implemented necessary and effective measures to provide new momentum and to strengthen the Centre, exemplified by internal grants fostering collaborations. It can be expected that LCSB will reverse the recent slight decrease in scientific research impact (as evidenced by bibliometrics).

The central distinguishing feature of the LCSB is its systems approach to study multifactorial diseases, in particular the neurological diseases, PD and AD. The breadth of the PD research approach which includes exposome and metagenomics in addition to epidemiology, clinical assessment, medical imaging, genetics/biochemistry/cytology, histology, iPSCs and organoids and typical tissue and cellular research is a strength and distinguishing feature of the research programme. Recognising the past scientific achievements of the LCSB, the continued focus on PD and AD is supported. The systems biology approach can equally apply to other complex diseases including cancer and immune disorders. The Panel, therefore, encourages the LCSB to share their experience in systems science with other health research institutions in Luxembourg to broaden research and societal impact. The excellent research infrastructure of the LCSB and the tight connection between research and technology are strengths of the Centre with high potential to generally advance life science research in Luxembourg.

LCSB's organisation and composition are suitable for conducting the research and the Centre has established itself in its field as a successful and productive research organisation with good to very good international standing. However, the self-evaluation SWOT analysis as well as the

site visit interviews indicated a number of structural and administrative issues that hamper the further development of the research programme and, more significantly, the mission and ambition of ICs to achieve societal impact. These include the following:

- i) The 5-year limit on temporary contracts. It hampers human resource development and is particularly detrimental for highly qualified scientific staff whose continuity is essential for platforms and facilities.
- ii) Numerous university processes (e.g. procurement, agreements, contracting, ethics approval, appointments and salary scales for key professionals) appear slow, inflexible and poorly aligned with the needs of ICs.
- iii) Funding mechanisms to adequately support inherently interdisciplinary and expensive systems biology projects are not available in Luxembourg.
- iv) Translation of research results to the clinic and society is substantially hampered by the lack of established structures for clinical trials, the lack of a university clinic for neurological disease and sustainable funding to bridge research institutions and clinical centres. In particular, with the Luxembourg National Research Fund (FNR) funding for the national PD centre ending, LCSB discontinuing in-kind support for the centre and the lack of accessibility to advanced imaging techniques to longitudinally follow PD patients could limit the scale of societal impact from LCSB research results. While the interactions between LCSB and Luxembourg Institute of Health (LIH) are promising, they need to be further supported and developed.
- v) Limitations in the capacity to manage and integrate clinical and research data nationally (LNDs) and within the LCSB, the highly competent LCSB IT facility notwithstanding.

Recommendations for the LCSB

- Explore more strongly synergies between the IT/data platform and the computational research groups
- Implement data management/analysis processes that support the combination and analysis of aggregate datasets generated by basic and translational research.

Recommendations for the University

- Work towards establishing an environment conducive to effectively translating research results into the clinic.
- Work with FNR or another funding agency to establish a funding mechanism that is conducive to supporting large, integrated systems medicine projects.
- Assess possibilities to increase flexibility and autonomy of IC administrative processes to facilitate research and address complex societal challenges

3 Quality of Research

The Luxembourg Centre for Systems Biomedicine is a standalone institution of the university with focus on neurodegenerative medicine. The research is organised in three pillars, i.e. experimental biology, computational biology and bioinformatics, and translational research, and undertaken with an interdisciplinary approach. The Centre has produced a significant scientific output in the form of publications (about 90 % of them open access), 12 patents and three spin-offs during the evaluation period.

In the analysis of multifactorial diseases, the teams integrate factors such as lifestyle, genetics, demographics, environment and microbiome. It is perceived that the last step of translation

could be improved if there were a university hospital, but LCSB is also very active in having common or tandem projects with other hospitals.

The bioinformatics core facility is very strong, providing service to the other groups with regard to data analysis and adherence to the standards for data publishing, storing and sharing. Highlights comprise the creation of “Disease maps”, especially a disease map for COVID19, and contributions to FAIR plus and FAIR data management culture as well Responsible Reproducible Research (R3). It is very important that these activities are continued after the lead's retirement.

Several groups also work in computational biology and bioinformatics. For example, the Systems Control Group creates tools for diagnosis and prediction combining AI with mechanistic modelling. The Biomedical Data Science group works on establishing interpretable machine learning that can predict clinical outcomes from data and uses causal reasoning. Computational Biology group investigates brain rejuvenation and uses computational approaches to devise therapies for neurodegenerative disorders and strategies to counteract neurodegeneration. The Environmental Cheminformatics group studies the role of chemical exposure in neurodegeneration. The Systems Ecology group investigates the interaction between humans and their microbiomes, with a special focus on gut microbiome and chronic brain diseases. The Gene Expression and Metabolism group asks how genetic differences influence ageing-related diseases, based on large proteomics data sets. The Integrative Cell Signalling group conducts multi-scale analysis of brain disorders using longitudinal multiomics data for predictive modelling. These groups are very active and innovative as well as important for improved understanding and treatment of neurodegenerative disorders. Some of the ideas encompassing the use of machine learning/artificial intelligence (AI) are still in their early phase, but promising. It appears that a better integration with the groups primarily focussed on biological aspects and methods could strengthen overall progress.

On the primarily experimental side, the Molecular and Functional Neurobiology group focuses on mitochondrial signalling in PD and how to exploit mitochondrial activity for patient stratification. The Enzymology and Metabolism group investigates catalytic dark matter, i.e. enzymes with unknown function, and the pathophysiological relevance of metabolic repair. The Immunology and Genetics groups studies the contribution of metabolism and redox control on neuroinflammation and neuroimmunology. The Developmental and Cell Biology group explores the contribution of neuronal development at different stages of life to PD based on not only patient samples, but also organoids, and personalised deep phenotyping. The Neuroinflammation group studies the adaptive and innate immune systems with various imaging techniques focusing on themes such as α -synuclein distribution and dynamics of amyloid- β and tau in AD. These groups have been productive and created interesting scientific output. Again, improved integration with the computational groups would certainly strengthen future output, especially if there is joint planning of projects from the outset.

In the translational research pillar, the Translational Neuroscience group has deep-phenotyped cohorts and conducts patient stratification for precision medicine by employing a high throughput/high content screening platform to create patient-derived cellular models for early disease onset. The Digital Medicine group performs health care service research, promoting the clinical utility of digital medical devices to support real world healthcare procedures and improve data collection, diagnostics and monitoring. The Translational Medicine group investigates the underlying mechanisms of chronic diseases by studying the impact of the expobiome (or eating habits) on patients with conditions such as Rheumatoid Arthritis, PD and long COVID. These groups have profound impact on translating the research results into clinical measures and patient-relevant outputs. At the same time, they also signal back the relevant research challenges.

Overall, the breadth of research in neurodegenerative diseases with basic research, data analysis and modelling, and translational efforts is unique and strong, leading to a number of important scientific publications.

Recommendations

- Strengthening the interactions between the experimental and the computational groups is important to leverage the unique capacity that LCSB has built up with its bioinformatics and modelling groups. LCSB has the potential not only to create large amount of data but also to valorise them through analysis, model-based prediction and eventually further experimental or patient-related tests of models' predictions.

4 Resources

4.1 Financial resources and infrastructure

Overall, LCSB has been well funded by the university and various grants. The FNR funding has increased from €6.8m in 2018 to €8.4m in 2023, with about two-thirds coming from competitive funding. However, there are worries about increasing competition for FNR funding in recent years with a decreasing success rate, and about the non-competitive funding being adjusted to inflation insufficiently.

Of the €69m total external income acquired between 2018 and 2023, about €44m came from FNR, about €8m from other national funding, about €12m from EU funding, and €5m through other international funding, including an increasing amount of philanthropic funding. One can notice a positive steady increase in EU funding during the 2018-2023 period, with ERC funding received in 2018, 2020 and 2022. In addition, LCSB has been successful in Marie Skłodowska Curie Actions (MSCA), which include doctoral networks and individual fellowships. However, salaries provided by the EU for post-doctoral fellowships are lower than the normal minimal level in Luxembourg, requiring top-ups from the LCSB Director's budget.

The proportion of public funding is much higher than that from private parties. Except for philanthropic funds, little support from public-private partnerships can be identified, with limited collaboration funding acquired from industrial partners during the period. One of the reasons stated for this is the relatively small biotech industry in Luxembourg. Three spin-offs were created during the evaluation period, including one for which a gap in funding has been filled by EU funding e.g. European Innovation Council instruments.

The LCSB infrastructure includes seven scientific technological platforms. The animal platform is being expanded adequately. Database and computing services, as well as laboratory data electronic management, are optimal and well connected to the ELIXIR European data platform, which involves 240 EU Research Institutes. LCSB is the Luxembourgish node of the ELIXIR infrastructure, which has fostered its participation in joint EU projects.

Each platform has an annual budget of approximately €500k, while the rodent facility has an annual budget of €1m. The platforms operate on a cost-based model that does not include water and energy charges. Assistance for grant applications is provided.

The internal budget distribution is coherent with 57% of the funding dedicated to laboratory research, 20% to platforms, 16% to support activity, and 3% for strategy and the Director's budget used to finance "tandem" projects between internal teams.

LCSB is involved in the international NCER-PD cohort in the Parkinson's Progression Markers Initiative (PPMI), a landmark clinical study sponsored by a private foundation. The

discontinuation of FNR funding and consequently in-kind LCSB support for the NCER-PD cohort raises some questions on the extent to which this state-of-the-art cohort study will be sustained despite other funding (internal LIH and external philanthropic) being obtained.

Recommendations

- The Centre needs to find more external competitive funding, especially by diversifying its participation to EU-sponsored programmes, to further strengthen its international networks.
- Philanthropic funding and industrial partnerships should be increased, particularly with the Biotech and Pharma industrial landscape in Benelux and Germany.
- Government-led financial instruments offering a higher level of financial support are strongly recommended for Luxembourg, for instance a funding vehicle large enough to support large, integrated systemic projects (> €1m) that are becoming the norm.

4.2 Human resources, careers, and related policies

LCSB has succeeded in attracting strong researchers and managers. The staff is very international. Except for full professorship salaries, employment conditions remain attractive in Luxembourg. However, high staff turnover, the 5-year rule and the insufficient number of tenured/tenure-track positions waste talent and slow LCSB's development through constant loss of experience and through discontinuities in staffing at the project level. Gender balance should be implemented by introducing the best European practice. Moreover, the share of women decreases going from junior to more senior positions.

Long-term succession planning is necessary. Most of the groups are led by a single tenured principal investigator, which brings uncertainty in terms of sustainability.

Through the University of Luxembourg, LCSB provides a variety of courses and platforms for professional development of researchers, post-docs and PhD students. The path of LCSB alumni is followed, most of them evolving further in the academic field. Internal promotion to junior principal investigator is made possible through a competitive process. Mobility and leave options are regulated centrally by the University, with e.g. the possibility for associate and full professors to take a 6-month sabbatical every 7 years, which seems too short a duration for efficacious knowledge acquisition.

Recommendations

- Where necessary, improve succession planning by involving a second, younger tenured staff member in the research groups which LCSB wants to sustain and in the platforms.
- Promote gender balance and diversity at the principal investigator level.
- The University should offer mobility opportunities that last at least one year every 7 years.

5 Contribution to teaching

In line with its main research mission, the contribution of LCSB to teaching is relatively modest, but falls within the recommendations of the European Commission for research-intensive universities, i.e., translating new research results and new technological advancements directly into teaching.

PhD students and postdocs are well embedded in the Centre's research activities and participate directly in the development of priority research projects. PhD students are supported well in their activities by their supervisors. PhD candidates and postdocs, could

benefit from some common activities, such as periodical scientific seminars and scientific exchange with peers from other institutions. Similarly, complementarity and synergy between young scientists working on different topics could be increased to ensure the training of new interdisciplinary experts who are able to address global challenges and to quickly adapt to a continuously changing environment.

Finally, a formal Alumni Network could help create an international community of ex-LCSB individuals who could provide a wide variety of different pro bono contributions to LCSB and the University in the future through e.g. contribution to teaching and advice/counsel.

Recommendations

- For both PhD candidates and postdocs, introduce a number of common compulsory activities, such as periodical scientific seminars and scientific exchanges with peers from other institutions.
- Establish a formal Alumni Association to create an international community with a sense of responsibility towards LCSB and the University which could provide a wide variety of different pro bono contributions in the future.

6 Contribution to the third mission

LCSB has been performing excellently in communicating the importance and impact of its ongoing research to Luxembourgish stakeholders and citizens. The Scienceteens Lab, an initiative which was started by LCSB in 2013 and now also involves the wider Faculty of Science, Technology and Medicine, represents a highly successful and outstanding initiative that should be further supported and continue to be implemented in the future.

LCSB has already activated an internal Technology Transfer office working on the protection of its intellectual property and on the activation of collaborations with external entities, including non-profit associations and industrial partners.

Recommendations

- Interactions with external stakeholders (more specifically, companies and start-ups in the biomedical field) should be extended to other international partners.
- Translation of the Centre's scientific results into practical marketable applications would benefit from collaborations focussed on new chemical entities and from the establishment of a University Hospital (see also the other sections). This would increase the Centre's ability to negotiate the commercial exploitation of its know-how and patents, opening new opportunities for a financially sustainable future.

7 Overall assessment and recommendations

LCSB is a young centre in a young university, successfully building a position in the comparatively new and exciting field of systems biology. It is well equipped and funded according to international standards. LCSB is doing good research and has excellent prospects to become a leader in its field, specifically in applying its systems biology approach to complex diseases, building on the centre's accomplishments.

LCSB's strong staff, service support and scientific performance together with its healthy financial position provides a solid platform from which to progress to excellence and building a leading position in the global scientific community.

Overall recommendations

For the LCSB:

1. Develop a well-defined strategy for LCSB's next phase to establish recognisable international leadership by further implementing critical mass in a few distinctive areas of excellence, and by taking corner positions in international projects and publications.
2. Further diversify funding sources and networks internationally, also through attraction of excellent foreign scientists among the ERC grantees.
3. Strengthen synergies among internal research groups and other scientists in the University.
4. Valorise the large amounts of data acquisition through further data analysis, predictive modelling, and validation.

For the University:

5. Streamline and accelerate administrative and governance processes including ethical approvals.
6. Develop longer-term HR strategies at the university level, taking succession planning into account to avoid constant loss of experience and achieve continuity in staffing at the project level.
7. Increase the freedom of the Centre to make autonomous decisions.
8. Increase structural and financial support for commercialisation and entrepreneurship.
9. Continue the efforts to create a university hospital in partnership with government.
10. Consider ways to build the needed capacity in medicinal chemistry by either bringing relevant competences in-house or through strategic alliances with industrial partners.

For the Government

11. Introduce a funding instrument for larger, integrated research projects

