Assessment report
Limited Programme Assessment

Master Life Sciences

University of Amsterdam

Contents of the report

1. Executive summary

In this executive summary, the panel presents the main considerations which have led to the assessment of the quality of the master's programme Life Sciences of University of Amsterdam, which was assessed according to the NVAO Assessment Framework.

The panel observed programme management has taken up the recommendations made in the previous assessment in 2009. In particular, programme management has taken steps to balance the study load, improve the study guidance and raise the student success rate.

The panel supports the plan of programme management of the Master Bioinformatics of Vrije Universiteit Amsterdam and the Master Life Sciences of University of Amsterdam programmes to acquire the formal status of a joint-degree programma. Both programmes are identical and students in effect are in one and the same programme, taking courses at both Universities. The joint-degree status would appropriately reflect this situation on the students' diplomas.

The panel is positive about the objectives of the programme. The combination of the two disciplines bioinformatics and systems biology in one programme is regarded by the panel to be an asset, giving the students the opportunity to acquire knowledge and skills in both domains, at the same time enabling them to specialize in one of these. Programme management received some favorable comments on a peer reviewed publication outlining the programme design, published by the chair groups organizing the programme, The intended learning outcomes represent the programme objectives fairly appropriately. They, also, comply with the Dublin-descriptors for the master's level and meet the master's requirements. The panel feels, however, the learning outcomes to be rather unfocused and recommends programme management to draft them in a sharper way.

Programme management and programme representatives are actively engaged in the research community in the Netherlands.

The collaboration between the two programmes is very good, leading to a nearly seamless organization across both Universities. In the opinion of the panel, this is quite an achievement.

The entry requirements of the programme are appropriate, admitting only students who have a fair chance of completing the programme. The panel is especially positive about the classes in biology, computer programming and mathematics in the first part of the curriculum, allowing students to remedy their deficiencies. The panel recommends to intensify the external information about the programme and to consider offering a major in this field for bachelor students, in order to attract more students.

The curriculum meets the intended learning outcomes of the programme. All subjects to be expected on the basis of the learning outcomes, are adequately covered. The curriculum is well-designed and very coherent.

The teaching methods in the programme fit the students' learning processes and allow them to achieve the intended learning outcomes. In the panel's opinion, an effective system has been put in place to balance the study load and to improve the study guidance for the courses in the first year as well as for the research projects in the second year.

The lecturers in the programme are renowned researchers and experienced teachers, being very capable of teaching the students effectively the concepts and applications in this field. As there is a somewhat limited number of core lecturers, coming from only three research groups and as the lecturers experience quite a demanding workload, the panel recommends to increase the number of lecturers and to involve more research groups and researchers in the programme.

The quality assurance system of the programme is adequate. The importance of the position and the role of the Education Committee in this respect are evident.

The panels considers the assessment system that has been set up to be very solid and to ensure the validity, reliability and transparency of the assessments. In their meeting with the panel programme management, lecturers and Examination Board confirmed working in accordance with the rules and regulations. The protocol for the guidance and assessment of the research projects is adequate and ensures, among other things, valid and reliable assessments. The assessment methods used for the course components are appropriate, matching the learning goals of these components.

The Examination Board, so the panel observed, monitors the quality of examinations and assessments on a regular basis and is, therefore, in a position to assure the assessment quality in the programme.

All of the theses, which the panel studied were found to be at least satisfactory. No unsatisfactory theses have been detected by the panel. A number of these theses were good to very good with relevant, clearly formulated hypotheses or scientific questions, a solid scientific structure and addressing topics of high computational or biological complexity. In some of the theses, the cycle of hypothesis-driven, data-driven or model-driven research seemed to be less explicitly addressed. For some of the theses, the panel would have given a somewhat lower but not substantially lower grade than the examiners in the programme did.

Some of the theses addressed subject matter, more closely related to the field of molecular biology than to the bioinformatics or systems biology study fields. The panel feels these theses in a strict sense would be somewhat outside of the domain of the programme and recommends programme management to make clear to what extent these theses may be regarded to be within the domain of the programme.

The panel observed the breadth of the programme not always to have been fully reflected in the second year of the Systems Biology profile and the computer programming aspects to have been somewhat underrepresented. The panel recommends programme management to ensure both biology and computer programming to be covered in the research projects.

For the panel, the favorable opinion about the graduates of the programme, as expressed by the professional field representatives, indicates these graduates having achieved the intended learning outcomes and meeting the requirements of these research institutions and commercial businesses.

The panel assesses the programme Master Life Sciences of University of Amsterdam to be satisfactory and recommends NVAO to grant re-accreditation to this programme.

Rotterdam, 19 April 2016

Panel chair
Prof. Y. Moreau PhD

Secretary
W. Vercouteren MSc, RC

2. Assessment process

Certiked VBI received a request to conduct a limited programme assessment for the re-accreditation of the academic master's programme Master Life Sciences. This request was submitted by University of Amsterdam.

Certiked requested the approval by NVAO of the proposed panel of experts to conduct this assessment. NVAO have given their approval. The panel composition was as follows (for more detailed information please refer to Annex 4: Composition of the assessment panel):

- Prof. Y. Moreau PhD, professor in Engineering, University of Leuven and programme director of the Master of Bioinformatics programme, University of Leuven (panel chair);
- Prof. V.A.P. Martins dos Santos PhD, professor in Systems and Synthetic Biology and director of Wageningen Centre for Systems Biology, Wageningen University (panel member);
- Prof. B. Snel PhD, professor in Bioinformatics and head of the executive board of Utrecht Bioinformatics Centre, Utrecht University (panel member);
- J.C. van Campenhout LLB, student in the pre-master programme in Law, University of Tilburg (student member).

On behalf of Certiked, W. Vercouteren MSc, RC was responsible for the process co-ordination and for drafting the panel's report. All panel members and the secretary signed a statement of independence and confidentiality.

The panel conducted this assessment on the basis of the standards of the NVAO Assessment Framework of 19 December 2014 (Staatscourant nr. 36791).

The following procedure was adopted. The panel members of the panel studied the documents presented beforehand by programme management, including a number of theses (please refer to Annex 2 and 3: Documents reviewed and Theses reviewed).

Prior to the site visit, the panel chair and the panel secretary met to discuss the assessment procedures. On 15 February 2016, the entire panel had a meeting to discuss their preliminary findings concerning the quality of the programme. Beforehand, the panel members had sent a number of questions to be put to the programme representatives during the site visit to the secretary. During the meeting on 15 February 2016, the findings of the panel members, including those concerning the theses were discussed, and some questions were added. On the basis of this input, the secretary drew up a list of questions, which served as a starting point for the discussions with the programme representatives during the site visit.

On 16 February 2016, the panel conducted a site visit on the campus of Vrije Universiteit Amsterdam. The site visit took place in accordance with the schedule drawn up beforehand (please refer to Annex 1: Site visit schedule). Programme management communicated the open office hours to the students in the programme and the staff. No one presented himself.

Due to an unfortunate case of miscommunication, panel member Mr Martins dos Santos could not be present in the afternoon of the site visit on 16 February 2016. Therefore, he did not take part in the afternoon discussions. Mr Martins dos Santos, however, participated fully and actively in the preparations of the panel and in the discussions during the morning of the site visit. At the end of the site visit, at the

start of the internal deliberations of the panel, Mr Martins dos Santos was via a Skype-connection informed by the panel chair about the afternoon discussions. The entire panel, including Mr Martins dos Santos via Skype, discussed the findings, considerations and conclusions with regard to the quality of the programme. The panel members, including Mr Martins dos Santos, unanimously came to the conclusions, as presented in this assessment report. The panel chair presented a broad outline of the findings to the Dean of the Faculty, programme management, lecturers and students.

A draft version of this report was finalised by the secretary having taken into account the information presented as well as the findings and considerations of the panel. The draft report was then sent to the members of the panel. The panel members studied the draft report and send in a number of changes. Thereupon, the secretary drew up the final report. This report was presented to programme management to be corrected for errors. After having been corrected for errors, the report was sent to the institution's Board to accompany their request for re-accreditation.

3. Overview of the programme

3.1 Basic information about the programme

Administrative information about the programme:

Name programme in CROHO:	M Life Sciences
Orientation, level programme:	Academic Master
Grade:	MSc
Number of credits:	120 EC
Specializations:	Bioinformatics, Systems Biology, Bioinformatics & Systems Biology
Location:	Amsterdam
Mode of study:	full time
Registration in CROHO:	60225

Administrative information about the institution:

Name of institution:	University of Amsterdam
Status of institution:	Government-funded university
Institution's quality assurance:	Approved

Quantitative data about the programme

Percentage of students who completed the programme in three years (n+1)

Cohort	2009	2010	2011
Percentage of students	63 %	25 %	50 %

Percentage of lecturers with the following qualifications

Qualification	Master	PhD	BTQ
Percentage of lecturers	100 %	100 %	58 %

BTQ means Basic Teaching Qualification

The students-to-teacher ratio is 19,5 to 1.

The number of contact hours is 640 hours in the first year and 140 hours in the second year.

3.2 Main facts about the institution

The degree programme Master Life Sciences is a programme of the Faculty of Science of University of Amsterdam.

University of Amsterdam was founded in 1632. About 30,000 students are enrolled in the programmes of the University. About 5,000 staff is employed by the University. University of Amsterdam is one of the

leading research universities in Europe with about 10,000 academic publications by University staff every year.

According to its website, University of Amsterdam aspires to be a broad, research-intensive academic institution, rooted in the history of the city of Amsterdam, an internationally oriented which can compete with leading in the Netherlands and around the world. University of Amsterdam provides academic training in all areas of science and scholarship, and welcomes students and staff, from all backgrounds, cultures and faiths, who wish to devote their talents to the development and transfer of academic knowledge as a rich cultural resource and foundation for sustainable progress.

University of Amsterdam adopted as core values innovation, determination and engagement. In its own words, the University wants to be innovative and take up a position in the vanguard of fundamental research and its applications. For determination, University students and staff are encouraged to carve out their own paths and thus to set new trends. Engagement for the University means to use acquired knowledge and insights to play an ongoing, prominent and visible role in the social debate.

The University of Amsterdam has seven Faculties, being the Faculties of Economics and Business, Humanities, Law, Medicine, Science, Social and Behavorial Sciences and Dentistry.

3.3 Intended learning outcomes

The intended learning outcomes of the programme are as follows. The graduates of the programme are expected to have:

- Both a solid academic basis as well as specialist knowledge and understanding in the field of bioinformatics and systems biology and in one or more sub-areas of bioinformatics and systems biology, quantitative life sciences and related fields such as biophysics, biochemistry, mathematical modelling and cell biology.
- Acquired profound knowledge, insight and practical experience in at least one specialist area of bioinformatics or systems biology.
- Knowledge and understanding of the iterative process, i.e. the relation between model, experiment and reality, of system biology.
- The ability to access and use international professional literature and to master current scientific research developments and knowledge of current scientific developments within relevant subdomains of bioinformatics and systems biology.
- The ability to get acquainted with a field of study and acquire specialist knowledge, understanding and skills in a short period of time.
- A view of the applications of bioinformatics and systems biology in general and specific specializations in particular and is able to apply this knowledge in new and continuously changing practical situations, also in broader, multidisciplinary contexts.
- The capability of writing research or project plans on the basis of realistic problem descriptions or to write a critical essay based on literature within a specialized field of study and one’s opinion.
- The ability to independently set up and implement experiments contributing to a line of research.
- The skills to analyze, interpret biological patterns and processes in both a qualitative and quantitative sense and make inferences based on these scientific results.
- The skills to present research plans and results orally or written in English, at various scales and levels of abstraction, and communicate these to specialist and non-specialist audiences.
- An attitude that enables critical reflection and discussion.

- The ability to successfully fulfill a position in society requiring an academic qualification as an independently operating professional that has a good knowledge base and attitude towards a biological approach to relevant societal issues.
- The ability to continue his/her career either as a researcher able to pursue a PhD degree at the best universities, as a scientist in research institutes worldwide, or as a research-skilled professional in organizations or government, civil society or business and industry.

3.4 Outline of the curriculum

In the table below, the programme curriculum is presented.

Courses Bioinformatics profile	Credits
Fundamentals of Bioinformatics	6.0 EC
Introduction to Systems Biology	6.0 EC
Algorithms in Sequence Analysis	6.0 EC
Bio-systems Data Analysis	6.0 EC
Structural Bioinformatics	6.0 EC
Bioinformatics for Translational Medicine	6.0 EC
Literature Review or Writing a Research Proposal	6.0 EC
Elective courses	18.0 EC
First year Bioinformatics profile	60.0 EC
Courses Systems Biology profile	Credits
Fundamentals of Bioinformatics	6.0 EC
Introduction to Systems Biology	6.0 EC
Systems Biology in Practice	6.0 EC
Bio-systems Data Analysis	6.0 EC
Basic Models of Biological Networks	6.0 EC
Statistics with R or Advanced Modelling in Systems Biology	6.0 EC
Literature Review or Writing a Research Proposal	6.0 EC
Elective courses	18.0 EC
First year Systems Biology profile	60.0 EC
Research Project 1	18.0 EC/42.0 EC
Research Project 2	18.0 EC/42.0 EC
Second year both profiles	60.0 EC
Total credits of the programme	120.0 EC

4. Overview of assessments

Standard	Assessment
Standard 1. Intended learning outcomes	Satisfactory
Standard 2: Teaching-learning environment	Good
Standard 3: Assessment	Satisfactory
Standard 4: Achieved learning outcomes	Satisfactory
Programme	Satisfactory

5. Findings, considerations and assessments per standard

5.1 Standard 1: Intended learning outcomes

The intended learning outcomes of the programme have been concretised with regard to contents, level and orientation; they meet international requirements.

Findings
Since 2011, programme management of the Master Bioinformatics programme of Vrije Universiteit Amsterdam and of the Master Life Sciences of University of Amsterdam have worked on the integration of both programmes into one programme, addressing both the subject matter of bioinformatics and systems biology. The integration process started about five years ago and has led to an integrated programme, offered by both Universities. At the time of this external programme assessment, the intended learning outcomes, the curricula, the courses and the examinations of both programmes are identical. Some formal differences remain. Students are enrolled at one of the Universities and their diploma is of one of the Universities as well. The qualifications of these students at completion of the programme and the courses they take are, however, exactly the same. Programme management informed the panel having the intention to submit to NVAO a request for a joint-degree programme. As the Dean of the Faculties of both Universities indicated, this step would be in line with Faculty policies.

Programma management's ambition, so they informed the panel, is to educate students to become very good researchers in the domain of bioinformatics and systems biology, being able to pursue PhD trajectories, to become researchers working in research institutes or to be employed as researchers in commercial businesses. The combined disciplines of bioinformatics and systems biology may, now and in the future, play an important role in addressing issues in domains like health, agriculture, nutrition and biotechnology. Depending on the courses they take, the graduates of the programme may either become specialist researchers in one of the disciplines systems biology or bioinformatics or may have a more generic profile, combining these two disciplines. The aim of programme management is to enable students to combine courses in such a way they will have in-depth knowledge and skills in both domains. Even if students specialize in bioinformatics or systems biology, they will also have knowledge of and skills in the other discipline.

Programme management presented domain-specific frameworks for bioinformatics and systems biology, emphasizing the close relations between these two disciplines, the relations having a tendency to become more intense. The objectives of the programme and the notions in the domain-specific frameworks have been converted into a series of intended learning outcomes (please refer to section 3.3. for the complete list). These learning outcomes not only specify the domain-specific knowledge and skills the graduates of this programme should have, but also their abilities to apply knowledge and skills in broader, multidisciplinary contexts, their research skills, their critical attitude, and their collaborative and communication skills.

In a table, programme management presented the relations between the intended learning outcomes and the Dublin-descriptors, being a measure for the master's level of the programme. From this table, it may be derived the intended learning outcomes meet all of the Dublin-descriptors.

Programme management has compared the programme to the developments and other programmes in this field in the Netherlands and abroad. The programme, so this comparison shows, is in line with

international developments. In the Netherlands, most of the Universities offer entire programmes or tracks or components of programmes, aimed at the study of bioinformatics and/or systems biology. The programme in Amsterdam distinguishes itself from other programmes in the Netherlands in emphasizing the design principles and the inner workings of biological systems. An article written by programme representatives on the objectives and design of the programme was published in a journal and met with positive comments.

Programme management indicated working together with a number of academic research institutes and having close relations with commercial businesses in this field.

Considerations
The panel supports the plan of programme management of both programmes, Master Bioinformatics of Vrije Universiteit Amsterdam and Master Life Sciences of University of Amsterdam to acquire the formal status of a joint-degree programma. As the panel has observed, both programmes are identical and, as a consequence, students in effect are in one programme, taking courses at both Universities. Having obtained a joint-degree status, this would appropriately be reflected on the diplomas of the students.

The panel is positive about the objectives of the programme and welcomes the interdisciplinary nature of the programme. Combining the two disciplines bioinformatics and systems biology in one programme is regarded by the panel to be an asset, giving the students the opportunity to acquire knowledge and skills in both domains, at the same time enabling them to specialize in one of these.

In the panel's opinion, the intended learning outcomes represent the programme objectives fairly appropriately. The intended learning outcomes address the various elements of knowledge and skills the graduates of the programma should have mastered. On the other hand, the panel feels the learning outcomes to be rather elaborate and diverse. The panel, therefore, recommends programme management to draft the intended learning outcomes in a more focused way, reflecting the programme focus and coherence.

The programme intended learning outcomes comply with the Dublin-descriptors for the master's level and, therefore, meet the master's requirements.

The comparison with other programmes in the Netherlands and abroad has been conducted adequately. In addition, the panel is positive about favorable comments on the article on the programme design by the programme representatives.

From the information file and the meeting with the representatives of the professional field, the panel has deduced programme representatives to be actively engaged in the research community in the Netherlands, in research institutions as well as in commercial businesses.

Assessment of this standard
These considerations have led the assessment panel to assess standard 1, *Intended learning outcomes* to be satisfactory.

5.2 Standard 2: Teaching-learning environment

The curriculum, staff and programme-specific services and facilities enable the incoming students to achieve the intended learning outcomes.

Findings
The number of students enrolling in the programme varied from 4 to 14 in the years 2009 to 2012, giving an average of about 9 per year. On average, about 20 % to 30 % of the incoming students came from abroad. Programme management has set a target of 40 to 50 students per year for the joint-degree programme, meant to start in 2017.

As no bachelor's programme in bioinformatics or in systems biology exists in the Netherlands, students come from different backgrounds. All of the students can be said to have deficiencies, since successfully completing the programme requires knowledge of three disciplines, biology, computer programming and mathematics. Most students lack knowledge of two out of three of these disciplines. Bachelor students studying at Vrije Universiteit Amsterdam or University of Amsterdam may take the minor Bioinformatics and Systems Biology (30 EC) and are better prepared for this programme, having taken courses in all three disciplines.

Students with Dutch bachelor's diplomas in Biology or Computer Science or with bachelor's diplomas in Biomolecular Sciences (VU University), Biomedical Sciences (University of Amsterdam, VU University), Medical Natural Sciences (VU University) or Beta Gamma (University of Amsterdam) are directly admitted. Experience has taught these students to be well prepared and to be able to complete the programme. Students having completed other science bachelor's programmes go through an intake procedure. They have to show having high grades in at least one of the fields of biology, computer programming or mathematics, have to demonstrate an interest in solving biological problems through algorithms or modelling and should be very motivated to enter the programme.

Students may ask for exemptions. Granting these will always have to be approved by the Examination Board.

In the first two courses, 4 EC or 1/3 of the total study load of these courses has been allocated to classes in biology, computer programming and mathematics. Students take two out of three of these classes, depending on their deficiencies. Some students may be required to take specific electives to remedy deficiencies.

Designing and modeling biological systems and relations is of key importance in the programme and, as a consequence, in the curriculum. The following three distinct principles govern this curriculum.
- Balance, meaning a balanced understanding of the disciplines of biology, computer programming science and mathematics.
- Translation, meaning being able to translate research problems from one discipline to another and communicating with experts from different scientific backgrounds.
- Focus, meaning focusing on technical skills such as experimental design, mathematical modelling and computer programming.

Programme management drafted a table in which the relations between the intended learning outcomes and the curriculum components have been specified.

In the first year of the curriculum, the two starting courses offer knowledge of the basic concepts. In the subsequent courses the students are taught more advanced knowledge and understanding of bioinformatics and also get acquainted with more complex issues in systems biology. For each of the courses, programme management has outlined the learning goals, contents, course coordinator, literature to be studied, teaching methods and examination methods.

As has been indicated in standard 1, the design of the curriculum allows students to either specialize in one of the profiles Bioinformatics or Systems Biology or to cover both profiles. The latter students take the courses of the other profile in the 18 EC, which have been made available for electives in the first year (please refer to section 3.4 of this report). The figures for the programme show 5 % of the students choosing the Bioinformatics profile, 58 % selecting the Systems Biology profile and 37 % opting for the combination of both profiles.

In the second year of the curriculum, students do two separate research projects, one major project and one minor project. The students are required to do their major research project within the domain of their profile, Bioinformatics or Systems Biology. On average, 25 % of the projects are done at one of the two Universities involved, 25 % are abroad and 50 % take place at other Dutch universities.

The teaching methods in the courses are lectures, computer practicals, assignments, experimental work and project work. For the project work, small groups of students are formed. These groups are composed by the lecturers of students with different backgrounds, so the students may benefit from each other's knowledge and skills.

The first two courses in the curriculum are quite demanding. These courses promote the collaboration among the students, also as working in small groups is involved. The curriculum has been scheduled in a way to balance the study load. The number of contact hours in the curriculum is quite substantial, being about 16 hours per week in the first year. In the second year, the year of the two research projects, this figure is 140 hours in total.

Every one of the students has a personal mentor, who will guide the student through the study and will assist him or her in avoiding bottlenecks. The mentor will meet two times per year with the student and helps him or her in compiles a personal education plan (PEP), in which subjects and courses are listed. These plans are approved by the Examination Board. In the research projects, students are guided by a mentor as well. The mentor will assist the student in finding internship places to do their projects and will meet with him or her several times. In addition, the mentor will try to visit the internship places, at least if these are in the Netherlands.

The core lecturers in the programme are to a large extent full professors and associate professors, act as course coordinators, responsible for the courses or participate as lecturers in the courses. All of them have a PhD degree. They, also, are experienced researchers in their field of expertise. In particular, the core lecturers are members of three distinct research groups within the two organizing Faculties, these groups being the Bioinformatics group (Heringa, VU University), the Systems Biology group (Teusink, VU University) and the group for the Systems Biology in Practice (Teixeira de Mattos, University of Amsterdam). As for their educational capabilities, 58 % of the core lecturers have obtained the Basic Teaching Qualification. The core lecturers meet regularly, six times per year to discuss the curriculum. These lecturers indicated to the panel to experience rather challenging workloads. In addition, experts from a number of renowned research institutions in Amsterdam are invited to participate as lecturers in the programme.

Programme management is responsible for the organization and the quality assurance of the programme. The Education Committee of the programme, composed of lecturers and students, plays an important role in this quality assurance, advising programme management on improvements. In a formal sense, both the Master Bioinformatics and the Master Life Sciences have their own Education Committee. These meet in combined meetings, however, leading *de facto* to one committee. Evaluation results are input for the Education Committee to act upon, if required.

Considerations
The panel considers the collaboration between the two programmes of the Universities to be very good. The students with whom the panel met, were very positive about the organization of the programme across both Universities. For the panel, succeeding in this is quite an achievement.

The entry requirements of the programme are appropriate, admitting only students who have a fair chance of completing the programme. The requirements set for the students are adequate, reflecting years of experience of programme management in this respect. The panel is especially positive about the classes in biology, computer programming and mathematics in the first part of the curriculum, allowing students to remedy their deficiencies. The panel advises programme management to intensify the external information about the programme in order to attract more students. In addition, the panel recommends offering a major in this field for bachelor students, raising the interest in this domain among these students.

The panel observed the curriculum to meet the intended learning outcomes of the programme. The subjects and topics to be expected on the basis of the learning outcomes, are adequately covered. In the courses relevant subjects are addressed. The curriculum is considered by the panel to be well designed and to be very coherent.

The teaching methods in the programme fit the students' learning processes and allow them to achieve the intended learning outcomes. In the panel's opinion, programme management has taken important steps to balance the study load and to improve the study guidance for the courses in the first year as well as for the research projects in the second year. The panel feels programme management has an effective system for study guidance in place.

The panel regards the lecturers in the programme to be renowned researchers and experienced teachers, being very capable of teaching the students effectively the concepts and applications in this field. The panel observed quite a demanding workload for a somewhat limited number of core lecturers, coming from only three research groups. Therefore, the panel recommends to increase the number of lecturers and to involve more research groups and researchers in the programme.

The panel considers the quality assurance system of the programme to be adequate. The importance of the position and the role of the Education Committee in this respect is evident.

Assessment of this standard
These considerations have led the assessment panel to assess standard 2, *Teaching-learning environment* to be good.

5.3 Standard 3: Assessment

The programme has an adequate assessment system in place.

Findings
The examinations and assessments in the programme are governed by the programme assessment plan. In this plan, the rules and regulations for examinations and assessments have been stipulated. The plan distinguishes between formative and summative assessments, the latter being meant to ascertain whether the learning goals of the curriculum components have been achieved by the students. Summative assessments typically are organized halfway and at the end of each of the courses. These are prepared by a lecturer, are reviewed by a second lecturer and are accompanied by an alignment matrix, specifying the relations between the learning goals and the test items. Examiners for each of the curriculum components are appointed by the Examination Board. For the Literature Review and Writing a Research Proposal, two examiners are involved and assessment forms with assessment criteria have been designed. Written reports assessments are checked for plagiarism. Students are informed about the examinations, are entitled to resits and are given the opportunity to obtain feedback on their results.

The assessment methods applied in the programme vary substantially, depending on the learning goals of the curriculum components to be assessed. Assessment methods are, among other things, written examinations, paper discussions, written reports, (computer) assignments, presentations and group work.

For the research projects in the second year of the programme, a protocol has been developed. According to this protocol, research projects plans are to be approved by the supervisor, the examiners and the programme coordinator, before the project can start. Students will be guided during the research projects by their supervisor. About 4 to 8 weeks after the start a formal interim assessment will be conducted. In consultation with the supervisor two examiners will assess the research projects. Separate grades are given for the experimental work, the written report and the oral presentation. Each of these components has to be marked at least 5.0. The examiners use assessment forms, containing assessment criteria.

The Examination Board of this programme is responsible for the assessment quality of this programme only. In the near future, the system will change and the Examination Board will be charged with the responsibility for a number of similar programmes of the Faculty of Science of University of Amsterdam. To be able to check the assessment quality in the programme, the Examination Board regularly studies samples of examinations and assessments, including research projects reports. Abnormal success rates are a reason for the Board to study the examination at hand. In case of specific topics, the Board may call in experts in the field.

Considerations
The panel regards the programme assessment plan to be elaborate, detailed and complete, specifying the rules and regulations regarding examinations and assessments in the programme. The panel considers the assessment system which has been set up to be very solid and to ensure the validity, reliability and transparency of the assessments. In their meeting with the panel programme management, lecturers and Examination Board confirmed working in accordance with the assessment plan rules. The panel regards the protocol for the guidance and assessment of the research projects to be adequate and ensures, among other, valid and reliable assessments. Two examiners, not being the supervisor, assess the projects, using detailed assessment forms.

The assessment methods used for the course components are appropriate, matching the learning goals of these components.

The Examination Board, so the panel observed, monitors the quality of examinations and assessments on a regular basis and is, therefore, in a position to assure the assessment quality in the programme. In some cases, this Board could have been in closer contact with the programme.

Assessment of this standard
The considerations have led the assessment panel to assess standard 3, Assessment to be satisfactory.

5.4 Standard 4: Achieved learning outcomes

The programme demonstrates that the intended learning outcomes are achieved.

Findings
In order to obtain a clear view on the qualifications of the students at completion of the programme, the panel studied 15 theses, being the results of the major research projects. The theses were accompanied by the assessment forms, completed by the examiners in the programme.

A significant number of papers with contributions from research projects, done by students have been published in scientific journals.

The representatives from the professional field with whom the panel met, indicated to have employed graduates of this programme and to be very content with their performance. They expect the demand for graduates to increase quite considerably in the coming years.

Considerations
All of the theses, that the panel studied were found to be at least satisfactory. No unsatisfactory theses have been detected by the panel. A number of these theses were good to very good with relevant, clearly formulated hypotheses or scientific questions, a solid scientific structure and addressing topics of high computational or biological complexity. In some of the theses, the cycle of hypothesis-driven, data-driven or model-driven research seemed to be less explicitly addressed. For some of the theses, the panel would have given a somewhat lower but not a substantially lower grade than the examiners in the programme did.

Some of the theses which the panel studied, addressed subject matter, more closely related to the field of molecular biology than to the bioinformatics or systems biology study fields. The panel feels these theses in a strict sense would be somewhat outside of the domain of the programme. Therefore, the panel recommends programme management to make clear to what extent these theses may be regarded to be within the domain of the programme.

The panel observed the breadth of the programme not always being fully reflected in the second year of the Systems Biology profile. In some cases, in the research projects the computer programming aspects may have been underrepresented. The panel, therefore, recommends programme management to ensure both biology and computer programming being covered in the research projects.

For the panel, the favorable opinion about the graduates of the programme, as expressed by the professional field representatives, indicates these graduates having achieved the intended learning outcomes and meeting the requirements of the research institutions and commercial businesses.

Assessment of this standard
The considerations have led the assessment panel to assess standard 4, Achieved learning outcomes to be satisfactory.

6. Recommendations

In this report, a number of recommendations have been listed. For the sake of clarity, these are brought together below. The recommendations are the following.

- To continue the efforts to obtain the status of joint-degree programme.
- To draft the intended learning outcomes in a more focused way, in order to reflect the programme focus and coherence.
- To intensify the information about the programme among bachelor students to attract more students.
- To offer a major in this field to bachelor students, with the goal of raising the interest in this domain among these students.
- To increase the number of lecturers and to involve more research groups and researchers in the programme.
- In the Systems Biology profile, to observe the balance between the two research projects, in order to cover both the biology and computer programming disciplines and to meet the intended learning outcomes.
- To state to what extent theses addressing molecular biology subject matter may be regarded to be within the domain of the programme.

Annex 1: Site visit schedule

The site visit took place in Amsterdam on 16 February 2016 (UvA is University of Amsterdam; VU is Vrije Universiteit Amsterdam; names are listed without titles)

08.30 h. – 09.30 h.	Arrival and deliberations panel (closed session)
09.30 h. – 10.00 h.	Dean and programme management K. Maex (Dean Science Faculties, UvA, VU), N. van Straalen (education director, Faculty of Sciences, VU), M. Haring (Education Director, Faculty of Science, UvA (till 1 January 2016)), J. Heringa (programme director Master Bioinformatics, VU), H. Hoefsloot (programme director Master Life Sciences, UvA)
10.00 h. – 11.00 h.	Programme management and core lecturers J. Heringa (programme director Master Bioinformatics, lecturer, VU), H. Hoefsloot (programme director Master Life Sciences, lecturer, UvA), A. Feenstra (chair Education Committee, lecturer, VU), D. Molenaar (lecturer, VU)
11.15 h. – 12.00 h.	Examination Boards M. Rep (chair Examination Board, UvA), D. Gadella (member Examination Board, UvA), M. Hoogendoorn (member Examination Board, VU), H. Akkermans (member Examination Board, VU)
12.00 h. – 12.45 h.	Theses' examiners J. Westerhuis (lecturer, UvA), D. Molenaar (lecturer, VU), S. Abeln (lecturer, VU), F. Bruggeman (lecturer, VU), H. Hoefsloot (lecturer, UvA)
12.45 h. – 13.30 h.	Lunch panel (closed session), open office hours 13.00 h. – 13.30 h.
13.30 h. – 14.15 h.	Lecturers, including member of Education Committee J. Teixeira de Mattos (lecturer, member Education Committee, UvA), F. Bruggeman (lecturer, VU), A. Feenstra (lecturer, chair Education Committee, VU), B. Teusink (lecturer, VU), S. Abeln (lecturer, VU), J. Westerhuis (lecturer, UvA)
14.15 h. – 15.00 h.	Students, including member of Education Committee G. Teunisse (student, member Education Committee, UvA), M. de Ruijter (student, member Education Committee, UvA), M. Slagter (alumnus, UvA), T. Constandse (alumnus, UvA), R. Bouwmeester (student, member Education Committee, VU), S. Spoelstra (student, VU), M. Dijkstra (alumnus, VU)
15.00 h. – 15.30 h.	Representatives of professional field R. Fijneman (NKI), W. Pirovano (Baseclear), W. Wijstra (The Hyve)
15.30 h. – 17.30 h.	Deliberations panel (closed session)

Annex 2: Documents reviewed

The panel studied the following documents, presented prior to the site visit:

- Self-evaluation report Master Bioinformatics, VU and Master Life Sciences, UvA
- Domain-specific framework Bioinformatics and System Biology
- Curriculum overview
- Study Guide, VU
- Course overview, UvA
- Literature Review Protocol
- Literature Review Assessment Form
- Writing a Research Proposal Protocol
- Writing a Research Proposal Assessment Form
- Research Project Protocol
- Research Project Assessment Form
- Teaching and Examination Regulations, 2015/2016
- Overview academic staff
- Overview graduated students
- University education indicators
- Assessment plan
- Bioinformatics and Systems Biology: bridging the gap between heterogeneous student backgrounds (article)
- Summary report response alumni questionnaire
- Summary report response employers questionnaire
- Outline of differences between Master Bioinformatics and Master Life Sciences programmes

On the day of the site visit, programme management presented the following documents:

- Annual report Graduate School of Life and Earth Sciences
- Mission and Vision Statement Joint Programmes
- Annual report Examination Board
- Annual report Board of Studies
- Minutes Board of Studies
- Student curriculum evaluation
- Selection of course material
- Critical reflection report 2009
- NVAO decision, 2009
- Flow chart MSc Life Sciences, 2015/2016
- Folder for prospective students, 2016/2017
- Research Project Protocol
- Assessment Research Project
- Literature Review Protocol
- Assessment Literature Review
- Teaching and Examination Regulations 2015/2016, Parts A and B
- Rules and Guidelines of Examination Board
- Selection of examinations

In addition, the panel had access to the programme electronic learning system.

Annex 3: Theses reviewed

The theses of the following 15 students have been selected for review by the panel (UvA)

- 10390871
- 6175155
- 6177948
- 6158099
- 10426280
- 6164587
- 10652817
- 5991323
- 10425292
- 5872812
- 6389082
- 10231781
- 10617434
- 10230513
- 10225617

The theses of the following 15 students have been selected for review by the panel (VU)

- 2043599
- 1937456
- 2509689
- 2508896
- 1635875
- 2039974
- 1438549
- 2529069
- 1966553
- 1769618
- 2533688
- 2523859
- 2520133
- 2517509
- 2509007

Annex 4: Composition of the assessment panel

The assessment panel had the following composition:

- Prof. Y. Moreau PhD, professor in Engineering, University of Leuven and programme director of the Master of Bioinformatics programme, University of Leuven (panel chair);
- Prof. V.A.P. Martins dos Santos PhD, professor in Systems and Synthetic Biology and director of Wageningen Centre for Systems Biology, Wageningen University (panel member);
- Prof. B. Snel PhD, professor in Bioinformatics and head of the executive board of Utrecht Bioinformatics Centre, Utrecht University (panel member);
- J.C. van Campenhout LLB, student in the pre-master programme in Law, University of Tilburg (student member).

Prof. Y. Moreau PhD, panel chair
Mr Moreau is a professor in Engineering and the programme director of the Master of Bioinformatics programme at University of Leuven. He received his Master in Electrical Engineering from Faculté Polytechnique of Mons, Belgium and took his doctorate in Electrical Engineering at University of Leuven. His research interests are the development of computational methods for data analysis in rare genetic disorders. He holds a number of academic and non-academic positions in his field of expertise. Mr Moreau published widely.

Prof. V.A.P. Martins dos Santos PhD, panel member
Mr Martins dos Santos is a professor in Systems and Synthetic Biology as well as the director of Wageningen Centre for Systems Biology at Wageningen University. He took his doctorate on Environmental Bioprocess Engineering at Wageningen University. He did a post-doc at the Spanish Research Council in Granada, Spain and built the Systems and Synthetic Biology Research Group of the German National Centre for Biotechnology. Mr Martins dos Santos published many books and articles in his field of expertise.

Prof. B. Snel PhD, panel member
Mr Snel is a professor in Bioinformatics at Utrecht University and the head of the executive board of Utrecht Bioinformatics Centre of Utrecht University. He took his doctorate at Utrecht University, having done his PhD-research at the European Molecular Biology Laboratory in Heidelberg. His research focuses on novel high throughput data and novel genome sequences of eukaryotes at key phylogenetic positions to study the interplay between network and genome evolution. Mr. Snel published widely in his field of expertise.

J.C. van Campenhout LLB, student member
Mr Van Campenhout is a student in the pre-master's programme in Law of University of Tilburg. He completed the bachelor's programme in Law at Avans-Fontys Law School. He served as a member and as the student chair of the educational committee of this school. In addition, he was a student-assistant for this school. Mr Van Campenhout was a student member in NVAO-accreditation panels.