Assessment of Research Quality

Science for Life

Bijvoet Center for Biomolecular Research

Institute of Biodynamics and Biocomplexity

Institute of Environmental Biology

Utrecht Institute for Pharmaceutical Sciences

Utrecht University

2010-2015

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Contents

Summary

This report describes the assessment of research conducted at four institutes of Utrecht University's Faculty of Science in the period 2010-2015: the Bijvoet Center for Biomolecular Research, the Institute of Biodynamics and Biocomplexity, the Institute of Environmental Biology, and the Utrecht Institute for Pharmaceutical Sciences. These institutes have joined forces under the umbrella name 'Science for Life' (S4L) in 2015. The assessment was performed by an external assessment committee using the 'Standard Evaluation Protocol 2015-2021'.

The committee is impressed by the **excellent** quality of S4L research: it is a cluster of four world-leading institutes. The scientific output of the S4L institutes is very high in terms of both the number of publications and their citation impact. In addition, S4L researchers have received many marks of recognition from peers during the review period. The institutes harbour an impressive range of technology centres and core facilities and actively contribute to the advancement of technologies and bioinformatics approaches.

The committee judges the relevance to society as **varying from very good to excellent**. The institutes' scientific expertise and the technological developments provide answers to major societal questions related to health, food and environment. The viability of the institutes is also rated as **varying from very good to excellent**. This report contains recommendations on how to maintain and further improve each of the separate institutes and the overarching S4L in the near future. Table 1 summarises the assessment in numerical scores.

Table 1: Quantitative assessment of the research quality of the four S4L institutes[1]

	Research quality	Relevance to society	Viability
Bijvoet Center for Biomolecular Research	1	1	2
Institute of Biodynamics and Biocomplexity	1	2	1
Institute of Environmental Biology	1	1	1
Utrecht Institute for Pharmaceutical Sciences	1	1	1

[1] The four possible categories are excellent (=1), very good (=2), good (=3), and unsatisfactory (=4). See Appendix 4 for an explanation of these scores.

The committee also considered the research integrity policy and the PhD programmes at S4L. The institutes seem to be highly aware of the importance of research integrity measures and integrity issues are frequently discussed. In addition, a course is available, but unfortunately this course is not mandatory and as a result, not all PhD students are exposed to these issues. S4L's PhD students are enrolled in Utrecht University's Graduate School of Life Sciences. In this report, the committee provides recommendations on how to improve the PhD supervision and training at S4L and how to exploit the PhD programmes to nourish the spirit of S4L.

1. Introduction

1.1 Background

This report describes the assessment of research conducted at four collaborating research institutes at the Faculty of Science of Utrecht University (the Netherlands) in the period 2010-2015:

- Bijvoet Center for Biomolecular Research (Bijvoet)
- Institute of Biodynamics and Biocomplexity (IBB)
- Institute of Environmental Biology (IEB)
- Utrecht Institute for Pharmaceutical Sciences (UIPS)

These institutes have joined forces under the umbrella name 'Science for Life' (S4L). The assessment was performed by an external assessment committee using the Standard Evaluation Protocol (SEP) 2015-2021.[1] The primary aim of SEP assessments is to evaluate the quality and relevance of academic research and to suggest improvements where necessary. SEP assessments focus on the strategic choices and future prospects of research groups.

Target groups that are served by this assessment include:

- **S4L researchers and group leaders** need to know how the quality of S4L research, its societal relevance, and its strategy are perceived by independent experts and how these elements can be improved.
- **The Board of Utrecht University** wishes to track the impact of its research policy.
- **The Dutch government** wants to know the outcomes of assessments in connection with the institution's accountability for expenditure and its own efforts to support an outstanding research system.
- **Society and the private sector** seek to solve a variety of problems using the knowledge that S4L research delivers.

1.2 Members of the assessment committee

The board of Utrecht University has appointed as members of the assessment committee:

- Professor Paul Hooykaas, *chair* (Leiden University, the Netherlands),
- Professor Sven Frøkjær (University of Copenhagen, Denmark),
- Professor Sheena Radford (University of Leeds, UK),
- Professor Ove Nilsson (Swedish University of Agricultural Sciences, Umeå, Sweden),
- Professor Michel Labouesse (Institut de Biologie Paris Seine, France),
- Professor Sebastian Bonhoeffer (ETH Zürich, Switzerland),
- Professor Gunnar von Heijne (Stockholm University and SciLifeLab, Sweden).

Dr Linda van den Berg (Washoe Life Science Communications) served as the secretary to the assessment committee. Short CVs of the committee members are provided in Appendix 1.

[1] The SEP was drawn up and adopted by the Association of Universities in the Netherlands (VSNU), the Netherlands Organisation for Scientific Research (NWO), and the Royal Netherlands Academy of Arts and Sciences (KNAW). All research conducted at Dutch universities, university medical centres, and NWO or KNAW institutes is assessed once every six years in accordance with the SEP.

1.3 Procedures followed

The assessment committee evaluated S4L research based on its self-assessment report and interviews with S4L representatives during a site visit in March 2017. The site visit programme is listed in Appendix 2. The committee took into account international trends and developments in science and society as it formed its judgement. In addition, the committee bore in mind S4L's strategy in formulating its recommendations.

Qualitative and quantitative assessment of S4L research

The assessment committee passed a judgement of the four institutes and S4L as a whole based on three assessment criteria:

- **research quality,** i.e., contribution to scientific knowledge, scale of research results (scientific publications, instruments, and infrastructure produced and other contributions to science);
- **relevance to society,** i.e., quality, scale, and relevance of contributions (advisory reports for policy, contributions to public debates, etc.) targeting groups that S4L has itself designated as target groups (patients, the general public, students, and industry);
- **viability,** i.e., the strategy that S4L intends to pursue in the future and the extent to which it can meet its targets in research and society during this period, the governance and leadership skills of its management.

Qualitative assessments were supplemented by numerical scores (1–4) for each of the three criteria.

Assessment of S4L's PhD programmes

The assessment committee also considered the supervision and instruction of PhD candidates at S4L. The committee interviewed approximately 50 PhD students during the site visit and assumes that these individuals provided opinions that are representative of the group at large. The following topics were considered:

- institutional context of the PhD programmes,
- programme content and structure,
- supervision and the effectiveness of programme plans and supervision plans,
- quality assurance,
- guidance of PhD candidates to the job market,
- duration, success rate, and exit numbers, and career prospects.

Assessment of the S4L research integrity policy

The committee also considered S4L's policy on research integrity and the way in which violations of such integrity are prevented. This was discussed during the site visit. The committee was interested in how S4L deals with research data, data management and integrity, and the extent to which a critical pursuit of science occurs at S4L.

1.4 Research unit under assessment: Science for Life

Science for Life (S4L) is a cluster of four collaborating research institutes at the Faculty of Science of Utrecht University (see also Table 2 on page 9):

- **Bijvoet Center for Biomolecular Research (Bijvoet),**
- **Institute of Biodynamics and Biocomplexity (IBB),**
- **Institute of Environmental Biology (IEB),**
- **Utrecht Institute for Pharmaceutical Sciences (UIPS).**

The S4L cluster performs fundamental life science research with the aim to acquire a detailed understanding of life processes **and** to provide solutions for major societal problems. S4L's research is characterised by an interdisciplinary approach and the use of advanced technologies. S4L was initiated in 2015 to facilitate sharing of technological facilities, to increase the critical mass of the fundamental life sciences in Utrecht, and to create an attractive research community.

Embedding

S4L is embedded in Utrecht University's Faculty of Science, which consists of six departments (Chemistry, Biology, Pharmaceutical Sciences, Mathematics, Information and Computing Sciences, and Physics, see Figure 1). This assessment encompasses the entire Department of Biology (IBB and IEB) and Pharmaceutical Sciences (UIPS), and approximately half of the Department of Chemistry (Bijvoet). While the departments are responsible for personnel, finances, and the coherence between research and education, the institutes are responsible for their research quality and strategy.

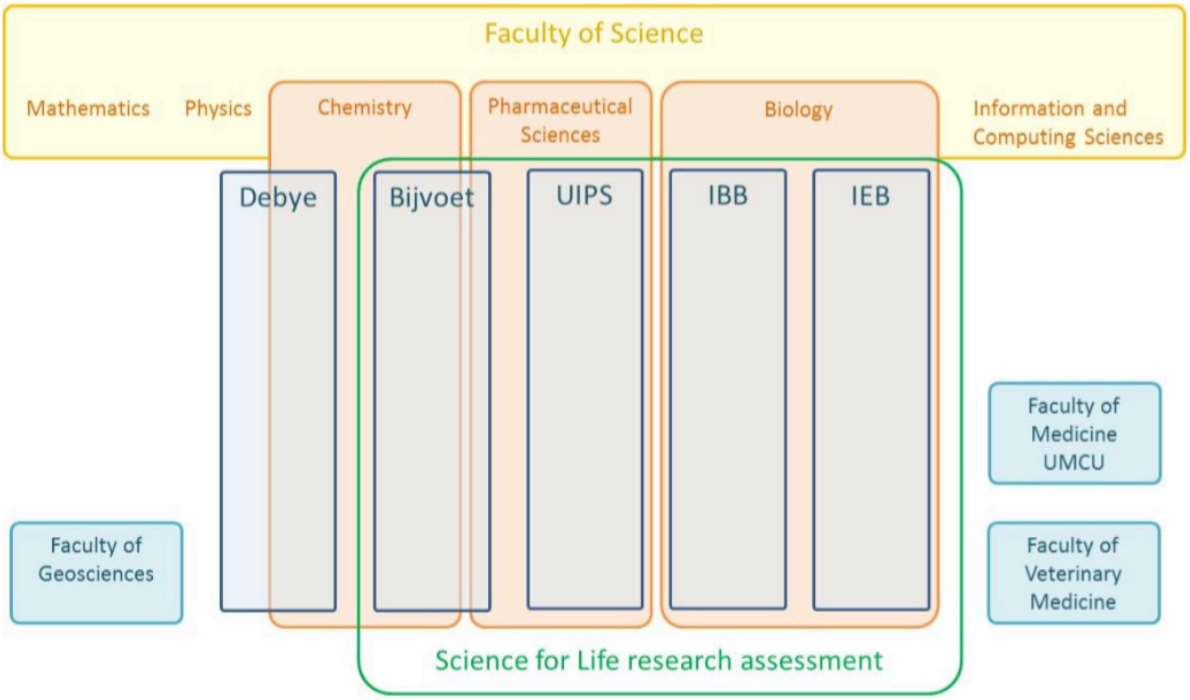

Figure 1: Embedding of the four S4L institutes in Utrecht University's Faculty of Science.

The interaction with the other disciplines at the Faculty of Science promotes interdisciplinary research. The S4L institutes are part of the lively life sciences community at Utrecht Science Park: S4L has intensive collaborations with research groups at the UMCU, the Faculty of Veterinary Medicine, the Hubrecht Institute, and the Fungal Biodiversity Centre. Moreover, 'Life sciences' is one of Utrecht University's four strategic themes. S4L researchers also collaborate with many national and international academic and industrial partners outside Utrecht.

Organisation

S4L is managed by the scientific directors of the four institutes: Professors Baldus, Van den Heuvel, Pieterse, and Heck. The directors coordinate initiatives of the four institutes, initiate collaborations, and ensure the accessibility of S4L's technological facilities and services to all principal investigators. Professor Hoogenraad served as the local S4L ambassador in the start-up phase. As of April 2017, one of the institute directors will be appointed as the managing director on a two-year rotation schedule, starting with Professor Baldus. The new director will further integrate the four institutes into a clear and workable structure, and organise the technology centres and core facilities within S4L. The director is supported by a small team consisting of Werner Most (policy advisor), Martje Ebberink (communications advisor), and Astrid Haijma (financial controller).

Staff, teaching and funding

S4L hosts approximately one hundred principal investigators (see Tables 1.1-1.4 in Appendix 3 for details about the staff of the four institutes). Most scientific staff members are involved in both research and education. On average, permanent staff spends 40% of its time on research, 40% on teaching, and 20% on management and committees. Postdocs and PhD candidates spend 90% of their time on research and 10% on teaching. The teaching activities of S4L staff mostly involve education and training of Bachelor's students within the Undergraduate School of the Faculty of Science and Master's and PhD students within Utrecht University's Graduate School of Life Sciences (GSLS). In 2015, 372 PhD candidates were performing a PhD project under supervision of a S4L institute. All of these students were enrolled in one of the PhD programmes of the GSLS. The average research budget for the combined S4L institutes in 2010-2015 was EUR 38M per year (including salaries), 34% of which was funded directly by the government and 66% was competitively obtained from national and international funding agencies and private funds (e.g., companies and charities). Details about funding of the four research institutes are provided in tables 2.1-2.4 of Appendix 3.

Infrastructure

Advanced technologies and core facilities play a key role in S4L research. The in-house research facilities include the Biology Imaging Center, Electron Microscopy Square, Phytotron (plant and microbe growth facilities), Nanobody Facility, National Single Crystal X-ray Facility, NMR Large Scale Facility, Large-Particle Flow Cytometry Facility, NPC Proteins@Work Proteomics Facility (mass spectrometry), and the Utrecht Bio-Informatics Center. The ambition to transform these facilities into accessible centres of expertise was one of the reasons for launching S4L. Most of S4L's technology centres and core facilities participate in national and European research infrastructure initiatives, such as 'Bioscopy' (a vision for a Dutch research infrastructure that integrates structural biology, imaging, and *omics* technologies) and 'Instruct' (a landmark European structural biology Research Infrastructure on the ESFRI Roadmap).

Table 2: The four S4L institutes in short

Bijvoet Center for Biomolecular Research (Bijvoet) **Research area:** individual biomolecules of which living organisms are built **Current Director:** Professor Baldus **Department:** Chemistry **Core research groups in March 2017:** Biomolecular Mass Spectrometry and Proteomics[1] (Heck), Cellular Protein Chemistry (Braakman), Chemical Biology and Drug Discovery[2] (Boons), Cryo-Electron Microscopy (Förster), Crystal and Structural Chemistry (Gros), Membrane Biochemistry & Biophysics (Killian), NMR Spectroscopy (Baldus) **In-house infrastructure:** Electron Microscopy Square, National Single Crystal X-ray Facility, NMR Large Scale Facility, NPC Proteins@Work Proteomics Facility (mass spectrometry) **Staff:** see Table 1.1 in Appendix 3 **Funding:** see Table 2.1 in Appendix 3 **PhD programme coordinated by Bijvoet:** Molecular Life Sciences
Institute of Biodynamics and Biocomplexity (IBB) **Research area:** fundamental principles that regulate dynamic biological processes **Current Director:** Professor van den Heuvel **Department:** Biology **Divisions in March 2017:** Bioinformatics (Snel), Cell Biology (Akhmanova and Hoogenraad), Developmental Biology (Van den Heuvel), Theoretical Biology (De Boer) **In-house infrastructure:** Biology Imaging Center (light and fluorescent microscopy), Nanobody Facility, Large-Particle Flow Cytometry Facility, Utrecht Bioinformatics Center **Staff:** see Table 1.2 in Appendix 3 **Funding:** see Table 2.2 in Appendix 3 **PhD programmes in which IBB students are enrolled:** Molecular Life Sciences; Biomembranes; Computational Life Sciences; Cancer, Stem Cells & developmental biology
Institute of Environmental Biology (IEB) **Research area:** molecular and ecological life processes of plants, microbes and animals **Current Director:** Professor Pieterse **Department:** Biology **Research groups in March 2017:** Ecology & Biodiversity (Kowalchuk), Plant Ecophysiology (Voesenek), Plant-Microbe Interactions (Pieterse), Molecular Plant Physiology (Smeekens), Animal Ecology (Sterck), Molecular Microbiology (Wösten) **In-house infrastructure:** Phytotron, research greenhouses **Staff:** see Table 1.3 in Appendix 3 **Funding:** see Table 2.3 in Appendix 3 **PhD programme coordinated by IEB:** Environmental Biology
Utrecht Institute for Pharmaceutical Sciences (UIPS) **Research area:** development of effective, safe, and affordable medications for society **Current Director:** Professor Heck **Department:** Pharmaceutical Sciences **Divisions in March 2017:** Pharmaceutics (Hennink), Pharmacology (Garssen), Pharmacoepidemiology and Clinical Pharmacology (Klungel), Chemical Biology and Drug Discovery[2] (Boons), Biomolecular Mass Spectrometry and Proteomics[1] (Heck) **In-house infrastructure:** NPC Proteins@Work Proteomics Facility, Utrecht Bioinformatics Center **Staff:** see Table 1.4 in Appendix 3 **Funding:** see Table 2.4 in Appendix 3 **PhD programme coordinated by UIPS:** Drug innovation

[1] The Biomolecular Mass Spectrometry and Proteomics group is embedded in both Bijvoet and UIPS.

[2] The Chemical Biology and Drug Discovery group is embedded in both Bijvoet and UIPS.

2. Assessment Bijvoet Center for Biomolecular Research

Bijvoet Center for Biomolecular Research in short

Director: Professor Baldus (2016-present), Professor Gros (2012-2016), Professor Heck (2006-2011)
Department: Chemistry
In-house infrastructure: Electron Microscopy Square, National Single Crystal X-ray Facility, NMR Large Scale Facility, NPC Proteins@Work Proteomics Facility (mass spectrometry)
Staff: see Table 1.1 in Appendix 3
Funding: see Table 2.1 in Appendix 3
PhD programme coordinated by Bijvoet: Molecular Life Sciences

Researchers at the Bijvoet Center for Biomolecular Research (Bijvoet) study the structure, interactions, activity, and function of biomolecules. The focus is on understanding the role of biomolecules in the molecular processes that govern cellular functions in health and disease. At the time of the site visit (March 2017), the Bijvoet Center consisted of seven core research groups:

- The Biomolecular Mass Spectrometry and Proteomics group uses mass spectrometry to understand the inner workings of cells (headed by Professor Heck, this group is also embedded in UIPS).
- The Cellular Protein Chemistry group studies the mechanisms and regulation of protein folding and assembly in the cell (headed by Professor Braakman).
- The Chemical Biology and Drug Discovery group focuses on the design and synthesis of compounds with biological or medicinal applications and their interaction with their receptors (headed by Professor Boons, this group is also embedded in UIPS).
- The Cryo-Electron Microscopy group uses Cryo-electron microscopy (Cryo-EM), innovation in 3D image processing, and computational modelling of macromolecular assemblies to characterise secretory pathway proteins in an integrative way (headed by Professor Förster, this group was established early 2013).
- The Crystal and Structural Chemistry group is specialised in structural biology and structural chemistry, applying and developing crystallographic methods for accurate three-dimensional structure determination (headed by Professor Gros).
- The Membrane Biochemistry & Biophysics group studies how biological membranes are built up and how they function at a molecular level (headed by Professor Killian).
- The NMR Spectroscopy group studies biological processes such as signal transduction across membranes and protein folding using a combination of NMR spectroscopy, molecular biology, and computational structural biology (headed by Professor Baldus).

2.1 Bijvoet strategy and targets

Bijvoet's mission is to discover the molecular basis of life. The institute aspires to be a world-class structural biology institute with state-of-the-art equipment. The current trend in structural biology is to determine the molecular structures and dynamics of large molecular machines, ideally when

embedded in the cellular membranes and/or inside cells. To this end, Bijvoet researchers use a combination of advanced technologies, including NMR spectroscopy, X-ray crystallography, electron microscopy, and mass spectrometry. To arrive at truly novel insights, the results from these measurements should be integrated through computational biomolecular modelling, bioinformatics, and big data analysis. The Bijvoet Center aims to exploit its unique combination of expertise, technological facilities, and scientific collaborations to address this challenge at the forefront of international research. This will help answer research questions that have been identified as top priorities on a national and international level.

Local collaborations
During the review period, the Bijvoet Center has strongly invested in collaboration with other research groups at the Utrecht Science Park. As a result, Bijvoet is now strongly embedded in Utrecht University's life science community. Bijvoet's research groups have fruitful collaborations with (and some are partly embedded in) the three other S4L institutes, UMCU, the Debye Institute for Nanomaterials Science, and the Faculty of Geosciences. Bijvoet has stimulated local collaborations by appointing associate members, which has resulted in several very high impact collaborative research papers. In addition, the institute collaborates with many companies at Utrecht Science Park. The Bijvoet Center aims to further intensify these links and strengthen alliances with national and international partners in the near future.

New groups and leaders
To strengthen Bijvoet's membrane research, two groups were merged in 2012 to form the current Membrane Biochemistry and Biophysics group. Moreover, the new Cryo-Electron Microscopy group was established in 2013. Professor Förster became the leader of this group in 2016. Bijvoet was also strengthened by the appointment of Professor Boons (a glycomics and chemical biology expert) and several promising assistant professors: Tzviya Zeev-Ben-Mordehai (Cryo-EM), Celia Berkers (metabolomics), Simone Lemeer (proteomics), Markus Weingarth (NMR spectroscopy), and Bert Janssen (protein crystallography).

Strategy for the next five to ten years
Bijvoet's research groups are uniquely positioned to probe biomolecular activity in relation with its cellular environment over various structural scales and functional levels. A core aspect of Bijvoet's future strategy will be the integration of these scientific outputs, their multi-scale analysis, and the generation of comprehensive quantitative models based on these data. As regards funding targets, the Bijvoet Center is shifting its efforts to alternative funding resources because the funding through the Netherlands Organisation for Scientific Research (NWO) is becoming more and more restrictive. The institute aims to strengthen its alliances with local, national, and international partners (academic or industrial) in order to improve its chances to obtain funding from the European Commission, NIH, and HFSP. In addition, the Bijvoet Center expects to increasingly perform research funded by charities.

2.2 Bijvoet research quality
The committee rates Bijvoet's research quality as **excellent**. Examples of research highlights include the unravelling of the role of Hsp90 chaperones in protein folding (relevant to diseases such as cystic fibrosis and Alzheimer's), the work on membrane soluble proteins, and the mechanistic insights into

complement initiation, amplification, regulation and pore formation, with immediate impact on development of complement therapeutics. The committee also noted that Professor Heck's group performs the best proteomics research in the Netherlands and that scientists from all over the country turn to Utrecht for proteomics research. The arrival of Professor Förster is crucial to complete the institute's repertoire of structural expertise, with a notable recent highlight including the circadian oscillator protein complex and protein translocation complex. Bijvoet researchers have published many high impact scientific papers over the review period, in journals such as Cell, Science, and Nature. The recognition of Bijvoet scientists through national and international grants, awards, and prizes (including the Spinoza prize for Professor Gros), as well as the coordination of national and international consortia also underscores its excellent research quality.

The Bijvoet Center harbours an impressive range of high-end technologies, including NMR, X-ray crystallography, electron microscopy, and mass spectrometry. The combination of these facilities in one place is a unique selling point. Bijvoet researchers use these technologies to study the structure, dynamics, and interaction of biomolecules *in vitro* and in living cells (NMR), the structure of proteins and protein complexes at atomic resolution (X-ray crystallography), the structure of proteins in a cellular context (electron microscopy), and proteomics and the structure of biomolecules in relation to their biological function (mass spectrometry). In addition to supporting Bijvoet's own outstanding research, the technology platforms are available for academic and industrial collaborators, thus further contributing to the advancement of science within and beyond Bijvoet's walls. For instance, Bijvoet's mass spectrometry and NMR facilities participate in European infrastructure initiatives. The Bijvoet Center also coordinates the Dutch arm of the structural biology ESFRI Landmark Project 'Instruct'. The committee values Bijvoet's contribution to the further development of technologies such as NMR and *in situ* Cryo-Electron Tomography (Cryo-ET).

Bijvoet researchers have also developed software tools to study biomolecules, which are shared with other researchers. For instance, they developed HADDOCK, an integrative modelling platform for characterising biomolecular interaction. HADDOCK is offered as a user-friendly web portal that serves more than 8000 users worldwide. It is the most used and cited software in this research area.

2.3 Bijvoet relevance to society

Bijvoet research is **highly relevant** to society because it uses structural biology to find solutions for various societal challenges. A detailed understanding of how biomolecules and cells work in health and disease is key to develop novel therapeutic approaches, more effective medicines, and early diagnostic methods. Bijvoet researchers study diseases such as cystic fibrosis, cancer, Alzheimer's diseases, and viral infections and they perform basic research which is important for the pharmaceutical industry. In addition, insights from Bijvoet research can add to the development of bio-based technologies, plants with improved qualities, and bacteria that produce key materials.

In its self-evaluation, the Bijvoet Center identified three areas of societal relevance: training of excellent students and scientists, collaboration with industrial partners, and outreach to the general public. Bijvoet's PhD graduates become professionals that implement their expertise in universities, research institutes, companies, schools, and governmental organisations. The Bijvoet Center has numerous collaborations with technological and pharmaceutical companies (e.g., Merus, Genmab, Danone, Zobio, Crucell, Merck, Thermo, and Bruker), ensuring that the research results have the

greatest opportunity of being translated into practical applications. Moreover, the institute's research facilities are frequently used by societal groups such as companies and governmental organisations. Several Bijvoet research groups have received funding from charities to discover the molecular basis of disease. Finally, the Bijvoet Center actively encourages its scientists to engage in dissemination of their research results to the general public, which is valued by the committee.

2.4 Bijvoet viability

The committee rates Bijvoet's viability as **very good**. Bijvoet researchers have performed world-leading research in the period 2010-2015 and they are expected to continue doing so. In addition, they have received many grants, prizes and scientific awards. The Bijvoet Center has managed to maintain a fairly stable level of funding in spite of the general decrease in funding through NWO (see Table 2.1 in Appendix 3). The institute is very strong in NMR and mass spectrometry and as a result, it has many fruitful local, national, and international collaborations. The presence of the Chemical Biology group is a strength because it enables the institute to synthesize its own molecules. Bijvoet has identified Cryo-EM/ET as an area of growth, which is applauded by the committee. The institute has excellent leaders and it has demonstrated its ability to attract internationally outstanding scientists (e.g., Professor Förster, Professor Boons, Dr Zeev-Ben-Mordehai, Dr Berkers, Dr Lemeer, Dr Weingarth, and Dr Janssen). This in turn attracts high quality PhD students and other scientists.

However, the committee has also identified potential threats to the long-term sustainability of the Bijvoet Center. The institute has expressed uncertainty about the future continuation of staff positions and financial support for its infrastructure. In addition, maintaining the required level of funding calls for substantial time investments of the scientific leaders. The committee also noted that, while the institute is proud to have recruited Professor Förster and Dr Zeev-Ben-Mordehai, the stakeholders (i.e., institute, departments, faculty, and university) do not seem to have a uniform vision on how to create a budget and machine time for Cryo-EM research. This situation is not viable without further investments. To deal with limited funding for infrastructure and its maintenance, it may be necessary to focus on those facilities that are seen as crucial and ensure they remain or are expanded to cutting edge, while collaborating with other institutes (nationally or internationally) to get access to complementary facilities, even though the broad spectrum of facilities at Bijvoet is a selling point.

Another concern is that Bijvoet seems to lack a clear vision of where it wants to go scientifically: it is unclear if the Bijvoet Center wants to drive biology (then they should clearly define which key biological questions they wish to pursue using their cutting-edge methods) or technology (i.e., provide technological platforms and develop technologies). This is illustrated by the fact that many of Bijvoet's research group names reflect their technological expertise rather than their biological research focus (e.g., 'Biomolecular Mass Spectrometry and Proteomics group'). This in turn reduces the possibilities to obtain funding through national and international public-private partnership programmes. Participation in S4L and increased collaboration with the other S4L institutes may be the best way for the Bijvoet Center to better position itself for participation in large public-private partnership programmes.

More in general, potential discontinuation of staff positions is a major threat to the viability of Bijvoet. The committee also thinks that the number of research groups (seven) is very large and the

number of principal investigators per group is small. The committee noted that there are not many females at the principal investigator level. The committee will provide recommendations on how to deal with the above-mentioned viability concerns in Chapter 7.

2.5 Bijvoet assessment in numerical scores

In line with the qualitative assessment of Bijvoet research described above, the committee has assigned Bijvoet to a discrete category for each of the assessment criteria (Table 3). The four possible categories are excellent (=1), very good (=2), good (=3), and unsatisfactory (=4); the scores are explained in more detail in Appendix 4.

Table 3: Quantitative assessment of Bijvoet research quality

	Research quality	**Relevance to society**	**Viability**
Bijvoet Center for Biomolecular Research	1	1	2

2.6 Bijvoet PhD programme

The evaluation of the PhD programmes of the four S4L institutes will be discussed in detail in section 6.5. The Bijvoet Center organises the PhD programme 'Molecular Life Sciences' within Utrecht University's Graduate School of Life Sciences. The committee learned that the Bijvoet Center was home to 55 PhD candidates in 2015, the majority of which were enrolled in the Molecular Life Sciences programme. Bijvoet's PhD students are offered bimonthly PhD evenings where the PhD candidates present their work without supervisors being present, regular Bijvoet seminars by internationally renowned speakers, an annual Bijvoet symposium where both PhD candidates and international speakers present their work, and expert courses in biomolecular mass spectrometry, protein crystallography, and NMR spectroscopy. Around 80% of Bijvoet's PhD candidates stay in research after graduation, the majority in academic research. In principle, Bijvoet provides an excellent training programme for its PhD students, but there are some aspects that could be improved. This will be discussed more thoroughly in section 6.5.

2.7 Bijvoet research integrity policy

The evaluation of the research integrity policies of the four S4L institutes will be discussed in detail in section 6.6. Utrecht University's 'Code of Conduct for Scrupulous Academic Practice and Integrity' forms the basis of the scientific integrity rules at the Bijvoet Center, in combination with the 'Netherlands Code of Conduct for Academic Practice' of the Association of Universities in the Netherlands. Since early 2016, Utrecht University requires data management plans to be established for all research projects. Bijvoet is in the process of defining its data management policies. Many research groups at the Bijvoet Center currently are in the process of implementing electronic lab journals. Datasets are commonly deposited in appropriate international databases.

Although Bijvoet claims to educate its PhD students about good research practices, the committee noticed that some PhD students were insufficiently aware of the concept of research integrity. In line with this, the committee learned that there is no mandatory course about research integrity for Bijvoet's PhD students. This is unfortunate, especially because the amount of contract research is increasing at Bijvoet. This will be discussed more thoroughly in section 6.6.

3. Assessment Institute of Biodynamics and Biocomplexity

Institute of Biodynamics and Biocomplexity in short

Director: Professor van den Heuvel (2015-present), Professor de Boer (2012-2014), Professor Scheres (2009-2011)
Department: Biology
In-house infrastructure: Biology Imaging Center (light and fluorescent microscopy), Nanobody Facility, Large-Particle Flow Cytometry Facility, Utrecht Bioinformatics Center
Staff: see Table 1.2 in Appendix 3
Funding: see Table 2.2 in Appendix 3
PhD programmes in which IBB students are enrolled: Molecular Life Sciences; Biomembranes, Computational Life Sciences; Cancer, Stem Cells & developmental biology

Researchers at the Institute of Biodynamics and Biocomplexity (IBB) study the biological mechanisms of health and disease in living organisms. By combining *in vivo* observations at the molecular and cellular level with computational approaches and mathematical modelling, IBB aims to achieve a systems-level understanding of complex dynamic processes and their evolution. At the time of the site visit (March 2017), IBB consisted of four divisions:

- The division of Bioinformatics uses genome-scale data to perform research in evolutionary genomics (headed by Professor Snel, this division was established in January 2015).
- The division of Cell Biology seeks to acquire novel insights into the structure and function of cells, to decipher the cellular basis of human diseases such as cancer and neurological disorders, and to contribute to development of diagnostic and therapeutic strategies (headed by Professor Akhmanova and Professor Hoogenraad, this division was established in January 2011).
- The division of Developmental Biology aims to discover the biological principles of normal cell and tissue formation and to translate the acquired insights into benefit for regenerative medicine, anti-cancer strategies, and food production (headed by Professor van den Heuvel).
- The division of Theoretical Biology studies evolutionary dynamics, evolution of development, bacterial growth in heterogeneous environments, host-pathogen evolution, and the immune system using a systems biology approach, involving quantitative biology, mathematical modelling, computer simulation and bioinformatics (headed by Professor de Boer).

The division of Molecular Microbiology, headed by Professor Wösten, was embedded in IBB during the evaluation period, but moved to the Institute of Environmental Biology (IEB) in January 2016. This division studies the molecular mechanisms enabling growth and development of microorganisms in a dynamic environment.

3.1 IBB strategy and targets

IBB's mission is to decipher the biological mechanisms of health and disease. Over the past decades, technological breakthroughs (e.g., imaging, high-throughput sequencing, mass spectrometry, and data analysis) have rapidly created new opportunities and scientific directions in the life sciences.

Now, the field's main challenge is to truly understand how the different elements work together to regulate biological processes. This calls for quantitative and interdisciplinary approaches, which IBB is increasingly implementing. The institute aspires to form an international centre of excellence in quantitative biological research and to create a lively academic environment for talented scientists and students. By focusing its curiosity-driven research on central questions in the life sciences, IBB seeks to contribute to solutions for important societal challenges related to human health, sustainable food production, and biotechnological innovation.

Reorganisation
IBB has been thoroughly restructured during the evaluation period because of the financial situation at the Faculty of Science. In 2012, three divisions left the institute (Behavioural Biology, Biomolecular Imaging, and Molecular Genetics). The division of Molecular Microbiology was embedded the Institute of Environmental Biology in January 2016 to create more focus in the research programmes of IBB and IEB. The reorganisation has resulted in a more coherent institute. Following the reorganisation, IBB has invested strongly in microscopy and bioinformatics. In addition, several new principal investigator positions were created.

Bioinformatics
IBB has invested in a new Bioinformatics division, which started in January 2015. The group is headed by Professor Snel and it will be connected to a special chair in algorithmic bioinformatics at the 'Centrum Wiskunde & Informatica', which is the Dutch national research institute for mathematics and computer science. This collaboration will further strengthen the development of quantitative biology in the Netherlands, which has high priority in the context of data science and handling of big data. Professor Snel's Bioinformatics group coordinates the new Utrecht Bioinformatics Center, providing bioinformatics training and bringing together Utrecht-based research groups with a range of bioinformatics expertise.

Strategy for the next five to ten years
IBB aims to increase its critical mass, coherence, stability and visibility in the next few years. The institute continuously seeks to enhance collaboration between its divisions, for instance through joint grant applications and appointments, as well as organising annual meetings, activities, and retreats. Another future goal is to improve the integration of advanced microscopy, bioinformatics, and modelling approaches.

To increase its critical mass IBB will 1) install a new chair in biophysics, headed by Dr Kapitein, 2) create opportunities for promising young researchers to become group leaders and offer tenure tracks with the potential to become full professors when progress is excellent, 3) interact closely with other research groups in Utrecht, and 4) appoint special professors and affiliated researchers. IBB will also further expand its participation in national and international consortia, largely through joint grant applications. IBB's future funding strategy will particularly focus on personal grants from ERC and NWO, as well as grants with national or international consortia (Zwaartekracht, Horizon 2020). In addition, they will explore possibilities for strategic alliances with industrial partners and for more applied grants (STW). IBB will continue its efforts to secure funding for its microscopy equipment via national investment grants.

3.2 IBB research quality

IBB's research quality is **excellent**, which is reflected by frequent publications in top scientific journals, scientific awards and prizes, and the acquisition of prestigious grants. The Theoretical Biology group headed by Professor de Boer is world-class in developing mathematical and computational approaches to address clinically relevant problems in infectious disease and immunology. The Bioinformatics group has an outstanding reputation for developing innovative bioinformatic tools and for basic research in genome evolution and metagenomics (e.g., the work of Dr Dutilh). Moreover, IBB gathers five principal investigators (Professors Akhmanova, Hoogenraad, Kapitein, Van den Heuvel, and the more recently recruited assistant professor Dr Boxem) who are world leaders in the field of cell architecture, microtubule-based processes, and cell polarity. IBB researchers successfully combine advanced imaging expertise with computational research. IBB's divisions all are very strong research groups that excel in basic science with a quantitative biological approach.

IBB houses state-of-the-art research facilities that it shares with researchers from other institutes and companies. In addition, the institute is leading in developing technology. For instance, the Biology Imaging Center functions as an expertise centre in advanced light and fluorescent microscopy techniques. The centre brings together microscopy-based research at Utrecht University's Faculty of Science, Veterinary Medicine, UMCU, and the Hubrecht Institute. It continuously develops and applies imaging analysis tools. It also participates in the national NL BioImaging AM consortium. IBB also houses the Large-Particle Flow Cytometry Facility, which provides access to the latest model large particle flow cytometer and is frequently used by researchers from other universities. The Utrecht Nanobody Facility within IBB offers technology for the selection and production of nanobodies for academic and industrial researchers. It collaborates with several institutes, academic hospitals, and companies.

The committee particularly values the Utrecht Bioinformatics Center, which provides bioinformatics training and brings together a range of bioinformatics expertise. By coordinating a High-Performance Computation Facility, the Utrecht Bioinformatics Centre provides access to a solid facility to compute the increasing amount of research data that is generated, for multiple research groups from UMCU, Utrecht University, and the Hubrecht Institute.

3.3 IBB relevance to society

IBB's curiosity-driven research is **relevant** to society as it creates new knowledge and possibly true innovation. In addition, IBB is training the future generations through its emphasis on and expertise in imaging and quantitative analysis, which is becoming more and more important in biology. There are many collaborations with industry that facilitate the translation of IBB's fundamental research into practical applications. Several IBB research project have a clinical relevance (e.g., research on cancer, neurodegenerative diseases, immunology and AIDS). IBB's work on the microbiome in human health is highly relevant to society. During the review period, IBB collaborated with companies such as DSM, Dupont, Heineken, Unilever, C4C, Crucell, GSK, QVQ, U-protein Express, Synthon, Philips, Crossbeta Biosciences, Unilever, Eisai Corp, PharmaMar, Union Biometrica, AquaGEN AS, BASF, Pepsico, Bayer, and Leica. In addition, the institute offers its technological facilities to companies and IBB members obtained seven patents in the period 2010-2015.

However, maybe due to the reorganisation, the institute has not yet established a clear strategy for the whole institute as to branding, valorisation, and creating societal relevance. As it is now, this seems more the *ad hoc* responsibility of each individual staff member in the institute. This is certainly not without success, but it could be further improved by a clear strategy at the level of the institute.

In its self-evaluation, IBB mentions four levels of societal relevance: training high quality scientists and critical minds, generating a deeper understanding of human health and disease, executing applied research projects with a focus on cancer therapy and collaborations with industry, and performing outreach activities to the general public and high school students. The IBB staff trains students to become professionals that implement their talents in universities, institutes, companies, schools, and governmental organisations. The committee particularly values IBB's education efforts in quantitative biology, because future biologists will need quantitative skills. In addition, the institute encourages its scientists to engage in outreach activities, including high school projects and visits, which is valued by the committee.

3.4 IBB viability

IBB is an institute of great potential with **excellent** viability. The reorganisation has resulted in a much more focused institute with a relatively young staff. The institute gives the impression of a coherent, well-functioning group, consisting of two subgroups (i.e., cell biologists and quantitative biologists) that are very willing to collaborate. IBB harbours several strong young group leaders and the atmosphere appears excellent. IBB researchers have been successful in obtaining personal grants and the amount of funding per researcher has seen a substantial increase in the period 2010-2015, despite increasingly intense competition and reduced governmental funding.

The institute's state-of-the-art technological facilities constitute a magnet for talented students and researchers. The committee underscores the high importance of research-driven bioinformatics as performed by Professor Snel's group. The group has a clear vision of what bioinformatics should be. The committee applauds the plans to establish a new biophysics group in close connection to biophysics groups within the Departments of Chemistry and Physics. The intended group leader Dr Kapitein seems to have a very clear vision and strategy.

3.5 IBB assessment in numerical scores

In line with the qualitative judgements of IBB research described above, the committee has assigned IBB to a discrete category for the three assessment criteria (Table 4). The four possible categories are excellent (=1), very good (=2), good (=3), and unsatisfactory (=4); the scores are explained in more detail in Appendix 4.

Table 4: Quantitative assessment of IBB research quality

	Research quality	**Relevance to society**	**Viability**
Institute of Biodynamics and Biocomplexity	1	2	1

3.6 IBB PhD programme

The evaluation of the PhD programmes of the four S4L institutes will be discussed in detail in section 6.5. The committee learned that IBB was home to 57 PhD candidates in 2015. These students were enrolled in four different PhD programmes of Utrecht University's Graduate School of Life Sciences (Molecular Life Sciences; Biomembranes; Computational Life Sciences; or Cancer, Stem Cells & developmental biology). The majority of IBB's PhD candidates find positions as post-doctoral researchers (81%) or in industry (13%) after graduation. The committee has the impression that IBB's PhD students are offered an excellent training programme, but there are some aspects that could be improved. This will be discussed more thoroughly in section 6.5.

IBB also organises the Quantitative Biology (Qbio) programme, which is a combined Master honours programme and PhD programme for top students. The programme starts with an honours' track in the Natural Sciences and Life Sciences master programmes, enabling students to write their own proposals for interdisciplinary PhD projects in quantitative biology. Based on the grant proposal and an interview, four of the most promising Qbio students will receive funding from NWO to carry out their own PhD project. The committee highly appreciates this initiative.

3.7 IBB research integrity policy

The evaluation of the research integrity policies of the four S4L institutes will be discussed in detail in section 6.6. IBB has seen a case of violation of academic integrity in the recent past (involving Dr Dhonukshe). This case has been discussed extensively within the institute and it has triggered discussions within the Faculty of Science on how to safeguard research integrity. Professor Hoogenraad of IBB's division of Cell Biology has developed a series of lectures on data handling and integrity for biology students. The IBB PhD students that were interviewed by the committee were all highly aware of research integrity issues.

4. Assessment Institute of Environmental Biology

Institute of Environmental Biology in short

Director: Professor Pieterse (2009-present)
Department: Biology
In-house infrastructure: Phytotron, research greenhouses
Staff: see Table 1.3 in Appendix 3
Funding: see Table 2.3 in Appendix 3
PhD programme coordinated by IEB: Environmental Biology

Researchers at the Institute of Environmental Biology (IEB) aim to unravel biological mechanisms that enable plants, microbes, and animals to adapt to their environment to maximize growth, fitness, and survival. In addition, they study the mechanisms that regulate biodiversity and ecosystem functioning in our dynamic world. At the time of the site visit (March 2017), IEB harboured six research groups:

- The Ecology & Biodiversity group investigates mechanisms that regulate plant and microbial biodiversity and allow for the maintenance of ecosystem functioning (headed by Professor Kowalchuk).
- The Plant Ecophysiology group studies mechanisms that confer flooding tolerance which facilitate plant life in frequently submerged environments and mechanisms underlying the shade-avoidance and tolerance responses initiated by light cues (headed by Professor Voesenek).
- The Plant-Microbe Interactions group studies molecular mechanisms by which the plant immune system orchestrates interactions with other organisms to accommodate beneficial microbes in the root microbiome, while warding off devastating pathogens and pests (headed by Professor Pieterse).
- The Molecular Plant Physiology group focuses on understanding sugar-, light- and high temperature-mediated signal transduction mechanisms and their effect on the regulation of plant growth and architecture under different environmental conditions (headed by Professor Smeekens).
- The Animal Ecology group performs research on the behavioural ecology of animal group living, with a special focus on primates and animal welfare (headed by Professor Sterck, this group joined IEB in 2012).
- The Molecular Microbiology group studies the regulation and dynamics of growth, development, and biologic activity of organic matter decomposing fungi and human pathogenic fungi, as well as the molecular mechanisms of protein secretion and biogenesis of the outer membrane of Gram-negative bacteria (headed by Professor Wösten, this group joined IEB in 2016, i.e., after the evaluation period).

4.1 IEB strategy and targets

IEB's mission is to develop sustainable innovations inspired by nature. The institute has recognised its excellent position to respond to the urgent societal challenges of food security, sustainable use of ecosystem services, and protection of natural resources. IEB aims to obtain a deep understanding of

molecular, physiological, and ecological processes that plants, microbes and animals have evolved, and to translate this 'inspiration from nature' into innovations that benefit society. IEB aspires to perform cutting-edge, curiosity-driven research at the international forefront of its scientific fields and to disseminate its knowledge to societal partners, such as the green life sciences industry and environmental agencies. IEB research is organised in three research themes: 1) learning-from-nature-based discovery of how plants grow and adapt to stress, 2) microbes and microbiomes for sustainability of life, and 3) ecosystem services and protection of our natural resources. IEB and IBB collaborate closely, especially in bioinformatics, computational biology, microscopy, and cell biology.

Extended research focus
Historically, IEB has had a strong orientation on plant sciences. Recent developments have strengthened the microbiological component of IEB research. Microbial ecology was introduced into IEB with the appointment of Professor Kowalchuk as the new head of the Ecology & Biodiversity group. A focus on fungal biology was added with the move of Professor Wösten's Molecular Microbiology group from IBB to IEB in 2016. In addition, several professors-by-special-appointment with an expertise in microbiology joined IEB during the evaluation period. These changes have resulted in an extension of the scientific scope of IEB from predominantly plant sciences to an integrated focus on plant and microbe biology. Professor Sterck's Animal Ecology group provides an animal component to IEB's research and broadens the training of MSc students in the Graduate School of Life Sciences.

Future Food Utrecht
In 2014, IEB scientists initiated the Utrecht University focus area 'Future Food Utrecht' to highlight and strengthen the university's position in this field. In Future Food Utrecht, scientists from several faculties of Utrecht University, the UMCU, and accompanying industry join their fundamental and strategic research capacities to tackle the grand societal challenge of food security and safety. This local positioning effort allows IEB to stay true to its curiosity-driven research focus, while also creating added value to Utrecht University and society at large.

Strategy for the next five to ten years
IEB aims to strengthen its local visibility, national and international position, and interactions with societal partners in the near future. To this end, seven high-potential young scientists were recently appointed on tenure-track assistant professor positions. In addition, three associate professors were promoted to full professor (Sterck, Pierik, and Van den Ackerveken). The institute has formed multiple strategic local alliances and has ample fruitful collaborations with research groups outside Utrecht.

As regards funding targets, IEB will focus on prestigious personal fellowships for basic science (e.g., from ERC and NWO), large collaborative research programmes (e.g., from Top Sector, STW, NWO Gravitation, KNAW Sino-Dutch Strategic Alliances Program, EU Horizon 2020, and KIC FoodNexus), individual projects (e.g., NWO and STW Open Competitions, NWO/STW dedicated calls, EU Marie-Curie fellowships, and Chinese Scholarship Council fellowships), and industry co-funded research programmes in which scientific discoveries are translated into practical applications.

4.2 IEB research quality

The committee rates IEB's research quality as **excellent**. IEB hosts world-leading researchers in the fields of plant science, microbiology, and ecology. Examples of research highlights include the discovery of molecular mechanisms of plant immune system functioning, the molecular mechanisms of plant growth and adaptation to environmental stress such as flooding, the biological mechanisms by which plants benefit from the root microbiome, and the effects of environmental change on biodiversity.

IEB has published at an exceptionally high level in the period 2010-2015: IEB's mean normalised citation score (MNCS) was 2.68 according to an analysis by the Center for Science and Technology Studies, meaning that the impact of IEB's publications is 2.68 times the world average. IEB's plant science papers had an even higher MNCS of 3.53. In addition, IEB staff has been successful in obtaining prestigious personal awards and fellowships.

IEB constitutes a very strong research environment with high quality in-house infrastructure. The Utrecht University Phytotron harbours excellent facilities for precision plant and microbe growth and monitoring. It includes 17 walk-in growth rooms and 20 smaller growth cabinets in which climate conditions can be precisely monitored and managed. In addition, IEB researchers have access to research greenhouses in the Botanical Garden and mesocosm facilities.

4.3 IEB relevance to society

IEB research is **highly relevant** to society as it provides a firm knowledge base to develop sustainable solutions for urgent societal challenges such as future food security, sustainable use of ecosystem services, and educated protection of natural resources. The institute performs fundamental and translational research on mechanisms of plant survival and microbial diversity. In addition, it tries to improve the production of edible mushrooms and sustainable biomaterials using agricultural waste streams and to reduce post-harvest spoilage of food. IEB has teamed up with other food-oriented scientists in Utrecht to create the focus area 'Future Food Utrecht', in order to provide interdisciplinary solutions for the future food challenge and to increase societal awareness.

IEB actively collaborates with companies and governmental organisations to ensure the translation of its findings into practical applications. An example of a successful collaboration with industry is the project with ENZA Zaden, who directly funded IEB research on downy mildew resistance technology and have successfully incorporated the technology in breeding programs of their vegetable crops. IEB scientists have also obtained funding from the 'Perspective' funding scheme of the Dutch Technology Foundation STW and diverse TopSector programmes. In these public-private funding programmes, scientists closely collaborate with industrial partners in the green life sciences industry (e.g., KeyGene, GeneTwister, DSM, Dupont, BASF), plant breeding companies (e.g., Rijk Zwaan, ENZA Zaden, Bejo Seeds, Vilmorin, PopVriend, Syngenta, Monsanto, Bayer Crop Science, and Royal van Zanten), biological control and seed companies (e.g., Koppert, Incotec, Soiltech, EcoStyle), and the food industry (e.g., Heineken, Pepsico, Unilever, C4C, Walkro). In addition, IEB scientists have close interactions with environmental consultancy firms (e.g., Dactylis, BioClear, Louis Bolk Institute), nature organisations (e.g., World Wildlife Foundation, Wetlands International, Netherlands Environmental Assessment Agency, Prince Bernhard Foundation), zoos, and provincial water boards, ministries and provincial authorities.

The committee particularly appreciates the appointment of Professor van den Ackerveken as a valorisation officer, with the assignment to enhance societal impact (e.g., interactions with industrial partners) and facilitate the translation of IEB's discoveries into practical applications. Training top scientists is an additional important societal value of IEB. Green life sciences companies are in continuous need for well-trained plant scientists. Indeed, many of IEB's PhD candidates and postdocs find employment in Dutch plant breeding companies, or other companies and governmental organisations after leaving IEB.

4.4 IEB viability

The committee considers IEB's viability to be **excellent**. The institute has performed world-leading research with a remarkably high impact in the period 2010-2015 and it is expected to continue along this line. The group leaders are successful in acquiring funding and there are many collaborative projects with industry. IEB works on three themes (plant science, ecology, and microbiology) that interact intensively, for instance through monthly meetings of group leaders and joint grant proposals. The staff is composed of a mix of established senior scientists and promising young researchers. Moreover, attracting high potential young scientists is an explicit part of IEB's strategy.

The institute harbours state-of-the-art plant growth facilities (the Phytotron) and there are plans to submit an ambitious National Roadmap proposal for a 'Netherlands Plant Eco-Phenotyping Centre' together with Wageningen University. This facility will harbour advanced multiscale plant/root analysis platforms, mycelium analysis platforms, automated phenotyping capabilities, climatic simulation environments, and advanced climatized Ecotron facilities. It will provide cutting-edge integrated growth and analytical facilities for a range of plant and microbial sciences required to tackle key issues in future food, health and environmental science. The close collaboration with IBB's bioinformatics division also adds to IEB's viability.

IEB is keenly aware of local and national politics and the need to profile itself. Funding organisations are aware of the fact that fundamental plant and microbiological science is needed to feed the world of the future, resulting in relevant funding schemes. The University investments in the Phytotron and the Future Food focus area illustrate that IEB's lobby pays off. The Future Food Utrecht focus area is a timely initiative that addresses a major societal challenge, which is also included in the recently published Dutch National Research Agenda (see section 6.3).

The plant sciences groups within IEB have their own niche compared to the research that is performed at Wageningen University. Therefore, IEB's research is complementary to rather than competing with Wageningen research. This is also evident from the joint Roadmap proposal that is currently being prepared. To maintain the vigorous plant science community in Utrecht, a successor should be appointed after the foreseen retirement of Professor Smeekens.

4.5 IEB assessment in numerical scores

In line with the qualitative judgements of IEB research described above, the committee has assigned IEB to a discrete category for each of the assessment criteria (Table 5). The four possible categories are excellent (=1), very good (=2), good (=3), and unsatisfactory (=4); the scores are explained in more detail in Appendix 4.

Table 5: Quantitative assessment of IEB research quality

	Research quality	Relevance to society	Viability
Institute of Environmental Biology	1	1	1

4.6 IEB PhD programme

The evaluation of the PhD programmes of the four S4L institutes will be discussed in detail in section 6.5. IEB organises the PhD programme 'Environmental Biology' within Utrecht University's Graduate School of Life Sciences (GSLS). IEB was home to 40 PhD candidates in 2015. The majority of these were enrolled in both the Environmental Biology programme of the GSLS and a national graduate school ('Experimental Plant Science' or 'Production Ecology & Resource Conservation'). The national graduate schools organise specialised courses that form a significant part of the education of IEB's PhD candidates. As a result, the candidates are offered a broad educational programme. Moreover, they can interact with peers from other universities to discuss their research, exchange ideas and start collaborations. By the end of 2015, 53% of the Environmental Biology PhD candidates that graduated during the review period were still active in academia, 23 % worked in industry (mainly plant breeding), and 8% at non-profit organisations. IEB offers its PhD students an excellent training programme, but there are some aspects that could be improved. This will be discussed more thoroughly in section 6.5.

4.7 IEB research integrity policy

The evaluation of the research integrity policies of the four S4L institutes will be discussed in detail in section 6.6. At IEB, lab meetings, subgroup meetings, journal clubs, and PhD report meetings facilitate thorough discussion of topics such as data processing, the use of image processing software, and statistical analyses. The institute aspires to train young scientists to keep a critical mind on their own results and those of others. IEB scientists are increasingly using an electronic lab journal, which allows for accurate digital recording of experiments and results with tractable, non-reversible version storage. Biological materials are stored via an electronic management system. They process raw data via standardised protocols. Large data sets are made available via international repositories and as supplemental data to publications. Taken together, the staff of the institute is well aware of research integrity, but this awareness does not seem to have reached all PhD students. This could easily be improved, for instance with a mandatory course for PhD students where research integrity is discussed.

5. Assessment Utrecht Institute for Pharmaceutical Sciences

Utrecht Institute for Pharmaceutical Sciences in short

Director: Professor Heck (2015-present), Professor Hennink (2012-2015), Professor Olivier (2010-2012)
Department: Pharmaceutical Sciences
In-house infrastructure: NPC Proteins@Work Proteomics Facility (mass spectrometry), Utrecht Bioinformatics Center
Staff: see Table 1.4 in Appendix 3
Funding: see Table 2.4 in Appendix 3
PhD programme coordinated by UIPS: Drug innovation

Researchers at the Utrecht Institute for Pharmaceutical Sciences (UIPS) aim to contribute to the development of effective, safe, and affordable medications for society. The research includes drug discovery, drug development, drug delivery, and drug use, where drugs are broadly defined as chemical, biological, biotechnological, or cellular entities to be used in diagnosis, prevention or treatment of diseases. Since 2010, the institute has been organised in five divisions:

- The division of Pharmacology aims to understand and validate new concepts for disease management via drugs, biologicals, and medical food concepts (headed by Professor Garssen).
- The division of Chemical Biology and Drug Discovery uses synthetic molecular approaches to study and modulate biological processes related to disease (headed by Professor Boons, this group is also embedded in Bijvoet).
- The division of Pharmaceutics focuses on the delivery and targeting of drugs by integrating chemistry, formulation, biopharmaceutics, and cell biology (headed by Professor Hennink).
- The division of Biomolecular Mass Spectrometry and Proteomics uses mass spectrometry to understand the inner workings of cells (headed by Professor Heck, this group is also embedded in Bijvoet).
- The division of Pharmacoepidemiology and Clinical Pharmacology studies the sources of individual variation in drug response with the goal to increase the benefit-risk ratio of therapeutics (headed by Professor Klungel).

5.1 UIPS strategy and targets

UIPS' mission is to pave the way for future medicines, ultimately improving people's health. A current international trend in pharmaceutical sciences is a shift towards personalised medicine. This calls for a systems pharmacology approach, where experimental measurements at different levels (molecular, cellular, organismal, whole body, population) are combined with modelling work. UIPS aspires to apply this systems approach with *omics* measurements (proteomics, metabolomics, glycomics), advanced drug delivery systems (e.g., nanomedicines), and new pharmacoepidemiological methods based on predictive biomarkers. UIPS' ambition is to foster development and translation of innovative research findings into clinical applications, also through interactions with clinical and/or

industrial scientists. In other words, UIPS aspires to form a natural bridge between fundamental and patient-oriented research.

Recruiting top scientists
During the review period, UIPS has strengthened its molecular-oriented research activities with the aim to contribute to advanced and affordable biomolecular and cellular therapies. Recruiting renowned scientists was one of the means to achieve this objective. For instance, glycobiologists Boons, Jongkees, and Wennekes were recruited into the Chemical Biology and Drug Discovery division. This has changed the group's research focus into the use of chemical approaches to study post-translational modifications, in particular glycosylation, in health and disease. This has strengthened UIPS' position in chemical biology and innovative drug design. Professor Masereeuw was recruited to strengthen the pharmacology research. Masereeuw also introduced lab-on-a-chip expertise to the institute, constituting an important alternative to animal testing.

Increasing coherence
The institute has seriously addressed the scientific integration of the research at its five divisions (i.e., the coherence of the institute), as well as the community feeling of staff and students. For instance, they now organise various meetings (e.g., pizza meetings for PhD students, PhD retreats, colloquia, the annual Molecules & Medicine/Future Medicines meeting). In addition, there have been seed grants for joint PhD projects.

Strategy for the next five to ten years
In response to the decline of direct university funding, UIPS has further increased its fund-raising efforts from national and international grants and contract research. UIPS has intensive collaborations with the private sector. Open source innovation and public private partnerships will be UIPS' research strategies in the near future.

Given S4L's strength in structural biology, virology, analytical chemistry, glycomics, and glycobiology, UIPS has taken the lead in setting up a glycomics centre, focusing on the glycobiology of host-pathogen interactions and disease biology. Another current development is the advent of precision medicine. Measuring patient characteristics with cleverly designed probes and *omics* technologies will become an integral part of future therapies. With its expertise in *omics*, bioinformatics, systems biology, and clinical translation, UIPS is in an excellent position to be at the forefront of these developments, in close collaboration with local partners. In addition, UIPS plans to take the lead in sustainable and affordable healthcare by creating new drug policy models. UIPS would also like to play an important role in initiating a university-wide Future Medicines focus area.

5.2 UIPS research quality
The research quality of UIPS' five divisions is **excellent**, for example the discovery of novel antibiotics and new nanomedicines, the study of glycans in host-guest interactions with smart chemical probes, and the pharmacoepidemiological research. The institute is highly recognised as one of the strongest pharmaceutical science groups in Europe. UIPS researchers frequently publish in high impact journals and they have received many scientific awards, prizes, and other marks of international recognition. UIPS' technology platforms are available for academic and industrial collaborators, thus contributing to the advancement of science in addition to supporting the institute's own outstanding research.

For instance, the Biomolecular Mass Spectrometry and Proteomics division has been running mass spectrometry analyses for local, national and international collaborations for more than ten years.

5.3 UIPS relevance to society

UIPS research is **highly relevant** to society as it contributes to the development of effective, safe, and affordable drugs. The institute has set itself the goal to perform science that can be used to reduce the prize of precision medicines, which is a response to society's demands. In addition, UIPS research findings are taken up in clinical guidelines and methodological standards, label changes, and new legislation. UIPS provides scientific advice on pharmaceutical policy and regulatory issues to public health authorities, NGOs, and academia. The institute collaborates with the World Health Organisation and other international organisations to improve the safe use of medicines. In addition, UIPS's staff members occupy important positions in healthcare-related committees such as the Medicines Evaluation Board and the European Federation of Pharmacological Societies.

UIPS collaborates closely with pharmaceutical companies, biotechnology companies, and clinics to ensure that its results are translated into novel treatments. The Nutricia Research-Utrecht University alliance and joint research activities with Genmab, PamGene, NKI, and Sanquin are good examples of companies using open source innovation. In addition, UIPS participates in several IMI sponsored public-private partnerships to collaborate with Big Pharma on drug discovery and development. UIPS has alliances with Sanquin for biomolecular therapies, and with GSK and CBG. The committee learned that, while UIPS collaborates intensively with industry, it actively strives to safeguard its independence, for instance by focussing on public-private partnerships rather than contract research. UIPS has strong links with clinical pharmacy practice through for instance the Utrecht Pharmacy Panel for Education & Research, the UMCU, the Netherlands Cancer Institute, the Royal Dutch Pharmacists Association, and clinical pharmacist training programmes.

UIPS' staff is intensively involved in education, which also constitutes a highly relevant contribution to society. In addition, the Department of Pharmaceutical Sciences organises the international research Master's 'Drug Innovation', the international honours research Bachelor's 'College of Pharmaceutical Sciences', the IMI European programme on Pharmacovigilance & Pharmacoepidemiology EU2P, and the 'Drug Innovation' PhD programme. Like the other S4L institutes, UIPS engages in outreach activities, for instance targeting primary school children.

5.4 UIPS viability

UIPS is an institute of **excellent** viability with great potential and internationally respected leaders. It successfully exploits its history in traditional organic chemistry to be at the forefront of modern pharmaceutical sciences. The institute has managed to attract excellent new staff within a very competitive area of great future importance to the field (e.g., Professor Boons). The staff members are well embedded in local, national, and international networks and there are many fruitful collaborations with industry. The institute has managed to maintain a stable level of funding in spite of decreasing direct funding from Utrecht University by investing more efforts in obtaining external funding.

The committee applauds the shift to glycosylation in the Chemical Biology and Drug Discovery division. This is a good strategy in view of the international trends in this field of science. The

committee is a bit cautious about the institute's recent interest in food pharma (i.e., nutriceuticals), as exemplified by its strategic alliance with Nutricia. The institute's basic science equipment is indeed suitable for both drug research and public health research, but the committee recommends maintaining the scientific background for drug research.

5.5 UIPS summary in numerical scores

In line with the qualitative judgements of UIPS research described above, the committee has assigned UIPS to a discrete category for each of the assessment criteria (Table 6). The four possible categories are excellent (=1), very good (=2), good (=3), and unsatisfactory (=4); the scores are explained in more detail in Appendix 4.

Table 6: Quantitative assessment of UIPS research quality

	Research quality	**Relevance to society**	**Viability**
Utrecht Institute for Pharmaceutical Sciences	1	1	1

5.6 UIPS PhD programme

The evaluation of the PhD programmes of the four S4L institutes will be discussed in detail in section 6.5. UIPS organises the PhD programme 'Drug Innovation' within Utrecht University's Graduate School of Life Sciences (GSLS). The majority of UIPS students are enrolled in this programme. In 2015, UIPS harboured 220 PhD students, including internal students (i.e., working in one of the UIPS divisions) and external students (i.e., working elsewhere, but having a promotor that is affiliated to one of the UIPS divisions). The Drug Innovation programme's mandatory introduction course is one of the best evaluated courses of the GSLS. This course features topics such as academic integrity and cross-cultural communication. The committee highly appreciates this introduction course. UIPS' PhD students are offered monthly David de Wied colloquia where both junior and senior staff give short lectures, bi-monthly pizza meetings, an annual PhD retreat, and an annual S4L Symposium. In general, the committee has the impression that UIPS' PhD programme is excellent, but there are some aspects that could be improved. This will be discussed more thoroughly in section 6.5.

In September 2016, UIPS started a graduate programme entitled 'Future Medicines Fellows', supported by NWO. The aim is to create a cohort of excellent PhD candidates, to promote 'Advanced Affordable Biomolecular and Cellular Therapies', and to strengthen the UIPS community. The Future Medicines Fellows are stimulated to write their own PhD research proposal and to interact with as many research groups as possible through rotation. They will form the heart of the PhD and Master community, organizing Future Medicines meetings for all Master students and PhD candidates. The committee is very positive about this initiative.

5.7 UIPS research integrity policy

The evaluation of the research integrity policies of the four S4L institutes will be discussed in detail in section 6.6. UIPS adheres to the general research integrity policy of Utrecht University. UIPS discusses research integrity in its PhD introduction course, focusing on the small integrity questions

rather than on the well-known cases of fraud. The committee applauds this. UIPS currently is in the process of establishing electronic lab journals for its researchers.

6. Assessment Science for Life as a whole (S4L)

6.1 S4L strategy and targets

In 2015, Bijvoet, IBB, IEB, and UIPS joined forces under the umbrella name 'Science for Life' (S4L). Their joint mission is to explore the fundamentals of life through world-leading life science research, aiming at future solutions for societal challenges related to health and environment. Multidisciplinary approaches and the use of the latest technologies are key features of S4L research and training. The cluster aims to create an intellectual and collaborative research environment that provides maximal freedom and inspiration for its scientists. S4L was initiated to

- increase the critical mass of institutes, and give the fundamental life sciences a voice,
- facilitate the sharing of technological centres and core facilities,
- create an attractive and diverse community of high-quality researchers,
- facilitate fund raising as a multidisciplinary team.

So far, S4L mainly invested in community building and the Young Investigators Forum.

Community building

It is S4L's mission to create an environment of curiosity, ambition, and intellectual challenges. The organisation is light and flexible and leadership is informal. In 2015 and 2016, S4L organised a very successful conference with high-profile speakers. The 2016 edition brought together the entire S4L community, attracting more than 450 researchers. The annual S4L conference and regular business meetings with the four institute directors and supporting staff are an important component of S4L management. The meetings provide opportunities to openly discuss scientific visions, talent policy for young investigators, and new initiatives with support from the four institutes. This strategy has proven to be attractive and productive for all research groups. In addition to the annual conference and regular meetings, there are some joint appointments (e.g., Professor Heck and Professor Boons) and principal investigators of multiple institutes are involved in the recruitment procedure of junior principal investigators.

S4L interacts with research groups of the UMCU, Faculty of Veterinary Medicine, the Hubrecht Institute, the Fungal Biodiversity Center, and many other local, national and international academic and industrial partners. The institutes intend to continue to foster and strengthen these collaborations, and to further extend their networks.

Young Investigators Forum

S4L launched the Young Investigators Forum (YIF) in 2015 to foster coherence and collaboration within the S4L community. It is a collective of enthusiastic principal investigators that are not yet professors. The eight YIF founders organise social networking events, provide feedback on S4L's policy, and actively merge scientific staff with starting scientists. In addition, they share resources for science and career development that are of interest to their community. With these activities, YIF helps young scientists to create the best environment to excel. YIF gatherings provide the perfect opportunity for the start of interdisciplinary and collaborative research projects.

The YIF focuses on

- supporting young PIs to create the best environment to excel in their careers (e.g., promoting a horizontal management structure and creating transparent career possibilities with uniform S4L-wide conditions),
- facilitate collaborative research (e.g., advocating a housing in one building for all S4L research groups, investing in S4L technology centres and core facilities by supporting new developments in high-end equipment, introducing 'senior scientist' positions that support the technology centres and core facilities)

It is the YIF's vision that, by supporting young principal investigators and facilitating access to technology centres and core facilities, S4L will develop into a unique and highly desirable environment for ambitious researchers who wish to pursue a career in the life sciences.

Infrastructure

State-of-the-art technology centres and core facilities play a key role in S4L research. In addition to being critical for research at the four S4L institutes, these facilities constitute a major asset when it comes to recruiting top researchers to Utrecht. Facilitating access to this research infrastructure and the associated expertise was one of the reasons for launching S4L. Hence, S4L is continuously investing in acquiring funding and creating visibility for its facilities to ensure that the institutes will remain equipped with state-of-the-art technology and expertise. The facilities typically use departmental and institutional budgets as leverage to obtain external funding. The S4L community has been very successful in acquiring funds from NWO and the European commission for its infrastructure.

The challenge of financing and maintaining expensive equipment and the associated expertise is not unique to Utrecht. Hence, the S4L institutes participate in national and European research infrastructure initiatives to find common solutions. For instance, S4L researchers play a leading role in the national research infrastructure consortia Proteins@Work (mass spectrometry), uNMR-NL (NMR spectroscopy), and NL BioImaging AM (microscopy). These initiatives are included in the NWO National Roadmap for Large-Scale Research Facilities and they have received significant funding.

Another example is the 'Bioscopy' vision, which S4L researchers developed together with several other Dutch research institutes. Bioscopy is a vision for a Dutch research infrastructure that integrates structural biology, imaging, and *omics* technologies. The Royal Netherlands Academy of Arts and Sciences (KNAW) has included the Bioscopy vision on its National Agenda for Research Infrastructures. In addition, interactions with COAST (public-private partnership for analytical sciences), DTL (public-private partnership for life sciences), and the national Life Science Grid e-infrastructure ensure embedding in the broader Dutch scientific landscape.

Strategy for the next five to ten years

To continue its efforts to create an inspiring research community, S4L envisions the following activities in the next few years:

- defining a joint housing strategy,
- defining a joint funding strategy,
- enabling access to technologies centres,

- attracting and fostering talent (internal and external),
- identifying additional expertise that is required to complement the in-house expertise,
- collaborating within Utrecht University's strategic themes and with external partners,
- organising joint communication and networking activities,
- highlighting showcase projects, demonstrating the strength of S4L collaboration.

In the next five-to-ten years, S4L aims to create the scientific and technological basis to bring structural chemistry and biology to cellular levels, to truly integrate multiple *omics* technologies, to develop strong computational and modelling approaches, and to integrate the acquired knowledge using a systems biology approach. This will result in an improved understanding of biological processes in health and disease, which will in turn contribute to future innovations (e.g., for sustainable food production and novel drug therapies). S4L's ultimate goal is to be a leading state-of-the-art science and technology community that develops and provides open access to advanced technologies for high-level research in fundamental life sciences.

6.2 S4L research quality

The committee is impressed by the excellent quality of S4L research: it is a cluster of four world-leading institutes. The scientific output of the institutes is very high in terms of both the number of publications and their citation impact. The staff has received many grants, honours, and awards, and they are actively involved in national and international research consortia and research infrastructure initiatives. S4L harbours an impressive range of technology centres and core facilities and actively contributes to the development of technologies as well as bioinformatics approaches. There are already some examples of excellent collaborative projects involving multiple S4L institutes, showing the potential of S4L to become more than the sum of the four institutes.

6.3 S4L relevance to society

The committee judges the relevance to society of S4L research as varying from very good to excellent. S4L focuses on fundamental questions and technology development within the chemical, biological, and pharmaceutical sciences. The institutes' expertise in these fields and the technological developments provide answers to societal questions related to health and environment. Indeed, several of S4L's research topics have been selected as important research themes by the general Dutch public in the 'Dutch National Research Agenda' project[2]. To ensure translation of its research findings, S4L collaborates with industrial and governmental partners. In addition, the S4L institutes contribute to society by training experts and by engaging in outreach activities. The committee thinks that joining forces under the S4L umbrella will empower the four institutes to develop a common strategy and thus increase their societal impact. The Future Food Focus area, in which at least two S4L institutes participate, is a nice example of this.

[2] In 2015, all Dutch citizens could submit their questions to science on the website 'wetenschapsagenda.nl'. These questions have been clustered in themes. The resulting agenda was launched in November 2015. In the short and medium term, the Dutch National Research Agenda will be translated into the profiles of universities and universities of applied sciences, the programming of the knowledge coalition's partners, the direction in which the national research institutes develop, and into investments in large-scale research facilities.

6.4 S4L viability

S4L consists of four excellent research institutes, which should be nourished. Depending on the continued commitment of the institutes, S4L could become more than the sum of its parts in the future. Joining forces may help the institutes to obtain major grants and to organise some aspects more efficiently (e.g., infrastructure, recruitment procedures). With its lively international community, S4L will constitute a magnet for talented young scientists. The awareness of S4L among junior researchers (e.g., PhD students), however, seems to be insufficient, so this should be improved. The committee is charmed by the Young Investigators Forum, which consists of young principal investigators that are very committed to S4L and genuinely see the advantages of interdisciplinary collaboration. As they are the next leaders within S4L, the future looks bright for S4L.

6.5 S4L PhD programmes

Institutional context of the PhD programmes

S4L harboured 372 PhD candidates in 2015. All of these students were enrolled in Utrecht University's Graduate School of Life Sciences (GSLS). This graduate school organises training and education for Master's students and PhD candidates in the life sciences. The GSLS is the shared responsibility of three faculties: Medicine (UMCU), Veterinary Medicine, and Science. The committee learned that the GSLS offers 14 PhD programmes, five of which are organised by the Faculty of Science (Biomembranes, Computational Life Sciences, Drug Innovation, Environmental Biology, and Molecular Life Sciences). The committee has the impression that the PhD students within each institute form coherent groups, but that there is little interaction between these groups of PhD students of the four S4L institutes.

Programme content and structure

In general, the committee has the impression that the PhD programmes of the GSLS are of excellent quality. Students enrolled in the GSLS typically follow a 20-credits training programme[3]. The students should spend at least 40% of these credits on thematic courses (e.g., expert courses in biomolecular mass spectrometry, protein crystallography, and NMR spectroscopy for the students enrolled in Bijvoet's Molecular Life Sciences programme). In addition, they should spend at least 20% on general courses. A maximum of 20% of the credits may be spent on symposia and conferences.

The GSLS offers a wide range of courses in general skills and personal development, including communication, management, statistics, and career orientation. It also offers 'That Thing Called Science', a course in science ethics and philosophy. The GSLS courses are offered through an online PhD Course Center (bit.ly/PhDCourseCentre). All courses can be attended for free, or at low cost, by the PhD candidates of the GSLS. In addition to various courses, most institutes organise regular PhD evenings where PhD candidates present their work without supervisors being present, seminars by internationally renowned speakers, and a yearly symposium where both PhD candidates and international speakers present their work.

[3] Credits are assigned according to the European Credit Transfer System (ECTS), where 1 credit = 28 hours.

The committee is impressed by the broad educational programme that is offered to the PhD students: the students can choose from a large diversity of courses. Maybe this is even a bit overwhelming for the students, as several students indicated that they would appreciate more guidance in compiling their education programme. The committee was surprised to learn that there are no compulsory courses in some of the institutes, while all students should be exposed to issues such as research integrity and the benefits of being part of S4L (e.g., the variety of technology platforms that are available at the three other S4L institutes). The committee will provide recommendations on how to deal with this in Chapter 7.

Supervision and quality assurance
The committee learned that the Dean of the Faculty of Science and/or the supervisor are responsible for the supervision of research progress and quality of PhD projects. In general, this responsibility is delegated to the supervisor. A Training and Supervision Agreement (TSA) is completed by the PhD candidates and their supervisors at the start of the PhD project. This agreement includes an education plan as well as the obligations and responsibilities of the PhD candidates and supervisors. Progress is monitored informally throughout the year and formally in an annual assessment interview. These interviews should also include the content and progression of the training programme as originally planned in the TSA. Every PhD candidate is assigned an external supervisor (i.e., a confidential person outside the research group of the supervisor whom the candidate can address with problems). A PhD candidate that has fully met the requirements of the TSA will receive the GSLS Training Certificate at the time of graduation.

The PhD candidates of the GSLS are represented by the PhD Council. Each of the 14 programmes of the GSLS has one representative in this council. The council aims to improve the quality of PhD-education and the regulations by raising issues and providing feedback on the propositions of the Executive Board of Studies. In addition, the PhD Council organises an annual PhD day and regular PhD events.

In theory, the TSA safeguards the quality of training and supervision of PhD candidates. However, the committee learned that in practice, some PhD students experienced a need for better guidance on which courses to take, as well as their obligations and responsibilities. The committee had the impression that the rules are not well-understood by some students. In addition, some students are not encouraged (and sometimes even discouraged) to take the recommended 20 ECTS education programme. The committee also learned that it is possible to obtain a PhD degree at Utrecht University without having met the training requirements of the GSLS (i.e., without obtaining the GSLS Training Certificate). Moreover, the committee noted that several students did not have an external advisor. The presence of a proper scientific advisory team including an external advisor, which gives feedback on a yearly basis, should be implemented into every student's TSA. In conclusion, the infrastructure to safeguard the PhD training seems in place, but the practical implementation of these measures leaves some room for improvement.

Success rate, duration, and exit numbers
The success rates of the PhD programmes are reasonable, but there are some exceptions, e.g., the committee noted that there are incidents where PhD students take very long to graduate and the drop-out rate was rather high at some points in time.

Guidance of PhD candidates to the job market and career prospects
The GSLS aims to train life scientists who are able to independently perform top research in an international environment. The GSLS also enables its PhD candidates to qualify for positions in policy making and management at companies and governmental institutions. The graduate school offers courses related to career orientation. Indeed, some of the students that were interviewed by the committee indicated that they had followed courses to prepare them for the job market (e.g., for a shift to industry). The career prospects of S4L's PhD graduates seem to be good, with the majority of students finding employment shortly after graduation.

6.6 S4L research integrity policy
To safeguard research integrity, the four S4L institutes adhere to the policies of Utrecht University and the Faculty of Science.

Utrecht University policy
Every employee of Utrecht University is required to comply with the Netherlands Code of Conduct for scientific practice, which includes topics such as scrupulousness, reliability, verifiability, impartiality, and independence. In addition to these national guidelines, Utrecht University's 'Code of Conduct for Scrupulous Academic Practice and Integrity' describes key principles on how to achieve the open culture that it desires. An academic integrity counsellor and a committee for academic integrity have been appointed to look into complaints concerning academic integrity.

Faculty of Science policy
The faculty policy aims to further strengthen the university's principles and standards. The most important factors are awareness, openness, and discussion. Discussions about research integrity and ethical dilemmas take place throughout the faculty, i.e., in the Master's programme, PhD programme, and staff meetings. In addition, the faculty has appointed several counsellors and committees, including the 'Faculty Contact Person Scrupulous Academic Practice' (who acts as an impartial, confidential, and accessible sparring partner for integrity issues and dilemmas), the faculty project team (that aims to stimulate the discussion about scrupulous academic practice and integrity and ensure their structural embedding), and the Faculty Academic Integrity Advisory Committee (which advises the dean on how to guarantee academic integrity in research and education).

Although the infrastructure to ensure research integrity is in place and the institutes seem to fully be aware of the importance, the practical implementation seems to lag behind here and there. The committee will provide recommendations on how to deal with this in Chapter 7.

7. Recommendations

7.1 Research quality

To intensify the collaboration between the four institutes and develop the spirit of S4L

1. The 'spirit of S4L' is most strongly felt at the junior group leader level (e.g., the Young Investigators Forum), but it has not yet penetrated the group of PhD students. For instance, the committee noted that many PhD students seem to be unaware of the variety of technology platforms that are available at the other S4L institutes. An improved S4L awareness among PhD students will help S4L to build its reputation: PhD students will take out the 'brand' when they move to other institutes for postdoctoral positions. To this end, S4L could launch a mandatory S4L introductory course for new PhD students, that will also be useful for new postdocs and technicians, featuring among other things an introduction to S4L's technology platforms. (See also recommendations about the PhD programmes below.)
2. S4L could substantially increase its visibility, for instance by:
    a. including 'S4L' in the affiliations on scientific posters, papers, and slide shows (this will help the 'S4L' to gain recognition and stature; the committee recommends keeping the institute names alive as well because these are widely known);
    b. creating a promotion video that appeals to a scientific audience;
3. S4L currently receives a limited budget from the Faculty of Science to finance some of its activities such as the meetings of the YIF and the yearly S4L symposium. Joint PhD students, postdocs and/or staff would help to intensify the collaboration between the four institutes. The committee also likes the Young Investigators Forum's suggestion to appoint a number of service staff members that can facilitate collaborative work and access to the technology platforms.
4. Collaboration between the institutes could greatly be enhanced if Bijvoet, IBB, and IEB could move into a new building in the vicinity of the David de Wied building, which is the current location of UIPS.

Other recommendations related to the further development of S4L

1. The committee feels that, in order to achieve the goal of strengthening fundamental life sciences in Utrecht, all S4L institutes need to develop a crisper **scientific strategy**. The committee recommends working on a clear articulation of the vision and strategy from a scientific point of view. This may include the following topics:
    a. What is your scientific goal for the next five years?
    b. What would you do if you had money? (i.e., create a 'drawer of ideas')
2. In line with the previous recommendation, the committee noted that the four institutes have invested substantial efforts in profiling themselves. However, it is the committee's impression that the excellent science that is performed at the institutes has faded into the background in these branding efforts. Instead, the technological expertise of the institutes is at the forefront. The committee recommends working on a branding strategy based on the wold-class **science** at the institutes, for instance by using group names that reflect the biological research areas rather than the technological expertise.
3. The committee recommends considering how joining forces can help the institutes to further increase the societal impact of their research.

4. To deal with the high costs of infrastructure and personnel, a 'pay-for-access' model should be considered, using grant resources to directly fund maintenance of infrastructure and enabling access to all researchers in S4L. The high quality and wide usage of the technology platforms by all researchers in S4L can be safeguarded by employing technical experts to facilitate access to new users. The committee learned that S4L is working to professionalize the commercial operation and exploitation of its facilities and to attract financial contributions by external users (from academia and industry) with the aim to establish a sustainable future for these facilities. The expectation is that these facilities will operate on a mixed funding model in the future, with investments covered by the university and competitive national and international grants and operational costs covered by the university, national and international funding instruments, and users of the facilities. The committee encourages S4L to continue along this line.
5. To optimise in house talent breeding and to attract top talent from outside
    a. S4L should improve its marketing efforts, see recommendation 2 above. It is of utmost importance to clearly disseminate S4L's *scientific* vision as this will attract top talents from outside.
    b. Some research groups should make sure that they improve the independence of young investigators at the associate professor level. There seems to be a rather strict 'full professor hierarchy' in some of S4L's research groups; this is a threat to retaining talent.
6. The committee believes that, in order to succeed, S4L will need more structured leadership. S4L is planning to appoint the institute directors as the managing director on a two-year rotation schedule. A two-year period is too short to ensure continuity. In addition, the S4L leadership does not seem to come with a strong mandate, i.e., the institute directors do not seem to have a position in the University hierarchy. The committee encourages S4L to reconsider this and to develop the academic leadership skills of people that are made director.
7. Although gender balance is obviously high on S4L's priority list (i.e., a diversity committee and a gender diversity policy project group have been installed), the number of females at the principal investigator level is still very low. The committee encourages the institute to continue striving to improve this.
8. The committee has a recommendation specifically for YIF members: apply to be an EMBO Young Investigator. EMBO Young Investigators receive a financial award of 15,000 euros in their second year. They can also apply for additional small grants of up to 10,000 euros per year. Networking is a key aspect of the programme, and Young Investigators benefit from extensive practical support.

Recommendations for specific institutes

1. The **Bijvoet Center** will need a clear vision and strategy on how to create and maintain a budget for its expensive infrastructure and machine time for local instruments, as well as higher specification instruments (Titan Krios needs) for its EM research.
2. The committee thinks that the number of research groups (seven) at **Bijvoet** is very large and as there are few principal investigators in some research groups, it might be better to merge some groups in order to create a larger critical mass and clearer scientific focus.
3. The committee feels that the **Bijvoet Center** has extremely strong overall expertise in protein folding, and membrane biology. The institute should consider these topics as potential biological selling points and branding.

4. It is the committee's impression that the catastrophic series of financially forced rearrangements in the past decade are still in the minds of **IBB**'s staff. The committee recommends leaving these struggles in the past because the staff can be proud of the 2017 version of IBB as an institute with phenomenal potential, harbouring many promising young leaders.
5. The committee thinks that **IBB** could brand itself better, for instance as an institute for quantitative biological research or 'quantitative biology of cellular architecture and dynamics'. The committee encourages the institute to better put forward as unique selling points their combined expertise in microtubule dynamics, polarity, bioinformatics, quantitative biology, and imaging.
6. Although **IBB** researchers have been very successful in obtaining personal grants in the period 2010-2015, the committee thinks that they could do even better as a group and therefore encourages IBB to pursue collaborative grant applications.
7. **IBB and IEB** are both excellent institutes and the committee recommends ensuring that the division of the Department of Biology in two institutes does not create unnecessary barriers, for instance in the realm of bioinformatics. (Please note that this does not imply that the committee recommends yet another reorganisation.)
8. **IEB** should make sure that it can retain its critical mass in the field of plant sciences upon retirement of senior principal investigators, for instance by attracting a new expert in plant molecular genetics.
9. Although **UIPS** has increased its coherence during the evaluation period, the committee thinks that the institute still covers a very broad range of research areas. It may be better to add more focus to UIPS' research.
10. The committee acknowledges the interface of drug research with healthy food research. However, **UIPS** should be careful not to lose the scientific background for drug research.
11. The committee applauds **UIPS**' efforts to exploit organoids and lab-on-a-chip as alternatives for animal models and encourages the institute to continue along this line.

7.2 PhD programmes

1. It would be very good to install a mandatory 'S4L introduction week', where new PhD students are introduced to the overall aims and spirit of S4L. In addition to a way of uniting the four S4L institutes, this could serve to familiarise the PhD students with the S4L research facilities. The course may include:
   - information about S4L's technology centres and core facilities,
   - research integrity training,
   - cross-cultural community training similar to what is currently offered at UIPS.
2. As described in the section 6.5, the practical implementation of measures to safeguard the quality of PhD training leaves room for improvement:
   - PhD students at S4L seem to have ample freedom of choice in compiling their own course portfolio. This is an asset, but the committee thinks that it would be good for the students to receive somewhat more guidance in choosing courses. In addition, the committee recommends installing a few mandatory courses for all S4L students, including the earlier-mentioned S4L-wide introductory course.
   - The committee has the impression that some PhD students do not sufficiently understand the rules and/or what is expected from them. This deserves attention.

- The committee learned that some supervisors are discouraging their students to follow courses so that the students can focus on research. This practice is to be frowned upon and measures should be taken to prevent this. Students can graduate without having earned the GSLS certificate, i.e., without having completed the 20 ECTS training programme. It is the committee's opinion that measures should be taken to ensure that *every* PhD student at S4L completes the full training programme, for instance by assessing the yearly reports at a higher level and checking whether the student has indeed followed a satisfactory education programme before graduating.
- Although every PhD candidate is assigned an external supervisor outside the research group of the supervisor, this person acts as a confidential rather than a scientific advisor. The committee advises appointing an external scientific advisor for each PhD student, who gives feedback on a yearly basis to provide both student and supervisor with advice about the scientific directions of the PhD project.

7.3 Research integrity policy

1. The committee recommends installing a mandatory research integrity course for PhD students at all four S4L institutes. (At present, this is only the case at IBB and UIPS.)

Appendix 1. Short CVs of the members of the assessment committee

Professor P.J.J. Hooykaas (chairman)
Paul Hooykaas is emeritus Professor of Genetics and former head of department and scientific director of the Institute of Biology of Leiden University (the Netherlands). He is still active in his research into the molecular mechanisms which are used by the soil bacterium *Agrobacterium tumefaciens* to induce crown gall tumours on plants and its use for genome editing in plants and fungi. Hooykaas studied Chemistry and obtained his PhD in Biochemistry in 1979. He received the C.J. Kok prize from Leiden University for his PhD thesis. After that, he continued with his research in Leiden as a member of staff. In 1994, he was also appointed as Professor of Molecular Genetics at Delft University of Technology and he was professor in Delft for about ten years. He has acted as director of the Institute of Molecular Plant Sciences and later on of the Institute of Biology. Nowadays, he is still chairman of the Science Committee of the Faculty of Mathematics and Natural Sciences, and until recently chairman of the KNAW section Biology, member of the KNAW Council of Earth and Life Sciences and member of the board the Top Institute Green Genetics. Hooykaas received the AKZO Prize in 1987, awarded by the Royal Holland Society of Sciences and Humanities. He was elected as a member of the Academia Europaea in 1992 and as a member of the Royal Netherlands Academy of Arts and Sciences (KNAW) in 2003. In 2009, he was appointed as a KNAW Academy Professor.

Professor S. Frøkjær
Sven Frøkjær is Professor of Pharmaceutics at the University of Copenhagen (Denmark). His main research interest is peptide and protein formulation, with a special emphasis on particulate drug delivery systems and peptide transport across biological membranes. Frøkjær received his MSc (pharmaceutical sciences) in 1970 and his PhD in physical chemistry in 1973 from the Danish University of Pharmaceutical Sciences. Frøkjær spent nearly 20 years at Novo Nordisk A/S, where he was involved in research on drug delivery systems and various aspects of peptide and protein formulation. In 1993, he was appointed a Professor of Pharmaceutics at the Department of Pharmacy. He was Rector at the Danish University of Pharmaceutical Sciences from 2003 to 2007. After the merge with the University of Copenhagen, Frøkjær became Dean at the Faculty of Pharmaceutical Sciences. Since 2012 and until 2016, he has been Vice-Dean at the Faculty of Health and Medical Sciences of the University of Copenhagen. From 2002 to 2005, he was the director of the industrial-oriented graduate research school Drug Research Academy where he his is now chairman of the board. Frøkjær is a member of several boards and committees including The Danish Pharmacopeia Commission and the Medicinal Products Commitee under the Danish Medicines Agency. He serves as member of editorial boards on several pharmaceutical journals. He has also served as member at the Danish Medical Research Council for a period of five years. Frøkjær is the co-founder of two biotech companies, Lica Pharmaceuticals A/S and LiPlasome Pharma A/S.

Professor S.E. Radford
Sheena Radford is an Astbury Professor of Biophysics at the University of Leeds (UK) and Director of the Astbury Centre for Structural Molecular Biology. Her research is focused on fundamental structural molecular biology, specifically the measurement of the conformational dynamics of proteins and the elucidation of the role that these motions play in protein folding and misfolding in

health and disease. Radford graduated in Biochemistry at Birmingham and completed her PhD at Cambridge University in 1987. She carried out extensive research at Oxford, before becoming a lecturer at the University of Leeds in 1995, rising to become Director of the Astbury Centre in 2012 and Astbury Professor of Biophysics in 2013. Radford has published more than 260 peer-reviewed papers and given more than 350 invited lectures at national and international meetings. She has successfully supervised more than 60 PhD students and employed a similar number of postdoctoral research assistants. Professor Radford is a fellow of the Royal Society, a Fellow of the Academy of Medical Sciences, and an EMBO fellow, She received awards from the a Biochemical Society Colworth Medal, Royal Society of Chemistry Astra Zeneca prize, Protein Society Carl Branden Award, and an RSC Rita and John Cornforth Award.

Professor O. Nilsson

Ove Nilsson is Professor of Forest Genetics and Plant Physiology at the Swedish University of Agricultural Sciences in Umeå (Sweden). He is also the Director of the Umeå Plant Science Centre (UPSC). His research is focused on various aspects of the regulation of meristem identity and flowering time in two model systems, Arabidopsis and poplar. Nilsson received his BSc in General Biology and Biochemistry from Gothenburg University and a BSc in Molecular Biology from the Univesity of Umeå in 1987. He completed his PhD in Forest Cell and Molecular Biology at the Swedish University of Agricultural Sciences in 1995. Nilsson was a postdoctoral researcher at the Salk Institute for Biological Studies in La Jolla (USA) before returning to the Swedish University of Agricultural Sciences, where he became a professor in 2002. Since 2005, he has been the Chairman of the UPSC board. He is also the Director of the UPSC Berzelii Centre for Forest Biotechnology, a centre of excellence funded by the Swedish Research Council and Vinnova. The vision of this centre is to promote an environment where cutting-edge research and Swedish forest industry can interact. In 2016, the European Molecular Biology Organization (EMBO) elected Nilsson as a member for his achievements in life science. In addition, he was elected as new member to the Royal Swedish Academy of Science early 2017.

Professor M. Labouesse

Michel Labouesse is the Director of the Institut de Biologie Paris Seine (IBPS) at the University Pierre et Marie Curie (UPMC, France). The general objective of the IBPS is to investigate issues of general interest for society in terms of environment, ageing, neurodegenerative diseases, behavioural diseases, while making steady progress in fundamental areas of Biology. A key aspect of the IBPS research strategy lies in the development of novel methodologies at the border between Biology and Maths or Physics. Labouesse studied Maths and Physics and received his PhD in genetics from UPMC in 1983. In the period 1983-1989, he was a staff scientist at the Centre national de la recherche scientifique (CNRS), studying the mechanisms controlling mitochondrial RNA splicing in *Saccharomyces cerevisiae* and the role of the leucyl tRNA synthetase. Labouesse then moved to the Massachusetts Institute of Technology (MIT, USA) for a postdoctoral fellowship on *C. elegans* biology. From 2006 until 2012, he served as Head of the Development and Stem Cells department of the Institute of Genetics and Molecular and Cellular Biology in Strasbourg (France). In 2014, he became the Director of the IBPS, when the institute was created by the UPMC and the CNRS, in association with INSERM, with the goal of rising to prominence to become a flag-bearer for Biology at UPMC. In 2012, Labouesse became a European Molecular Biology Organization (EMBO) member and an ERC Advanced Grant Fellow.

Professor S. Bonhoeffer

Sebastian Bonhoeffer is Professor of Theoretical Biology at the Institute of Integrative Biology at the ETH Zürich (Switzerland). He studies the dynamics of infectious diseases across different scales using mathematical or computational modelling and experiments. After studying Music in Basel, Bonhoeffer studied Physics in Munich and Vienna. In the period 1992-1995, he did a PhD on mathematical models of virus evolution at the Department of Zoology in Oxford. After his PhD, he stayed in Oxford as a Research Fellow of Wolfson College and worked as a visiting scientist at the Rockefeller University in New York (USA). Prior to his appointment as SNF Research Professor at the ETH in 2001, he was junior group leader at the Friedrich Miescher Institut in Basel. Bonhoeffer became full professor at the ETH Zurich in 2005. He received an ERC Advanced grant in 2011 to study the population biology of drug resistance.

Professor G. von Heijne

Gunnar von Heijne is Professor of Theoretical Chemistry at Stockholm University (Sweden) and was Vice Director of the Science for Life Laboratory (Scilifelab) Stockholm until 2015. He has worked mainly on protein sorting and membrane protein biogenesis and structure, including the development of bioinformatics methods and experimental studies in *E. coli* and eukaryotic systems. Von Heijne received a PhD in Theoretical Physics from the Royal Institute of Technology in Stockholm in 1980. After a postdoc project at the University of Michigan (Ann Arbor, USA), he returned to Stockholm to work an assistant professor at the Royal Institute of Technology (1981-1988) and a Science correspondent for the Swedish National Radio (half-time, 1982 – 1985). In the period 1989-1994, he was an associate professor at Karolinska Institutet, (Stockholm). In 1994, Von Heijne became a professor at Stockholm University. He was the Director of the Center for Biomembrane Research (2006-2015) and Vice Director of the Science for Life Laboratory Stockholm (2009-2015). He has received many awards and honours, including the T. Svedberg Award of the Swedish Biochemical Society (1990), the Göran Gustafsson Prize of the Swedish Academy of Sciences (1995), the Arrhenius Medal of the Swedish Chemical Society (1997), The Björkén Prize of Uppsala University (1998), the van Deenen Medal of Utrecht University (2009), the Accomplishment by a Senior Scientist Award of the International Society for Computational Biology (2012). In addition, he has been elected an EMBO member (1994), member of the Royal Swedish Academy of Sciences (1997), member of the Academia Europaea (1998), member of the Royal Swedish Academy of Engineering Sciences (2000), Friday Lecturer at Rockefeller University (2007), Kroc Lecturer at MIT (2008), and a member of the Nobel Committee for Chemistry 1998-2009 (Chairman 2007-2009).

Dr Linda van den Berg

Linda van den Berg assisted the committee as an external independent secretary. She is a self-employed science writer and communications consultant with a background in the life sciences. Her company *Washoe Life Science Communications* offers a variety of communication services to academic institutes and companies.

Appendix 2. S4L site visit programme

Sunday 19 March 2017			
18:00	19:00	Welcome drinks	Review committee, Gerrit van Meer (Dean), Casper Hoogenraad, Antoinette Killian, and Institute directors
19:00	21:30	Dinner	Review committee only

Monday 20 March 2017			
8:30	9:30	Private kick-off meeting *(Discussion of procedure and preliminary findings based on self-assessment)*	Review committee only
9:30	10:15	Meeting Faculty Management Board Introduction S4L 10' presentation by S4L Director	Dean, Vice dean research, Heads of departments Biology, Chemistry and Pharmaceutical Sciences, Director GSLS *As audience only: S4L directors, Casper Hoogenraad, Antoinette Killian*
10:15	10:45	Meeting Institute Management of all 4 institutes and S4L 30' discussion	S4L directors, Casper Hoogenraad, Antoinette Killian *As audience only: Dean, Vice dean research, Heads of departments Biology, Chemistry and Pharmaceutical Sciences, director GSLS*
10:45	11:00	Coffee break, Preparation for Bijvoet session	Review committee only
11:00	12:00	Bijvoet Center 10' presentation by Institute Director 20' discussion 10' research highlight by PI 20' discussion	Bijvoet representatives
12:00	13:00	Bijvoet Center lab tour + interviews with PhD students	
13:00	14:30	Lunch, Interim evaluation Bijvoet, Preparation for IBB session	Review committee only
14:30	15:30	Institute for Biodynamics and Biocomplexity (IBB): 10' presentation by Institute Director 20' discussion 10' research highlight by PI 20' discussion	IBB representatives
15:30	16:30	IBB lab tour + interviews with PhD students	
16:30	17:30	Interim evaluation IBB	Review committee only
17:30	18:30	Young Investigators Forum + drinks	S4L Young Investigators Forum
19:00	21:00	Dinner	Review committee only

Tuesday 21 March 2017			
8:30	8:45	Preparation for IEB session	Review committee only
8:45	9:45	Institute of Environmental Biology (IEB): 10’ presentation by Institute Director 20’ discussion 10’ research highlight by PI 20’ discussion	IEB representatives
9:45	10:45	IEB lab tour + interviews with PhD students	
10:45	12:30	Interim evaluation IEB, Walk to DDW building via Koningsberger building and botanical gardens, Lunch @12:00, Preparation for UIPS session	Review committee only
12:30	13:30	Utrecht Institute for Pharmaceutical Sciences (UIPS): 10’ presentation by Institute Director 20’ discussion 10’ research highlight by PI 20’ discussion	UIPS representatives
13:30	14:30	UIPS lab tour + interviews with PhD students	
14:30	15:30	Interim evaluation UIPS and coffee break	Review committee only
15:30	16:30	Open discussion with Institute Directors	S4L Institute Directors, Casper Hoogenraad, Werner Most, Theodora de Vries
16:30	17:30	Private final meeting	Review committee only
17:30	17:45	Presentation of provisional findings by chairman	Public Faculty
17:45	18:30	End, drinks and bites	Public Faculty

Appendix 3. Quantitative data on S4L's composition and financing

Table 1.1: Bijvoet research staff

	2010		2011		2012		2013		2014		2015	
	#	FTE	#	FTE	#	FTE	#	FTE	#	FTE	#	FTE
Scientific staff [1]	19	7.6	18	7.2	18	7.2	18	7.2	19	7.6	17	6.8
Post-docs [2]	38	34.2	37	33.3	25	22.5	28	25.2	28	25.2	22	19.8
PhD candidates [3]												
Employed by UU	48	43.2	46	41.4	49	44.1	57	51.3	49	44.1	44	39.6
Not employed by UU	0	0.0	5	4.5	9	7.7	14	12.2	9	7.7	11	10.1
Total res. staff	105	85.0	106	86.4	101	81.5	117	95.9	105	84.6	94	76.3
Support staff[4]	15	15.0	16	16.0	11	11.0	11	11.0	14	14.0	13	13.0
Total staff	**120**	**100.0**	**122**	**102.4**	**112**	**92.5**	**128**	**106.9**	**119**	**98.6**	**107**	**89.3**

#: Total number of staff members; FTE: Research Capacity in Full Time Equivalents;
Standards for Research Capacity:
[1] Professor, Assistant Professor, and Associated Professor: Research Capacity = 40 % of the appointment;
[2] Post-doc: Research Capacity = 90 % of the appointment;
[3] PhD candidate: Research Capacity = 90 % of the appointment;
[4] Support staff in the institute (i.e., technicians and research support).

Table 1.2: IBB research staff

	2010		2011		2012		2013		2014		2015	
	#	FTE	#	FTE	#	FTE	#	FTE	#	FTE	#	**FTE**
Scientific staff (1)	30	11.6	31	11.8	21	7.9	22	8.3	24	8.9	24	**8.8**
Post-docs(2)	32	28.3	31	27.5	26	22.5	20	16.7	23	19.6	24	**8.8**
PhD candidates(3)	63	56.7	75	67.5	64	57.6	59	53.1	59	53.1	57	**51.3**
Total res. staff	125	96.6	137	106.8	111	88	101	78.1	106	81.6	105	**68.9**
Support staff(4)	34	31.3	26	24	20	18.3	22	20.3	23	21.3	23	**20.6**
Total staff	**159**	**127.9**	**162**	**130.8**	**131**	**106.3**	**123**	**98.4**	**129**	**102.9**	**128**	**89.5**

#: Total number of staff members; FTE: Research Capacity in Full Time Equivalents;
Standards for Research Capacity:
[1] Professor, Assistant Professor, and Associated Professor: Research Capacity = 40 % of the appointment; teaching staff 0% of the appointment;
[2] Post-doc: Research Capacity = 90 % of the appointment;
[3] PhD candidate: Research Capacity = 90 % of the appointment;
[4] Support staff in the institute (i.e., technicians and research support) 100%.

Table 1.3: IEB research staff

	2010		2011		2012		2013		2014		2015	
	#	FTE	#	FTE	#	FTE	#	FTE	#	FTE	#	FTE
Scientific staff [1]	24	8.4	21	6.6	13	4.3	15	5.4	19	6.6	20	6.8
Post-docs[2]	6	4.5	13	11.3	18	15.8	18	15.4	16	12.6	16	12.7
PhD candidates[3] Employed by UU	30	26.6	32	28.5	24	21.0	25	22.0	25	20.9	24	20.6
Not employed by UU	18	16.2	13	11.7	11	9.9	11	9.9	15	13.5	16	14.4
Total res. staff	78	55.7	79	58.1	66	51.1	69	52.8	75	53.6	76	54.5
Support staff[4]	24	20.0	25	20.2	21	16.8	22	18.0	18	12.8	17	12.5
Total staff	**102**	**75.7**	**104**	**78.3**	**87**	**67.9**	**91**	**70.8**	**93**	**66.4**	**93**	**67.0**

#: Total number of staff members; FTE: Research Capacity in Full Time Equivalents;

Standards for Research Capacity:

[1] Full Professor, Assistant/Associated Professor: Research Capacity = 40 % of the appointment;

[2] Post-doc: Research Capacity = 90 % of the appointment;

[3] PhD candidate: Research Capacity = 90 % of the appointment;

[4] Support staff in the institute (i.e., technicians and research support).

Table 1.4: UIPS research staff

	2010		2011		2012		2013		2014		2015	
	#	FTE	#	FTE	#	FTE	#	FTE	#	FTE	#	FTE
Scientific staff [1]	76	25.25	50	23.86	50	24.26	48	24.04	49	22.92	46	23.10
Post-docs [2]	41	27.95	41	22.85	36	19.6	42	22.99	45	25.61	39	28.09
PhD candidates[3] Employed by UU	120	84	116	81.2	97	67.9	100	70	86	60.2	88	61.6
Not employed by UU	89	44.5	102	51	110	55	112	56	118	59	132	66
Total res. staff												
Support staff[4]	25	17.84	23	16.82	25	17.67	24	17.45	26	18.84	30	22.46
Total staff	351	199.54	332	195.73	318	184.43	326	190.48	324	186.57	335	201.25

#: Total number of staff members; FTE: Research Capacity in Full Time Equivalents;

Standards for Research Capacity:

[1] Professor, Assistant Professor, and Associated Professor: Research Capacity = 70% or 0% of the appointment;

[2] Post-doc: Research Capacity = 100% of the appointment;

[3] PhD candidate: Research Capacity = 70 % of the appointment for Employed and an estimated 50% of the appointment for Not employed;

[4] Support staff in the institute (i.e., technicians and research support).

Table 2.1: Bijvoet funding

	2010	2011	2012	2013	2014	2015	Average
Funding:	k€ / %	k€ / %	k€ / %	k€ / %	k€ / %	k€ / %	**k€ / %**
Direct funding (1) By the university /	3576 / 25	3301 / 34	2898 / 25	2901 / 21	3270 / 28	3177 / 26	**3187 / 26**
Sectorplan	-	-	29 / <1	324 / 2	1043 / 9	297 / 2	**282 / 2**
Zwaartekracht	-	-	-	-	23 / <1	455 / 4	**80 / 1**
Research grants nat. (2)	7743 / 54	4049 / 42	6170 / 53	7866 / 57	4564 / 40	6100 / 50	**6082 / 50**
Research grants inter. (3)	1653/ 12	1320 / 14	1521 / 13	2034 / 15	1652 / 14	1114 / 9	**1549/ 13**
Contract research (4)	1235 / 9	1022 / 11	1090 / 9	623 / 5	937 / 8	981 / 8	**981 / 8**
Other (5)	-	-	-	20 / <1	39 / <1	38 / <1	**16 / <1**
Total funding	**14207**	**9692**	**11708**	**13768**	**11529**	**12163**	**12178**
Expenditure							
Personnel costs	6821 / 48	6798 / 70	6333 / 54	6567 / 48	6942 / 60	6281 / 52	**6624 / 54**
Other costs	7386 / 52	2895 / 30	5375 / 46	7201 / 52	4586 / 40	5882 / 48	**5554 / 46**
Total expenditure	**14207**	**9692**	**11708**	**13768**	**11529**	**12163**	**12178**

The earning capacity (the ratio between other funding acquired and direct funding) was 4.2 averaged over the reporting period and did not significantly change since 2010.

(1): Direct funding by the University; Sectorplan and Top research schools/Zwaartekracht are shown separately.

(2): Research grants obtained in national scientific competition through open calls (e.g., grants from NWO, KNAW).

(3): Research grants obtained in international scientific competition through open calls (e.g., Horizon 2020 grants).

(4): Research contracts for specific research projects obtained from external organisations, such as industry, governmental ministries (not through open calls).

(5): Funds that do not fit into any of the other categories (e.g., consultancies, conferences, etc.).

Table 2.2: IBB funding

	2010	2011	2012	2013	2014	2015	Average
Funding:	k€ / %	k€ / %	k€ / %	k€ / %	k€ / %	k€ / %	**k€ / %**
Direct funding (1) By the university	3416 / 43	2619 / 38	2612 / 37	2292 / 32	2359 / 28	2693 / 36	**2665 / 36**
Research grants (2) national	1856 / 23	2065 / 30	2618 / 37	2911 / 40	4250 / 50	2431 / 33	**2689 / 36**
Research grants (3) international	317 / 4	469 / 7	475 / 7	647 / 9	1397 / 16	1256 / 17	**760 / 10**
Contract research (4)	2450 / 31	1762 / 26	1369 / 19	1393 / 19	542 / 6	1097 / 15	**1436 / 18**
Other (5)	-	-	-	-	-	-	
Total funding	**8039**	**6915**	**7074**	**7243**	**8548**	**7477**	**7549**
Expenditure							
Personnel costs	5784	4834	4900	5075	5271	5314	**5196**
Other costs	2255	2081	2174	2168	3277	2163	**2353**
Total expenditure	**8039**	**6915**	**7074**	**7243**	**8548**	**7477**	**7549**

(1): Direct funding by the University Sectorplan and Top research schools/zwaartekracht are shown separately.

(2): Research grants obtained in national scientific competition through open calls (e.g. grants from NWO, KNAW).

(3): Research grants obtained in international scientific competition through open calls (e.g. Horizon 2020 grants).

(4): Research contracts for specific research projects obtained from external organizations, such as industry, governmental ministries (not through open calls).

(5): Funds that do not fit into any of the other categories (e.g. consultancies, conferences etc.).

Table 2.3: IEB funding

	2010	2011	2012	2013	2014	2015	Average 2010-2015
Funding:	k€/%	k€/%	k€/%	k€/%	k€/%	k€/%	**k€/%**
Direct funding[1]	1528/34	1471/31	938/27	1232/27	1391/31	1593/35	**1359/31**
Research grants national[2]	1451/32	1372/29	1247/36	1640/36	1883/42	1880/42	**1579/36**
Research grants internatl.[3]	500/11	780/17	693/20	1073/23	788/18	557/12	**732/17**
Contract research[4]	1058/23	1077/23	562/16	659/14	385/9	494/11	**706/16**
Total funding	**4536**	**4700**	**3439**	**4603**	**4447**	**4523**	**4375**
Expenditure							
Personnel costs	1457/32	1427/30	1045/30	1428/31	1029/23	1133/25	**1253/29**
Other costs	3079/68	3273/70	2394/70	3175/69	3418/77	3391/75	**3122/71**
Total expenditure	**4536**	**4700**	**3439**	**4603**	**4447**	**4523**	**4375**

[1] Direct funding by the University.

[2] Research grants obtained in national scientific competition through open calls (e.g. grants from NWO, KNAW).

[3] Research grants obtained in international scientific competition through open calls (e.g. grants from ERC, Horizon 2020).

[4] Research contracts for specific research projects obtained from external organizations, such as industry, governmental ministries (not through open calls).

Table 2.4: UIPS funding

	2010	2011	2012	2013	2014	2015	Average
Research Institute							
Funding:	k€/%	k€/%	k€/%	k€/%	k€/%	k€/%	**k€/%**
Direct funding (1) By the university Sectorplan Top research schools/zwaartekracht:	5544/34	5558/36	6208/39	5661/38	5444/39 91/1	6350/48 224/2	**5794/38** **157/1**
Research grants nat. (2)	1837/11	6310/41	2818/18	1941/13	3027/22	2192/17	**3021/20**
Research grants inter. (3)	796/5	1048/7	1850/12	2372/16	1844/13	1765/13	**1613/11**
Contract research (4)	7916/49	2517/16	5125/32	4957/33	3457/25	2570/20	**4424/29**
Other (5)	75/1	119/1	126/1	168/1	86/1	34/0	**101/1**
Total funding	**16169**	**15551**	**16128**	**15099**	**13949**	**13135**	**15005**
Expenditure:							
Personnel costs	9741/60	9752/63	9943/62	9515/63	8746/63	8096/62	9299/62
Other costs	6427/40	5799/37	6184/38	5583/37	5204/37	5039/38	5706/38
Total expenditure	**16169**	**15551**	**16128**	**15099**	**13949**	**13135**	**15005**

From Table 2.4 we observe that the earning capacity (other funding/direct funding) has increased from 1/1 (2004-2009) to 1.6/1 (2010-2015).

(1): Direct funding by the University Sectorplan and Top research schools/Zwaartekracht are shown separately.

(2): Research grants obtained in national scientific competition through open calls (e.g. grants from NWO, KNAW).

(3): Research grants obtained in international scientific competition through open calls (e.g. Horizon 2020 grants).

(4): Research contracts for specific research projects obtained from external organizations, such as industry, governmental ministries (not through open calls).

(5): Funds that do not fit into any of the other categories (e.g. consultancies, conferences etc.).

Appendix 4. Explanation of the categories utilised

Category	Meaning	Research quality	Relevance to society	Viability
1	World leading/ excellent	The research unit has been shown to be one of the few most influential research groups in the world in its particular field.	The research unit makes an outstanding contribution to society.	The research unit is excellently equipped for the future.
2	Very good	The research unit conducts very good, internationally recognised research.	The research unit makes a very good contribution to society.	The research unit is very well equipped for the future.
3	Good	The research unit conducts good research.	The research unit makes a good contribution to society.	The research unit makes responsible strategic decisions and is therefore well equipped for the future.
4	Unsatisfactory	The research unit does not achieve satisfactory results in its field.	The research unit does not make a satisfactory contribution to society.	The research unit is not adequately equipped for the future.

Source: Standard Evaluation Protocol 2015 - 2021