wo master Nanobiology (joint degree)

Delft University of Technology
in cooperation with
Erasmus University Rotterdam

12 May 2015

Initial accreditation

Panel report

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1 Executive summary

The Accreditation Organisation of the Netherlands and Flanders (NVAO) received a request for an initial accreditation procedure with regard to the academic (wo) master's programme Nanobiology of Delft University of Technology. This institution has the intention to offer this programme as a joint degree programme in collaboration with Erasmus University Rotterdam. NVAO convened an expert panel, which studied the information available and discussed the proposed programme with representatives of both institutions and programme management during a site visit. In this executive summary, the panel presents the main considerations which have led to the assessment of the quality of this programme. Since the programme is meant to be a joint degree programme, the panel considered the joint degree requirements as well. As the programme management has applied for a two-year master's programme, the panel examined the programme in this respect also.

The programme management drafted a subject benchmark statement, as no internationally accepted benchmark statement is yet available for the relatively new nanobiology domain. For the panel, the field of nanobiology has been described very appropriately in this statement. The objectives of the programme have been derived from the subject benchmark statement, meeting the international requirements of this field of study. In turn, the intended learning outcomes are an adequate representation of these objectives. The disciplines required for the study of nanobiology, being biology, physics, mathematics and chemistry are addressed in the learning outcomes as is the integration of these disciplines. Also, the learning outcomes specify the required research skills and communication skills of the graduates. The panel considers the learning outcomes to comply fully and unquestionably with the requirements of a master's level programme. From a comparative study by the programme management, it has become clear the programme is comparable to master's programmes abroad. The representatives of the professional field indicated the graduates are welcome in universities for PhD positions as well as in industry.

The programme is very demanding. In the opinion of the panel, the entry requirements, requiring incoming students to be knowledgeable in the disciplines molecular biology, chemistry, physics and mathematics at the required levels, are in line with the programme management's ambitions.

The panel established that all the intended learning outcomes have been covered by the contents of the courses. The panel supports the goal to deeply acquaint the students with the aforementioned disciplines and feels the contents and the structure of the curriculum as well as the lecturers' commitment will enable the students to reach this goal. Although the programme in principle offers enough opportunities for students who want to specialize in the theoretical or modelling aspects of nanobiology, the panel recommends to design more explicit study paths in the curriculum leading to this specialization. The panel approves of the focus of the programme on cancer-related subjects, observing these subjects provide ample opportunities for studying nanobiology in satisfactory breadth but suggests to consider including other fields of application in due time, such as immunology and neuroscience.

The structure of the curriculum is adequate, mandatory courses, electives, internship and research project having been assembled logically. The panel considers the number and contents of the electives to be offered to be quite appropriate in this stage.

The teaching staff consists of well-qualified researchers, a number of whom being internationally renowned. Not only are the lecturers experts in their field but they also have adequate teaching competencies. Most lecturers have basic teaching qualifications certificates and may, in future, apply for senior teaching qualification certificates.

The panel is positive about the educational principle and the study methods to be adopted, as these encourage students to participate actively in the classroom and are in line with the various elements of knowledge and skills the students are to acquire. The average number of contact hours and the staff-to-students ratio meet the requirements. Measures to ensure a solid network of study guidance and study advice have been taken.

The panel considers the responsibilities and the workings of the board of examiners to be a safeguard for the quality of the examinations and the procedures in this respect. In most cases, the assessment methods conform to the learning goals to be assessed. The panel would suggest adding one particular assessment method, i.e. the poster presentation, which may prepare students for presentations for academic audiences and may, therefore, be of interest to the students. In addition, the panel suggests to make explicit that two examiners will assess and grade the internships. In all of the courses, formative assessments have been introduced. The panel considers these to be beneficial for monitoring the students' progress. The design of the research projects trajectory is very complete, including presentation and writing skills lectures and sessions for lecturers and students to comment on research proposals. The assessment of the research projects is appropriate, including a list of assessment criteria and involving a number of non-supervising, independent examiners.

The two institutions cooperating to offer the programme have submitted a guarantee for the students to be able to complete the programme. Having studied the budget statement for the programme, the panel does not question the financial viability of the programme.

The two institutions have a long and successful history in collaboration and joint degrees. In this programme, they participate on an equal basis in the curriculum, each of the institutions designing and offering courses, in the staff deployment, researcher and lecturers of each of the institutions lecturing in the programme, and in the facilities, each of the institutions providing lecture rooms, laboratories and equipment.

In view of the complexity of the curriculum and the level the students are to achieve, the comparison with similar programmes abroad and the competitiveness of this programme in an international perspective, the panel is convinced a duration of two years (120 EC) for this programme is imperative.

Given these considerations, the panel advises NVAO to take a positive decision with regard to the quality of the academic master's programme Nanobiology of Delft University of Technology in collaboration with Erasmus University Rotterdam and to grant the programme the initial accreditation. As the programme meets the joint degree requirements, the panel advises NVAO to grant the programme the status of a joint degree programme. Given strong arguments in favour of a duration of two years, the panel advises to grant the programme the right to offer a two-year master's programme (120 EC).

The panel supports Delft University of Technology's request for the programme to be registered under "Technology" as its field of study (CROHO-onderdeel).

The Hague, 12 May 2015

On behalf of the initial accreditation panel convened to assess the academic (wo) master's programme Nanobiology of Delft University of Technology in collaboration with Erasmus University Rotterdam.

dr. W. Voorhout
(chair)

drs. W.J.J.C. Vercouteren RC
(secretary)

2 Introduction

2.1 The procedure

NVAO received a request for an initial accreditation procedure including programme documents regarding the proposed academic (wo) master's programme Nanobiology (joint degree). The request was received on 11 November 2014 from Delft University of Technology in collaboration with Erasmus University Rotterdam. In addition, NVAO received a request by the institutions to assess the two-year duration (120 EC) of this master's programme.

An initial accreditation procedure is required when a recognised institution wants to offer a programme and award a recognised bachelor's or master's degree. To a certain extent, initial accreditation demands a different approach to the accreditation procedure than for programmes already being offered. Initial accreditation is in fact an *ex ante* assessment of a programme, and a programme becomes subject to the normal accreditation procedures once initial accreditation has been granted.

NVAO has convened a panel of experts. The panel consisted of the following persons:
- dr. W. Voorhout, product marketing manager, Life Science business unit, FEI Europe, panel chair;
- prof. dr. V. Subramaniam, director FOM-institute AMOLF, panel member
- prof. dr. J. Schymkowitz, professor, VIB Switch Laboratory, KU Leuven, panel member
- L.V.R. van Doremalen BSc, student master's programme in Physics, Utrecht University, student member.

On behalf of NVAO, drs. F. Mulder, NVAO policy advisor, acted as the co-ordinator of the initial accreditation process. Drs. W. Vercouteren RC drafted the panel report.

The panel's composition reflects the expertise deemed necessary by NVAO (please refer to Annex 1: Composition of the panel). All the panel members as well as the secretary have signed a statement of independence and confidentiality.

The panel based its assessment on the standards and criteria described in the NVAO Initial Accreditation Framework (Stcrt. 2010, nr 21523). The joint degree aspects of the proposed programme were assessed by the panel on the basis of the NVAO Protocol for Dutch Applications for Initial Accreditation leading to a joint degree (7 June 2010, version February 2011). To assess the two-year duration (120 EC) of the programme, the panel followed the guidelines of the NVAO Protocol cursusduur masters (8 October 2003).

The following procedure has been followed. The panel members studied the programme documents (please refer to Annex 3: Documents reviewed) regarding the proposed programme. Their first impressions were sent to the co-ordinator of NVAO, in order to outline these remarks within the accreditation framework and to detect the items to be clarified during the site visit.

Based on the first findings, the panel held a preparatory meeting on 19 March 2015. The site visit took place on 20 March 2015 on the Delft University of Technology campus (please refer to Annex 2: Schedule of the site visit).

The panel formulated its preliminary assessments per standard immediately after the site visit. These were based on the findings during the site visit, building on the assessment of the programme documents.

On 25 April 2015, the first draft version of this report was finalised, taking into account the available information and relevant findings of the assessment. Where necessary, the panel corrected and amended the report. The panel finalised the report on 12 May 2015.

2.2Panel report

The first chapter of this report is the executive summary of the report, while the current chapter is the introduction.

The third chapter gives a description of the programme including its position within Delft University of Technology and Erasmus University Rotterdam, and within the higher education system of the Netherlands.

The panel presents its assessments in the fourth chapter. The programme is assessed by using the standards in the Initial Accreditation Framework. For each standard the panel has presented an outline of its findings, considerations and a conclusion. In the last section of this chapter, section 4.5, the panel has presented the considerations regarding the two-year duration of the programme.

The *outline of the findings* are the objective facts as found by the panel in the programme documents, in the additional documents and during the site visit. The panel's *considerations* are the panel's subjective evaluations regarding these findings and the importance of each. The *considerations* presented by the panel logically lead to a concluding assessment.

The panel concludes the report with a table containing an overview of its assessment per standard.

3 Description of the programme

3.1 Overview

Country	Netherlands
Institutions	Delft University of Technology and Erasmus University Rotterdam
Programme	Nanobiology
Level	master
Orientation	academic (In Dutch: wo or wetenschappelijk onderwijs)
Degree	MSc
Location(s)	Delft and Rotterdam
Mode of study	full-time
Field of study	Technology (Techniek)

3.2 Profile of the institutions

The master's programme Nanobiology is a joint degree programme of Delft University of Technology (Faculty of Applied Sciences) in collaboration with Erasmus University Rotterdam (Erasmus Medical Centre).

Delft University of Technology website says an important part of the University's strategy is the co-operation with many other educational and research institutions, in the Netherlands and abroad. The high quality of the University's research and teaching, so it reads, is renowned. Delft University of Technology has numerous contacts with governments, trade associations, consultancies, industry and small and medium-sized companies. The University's mission is to make a significant contribution towards a sustainable society by conducting groundbreaking scientific and technological research, by training scientists and engineers showing commitment to society and by helping to translate knowledge into technological innovations and into activities with both economic and social value.

According to its website, Erasmus University Rotterdam concentrates its expertise on issues of management, organization and policy in the public and private sectors as well as on the field of health care and medicine. The University has bundled its education and research in four areas of expertise in which the university has a national and international reputation to maintain: health, wealth, governance and culture. In its own words, the principal tasks of Erasmus University Rotterdam are the generation and transfer of knowledge proceeding from a high degree of social engagement. To this end, the University pursues knowledge in an inquiring, critical, investigative and flexible manner, with a strong international orientation and based on the values of professionalism, teamwork and fair play.

3.3 Profile of the programme

The proposed academic master's programme Nanobiology is a joint degree programme, to be offered by Delft University of Technology and Erasmus University Rotterdam. The programme is a new programme for both institutions. In 2012, the institutions were granted the initial accreditation of the new bachelor's programme Nanobiology. This new master's programme will allow bachelor's students to complete a subsequent master's programme in

Nanobiology. There are no similar programmes in the Netherlands. Therefore, this programme may be regarded to be a new programme in the Netherlands.

The programme management has drafted the intended learning outcomes. These have been divided into intended learning outcomes regarding knowledge, research skills and communication skills. The intended learning outcomes are the following:

- The graduates have theoretical and practical knowledge of the physics of biological processes and the methods to observe them (knowledge).
- The graduates are able to build mathematical models of physical and biological systems, and can solve them numerically and/or analytically (knowledge).
- The graduates can apply their knowledge to quantify biological processes from experimental results (knowledge).
- The graduates are able to formulate a relevant problem and translate this into a research question (research skills).
- The graduates are able to conduct elaborate literature investigations, related to the research questions (research skills).
- The graduates are able to translate a research question into a research proposal (research skills).
- In collaboration with other research group members, the graduates are able to set up and conduct a research project, collect data, analyze data, and come to conclusions.
- The graduates are able to write down research findings in the form of a draft manuscript, which in collaboration with a research supervisor may be developed into a scientific article, suitable for publication in an international, peer-reviewed journal (communication skills).
- The graduates can communicate their results in oral or written form to audiences of specialists and non-specialists (communication skills).

The curriculum of the programme consists of the following courses (with number of EC).

Math of Nanobiology	6 EC
High Resolution Imaging	4 EC
Biology of Cancer	4 EC
Electives	16 EC
Internship	18 EC
Engineering Genetic Information	3 EC
Computational Modeling and Dynamic Systems	3 EC
Electives	6 EC
First year	60 EC
Research Project	36 EC
Project Proposal Writing	2 EC
Research Presentation	2 EC
Thesis Writing	4 EC
Thesis Defence	4 EC
Seminars	4 EC
Literature Review Report	4 EC
Electives	4 EC
Second year	60 EC
Total credits	120 EC

4 Assessment per standard

This chapter presents the evaluation by the assessment panel of the four standards. The panel has reproduced the criteria for each standard. For each standard the panel presents (1) a brief outline of its findings based on the programme documents and on documents provided by the institution and the site visit, (2) the considerations the panel has taken into account and (3) the conclusion of the panel. The panel presents a conclusion for each of the four standards.

4.1 Intended learning outcomes (standard 1)

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

Outline of findings
The programme management of the proposed master's programme Nanobiology drafted a subject benchmark statement, with the intention to describe the field of nanobiology, using among other, the subject benchmark statements for biology and physics by QAAHE in the United Kingdom. The statement has been drawn up by the programme management, since no internationally accepted subject benchmark statement has thus far been written for this relatively new field of study.

In this subject benchmark statement, it reads nanobiology is the study of biological phenomena occurring in living systems from the perspective of the underlying physical and chemical processes at the (sub)cellular level. The nanobiology domain finds itself at the intersection of molecular biology and physics and, therefore, is inherently interdisciplinary. The combination of these disciplines allows the quantitative understanding of life at the molecular level. In addition to physics and molecular biology, knowledge of chemistry and mathematics are required to study these phenomena. Nanobiology may, especially, be very helpful in understanding processes of human health and disease and, by extension, finding remedies to a variety of diseases.

In the subject benchmark statement the programme management drafted, a comparison has been made with similar programmes of renowned institutions in Germany (Humboldt Universität Berlin, Saarland Universität), Switzerland (Basel University, Swiss Nanoscience Institute) and the United States (Harvard University, Berkeley University). From the descriptions of the curricula, it is evident the contents of the programmes in these countries are to a large extent comparable to this master's programme.

The objectives of the programme have been defined as enabling graduates to conduct interdisciplinary research in the field of nanobiology, nanomedicine and biophysics and to contribute to the development of these fields of study, based on knowledge and skills to do so, and to communicate about these subjects with researchers in related disciplines. The programme management listed a number of intended learning outcomes, complying with these objectives and specifying the knowledge and skills to be acquired by the graduates. These intended learning outcomes address the graduates' knowledge, research skills and communication skills.

The programme management has drafted a table comparing the intended learning outcomes to the Dublin-descriptors. From this table it may be derived that the learning outcomes meet all of the Dublin-descriptors and, therefore, meet the master's level.

Graduates of this programme may analyze processes at the cellular level, including interpreting large amounts of data, in order to assist in addressing medical problems. The career prospects of graduates of a master's nanobiology programme in the Netherlands as well as abroad are good. In the opinion of the representatives of the professional field, with whom the panel met, this programme meets very well the demand in this field. Graduates of this programme are likely to be especially sought after, since they combine knowledge and skills in biology as well as in physics and mathematics. The programme's graduates may find jobs in fundamental and applied research, in universities, with life sciences, pharmaceutical or chemical companies or with companies manufacturing instruments in this domain. The professional field representatives confirmed the graduates of the programme may not only find jobs in academia but also in industry.

The programme is to be a joint degree programme of Delft University of Technology and Erasmus University Rotterdam. Delft University of Technology provides the physics and mathematics expertise, whereas Erasmus University offers expertise in the biology discipline. Delft University of Technology and Erasmus University Rotterdam have a prolonged history in working together and in offering joint degree programmes (Medical Delta). Therefore, both institutions have ample experience in mutual projects. The deans of the Faculties of both institutions referred to their collaboration as being very successful, including the balance of the financial aspects.

Considerations
The panel considers the programme's subject benchmark statement to be well-elaborated. In the panel's opinion, in this statement the field of study of nanobiology has been described very appropriately. The objectives of the programme have been derived equally appropriately from the subject benchmark statement, meeting the international requirements of this field of study and addressing the subjects relevant to this field.

The panel has studied the comparison of this programme with similar programmes abroad and has verified the objectives and set-up of this programme are in line with the objectives of these programmes, offered by several reputed institutions in other countries. In the opinion of the panel, the programme, therefore, meets the internationally accepted characteristics of a master's programme in nanobiology.

The panel regards the intended learning outcomes to be an adequate representation of the objectives of the programme and to cover the requirements the graduates ought to meet. The panel has observed that the intended learning outcomes meet the requirements with regard to domain-specific knowledge, research skills and communication skills. The panel noted the various disciplines required for the study of nanobiology, being biology, physics, mathematics and chemistry are addressed in the intended learning outcomes. As the integration of these disciplines is indicated as well, the panel feels the interdisciplinary nature of nanobiology has been adequately covered in the learning outcomes. On the other hand, the panel approves of the broadness of the intended learning outcomes, allowing graduates to focus on one or more subfields or specializations within the field of nanobiology.

From the comparison of the intended learning outcomes to the Dublin descriptors the panel has been able to deduce that all of the Dublin descriptors are represented in the learning outcomes. The panel considers the learning outcomes to comply fully and unquestionably with the requirements of a master's level programme.

As the representatives of the professional field indicated, the graduates of this programme are equally welcome in universities for PhD positions as in industry. For the panel, these statements give evidence of the ample opportunities graduates of this programme may have on the labour market.

From their meeting with the deans of the Faculties of both institutions, the panel deduced the cooperation between the two institutions to be very solid. The panel regards this to be a sound foundation for this joint degree programme and a major factor for the continuity of the programme.

Conclusion
The panel assesses standard 1 'Intended learning outcomes' as satisfactory.

4.2 Teaching-learning environment (standard 2)

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

Outline of findings
The two institutions cooperating in this joint degree programme expect in the steady state about 50 students to enrol in the programme. In the first year, 2015/2016 this number is expected to be about 10 students. The number of students applying will gradually increase with the target set at 50 students, to be reached after a number of years. As the deans of the Faculties of the institutions informed the panel, this number of incoming students is considered by the institutions to be feasible.

Most of the incoming students may be graduates of the bachelor's programme Nanobiology which is offered by Delft University of Technology and Erasmus University Rotterdam from 2013/2014 onwards. About 50 % of these bachelor's students are expected to continue their studies in this master's programme. On the other hand, students having obtained a bachelor's degree in physics, biology or a related field, may apply as well. In their meeting with the panel, the deans of the Faculties said to expect an influx of about 20 students with these backgrounds.

Speaking with the panel, the programme management explicitly indicated this programme to be meant for very talented and motivated students who will be challenged to reach distinctly high performance levels. Accordingly, the programme management has drafted a list of prerequisites the incoming students will have to meet in order to enrol. Applicants, especially, are to have knowledge of molecular biology, physics and mathematics at the required levels.

Bachelor's students Nanobiology will be admitted. Students with other bachelor's diplomas may be admitted after having completed a pre-master programme to remedy their deficiencies. For a number of bachelor's programmes, the programme management calculated the number of credits their pre-master programme is to consist of to be able to

enrol. For students with a bachelor's degree in Life Science & Technology this number will be 38 EC. Students having a bachelor in Physics will have to take a pre-master programme of 38.5 EC, whereas the pre-master programme for students with a bachelor's diploma in Biology will be 70.5 EC, which is over a year. The board of examiners will be responsible for admitting students.

Students may enter the programme in September or in February, this being in line with Delft University of Technology policy. Students who need more time to complete their bachelor's programme may enrol in February, thus not losing time. Scheduling problems or bottlenecks will be solved by the management of the programme.

The programme management has drawn up a table, indicating the relationships between the intended learning outcomes and the courses in the curriculum. From this table it may be derived that all of the intended learning outcomes are covered by the courses the curriculum is made up of. The programme management presented the course descriptions of the first-year courses, thereby presenting in detail the learning goals and the contents of the courses.

The programme has a number of distinct features. These are:

- A major factor to be successful in nanobiology is being knowledgeable in biology as well as in physics and mathematics. Therefore, the programme management stresses this aspect and has the intention to submerge students in the constituent disciplines, molecular biology on the one hand and physics and mathematics on the other hand. The programme management has chosen not to offer specializations but to allow students to specialize by selecting electives, by taking a specific internship and doing their research project in a specific field of study.
- The programme management intends to focus on experimental nanobiology, although students are offered the opportunities to specialize in theoretical modelling as well. The panel discussed at length with the programme representatives the opportunities for students to specialize in the theoretical or modelling dimension of nanobiology, as opposed to the experimental dimension, which is the focus of the programme. From these discussions became evident that a number of compulsory courses, such as *Mathematics for Nanobiology* and *Computational Modeling and Dynamic Systems* address these aspects. In addition, students may select a number of electives, which especially will be designed for the in-depth study of these subjects.
- The programme management also intends to primarily study the field of cancer, as this field offers ample room to become acquainted with diverse aspects of nanobiology.

The programme consists of mandatory courses and electives in the first year, allowing students to deepen their knowledge of nanobiology in each of the constituent disciplines (biology, physics, mathematics) and preparing them for the research project in the second year. The electives amount to 26 EC, nearly 20 % of the curriculum. A number of electives are especially designed for this programme. The electives allow students to a certain extent to design the curriculum according to their preferences. The internship may be taken at one of the research groups of the two collaborating institutions or at an external research institute, either academic or from industry. Students ought to find internships themselves. The research project, covering a major part of the second year, should be done in another research centre than where the internship was taken and should also address another of the constituent disciplines.

The lecturers in this joint degree programme belong to either one of the Faculties of the collaborating institutions (Erasmus Medical Centre of Erasmus University Rotterdam, Faculty of Applied Sciences or Faculty of Electrical Engineering, Mathematics and Computer Science of Delft University of Technology). Each one of the lecturers is a researcher in one of the constituent disciplines of nanobiology and most of them are internationally renowned academics. The records of the research groups the lecturers are a member of show an above average performance. The quality of each of the courses in the programme is the responsibility of a course coordinator. Lecturers of various backgrounds may be involved in courses in which more than one discipline will be addressed. This applies to the majority of the courses in the programme. Lecturers are invited to obtain the basic teaching qualification (BKO). The deans of the Faculties indicated to expect the senior teaching qualification (SKO) to be introduced as well within the programme, although they would prefer this to be part of a life-long learning programme for lecturers. The programme management intends to organize regular meetings with the lecturers to discuss the structure and the contents of the curriculum.

The educational principle of the programme is primarily meant to encourage the active participation by the students in the classroom. Students are expected to prepare the lectures and the tutorials. In these lectures and tutorials, students are to engage actively in the learning processes. On top of lectures and tutorials, study modes applied in the programme are, among others, practicals, class exercises, presentations, work sessions and demonstrations. In the courses, the number of contact hours is 15 hours per week on average. The teacher-to-student ratio is about 1 : 18.

Each one of the students is entitled to feedback sessions with their tutor, which take place once or two times per year. Students may also turn to the study advisor for assistance with their studies. During their internship as well as during their research project, students will be guided on a day-to-day basis by a supervisor of the research centre and by a supervisor of the academic staff of the programme. Study associations are being set up in both cities. In their meeting with the panel, the programme management confirmed students with a physical handicap will be provided the means and guidance to study in the programme. Rules for fraud and cum laude are in place, so the panel observed.

In this joint degree programme, students take courses either in Delft or in Rotterdam, as some of the courses are offered by Delft University of Technology and other courses are offered by Erasmus University Rotterdam. In both cities, laboratories with appropriate equipment will be available. The programme management is committed limiting the travel time of the students. In the second year, during the research project, the students normally are in one city.

Considerations
The panel approves of the entry requirements of the programme and the way in which the programme management wants to enforce these. Since this programme, obviously, will be very demanding, incoming students have to master molecular biology, chemistry, physics and mathematics at the required level. The panel approves of the high standards the programme management intends to set for the students.

The panel considers the curriculum to meet the intended learning outcomes completely and appropriately. All the intended learning outcomes have been covered by the learning goals and the contents of the courses.

The panel supports the programme management's aim to deeply acquaint the students with biology as well as with physics and mathematics. The panel acknowledges this not to be straightforward to accomplish, as the methodology of these two disciplines is quite distinct. The panel, however, feels the contents and the structure of the curriculum as well as the commitment of the lecturers will enable the students to reach this goal. From the information presented by the programme management, the panel derives the programme in principle offers enough opportunities for students who want to specialize in the theoretical or modelling aspects of nanobiology. The panel, however, recommends the programme management to design more explicit study paths in the curriculum leading to this specialization. The panel approves of the focus of the programme on cancer-related subjects, observing these subjects provide ample opportunities for studying nanobiology in sufficient breadth. The panel advises the programme management, however, to consider including other fields of application in due time, such as immunology and neuroscience.

The panel is positive about the structure of the curriculum, as this structure reflects the steps students ought to take to achieve the intended learning outcomes. The mandatory courses, electives, internship and research project have been assembled in a logical sense. The panel considers the number and contents of the electives to be offered to be quite appropriate for the programme in these early stages. In later years, the number and contents of the electives may be increased.

The panel has observed the teaching staff to consist of well-qualified lecturers, a number of whom being internationally renowned researchers and considers the qualifications of the lecturers to be appropriate for the programme. Not only are the lecturers experts in the field they are teaching but they also are experienced lecturers and have adequate teaching competencies, as most lecturers have basic teaching qualifications certificates. The plans of the institutions regarding the senior teaching qualifications are positive.

The panel is positive about the educational principle of the programme and the study methods to be adopted. These encourage students to participate actively, promoting their learning processes and are in line with the various elements of knowledge and skills the students are to acquire. The average number of contact hours in the courses and the staff-to-students ratio meet the requirements.

The panel feels the programme management has taken the required measures to ensure a solid network of study guidance and study advice.

The panel considers the joint degree characteristics of the programme to be adequately implemented. The two institutions cooperating in the programme participate on an equal basis in the curriculum, each of the institutions designing and offering courses, in the staff deployment, renowned researcher and lecturers of each of the institutions lecturing in the programme, and in the facilities, each of the institutions providing lecture rooms, laboratories and equipment.

Conclusion
The panel assesses standard 2 'Teaching-learning environment' as satisfactory.

4.3 Assessment (standard 3)

The programme has an adequate assessment system in place.

Outline of findings
The board of examiners of the programme has a number of responsibilities, among which are supervising and assessing the quality of written examinations and other assessments, supervising the handling of the teaching and examination regulations and dealing with cases of fraud and appeals by students. The board of examiners meets regularly.

The examination in a course typically consists of a written examination at the end of the course and an assignment or take-home examination half-way the course. Other forms of examination applied in the programme are practical assignments and presentations. In all of the courses, the course grading depends on more than one examination. The weight of the examinations has been determined beforehand, at the beginning of the course. Also at the beginning of the course, students are informed about what will be expected from them. Afterwards, these examinations are discussed in class and may be discussed individually with the lecturers. In the courses, formative assessment is introduced and students are given feedback on these assessments about their study progress. For instance, student groups may present their findings on scientific articles and these presentations will be commented on by other groups of students. As another example, in lab sessions the lecturers give day-to-day feedback on the students' progress.

In the information file the programme management submitted, a number of two examiners had been indicated for external internships. With regard to internal internships, this was less clear and there seemed to be only one examiner.

The research project is an individual project with one exception. Students participating in the iGEM Competition, an international competition for students in the field of synthetic biology, are member of a team of students from different Faculties. The research projects are to be done either with a research group in Delft or in Rotterdam. Only very rarely, students are allowed to do their projects elsewhere. The programme management indicated having no problems in offering suitable research projects to students. Students start the research project by drafting a problem statement. After some time, students present their research proposal to the lecturers and their fellow students who read two proposals of other students and comment on these. Part of the research projects are trainings in presentation and academic writing skills. Students are to present their findings in meetings within their research group and at the end of the research project. For the assessment of the research projects, the programme management drafted a list of assessment criteria. The research projects, including the presentation and the thesis, will be assessed by an evaluation committee, composed of the project supervisor, an expert in the specific field (which may be the supervisor) and two other lecturers in the programme.

Considerations
From the documentation presented and the information acquired in the meeting with the board of examiners, the panel obtained a clear view on the responsibilities and the workings of this board. The panel considers these to be appropriate and to be a safeguard for the quality of the examinations in the programme and the procedures in this respect.

The panel studied the assessment methods the programme management intends to adopt and is of the opinion that in most cases these methods conform to the learning goals to be

assessed. There is one particular method which the panel would suggest introducing, being the poster presentation. This method may prepare students for presentations for academic audiences and may, therefore, be of interest in the programme.

The panel is positive about the formative assessments in the courses, noticing these are held on a very regular basis and assist in monitoring the students' progress. The students with whom the panel met, indicated to be very content about these formative assessments.

The panel approves of the design and implementation of the research projects trajectory, including the presentation and writing skills lectures. The panel also welcomes the set-up of the research proposals, including notably the comments the students are to give on each others' proposals. The panel feels this is beneficial to the learning processes of the students in this respect. The assessment of the research projects is appropriate, as this assessment includes a list of specific assessment criteria and involves a number of non-supervising, independent examiners.

Following the findings on the number of examiners involved in the internal internships, the panel suggests the programme management to make explicit that two examiners will assess and grade these internships.

Conclusion
The panel assesses standard 3 'Assessment' as satisfactory.

4.4 Graduation guarantee and financial provisions (standard 4)

The institution guarantees students that they can complete the entire curriculum and makes sufficient financial provisions available.

Outline of findings
The two cooperating institutions guarantee the students have the right to complete the programme. In case the programme would be ended prematurely, students are given at least three years in total to complete the programme. Additional costs incurred by the students, if any, will be reimbursed by the two cooperating institutions.

The deans of the Faculties of both institutions informed the panel that the break-even number of students is about 20 incoming students. As has been indicated in standard 2, they are of the opinion this number of students is feasible. The programme management presented a budget statement for the programme, showing the income and expenses for the coming years. The deans of the Faculties informed the panel initial investments and initial budget deficits will be financed by the two institutions. They also indicated that the costs and revenues of joint degree programmes tend, in the long run, to be balanced between the two institutions.

Considerations
The panel regards the guarantee, presented by the institutions, for the students to be able to complete the programme to be solid.

The panel studied the budget statement for the programme and considers this to be an adequate representation of the revenues and costs to be expected. On the basis of the

information provided, the panel has no reason to question the financial viability of the programme.

Conclusion
The panel assesses standard 4 ‘Graduation guarantee and financial provisions’ as satisfactory.

4.5 Two-year duration of programme

In the information dossier, the programme management presented a number of arguments in favour of a two-year programme duration (120 EC). The programme management’s arguments regarded the international requirements of the programme and the level of complexity of the programme, reflecting the requirements of the nanobiology domain. Below, the panel will give their assessment of these arguments, using the criteria put forward in the Protocol cursusduur masters of NVAO, published on 8 October 2003.

According to the first criterion, the learning outcomes to be attained by the students ought to be consistent with the international requirements for the domain. When the bachelors and masters were introduced in the Netherlands, technical academic programmes in the Netherlands, leading to the title ir (ingenieur) were set at a duration of five years (300 EC; three years bachelor; two years master). The reason to have done so, was to allow the students to attain an international comparable level. The international standard for the programmes was five years and offering an education of four years, implying a one-year master’s programme, would have put graduates of Dutch programmes in a unfavourable position compared to their peers abroad, regarding the knowledge and skills they would have acquired. To establish whether this argument is valid for the domain of nanobiology, the programme management analyzes a number of master’s programmes in nanobiology abroad. These programmes are Biophysik (Humboldt Universität Berlin, Germany), Biophysik (Universität Saarland, Germany), Integrated Life Sciences: Biologie, Biomathematik, Biophysik (Friedrich-Alexander Universität Erlangen-Nürnberg, Germany), Nanophysics (TU Dresden, Germany) and Physics and Nanotechnology (Technical University of Denmark). All these programmes take two years (120 EC). The structure and contents of these programmes is very much comparable to the proposed programme. Other programmes with which the proposed programme has been compared are Research Master Modelling Biological Complexity (University College London, United Kingdom), MSc in Biophysics and Molecular Life Sciences (University of Bristol, United Kingdom) and Biochemistry and Biophysics (Brandeis University, United States). The last programme takes two years and is quite similar to the proposed programme. The programmes in the United Kingdom take one-and-a-half years (90 EC). These programmes are more restricted, offer little room for specialization, are distinctly less elaborate and include a 15 EC research project. The panel regards the comparison made by the programme management to be thoroughly executed, focusing on the relevant elements in the curricula, and concludes the vast majority of similar programmes abroad take two years (120 EC). In the opinion of the panel, graduates of the proposed programme should take a two-year master’s programme to achieve the learning outcomes, set at an international level.

According to the second criterion, the learning outcomes to be attained by the students should enable them to compete on an equal basis with their peers from other countries. Students having completed the nanobiology programme are to have mastered a number of separate disciplines, being biology, chemistry, physics and mathematics and ought to be

able to integrate these disciplines. Moreover, students not only should have obtained in-depth knowledge of these disciplines, their relations and their integration but also ought to have acquired research skills, communication skills and practical lab skills. Since the programme is a research-oriented programme, the thesis should be the result of a research project, having a work load of at least 30 EC. In addition, the panel wants to emphasize that the disciplines nanobiology rests on, are methodologically very disparate, requiring the students to analyze problems in quite different, not so say opposed ways. To be able to become successful in nanobiology, understanding of these very different disciplines and their very distinct methodologies is imperative. The panel strongly feels these arguments to be very relevant and is convinced the qualifications the graduates should have in order for them to be competitive in the international academic nanobiology job market, may not be achieved in a programme of less than two years.

6 Overview of the assessments

The panel presents their assessments per standard, as outlined in chapter 4, in the following table.

Standard	Assessment
1 Intended learning outcomes	Satisfactory
2 Teaching-learning environment	Satisfactory
3 Assessment	Satisfactory
4 Graduation guarantee and financial provisions	Satisfactory
Conclusion	Positive

Annex 1: Composition of the panel

The panel which assessed the quality of the academic (wo) master's programme Nanobiology of Delft University of Technology in collaboration with Erasmus University Rotterdam consisted of the following persons:

- dr. W. Voorhout, product marketing manager, Life Science business unit, FEI Europe, panel chair;
- prof. dr. V. Subramaniam, director FOM-institute AMOLF, panel member
- prof. dr. J. Schymkowitz, professor, VIB Switch Laboratory, KU Leuven, panel member
- L.V.R. van Doremalen BSc, student master's programme in Physics, Utrecht University, student member.

dr. W. Voorhout, panel chair
Mr Voorhout is product marketing manager of the Life Science business unit of FEI Europe. He studied Chemistry at Utrecht University and obtained his PhD from Utrecht University in the field of biological electron microscopy. He pursued his career, holding a post-doc position at Utrecht University Medical Centre and being an associate professor at the Faculty of Veterinary Medecine of Utrecht University, before being employed at FEI Europe.

prof. dr. V. Subramaniam, panel member
Mr Subramaniam is director of the FOM institute AMOLF and group leader of the Nanoscale Biophysics group. Formerly, he was professor and chair holder as well as scientific director of MIRA Institute for Biomedical Technology and Technical Medicine at University of Twente. He was trained in Electrical Engineering and Applied Physics at Cornell University, New York, United States and University of Michigan, Ann Arbor, United States.

prof. dr. J. Schymkowitz, panel member
Mr Schymkowitz is professor at VIB Switch Laboratory, Department of Cellular and Molecular Medicine of KU Leuven. He obtained his PhD in 2001 from the University of Cambridge (UK) where he worked on mechanisms of protein folding in the laboratory of Sir Alan Fersht. He then moved to the European Molecular Biology Laboratory in Heidelberg (Germany) where he did postdoctoral work in the laboratory of Luis Serrano. There he contributed to the development of several structural modeling tools. He is now one half of a group leader duo at the Flanders Institute for Biotechnology (VIB) at the KU Leuven where he conducts research on mechanisms of protein misfolding and aggregation

L.V.R. van Doremalen, student member
Mr Van Doremalen studies the master Expiremental Physics at Utrecht University. He was a member of the University Council of this university for two years. He is one of the founding members of the party Student & Starter for the municipal council of Utrecht. During his studies he held numerous board, chair and advisory positions. He also was a member of the organisation committee for the International Conference of Physics Students, held in 2012.

Annex 2: Schedule of the site visit

The panel conducted the programme site visit on 20 March 2015 in Delft.

09.00 h. – 09.30 h.	Arrival and document study panel (closed session)
09.30 h. – 10.15 h.	Lecturers prof. dr. R. Kanaar (programme director, EUR), prof. dr. I. Touw (lecturer, EUR), dr. T. Idema (lecturer, TUD), dr. ir. J. Lebbink (lecturer, EUR), dr. ir. W. Baarends (lecturer, EUR), dr. ir. J. de Ridder (lecturer, TUD)
10.30 h. – 11.15 h.	Board of examiners/programme committee dr. A. Meyer (board of examiners chair, TUD), dr. K. Jaspers (board of examiners member, EUR), dr. F. van de Bult (programme committee chair, TUD), M. Verhagen (bachelor Nanobiology student, study assocation board member), M. Visser (bachelor Nanobiology student), A. Cramer (study association board member, EUR)
11.30 h. – 12.00 uur	Deans and directors of education prof. dr. J. Verweij (dean Faculty of Medicine, EUR), prof. dr. ir. T. van der Hagen (dean Faculty of Applied Sciences, TUD), prof. dr. R. Mudde (vice dean Faculty of Applied Sciences, TUD), dr. C. Festen (director Service Organisation Knowledge, EUR)
12.00 h. – 13.00 h.	Lunch and document study panel (closed session)
13.00 h. – 13.45 h.	Programme management prof. dr. R. Mudde (vice dean Faculty of Applied Sciences, TUD), dr. C. Festen (director Service Organisation Knowledge, EUR), dr. I. Croese (head of Department Education and Students Affairs Applied Sciences, TUD), prof. dr. R. Kanaar (programme director, EUR), prof. dr. C. Wyman (programme director bachelor's programme Nanobiology, EUR), drs. L. Dirksen-de Tombe (senior educational advisor, EUR), drs. S. Donkers (programme co-ordinator, TUD)
14.00 h. – 14.45 h.	Professional field representatives prof. dr. M. Dogterom (Department Bionanoscience, Faculty of Applied Sciences, Delft University of Technology), prof. dr. G. Borst (professor of Neurophysiology, Department Neuroscience, Erasmus Medical Centre), prof. dr. R. Bovenberg (corporate scientist Biotechnology, DSM Food Specialist)
15.00 h. – 16.00 h.	Deliberations panel (closed session)
16.00 h. – 16.30 h.	Presentation of main findings to programme management by panel chair

Annex 3: Documents reviewed

The programme management presented the following documents prior to the site visit:
- Information dossier Initial accreditation Master Nanobiology
- Subject benchmark statement and learning outcomes
- Curriculum overview
- Electives
- Assessment criteria thesis
- Short description of first year subjects
- Arguments for a two-year programme
- Staff
- Teaching and examination regulations
- Macro-efficiency decision
- Institutional quality assurance assessment report, Delft University of Technology
- Institutional quality assurance assessment report, Erasmus University Rotterdam

Upon request by the panel, the programme management, additionally, presented the following documents:
- Answers by programme management to the panel's questions, prior to the site visit
- General information regarding bachelor's programme Nanobiology
- Curriculum overview bachelor's programme Nanobiology
- Internal report Nanobiology, 2013 – 2014
- Course descriptions electives master's programme Nanobiology
- Curricula vitae programme director, programme co-ordinator

During the site visit the programme management presented the following documents:
- Master's Nanobiology brochure
- Curriculum overview
- Literature to be studied
- Courses teaching methods and examinations methods
- Prerequisites to enroll for students coming from various bachelor's programmes
- Lecturers' teaching qualifications
- Teaching and examination regulations, March 2014
- Rules and guidelines of the board of examiners

Annex 4: List of abbreviations

CROHO	Central Register of Higher Education Study Programmes
EC	credits according to the European Credit Transfer System
EUR	Erasmus University Rotterdam
hbo	professional higher education (hoger beroepsonderwijs)
NVAO	Dutch-Flemish Accreditation Organization (Nederlands-Vlaamse Accreditatie Organisatie)
TUD	Delft University of Technology
wo	academic education (wetenschappelijk onderwijs)

The panel report has been ordered by NVAO for the initial accreditation of the academic (wo) master's programme Nanobiology of Delft University of Technology in collaboration with Erasmus University Rotterdam.

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