

Aan: College van Bestuur UL

Betreft: aanbieding en reactie op het visitatierapport IBL.

6 maart 2018

Geacht college,

Met veel plezier bieden wij u hier het rapport aan van de onderzoek visitatie 2011-2016. Wij zijn van mening dat de commissie, geleid door prof. C.J.M. Pieterse een zeer accuraat rapport heeft uitgebracht. De conclusies over kwaliteit en relevantie voor de samenleving zijn met beiden een excellent (1) eindscore erg verheugend. Met deze score sluit het rapport aan bij de citatie analyses van het CWTS waarin wij in vergelijking met 5 top instituten van universiteiten in Nederland en omliggende landen van Europa als beste scoren in de MNCS citaties.

Wat betreft de levensvatbaarheid scoren wij zeer goed (2). Wij zijn het met de conclusies die hier aan ten grondslag liggen volledig eens. Inderdaad zijn er enkele punten waar de komende jaren veel aandacht voor zal moeten zijn. De vergrijzing van een deel van de staf zal als belangrijkste punt aangepakt dienen te worden. Met name in het planten cluster is dit urgent en zijn wij met een vacature voor een tenure track positie aan het werven. Gezien de grote competitie in ons vakgebied blijkt dit niet eenvoudig en is het mogelijk nodig deze vacature op hoogleraarsniveau in te vullen. Zoals de commissie aanbeveelt zullen wij bredere profielen voor nieuwe stafleden aanhouden. Voor een versterking van het plantencluster zullen wij een voorstel doen om het arbeidscontract van de recent benoemde Prof. Bezemer uit te breiden. Dit zal ook de in het rapport genoemde verbetering van samenwerkingen in de groene biologie vorm kunnen geven. De daar uit voortvloeiende grotere samenwerking op gebied van biodiversiteit/milieu zal ook verder gestalte kunnen krijgen door nul aanstellingen van IBL medewerkers bij Naturalis te bewerkstelligen. Een tweede urgentie is om de bioinformatica en computationele biologie te versterken. Hiervoor zijn nu plannen in de maak die op korte termijn zullen worden besproken binnen het faculteitsbestuur. Ten derde zal grote aandacht gegeven worden aan een betere verbinding van de expertises binnen het dierencluster. Met de komst van Dr. Nathaniel Martin wordt momenteel goed geïnvesteerd in de microbiologie. Maar ook voor microbiologie zal voor verdere groei investeringen in projectmanagement moeten plaatsvinden.

Wat betreft de aanbevelingen over de balans tussen verschillende categorieën PhDs en verkorting promotieduur verwachten wij net als de commissie dat de actiepunten genoemd in het zelf evaluatie rapport op langere termijn tot succes zullen leiden en met bovengenoemde korte termijn actiepunten dit ook verder zal worden bevorderd.

Wij zijn zeer gemotiveerd om het instituut in branding te laten toenemen. Als voorbeeld van recente initiatieven sturen wij hierbij ons recent verschenen boekje "over transparante zebravissen en antibiotica uit het bos" ook verschenen in een Engelse vertaling.

In samenvatting: dit rapport geeft zeer veel vertrouwen voor de toekomst en bevestigt onze sterke positie in het internationale onderzoeksveld. We hopen en verwachten dat met wat strategische investeringen het instituut Biologie haar excellente en concurrerende positie kan vasthouden en wellicht uitbouwen.

Met vriendelijke groet,

Herman Spaik

Wet. Dir. IBL

Assessment of Research Quality

**Institute of Biology Leiden
(IBL)**

2011-2016

final report – 2 February 2018

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1. Introduction

1.1 Background

This report describes the assessment of the quality and relevance of research conducted at the Institute of Biology Leiden (IBL) in the period 2011-2016. The IBL is one of the eight research institutes of the Faculty of Science at Leiden University in the Netherlands. The assessment was performed by an external assessment committee using the Standard Evaluation Protocol (SEP) 2015-2021. 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. 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

- **IBL's researchers and group leaders** need to know how the quality of IBL research, its societal relevance, and its strategy are perceived by independent experts and how these elements can be improved.
- **The Board of the University of Leiden** 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 IBL research delivers.

1.2 Members of the assessment committee

The Board of Leiden University has appointed as members of the assessment committee

- Professor C.M.J. Pieterse, *chair* (Utrecht University, the Netherlands),
- Professor A.T. Look (Dana-Farber Cancer Institute, Harvard Medical School, USA),
- Professor F.A. Huntingford (University of Glasgow, UK),
- Professor R.G. Gillespie (University of California Berkeley, USA),
- Professor I.W.C.E. Arends (Delft University of Technology, the Netherlands).

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.

1.3 Procedures followed

The assessment committee evaluated IBL research based on the institute's self-assessment report and interviews with IBL representatives during a site visit in November 2017. The site visit

programme is listed in Appendix 2. Additional reference materials included short CVs of IBL's principal investigators, the complete publication list that was used for the citation analysis in the self-report, a list of key scientific publications of the three IBL clusters, and the previous assessment report (QANU Research Review Biology 2005-2010, an assessment of the research at several Dutch biology institutes, including the IBL). 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 IBL's strategy in formulating its recommendations.

Qualitative and quantitative assessment of IBL research

The assessment committee made a qualitative judgement of the IBL and its three research clusters based on three assessment criteria:

1. *research quality*, i.e., contribution to scientific knowledge, scale of research results (scientific publications, instruments, and infrastructure produced and other contributions to science),
2. *relevance to society*, i.e., quality, scale, and relevance of contributions (advisory reports for policy, contributions to public debates, etc.) targeting groups that the IBL has itself designated as target groups (patients, the general public, students, and industry),
3. *viability*, i.e., the strategy that the IBL 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 IBL's management.

For the IBL as a whole, the qualitative assessments were supplemented by numerical scores (1–4) for each of the three criteria.

Assessment of IBL's PhD programme

The assessment committee also considered the supervision and instruction of PhD candidates at the IBL. During the site visit, the committee interviewed seven PhD students, who were in varying stages of the PhD track. The committee assumed that these individuals provided opinions that are representative of the group at large. In addition, the committee interrogated several IBL staff members about the PhD programme. The following topics were considered:

- institutional context of the PhD programme,
- selection and admission procedures,
- 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, exit numbers, and career prospects.

Assessment of IBL's research integrity and diversity policy

The committee also considered IBL'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 the IBL deals with research data, data management, and scientific integrity, and the extent to which a critical pursuit of science occurs at the IBL. In addition, the committee evaluated IBL's efforts to ensure a diverse staff composition.

1.4 Research unit under assessment: Institute of Biology Leiden

Building on a history of more than 400 years of biological research in Leiden, the IBL forms the core of today's biological research in the Dutch city of Leiden. IBL's research and teaching activities encompass biology from the molecular and cellular level, to the organismal level. Since 2011, IBL research has been organised into three research clusters:

- Animal Sciences and Health,
- Plant Sciences and Natural Products,
- Microbial Biotechnology and Health.

The clusters share high-end facilities and technical expertise, and collaborate on four institute-wide research themes:

- Biology of health and disease,
- Development and evolution,
- Biological interactions from molecule to organism,
- Discovering bioactive compounds.

The organisational structure of the institute is summarised in Figure 1 on page 6. From September 2010 to September 2014, the IBL was led by Professor Carel ten Cate (Scientific Director) and Professor Herman Spink (Vice Director). Since September 2014, the IBL has been headed by Professor Herman Spink (Scientific Director) and Professor Gilles van Wezel (Vice Director). IBL's Management Team consists of the Scientific Director, three cluster leaders (one of which is the Vice Director), two Education Managers (BSc and MSc), and an Institute Manager. The Management Team is advised by a Scientific Council (i.e., all full professors at the IBL), an External Advisory Board (consisting of four prominent Dutch scientists and a member from industry), and an Institute Council (formed by representatives of IBL's scientists, PhD students, a MSc student and a support staff member).

In 2016, the IBL research staff represented 77.0 full-time equivalents (FTE), consisting of 33.8 FTE PhD students, 15.6 FTE post-docs, and 27.6 FTE senior staff members. In addition, the institute harboured 31.9 FTE in support staff members and 50.0 FTE external PhD students (i.e., 35 PhD students with a foreign scholarship and 15 PhD students of IBL honorary professors that were affiliated to external research institutes). Further details about the IBL staff are provided in Table 1 of Appendix 3. The IBL has a secure financial basis, with funding sources balanced between university, external funding from science organizations (NWO, EU), and funding from industry and other third parties. Details about IBL's funding are provided in Table 2 of Appendix 3. The IBL is responsible for Leiden University's BSc and MSc education programmes in biology, with respectively >420 and >250 students in the academic year 2017-2018. Research and education are intricately linked at the IBL, with BSc and MSc students performing research projects that are fully integrated in the general research activities of the institute.

The IBL is one of the eight research institutes of the Faculty of Science of Leiden University. The IBL laboratories are located at two buildings on the Leiden Bioscience Park, which also harbours collaborating institutions such as the Leiden Academic Centre for Drug Research (LACDR), Leiden Institute of Chemistry (LIC), Institute of Environmental Sciences (CML), Naturalis Biodiversity Centre,

and Leiden University Medical Centre (LUMC). The Leiden Bioscience Park also harbours more than 100 companies working on biotechnology, drug development, and related services. Several IBL researchers collaborate with these companies and others have initiated start-up companies as spin-offs from IBL research. In addition to these local collaborations, IBL's scientific staff actively participates in many national and international collaborations within academic, industrial, and governmental organisations.

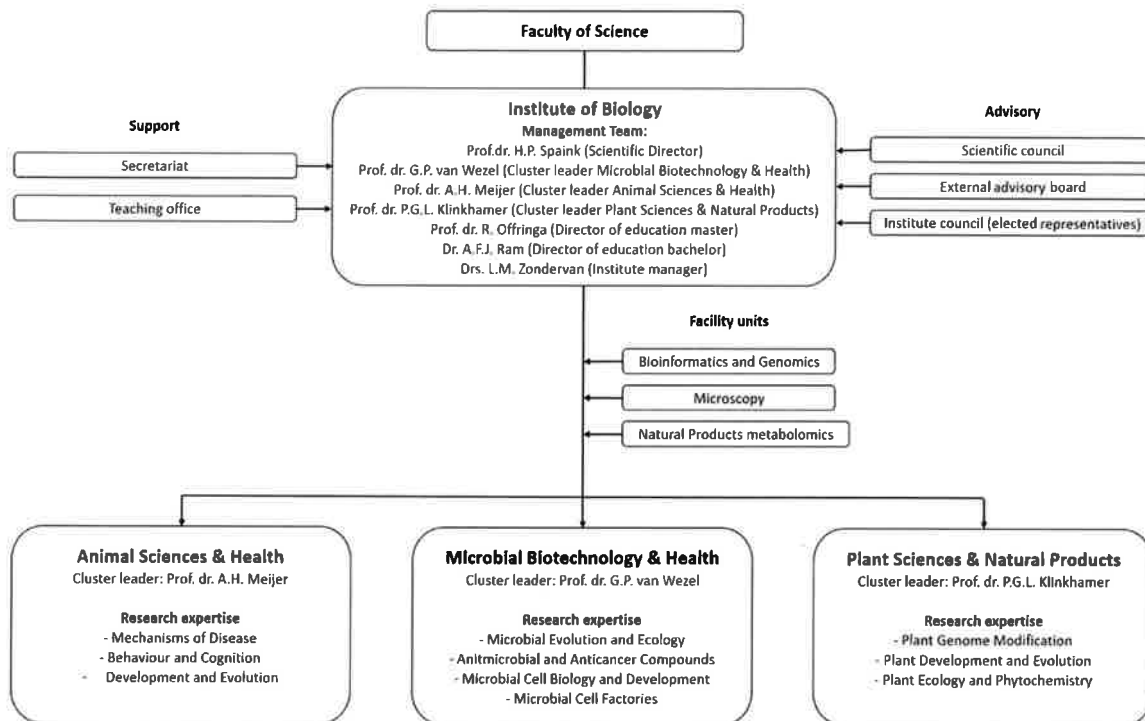


Figure 1: Organisational structure of the Institute of Biology Leiden

2. Assessment of IBL research

2.1 IBL's strategy and targets

Mission, objectives and research area

IBL's mission is to perform outstanding and internationally competitive research and teaching in biology from the molecular and cellular to the organismal level. IBL scientists work on fundamental questions related to biological mechanisms of health and disease, development and evolution, and host-microbe-interactions in the context of a changing environment (theme 'Healthy lives in a changing world'). IBL scientists aim to understand molecular processes that are fundamental to the functioning of cells within an organism and to the interaction with other higher organisms or microbes. IBL scientists actively seek to capitalise on societal relevance of their research, as exemplified by their research theme on the discovery of novel bioactive compounds. They distinguish themselves by studying a small number of model organisms with highly innovative technologies and a multidisciplinary approach. The institute successfully translates new insights into industrial and medical applications. They have created an atmosphere in which research and education can thrive, exploiting the resources and networks that are available in Leiden. It is a lively institute that organises a variety of scientific, strategic and social meetings (e.g., IBL symposium, Spotlight Meetings, PhD & Postdoc days, yearly staff retreat, and the Christmas dinner).

Reorganisation

At the time of the previous research assessment, IBL research was divided into Evolutionary Biosciences and Molecular Biosciences. In response to international trends and developments in science and society, the institute was restructured in 2012, resulting in three research clusters and four institute-wide research themes (see Figure 1). The cluster structure promotes interdisciplinary research, stimulating scientists to combine their molecular, evolutionary, and ecological expertise. The clusters share facilities, expertise, and model organisms. The reorganisation has strengthened the IBL profile and increased interactions among the staff. In addition, the restructuring has created new opportunities for funding and applications. During the review period, IBL's strategic investments were mainly in facilities and new staff appointments.

Investments in staff

The IBL has substantially invested in recruiting top scientists during the evaluation period. For instance, the institute recruited Gilles van Wezel from the Leiden Institute of Chemistry, Ariane Briegel from Caltech, and (more recently) Nathaniel Martin from Utrecht University. The IBL has also promoted/appointed new professors, extraordinary professors, and tenure trackers to strengthen the four research themes, including Professor Annemarie Meijer, Professor Ewa Snaar, Dr Dennis Claessen, Professor Vera van Noort, Professor Martijn Bezemer, Professor Jos Raaijmakers, and Professor Remko Offringa. Due to upcoming retirements, the institute has the ambition to fill several new tenure track positions in the near future. The IBL will devote future staff recruitments at further strengthening the themes, adding to the international visibility, earning power, and viability of the institute.

Investments in facilities

The IBL harbours state-of-the-art research facilities, including excellent molecular biology laboratories, plant and animal breeding facilities, microbiology labs, fermentation units, high-end microscopy facilities, a natural products laboratory, a bioacoustics facility, and a genomics facility. The imaging facility is supported by experienced support staff, including Dr Joost Willemse, who was recently recruited to meet the increasing demand for high-quality imaging. This facility is closely linked to the Cell Observatory and the NeCEN (see below). The genomics facility specialises in nanopore sequencing in collaboration with a newly founded company in which the university is shareholder (Future Genomics Technologies). To support its zebrafish studies, the IBL has created a second zebrafish facility at the Gorlaeus building of the Faculty of Science. In addition, the institute has established a genomics and bioinformatics core centre together with the Leiden Institute of Advanced Computer Science (LIACS).

The IBL runs several large (some national) technology platforms in collaboration with other institutes at the Faculty of Science, including the Netherlands Center for Electron Nanoscopy (NeCEN), Cell Observatory, and Leiden Metabolomics Centre. NeCEN is the only cryo-electron microscopy (CryoEM) facility in the Netherlands that provides access to and expert operation of two state-of-the-art Titan Krios machines. Its administrative office is run by the IBL. The Cell Observatory offers advanced equipment for microscopic imaging from molecule to cell to organism, including high-throughput and high-content imaging equipment. It is jointly coordinated by the IBL (Professor Meijer) and LACDR (Professor van de Water). The Leiden Metabolomics Centre runs advanced metabolomics analyses, for instance to identify novel bioactive compounds from natural sources. It is run by the IBL (Professor Spaank, Dr Choi) and LACDR (Professor Irth, Professor Hankemeier). The IBL participates in several national large-scale research infrastructure initiatives, including the Roadmap NEMI in which the NeCEN plays a key role, the Roadmap Netherlands Metabolic Phenome Centre, and NL Bioimaging.

Bioinformatics and data stewardship

The high-end technologies that are used by IBL scientists produce massive amounts of data. Managing and analysing these data calls for specific expertise. The institute has taken strategic measures to meet this challenge, including establishing collaborations with the Leiden Centre of Data Science and the LIACS. Professor Vera van Noort has been appointed as Professor in Computational Biology in 2016 (0.2 FTE). Professor Fons Verbeek became a full Professor of Computer Science in Computational Bioimaging in 2017; his chair is a joint appointment between the IBL and the LIACS. These two persons will be the driving force for the future expansion of the bioinformatics expertise at the IBL. More specialised bioinformatics expertise is brought in through collaborations, for instance with BaseClear (RNA sequencing analysis). The IBL has also started an Informatics and Biology BSc education track, which is expected to stimulate the computational aspects of IBL research and enhance the interactions with the Leiden Centre for Data Science. In addition, they are planning to start a new MSc in bioinformatics, in collaboration with LIACS, Delft University, and the Leiden University of Applied Science.

Strategic collaborations

The IBL collaborates with several Leiden-based institutes for life science research. In 2015, the IBL, CML, Hortus Botanicus, and Naturalis Biodiversity Centre have formed the Leiden Evolution,

Biodiversity, and Environment Network (LEBEN). This network organises bi-monthly informal discussion meetings as well as a yearly symposium. Recently, the Archaeology Faculty also joined the LEBEN meetings. The molecular laboratories of Naturalis are located at the IBL. In addition, the IBL, Naturalis, and CML collaborate in the education of BSc and MSc students. The IBL also actively collaborates with the LACDR and LUMC, and with the institutes of chemistry, physics, and computer sciences of the Faculty of Science. Leiden University has selected 11 research priorities, three of which relate to life sciences (Bioscience: the science base of health, Translational drug discovery & development, and Brain function & dysfunction over the lifespan). IBL researchers participate in these three priorities and have received significant funding from them. The IBL organises and contributes to several local lectures and meetings (e.g., weekly This Week's Discoveries Seminars, monthly Van Leeuwenhoek Bioscience Lectures, and quarterly Cell Observatory Symposia).

In addition to the local interactions, the IBL actively collaborates with national and international partners. Leiden University participates in the League of European Research Universities (LERU) and the IBL works with other LERU members (e.g., University of Edinburgh, KU Leuven, Imperial College London, Lund University, Université Paris-Sud, Utrecht University). In addition, IBL researchers collaborate with leading European research groups in drug research, zebrafish as disease model, actinomycete biology, and various technologies (e.g., metabolomics, bioinformatics, computational research, and high resolution imaging). Outside Europe, the IBL collaborates with institutes in North-America (USA, Canada), South America (Mexico, Brazil), and Asia (Chinese Academy of Sciences, Singapore, Japan, and Indonesia).

Funding

The IBL budget has increased since 2011 as a result of a rise in university funding due to an increased number of students and PhD students. The proportion of research input from non-direct funding has increased, in particular research funded by industry. The institute aims to further enhance its income from industrial partners in the future. In addition, it aspires to improve the funding from competitive NWO grants (in particular Veni, Vidi, Vici grants) and European research grants (e.g., H2020 programmes and ERC). To this end, experienced IBL scientists actively coach younger scientists in writing grant proposals. The IBL has appointed several scientists to teaching positions, allowing other researchers to spend more time writing grants. The facilities at the IBL are currently financed with university money, NWO grants, and national government funding. To safeguard the expensive equipment and associated expertise in the future, the IBL is applying for funding from NWO and companies.

2.2 Assessment of the Institute of Biology Leiden as a whole

Research quality

The committee is impressed by IBL's overall research quality, which is **excellent**. The IBL performs world-class research in the scientific areas of animal, plant, and microbial biology. In each of these areas, they have specific international reputations, especially in the fields of zebrafish as a model for animal host-microbe interactions, *Arabidopsis* as a model for plant development, gene targeting technologies in plants and animals, natural product discovery, microbial biotechnology, and bird song in relation to human language acquisition. IBL researchers have published many high impact scientific papers over the review period, in journals such as Nature, Nature brand journals, Elife, PNAS, Current

Biology, Genes & Development, PLoS Pathogens, ISME J, ACS Chem Biol, Chemistry & Biology, Cancer Research, Autophagy, and TREE. A prospective bibliographic analysis of the Centre for Science and Technology Studies revealed that IBL's mean normalised citation score was 1.74 in the period 2010-2015, meaning that the impact of the publications of the current IBL scientific staff is 1.74-fold the world average (This figure is based on a bibliometric analysis of 680 publications with at least one author that was affiliated to the IBL in 2017.) The institute is home to high profile scientists and technological experts that have been awarded prestigious awards and grants. The staff holds leading positions in European research networks, international societies and committees, professional organisations, and evaluation panels.

The IBL harbours state-of-the-art research facilities, including the national CryoEM facility NeCEN with its two state-of-the-art Titan Krios machines for CryoEM research, the Cell Observatory with its excellent imaging facilities, new zebrafish facilities, high-quality plant growth facilities, microbial fermentation units, and animal behaviour and bioacoustics facilities. These facilities are also available to collaborators, thus further contributing to the advancement of science within and beyond the IBL. The committee considers the potential for interdisciplinary collaborations with neighbouring institutes such as LACDR, LUMC, and Naturalis a major strength, adding substantially to the research quality at the IBL.

Relevance to society

IBL's research is **highly relevant** to society. Given the fact that the IBL is a basic science institute, its research has a surprisingly translational nature, with almost every study appearing to have a potential application. Examples of IBL discoveries with potential for application are the discovery of the rejuvenation gene in plants, novel DNA repair mechanisms with potential in gene editing, novel antibiotics produced by microbes, novel resistance traits against insect pests, and a method to discriminate male from female chickens when they are still in the egg. Furthermore, IBL scientists that study song learning in zebra finch birds collaborate with experts in human linguistics. Their joint work has provided insight in vocal learning in humans, with interesting potential applications. In addition, the IBL made discoveries in the field of diagnostics and prevention of human diseases such as cancer and tuberculosis, thus adding to medical knowledge that may be used to prevent or treat diseases in the future. IBL research is also relevant to environmental issues, for instance studies on the effects of anthropogenic noise on birds and fish.

The institute has ample collaborations with industry, ensuring that the research results are applied, especially in the domains of health and agriculture. IBL staff members are strongly involved in steering committees of the Dutch top sectors, such as the Top Institute TTI Green Genetics, Top Sector Chemistry, Top Sector Life Science & Health, and the TKI Horticulture & Starting Materials. Several IBL researchers have initiated start-up companies as spin-offs from IBL research, including InOvo (developing methods for gender screening in the egg to prevent killing of one-day-old roosters), Life Science Methods (high-throughput cell biology methods and consulting services), NewCatch (fish reproductive research), ZF Screens (product development for pharmaceutical applications based on zebrafish), Add2X Biosciences (an R&D company for DNA and protein therapeutics), ExPlant Technologies (R&D drug discovery from plants), and Future Genomics Technologies (joint venture of BaseClear and Leiden University).

The IBL also contributes to society by training excellent students and scientists. The institute aims to maintain a broad BSc curriculum and a specialised high-profile MSc and PhD education. Many IBL studies naturally appeal to the general public and the institute is very active in public outreach. The IBL has a high visibility in national newspapers and magazines, and on national radio and television. Several IBL research topics have been selected as important research themes by the general Dutch public in the 'Dutch National Research Agenda' (<https://wetenschapsagenda.nl/?lang=en>).

The committee applauds the imminent incorporation of Professor Ionica Smeets' Science Communication & Society group in the IBL. This group aims to understand how science communication can improve the interaction between science and society, leading to evidence-based science communication. They collaborate with museums such as Naturalis and the Museon, for instance to develop evidence-based communication materials about biodiversity. As Professor Smeets explained during the site visit, knowledge of biology is of great relevance to the general public. For instance, understanding how antibiotics work may directly benefit people's health. Hence, it clearly makes sense to incorporate this group in a biology research institute.

Viability

Overall, the committee rates IBL's viability as **very good**. The restructuring of the institute in three clusters has aided the IBL to stimulate interdisciplinary research, which is in line with current trends in science. It has also helped the institute to sharpen its profile, attract more funding, and develop strong technological facilities. The clusters interact in the four bottom-up research themes. Good examples are the diverse interactions between the Microbiology cluster and the Plant and Animal clusters, e.g., on mining plant root-associated microbes for novel antibiotics and other natural products, and on the interaction of microbial pathogens with the zebrafish model. The excellent imaging facilities play a central role in facilitating connections between the clusters and the themes.

IBL researchers have performed world-leading research in the period 2011-2016 and they are expected to continue doing so. The committee noted that the citation analysis performed and described by the Centre for Science and Technology Studies (CWTS) mistakenly states that the analysis is based on "680 publications published under the address of IBL". The committee noticed that 25% of the publications actually do not have an IBL affiliation, as they are from current IBL staff prior to their appointment at IBL. Therefore, the citation scores must be interpreted as the citation performance of the current IBL staff.

The institute's excellent facilities will likely continue to nourish fruitful collaborations in the future. In addition, the location on the Leiden Science Park is favourable, stimulating industrial and academic collaborations. The committee is positive about IBL's leaders. Examples of strong strategic decisions include transferring Professor Gilles van Wezel into the institute, recruiting several other high profile scientists, investing in state-of-the-art equipment, and taking appropriate measures to limit the duration of PhD tracks.

However, the committee has also identified potential threats to the long-term sustainability of the IBL:

- The institute is experiencing difficulties in recruiting new staff to succeed some senior researchers that are approaching retirement. More in general, the committee feels that the IBL

seeks for candidates with a highly specific and relatively narrow profile to fill its vacancies. This narrows the pool of potential candidates and prevents the institute from optimally exploiting its rich opportunities. A more flexible profile will likely expedite recruiting talented candidates.

- The committee shares the IBL’s concerns about the national and international decrease in opportunities to secure funding for fundamental research.
- The institute has had limited success in obtaining funding from the EU.
- The committee thinks that there is much potential to further strengthen the interactions with neighbouring institutes, especially Naturalis Biodiversity Centre and the CML. This potential is currently underexploited.
- The IBL may not harbour sufficient in-house bioinformatics expertise to fully exploit the data that it produces. The analysis of imaging data is well under control because of the expertise of Professor Verbeek and investments in professional user-friendly software. However, bioinformatics may be a bottleneck in other IBL fields, most notably genomics.

The committee will provide recommendations on how to deal with these viability concerns in Chapter 4.

Summary in numerical scores

In line with the qualitative judgements of IBL research described above, the committee has assigned the IBL to a discrete category for each of the assessment criteria. 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 of this report.

	Research quality	Relevance to society	Viability
Assessment of IBL research 2011-2016	1	1	2

2.3 Assessment Animal Sciences & Health cluster

The Animal Sciences & Health cluster is headed by Professor Annemarie Meijer. The cluster’s main research topics are:

- **Mechanisms of disease:** biological mechanisms of health and disease, focusing on developmental processes, metabolism, and the immune system.
- **Behaviour & cognition:** proximate and ultimate factors underlying animal behaviour and cognition, and the consequences of anthropogenic environmental changes on physiology and behaviour.
- **Development & evolution:** how genetic changes in developmental mechanisms drive the evolution of new functions and phenotypes.

The zebrafish as a model species connects these topics; the zebrafish has strong translational value for research into human development and disease. The cluster also studies some other animal models, including invertebrate species and birds, especially the zebra finch.

Research quality

The committee is impressed by the research quality of the Animal Sciences & Health cluster. The cluster hosts world-class scientists. The Cell Observatory facility allows the cluster to perform innovative studies at the cellular and molecular level. The behavioural monitoring of zebra finches and imaging of zebrafish embryos is state-of-the-art, using excellent equipment such as the high-throughput zebrafish screening facilities. The cluster has developed a new robot to inject zebrafish larvae. Examples of research highlights include the development of innovative methods for bio-imaging of antibacterial immune responses, the identification of SYK as a candidate kinase target for the treatment of advanced prostate cancer, a demonstration of the translational value of zebrafish xenograft models for cancer research, the work on the behavioural and physiological indicators of stress coping styles in zebrafish linking coping styles to variation in the biological clock, the discovery that the extraembryonic membrane of insect eggs protects against desiccation and has an innate immune function, the work on snake venom evolution, the finding that budgerigars are the first animal species capable of abstracting a grammatical rule also abstracted by human infants, and the work on animal behavioural changes in response to sound exposure.

Relevance to society

The research of the Animal Sciences and Health cluster is highly relevant to society because it addresses major public health problems such as cancer, diabetes, tuberculosis, and arthritis. In addition, the cluster performs screening studies for drugs, natural compounds, and toxins. The cluster has many collaborations with industrial partners, including BaseClear, Syngenta, Generade, Smartmix, GlaxoSmithKline, Shell, Enwco, van Oord, and Gemini, which facilitate the translation of the cluster's fundamental research into practical applications.

The cluster has organised several charming outreach activities during the review period, for instance the super high resolution stitched TEM image of a zebrafish larvae. The interactive image is now part of the permanent exhibition of the Naturalis museum, allowing visitors to zoom in on the larvae 500,000 times. The image also acts as education material for students on blackboard. Another inspiring example of successful public outreach is the media attention for the research on snake venoms by Professor Richardson; his former IBL PhD student Freek Vonk has become a celebrity on Dutch television and is an ambassador who conveys the excitement of biology to children.

Viability

This cluster is in a unique position because it harbours behavioural, physiological, and molecular expertise. The groups link these domains and also study links with disease susceptibility, making the research highly relevant. However, the individual programmes within the cluster appear to be less integrated than those within the other two clusters, meaning that the scientists do not seem to fully exploit each other's expertise. The committee will elaborate on this in Chapter 4. The Animal Science & Health Cluster aspires to recruit a developmental neurobiologist to link its behavioural, physiological, and molecular work. The committee supports this plan.

2.4 Assessment Microbial Technology & Health cluster

The Microbial Technology & Health cluster is headed by Professor Gilles van Wezel. His group moved from the Leiden Institute of Chemistry to the IBL in 2011. The cluster studies the structure, function,

and evolution of microbes at all levels of biological organisation, from communities, through development, to cellular structures, and molecules at atomic resolution. The cluster's research topics are:

- Antibiotics & anticancer compounds: discovery of new bioactive natural products from actinomycetes.
- Microbial evolution & ecology: how bacteria sense and respond to their environments, how bacterial diversity and evolution is influenced by microbial cooperation and antagonism, and developing strategies to prevent and reverse antibiotic resistance.
- Microbial cell biology & development: cellular morphogenesis, growth, development and virulence of microbes.
- Microbial cell factories: biological and process-technological parameters that determine the production efficiency of microbial cell factories.

Ultimately, the cluster aims to translate fundamental insights into sustainable applications in industrial production and human & plant health.

Research quality

During the evaluation period, the Microbial Technology & Health cluster has grown into an internationally highly competitive microbiology research unit. The committee regards it as a well-organised and dynamic cluster, that seems to be at the centre of collaboration in the IBL as a whole. The high-end equipment at the NeCEN and Cell Observatory allows the cluster to perform exciting studies on host-pathogen and microbial interactions. Examples of research highlights include discoveries on growth and cell division of *Streptomyces* bacteria, structural biology studies of *Vibrio cholera* chemotaxis arrays using CryoEM, the work on the molecular regulation of microbial plant cell wall-degrading enzymes, the breakthrough in ecological understanding of the competitive advantage of antibiotics in microbial communities, the role of microbes in the plant health on demand concept, and the discovery of lugdunomycin (an antibiotic with completely new chemical scaffold).

Relevance to society

The research results of this cluster are highly relevant to society, for instance through the discovery of novel antimicrobial and anticancer compounds, and the realisation that changes in the (microbial) environment are highly instrumental in novel bioactive natural compound discovery. The cluster is involved in various public outreach activities, such as the Micropia display at Artis Zoo in Amsterdam and the school practicals 'From soil to antibiotics'. Gilles van Wezel and Dennis Claessen have won the 2011 Academic Year Prize for their outreach project 'Wanted, antibiotics!'. The cluster plays a major role in Dutch antimicrobial research policy, with co-directorship of the Netherlands Centre of One health, the Netherlands Antibiotic Discovery Platform founded by the Ministry of Health, and the Leiden Centre for Antibiotic Research.

Viability

This cluster seems very coherent, with research programmes that are well integrated within the cluster and with the other clusters. The principal investigators are well-embedded and fully use each other's expertise. The formation of this cluster has improved the funding opportunities of the group, which has already resulted in research grants. Professor Gilles van Wezel is a strong leader and the cluster has recently recruited high profile scientists, including Ariane Briegel and Nathaniel Martin.

Professor Briegel was recruited from Caltech (California) in 2016. She is a specialist in CryoEM and therefore, her embedding in the NeCEN is of great strategic importance. Professor Martin is a highly reputable young organic chemist who will strengthen the antibiotic research at the IBL. In addition, the affiliation of honorary professor Jos Raaijmakers from the Netherlands Institute of Ecology (NIOO) is a strong asset to the cluster. With his internationally renowned expertise on plant microbiome research, he can make important links with the IBL plant cluster. The committee therefore foresees a bright future for this cluster.

2.5 Assessment Plant Sciences & Natural Products cluster

The Plant Sciences & Natural Products cluster is headed by Professor Peter Klinkhamer. The cluster performs innovative research in the field of plant science, with the main research topics being

- Plant genome modification: generating knowledge to develop tools for the modification of the plant genome.
- Plant development & evolution: plant developmental processes controlled by the plant hormone auxin, with a focus on developmental switches.
- Plant ecology & phytochemistry: interactions between plants and their environment with an emphasis on the role of secondary metabolites.

Ultimately, the plant cluster wants to contribute to the sustainable production of healthy foods, flowers, and high-value bio-based products.

Research quality

The committee considers this cluster's research as state-of-the-art. The cluster works on clearly distinguished topics in plant science. The cluster has access to excellent research infrastructure, including state-of-the-art plant growth chambers, facilities for genotyping, the natural products facility, plant tissue culture, imaging, and bioactivity screening. Research highlights include the patented discovery of NADES (Natural Deep Eutectic Solvents, a new class of plant based natural solvents that contain no water and in which most non-water soluble plant secondary metabolites can be dissolved), the discovery of REJUVENATOR as a key switch from monocarpic & annual to polycarpic & perennial plant life history, the discovery of PolQ as a factor essential for (T-)DNA integration in plants allowing the development of efficient tools for precise genome engineering, and the work on parallel evolution in *Jacobaea vulgaris*.

Relevance to society

The cluster has strong connections with the Dutch plant breeding industry, including tomato, chrysanthemum, tulip, and strawberry breeding companies. The cluster formation has increased the opportunities for industrial collaborations, because the cluster can now offer a complete package to the plant breeding industry. There are ample examples of the societal relevance of this cluster's research. For instance, the above-mentioned work on NADES has broad applications in medicine, plant protection, and cosmetics. The plant cluster is also actively involved in screening plants for valuable compounds and risk assessment studies on genetically modified organisms. They are a member of a SAPEA Steering Group 'New Techniques in Agricultural Biotech' that recently published an Explanatory Note on New Techniques in Agricultural Biotechnology. Professor Hooykaas was a

member of the KNAW Council for Earth and Life Sciences, which recently organised a stakeholder meeting on the risks and benefits of genome editing and published a position paper on this topic.

Viability

The integration in this cluster seems to have worked out particularly well. While the groups were separated in molecular and ecological clusters in the previous review period, they have now managed to implement functional connections through new research collaborations. The cluster faces a significant challenge as several senior staff members are approaching retirement. The committee thinks it is of great importance to ensure that this successful cluster will continue to flourish, e.g., through the appointment of tenure trackers to compensate for the imminent retirements and by moving up next generation scientists to leadership positions.

3. Assessment of PhD programme, research integrity policy, and diversity policy

3.1 Quality and organisation of IBL's PhD programme

In 2016, the IBL hosted 84 PhD students, including 34 'regular' PhD students, 15 external PhD students (i.e., students that were paid by companies or research institutes such as KNAW-NIOO, but had a promotor affiliated to the IBL), and 35 PM scholarship PhD students (i.e., foreign PhD students with their own scholarship). Overall, the committee has the impression that IBL's PhD students are offered an **excellent** training programme. The PhD students are offered different specialised and general skill courses, either locally, or within the context of national Graduate Schools. The PhD programme appears well-organised and the interviewed students uniformly expressed their high level of satisfaction with the programme.

Institutional context of the PhD programme

IBL's PhD programme is embedded in the Graduate School of Leiden University's Faculty of Science. The Graduate School oversees the admission, registration, and performance of all PhD students. In addition, it handles the administrative procedures concerning the approval of the manuscript and the public defence of the thesis.

Selection and admission procedure

A substantial proportion of IBL's PhD students are PM scholarship students from countries such as China and Indonesia. There have been concerns about the academic level of these students in the past. In response, the IBL has intensified the selection procedure for PM scholarship students. The selection procedure includes a Skype interview at the minimum, but IBL staff members preferably visit aspiring candidates in China or Indonesia before admitting them into the IBL PhD programme. This allows the staff to make sure that the students' scientific level and English communication skills are sufficient for a successful PhD track in the Netherlands. Nevertheless, there are still issues with the large number of students from China and Indonesia, with frequent cultural and personal differences that can make advising more challenging.

Quality assurance and supervision

The committee has the impression that the IBL has installed adequate measures to guarantee the quality of supervision and education of its PhD students. In line with the rules of the Graduate School, each PhD student creates an individual Education & Supervision Plan in close collaboration with the supervisor. This is done at the start of the PhD project. The plan is used to monitor the student's progress in research (progress, presentations, publications) and education (mandatory courses of the Graduate School, elective courses, conferences) on a yearly basis. In addition, the plan contains agreements about responsibilities of the PhD supervisors and others. The students' progress is formally evaluated after nine months, resulting in a go/no-go decision. The committee learned that a 'no go' is very rare. The IBL has recently installed the regulation that every student should have a second independent supervisor.

In addition to the general quality assurance procedures described above, the IBL has established a monitoring committee consisting of two former IBL directors in 2016. The committee applauds these extra measures. The monitoring committee monitors the students' progress at two points:

1. Six months after the start of the PhD track, students are requested to produce a report about the theoretical background of their project, the work done so far, and their planning. Based on this report and a presentation, as well as interviews with the student and supervisors, the monitoring committee estimates whether the candidate is likely to receive a positive 9-month assessment and advises on aspects that need special attention.
2. Around the end of the third year, the monitoring committee requests another report, describing the progress of the thesis, what is still needed, the planning (i.e., will the student finish in four years), and the student's future career plans.

PhD students and postdocs have organised themselves in the IBL PhD and Postdoc Association (IPPA), which communicates directly with the more formal Institute Council and with IBL's cluster leaders. The committee met an IPPA representative during the site visit and learned that IPPA consists of seven PhD students that organise social events and offer support for PhD/Postdoc-related problems.

Programme content and structure

The IBL trains its PhD students to become independent, critical scientists. The students are well-integrated in the research groups, fostering a 'master-apprentice' relationship between student and supervisor. Students regularly present their results during research meetings. The seven interviewed students felt that they were given the freedom to develop their own research ideas, especially towards the end of the PhD track.

The Graduate School of the Faculty of Science organises several mandatory courses dedicated to basic research and personal skills, e.g., scientific integrity, presentation skills, scientific writing, time management, data management, and teaching & supervision. The interviewed students were positive about these courses. In addition, most students follow courses tailored to their specific projects, organised by local or national research schools. In addition to the courses, students participate in the monthly 'Spotlight' lectures, a yearly IBL symposium, and other relevant local lectures. In addition, the students are encouraged to present their work at international conferences. Students typically attend at least one national conference per year and one international meeting once every two years. In addition, they may participate in teaching under supervision of a staff member. Teaching typically does not consume more than 10% of a PhD student's time.

Success rate, duration, and exit numbers

The IBL strives for PhD theses to be finished in four years' time, resulting in a defence in the fifth year because of the interval between manuscript approval and formal examination (Unlike several other Dutch universities, Leiden University does not allow students to set an examination date before the PhD reading committee has officially approved the thesis). Nevertheless, many students have taken more than five years to finish in the recent past. (Note that the committee was not provided with sufficient data to create a detailed picture of the actual PhD duration in years for internal and external PhD students in the period 2011-2016.) The IBL is now implementing a stricter control on year reports of PhD students to enable early detection and intervention in case of imminent delays.

Guidance of PhD candidates to the job market and career prospects

IBL supervisors encourage their PhD students to think about career prospects well before their thesis defence. Since 2016, this has also been a mandatory aspect of the 3 year-report that is evaluated by the monitoring committee (see above). In the last year of the PhD track, students can follow a two-day course at Leiden University, which offers insight into career possibilities ('Competences and motives course'). In addition, Leiden University has a Science Career Service that helps students orient on job prospects. Most of IBL's PhD students find a job after their PhD defence, including postdoc and other positions (industry, government, other organisations, etc.).

3.2 Research integrity policy

The assessment committee discussed IBL's research integrity policy and the way in which violations of research integrity are prevented with representatives of the IBL staff and with seven PhD students. All of the committee's questions on this subject were adequately addressed. Appropriate measures to ensure research integrity are in place at the IBL, including:

- Each IBL scientist signs the code of conduct on scientific integrity as issued by the VSNU (Association of Dutch Universities), including topics such as honesty and scrupulousness, reliability, verifiability, impartiality, independence, and responsibility.
- Leiden University has a central office that offers confidential advice on research integrity. The office can appoint a scientific integrity committee when there are indications of misconduct.
- The Faculty of Science has formulated ten rules of conduct for scientific integrity, to which IBL researchers should adhere.
- All PhD students follow a mandatory workshop about research integrity, which is organised by the Graduate School. In addition, they are offered a data management course and they prepare a data management plan for their research project. Supervisors regularly draw attention to researchers' obligations to science and society. All PhD and MSc theses are checked for plagiarism before submission to the doctorate committee. The IBL has recently installed the regulation that every student should have a second independent supervisor, lowering the barrier for students to report problems. The interviewed students felt that the IBL encourages openness about integrity issues.
- The Leiden University Executive Board has set criteria for data management that Leiden researchers are required to meet, including access to raw data in a structured, transparent, and understandable manner. The new regulations will be adhered to by all Leiden Institutes in 2018 at the latest.
- In 2018, the IBL will start using electronic laboratory notebooks. These will be regularly checked for accuracy, completeness, and traceability of data. They will be approved and countersigned by an independent yet knowledgeable observer.
- The IBL is aware of the risk for conflicts of interest caused by its collaborations with industry. Therefore, all professional activities of staff members are made public, and all data generated by PhD students, post-docs, and technicians are stored. A business developer from LURIS (the knowledge exchange office of Leiden University and LUMC) assists the IBL in ensuring research integrity.
- Animal experiments are only started when approved by the national regulatory authorities, and when fully compliant with the Dutch governmental guidelines, which in turn are compliant with

the guidelines from Directive 2010/63/EU of the European Parliament. The IBL ascribes to the principle of the 3Rs (replacing, reducing, and refining the use of animals).

3.3 Diversity and inclusiveness policy

The Leiden Faculty of Science has adopted an Action Plan Diversity and Inclusiveness in 2015. The objective of this plan is to further develop the Faculty of Science as a science and education institution that is attractive for female or minority group scientists and students. The committee was delighted to discover that the number of female professors at the IBL has grown from zero to five during the evaluation period. The institute clearly takes the gender balance of its staff seriously, for instance by striving to recruit female employees at the tenure track level. Indeed, there is room for growth in the female faculty population, as only eight of the senior staff members (i.e., UD/UHD/Professor) are female. The IBL appears to foster a family-friendly environment, for instance by scheduling meetings and networking events mostly during office hours. The IBL aims to create an open atmosphere where people from diverse backgrounds, ages, nationalities, and religions are welcome and respected, and receive equal opportunities. The IBL currently harbours people from 32 different countries and around 30% of the IBL staff has a non-Dutch country of origin, which is satisfactory in the committee's opinion.

4. Recommendations

4.1 Quality of the research unit

1) Clusters

In 2012, the IBL created three research clusters to strengthen the institute's profile and to promote coherence among the staff. The added value of the three clusters is starting to become clear. However, the committee thinks that IBL researchers could interact even more with their cluster colleagues, especially in the Animal Science & Health cluster. The committee encourages the IBL to further strengthen the interactions within and between the clusters. The overarching research themes provide ample opportunities to this end. In addition, the themes will help the IBL to line up for future large-scale grant opportunities, where the clusters or the IBL as a whole can be presented as an attractive place for young scientists (e.g., EU international training networks).

2) Research focus and local interactions

The IBL has asked the committee to reflect on whether the IBL has to maintain a broad biology research basis or should rather focus on specific directions. The committee advises **against** further narrowing down the research focus. The committee actually considers the range of topics that are studied at the IBL to be at a minimum level required for teaching and training of scientists to become multidisciplinary biologists with added value on the job market. The committee is enthusiastic about the choice of the model organisms zebrafish, zebra finch, *Arabidopsis*, and *Actinomyces* because this enables the institute to join forces from different research angles. Nevertheless, the committee advises the institute to be open-minded about other systems (model and non-model) when recruiting high-potential new group leaders (see also recommendation 3). Currently, biological research areas such as ecology and non-model organism studies are underrepresented in IBL research. As a result, IBL's collaborations with industry are mostly in the domains of health and agriculture. Through its participation in the Leiden Evolution, Biodiversity, and Environment Network (LEBEN), IBL may strengthen its collaborations in the domains of conservation and biodiversity. The committee recommends developing the scopes of the current IBL research clusters in such a way that the collaborations with neighbouring institutes are better accommodated and augmented. In doing so, the IBL may broaden its overall research focus without significant investments.

While the committee feels that further narrowing the focus of the IBL would jeopardise the institute's national and international position, the committee does **not** favour a strong expansion of the scope of research topics either. Future high-profile hirings should be strategically positioned within the clusters or between the clusters to maximise collaborations and IBL profile. Moreover, as mentioned above, we strongly encourage the IBL to strengthen its local collaborations, especially with the CML and Naturalis Biodiversity Center (i.e., the LEBEN partners). This may be done first by explicitly incorporating biodiversity research within the domains of the existing research clusters, while maintaining the focus of each. In addition, the IBL could increase the number of joint appointments, embracing more opportunities for interaction and collaboration, and embarking in additional joint outreach activities. The IBL can become the natural nexus of the full range of biology

research in Leiden, resulting in a highly attractive institute, making it easier to recruit and retain top scientists.

3) Personnel planning

Several of IBL's senior researchers are approaching retirement, and the institute has experienced difficulties in recruiting new scientists to succeed some of them. The committee has the impression that these difficulties are partially the result of the IBL seeking for candidates with a relatively narrow and highly specific profile. A vacancy may constitute an opportunity for a slight shift of focus. We think that it may be wise to be open-minded regarding the expertise of potential candidates and allow new topics to be brought into the institute when the candidate is high-profile or offers an avenue of research that capitalises on the strengths of the IBL research, including external collaborators. The recruitment of Professor Gilles van Wezel into the institute is an excellent example of the favourable results of such an open-minded hiring strategy. More in general, it would be good to devise a strategy to compensate for the expected departure of senior staff members well in advance. The institute may even want to consider changing leadership in anticipation of retirement, to prevent a leadership vacuum in a cluster.

4) Bioinformatics and data stewardship expertise

The advanced technologies that are used by the IBL scientists produce large volumes of data. At present, the IBL does not harbour sufficient bioinformatics, computational biology, and data stewardship expertise to fully exploit these data. The Management Team of the IBL is keenly aware of this issue and has already undertaken action to improve the situation (e.g., they appointed Professor Vera van Noort and Professor Fons Verbeek, sought collaboration with the Leiden Centre of Data Science and the LIACS, and started an Informatics and Biology BSc education track). The committee encourages the IBL to continue along this line to create more structural bioinformatics expertise. In addition, the committee recommends investing in dedicated data stewards/bioinformaticians. They will be crucial to safeguard top-level data analysis of IBL's research in the future.

5) Funding

The institute has expressed its concern about future funding of fundamental research. The committee sees opportunities in the NWO Veni/Vidi/Vici and the ERC schemes, but also in the H2020 research programme. In the past years, EU funding of IBL research has been sub-optimal. The committee encourages the IBL to invest more efforts in pursuing European research grants. To be successful in personal granting schemes (Veni/Vidi/Vici and ERC), candidates should be scouted at an early stage and be intensively coached during the grant writing process. As was argued above, stronger collaborations with other major institutes in Leiden would almost certainly enhance the profile of the IBL and its stature in the context of procuring such funding.

6) IBL branding

The committee encourages the IBL to work on its overall branding to the outside world. Although the clusters are continuously reaching out to the general public, the IBL per se is not selling itself as a brand. The institute harbours a unique combination of talented scientists and has links with a number of world-class research institutes at close range. In the past years, the IBL clearly worked on

its research profile and how to brand it to science and society (e.g., via the clusters and the overarching themes). The committee encourages the IBL to further professionalise this and use its unique selling points (including the other world-class research institutes at close range) to present itself more proactively.

4.2 PhD programme

1) Scholarship students

In general, the committee is very positive about IBL's PhD programme. However, the committee considers the proportion of PM PhD students with a scholarship from abroad rather large. At present, roughly one third of IBL's PhD students are such PM scholarship students. The committee learned that there have been concerns about the scientific level and communication skills of these students and mentoring them may be difficult. In addition, a bench fee is typically not included in these scholarships, rendering them relatively costly for the institute. Hence, the committee recommends IBL to re-evaluate the ratio of regular and scholarship PhD students, and develop policy for a good balance.

2) Duration

The committee learned that many students have taken more than five years to finish their PhD track in the recent past. It is the committee's opinion that the IBL has now installed adequate measures to limit the duration of PhD tracks and the committee expects that this will pay off. Nevertheless, the IBL is advised to systematically evaluate the effect of these measures on the duration of PhD tracks in the coming years.

4.3 Research integrity

Although IBL's **integral** vision on scientific integrity was not immediately evident from the information provided to the committee, the IBL was able to clarify this during the site visit. The IBL convinced the committee that the institute, its Faculty, and the University have installed an adequate research integrity policy. Recommendations beyond existing practice are therefore not deemed necessary.

4.4 Diversity and inclusiveness

The IBL is keenly aware of the importance of a diverse staff, in terms of gender and ethnicity. The committee supports the IBL in its endeavour to increase diversity and to foster a family-friendly working environment.

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

Professor C.M.J. Pieterse (chairman)

Corné Pieterse is Professor Plant-Microbe Interactions and Scientific Director of the Institute of Environmental Biology at Utrecht University (the Netherlands). His research group investigates how the plant immune system protects plants against microbial pathogens and insect herbivores and how beneficial microbes in the plant root microbiome stimulate plant growth and health. Pieterse received his MSc (Plant Breeding and Plant Molecular Biology, *cum laude*) in 1988 and his PhD (Phytopathology) in 1993, both from Wageningen Agricultural University (the Netherlands). In the period 1993-2004, he was a Postdoc and subsequently an Assistant Professor in Molecular Phytopathology at Utrecht University's Department of Biology. Pieterse was appointed as Professor Plant-Microbe Interactions in 2004 and as Scientific Director of the Institute of Environmental Biology in 2009. He has served as the Programme Leader of the 'Environmental Biology' MSc programme (2005-2015) and PhD programme (2009-2015) of the Utrecht Graduate School for Life Sciences. Pieterse was awarded a European ERC Advanced Investigator grant for innovative research in 2010, was elected member of the Royal Netherlands Academy of Arts and Sciences (KNAW) in 2013, and has been a Thomson Reuters Highly Cited Researcher (World's top-1% in the field) since 2014. In 2015, he was appointed as 'Distinguished Professor Faculty of Science'.

Professor A.T. Look

Thomas Look is Professor of Paediatrics at the Dana-Farber Cancer Institute of Harvard Medical School (Boston, MA, USA). His laboratory seeks to elucidate the molecular pathogenesis of human leukaemias and solid tumours using both a cell culture model and a zebrafish animal model. Look obtained his BSc degree in 1971 and his Medical Doctor degree in 1975, both from the University of Michigan (USA). He worked as a Postdoc in the period 1975-1979, first at the University of Michigan (Intern and Resident in Paediatrics) and later at St. Jude Children's Research Hospital in Memphis, Tennessee (Fellow and Research Associate in Paediatric Haematology-Oncology). Next, he accepted a faculty position at St. Jude and remained there for 20 years, ultimately becoming the Chair of the Experimental Oncology Department. Look joined the Dana-Farber Cancer Institute in 1999, as Vice-Chair for Research in Paediatric Oncology and Professor of Paediatrics at Harvard Medical School. He has received numerous awards for his research, including the Allison Eberlein Award for Childhood Leukaemia Research, the Award for Excellence from the American Academy of Paediatrics, the 10th Annual Paediatric Cancer Research Foundation Memorial Lectureship, the Paediatric Oncology Lectureship of the American Society of Clinical Oncology, the ASPHO Frank A. Oski Memorial Lectureship Award, and election as a Fellow of the American Association for the Advancement of Science.

Professor F.A. Huntingford

Felicity Huntingford is emeritus Professor of Functional Ecology at the Institute of Biodiversity, Animal Health, and Comparative Medicine of the University of Glasgow (UK). Her research interests are behavioural and morphological diversity in sticklebacks, strategies for resource acquisition and life history variation in salmon, behaviour and aquaculture, and welfare of farmed fish. Huntingford obtained a BA in Zoology Oxford University in 1970 and DPhil in the Department of Experimental

Psychology in 1973. She was a lecturer, senior lecturer, and reader at the Department of Zoology of the University of Glasgow in the period 1974-1994. In 1994, she was appointed Titular Professor in Functional Ecology at the Division of Environmental and Evolutionary Biology, IBLS, University of Glasgow. Huntingford has been Head of the University of Glasgow's Division of Environmental and Evolutionary Biology twice (1995-1998 and 2002-2006). Since 2010, she has been Emeritus Professor of Functional Ecology at the Institute of Biodiversity, Animal Health and Comparative Medicine, University of Glasgow. She is a former president of the Fisheries Society of the British Isles (2007-2011) and of the Association for the Study of Animal Behaviour (2001-2004). She has been a Fellow of the Royal Society of Edinburgh since 1996. Huntingford served as European Editor for the journal *Animal Behaviour*, the major international journal in her field, and Associate Editor for *Physiology & Behaviour* and the *Canadian Journal of Fisheries & Aquatic Science*. She has also served in numerous grant advisory boards.

Professor R.G. Gillespie

Rosemary Gillespie is a Professor of Systematic Entomology at the University of California Berkeley (USA). Her research focuses on understanding evolutionary patterns and processes among populations and species, with a primary focus on islands, particularly remote hotspot islands of the Pacific. Gillespie obtained a BSc in zoology from the University of Edinburgh (UK) in 1980 (with honours) and a PhD in zoology from the University of Tennessee-Knoxville (USA) in 1986. She worked as a researcher at the University of the South in Tennessee (USA) in the period 1986-1987 and at the University of Hawaii at Manoa (USA) in 1986-1999. Gillespie was appointed as a Professor at the University of California Berkeley in 1999. She has been President of the International Biogeography Society, President of the American Arachnological Society, and Treasurer of the International Society for Arachnology. Gillespie was awarded NSF's Presidential Award for Excellence in Science, Mathematics, and Engineering Mentoring (PAESMEM) in 2005. She currently is the President of the American Genetics Association, is the Associate Director of the Essig Museum of Entomology, and holds a Professor and Schlinger Chair at the University of California, Berkeley.

Professor I.W.C.E. Arends

Isabel Arends is Professor in Biocatalysis and Organic Chemistry at Delft University of Technology (the Netherlands). She is the Chair of the Department of Biotechnology of the TU Delft and a member of the Management Team of the Faculty of Applied Sciences of the TU Delft. Her research focuses on the development of enzymes as catalysts. Arends obtained a MSc in Physical Organic Chemistry in 1988 and a PhD in 1993, both from Leiden University (the Netherlands). She was a Postdoctoral Researcher at the National Research Council Ottawa (Canada) in 1994. In the period 1995-2001, she performed a Fellowship of the Royal Dutch Academy of Sciences (KNAW) at the TU Delft. She was an Assistant and Associate Professor at the Department of Biotechnology of the TU Delft from 2001-2006. She is the Director of the recently founded Delft Bioengineering Institute and the Vice-director of the COST action systems bio-catalysis. In addition, she is an advocate for women in science within the Delft University of Delft and Delft Technology Fellowship. She is active as Board member and Vice-director of the domain of applied and engineering science within the national Science Foundation (NWO-TTW, previously STW). In the bio-renewables field, Arends is a Board member of BE-Basic consortium, an international public-private partnership that develops industrial bio-based solutions to build a sustainable society.

Dr L. van den Berg

Linda van den Berg is an independent science writer and communications consultant with a background in the life sciences. She obtained a MSc in fundamental biomedical sciences in 2000 and a PhD in behavioural genetics in 2006, both from Utrecht University (the Netherlands). In the period 2006-2012, she was a Postdoctoral Researcher at VU University Medical Center (the Netherlands), the Broad Institute of Harvard and MIT (USA), and Leiden University Medical Center (the Netherlands). Since 2012, she has worked as a professional science writer, with a special interest in research quality, research data stewardship, and research infrastructure. Her company Washoe Life Science Communications offers a variety of communication services to academic institutes, patient organisations, and companies. Since 2015, she has served as an independent secretary to several research assessment committees.

Appendix 2. IBL site visit programme

Thursday 16 November 2017	
13.00 - 14.00	Arrival at the IBL (Gorlaeus Laboratory) and lunch <i>[Committee only]</i>
14.00 – 15.30	Preparatory meeting <i>[Committee only]</i>
15.30 – 16.30	Management meeting including presentation by Scientific Director
16.30 – 17.45	Lab tour Gorlaeus Building (NeCEN, Cell Observatory, zebrafish facility)
17:45 – 18:00	Taxi to restaurant
18:00 – 19.30	Committee meeting in restaurant <i>[Management Team and Committee]</i>
19.30	Dinner <i>[Management Team and Committee]</i>

Friday 17 November 2017	
8.45 – 9.00	Arrival committee at the IBL (Sylvius Laboratory) and welcome
09.00 – 09.45	Cluster Microbial Biotechnology and Health (MBT) Presentation by Gilles van Wezel (cluster coordinator)
09.45 – 10.30	Cluster Plant Sciences and Natural Products (PS) Presentation by Peter Klinkhamer (cluster coordinator)
10.30 – 10.45	Coffee break
10.45 – 11.30	Cluster Animal Sciences and Health (AS) Presentation by Carel ten Cate (cluster coordinator)
11.30 – 12.15	Lab tour Sylvius Building (zebrafish, zebra finch, microscopy, plant, and fungal facilities)
12.15 – 13.15	Lunch <i>[Committee only]</i>
13.15 – 14.00	Poster session PhD students: <ol style="list-style-type: none"> 1. Michiel Hooykaas (Communication Science & Society) 2. Ebru Alazi (MBT) 3. Anne van der Meij (MBT) 4. Arezoo Rahimi (PS) 5. Gang Chen (PS) 6. Ralf Boland (AS) 7. Annabelle Kok (AS)
14.00 – 14.30	Management (final questions)
14.30 – 16.30	Committee meeting <i>[Committee only]</i>
16.30 – 17.30	Oral presentation Chairman Drinks

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

Table 1: The IBL research staff¹

Average staff numbers	2011	2012	2013	2014	2015	2016
Professor	5.9	6.8	7.0	7.0	7.7	7.0
Associate professor	8.5	8.4	8.8	8.8	9.2	8.8
Assistant professor	7.7	9.8	9.5	9.4	9.2	9.5
Lecturer	1.8	2.2	2.3	1.8	2.1	2.3
Postdoc	24.4	17.8	15.6	19.8	20.1	15.6
PhD student	36.9	38.8	33.8	29.7	30.2	33.8
PM Scholarship PhD student ²	25.0	32.0	35.0	36.0	33.0	35.0
External PhD students with other affiliation	9.0	14.0	15.0	15.0	16.0	15.0
Education & research support staff	23.8	21.5	23.0	25.2	29.3	23.0
Other support staff	5.2	7.4	8.9	10.6	10.7	8.9
Total staff (without scholarship PhD)	114.2	112.7	108.9	112.3	118.5	108.9

¹ Numbers in this table represent total capacity in full-time equivalents (FTE). Staff capacity includes teaching and management responsibilities, with professors, associate professors, and assistant professors spending 40% of their FTE on research, 40% on education, and 20% on management tasks. Lecturers spend 30% on research, 60% on education, and 10% on management tasks. Postdocs spend 80% on research and PhDs spend 100% on research.

² PM Scholarship PhD students are students on foreign personal fellowships.

Table 2: IBL funding in k€ based on Financial Statement IBL 2011-2016 and Forecast 2017

	2011	2012	2013	2014	2015	2016	2017
Direct funding							
Staff	3885	4281	4579	5088	5541	5724	6000
Material costs	1689	1475	2131	1699	1652	1558	1800
Research grants national							
Staff	1554	1714	1737	1762	1909	1824	1800
Material costs	667	775	135	1652	564	628	650
Research grants EU							
Staff	815	570	318	159	131	243	200
Material costs	270	275	403	200	114	287	175
Research grants other¹							
Staff	867	721	770	661	721	660	850
Material costs	981	873	1066	542	1139	679	650
Total							
Staff	7121	7286	7404	7670	8302	8451	8850
Material costs	3607	3398	3735	4093	3469	3152	3275

¹ 'Research grants others' consists of funding from industry and from research funders that are not included in the above-mentioned national and EU research grants, such as the Human Frontiers programme, the Leiden University Fund, and the Dutch Cancer Society and other charities. Salaries and equipment costs of external PhD students are not included here.

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