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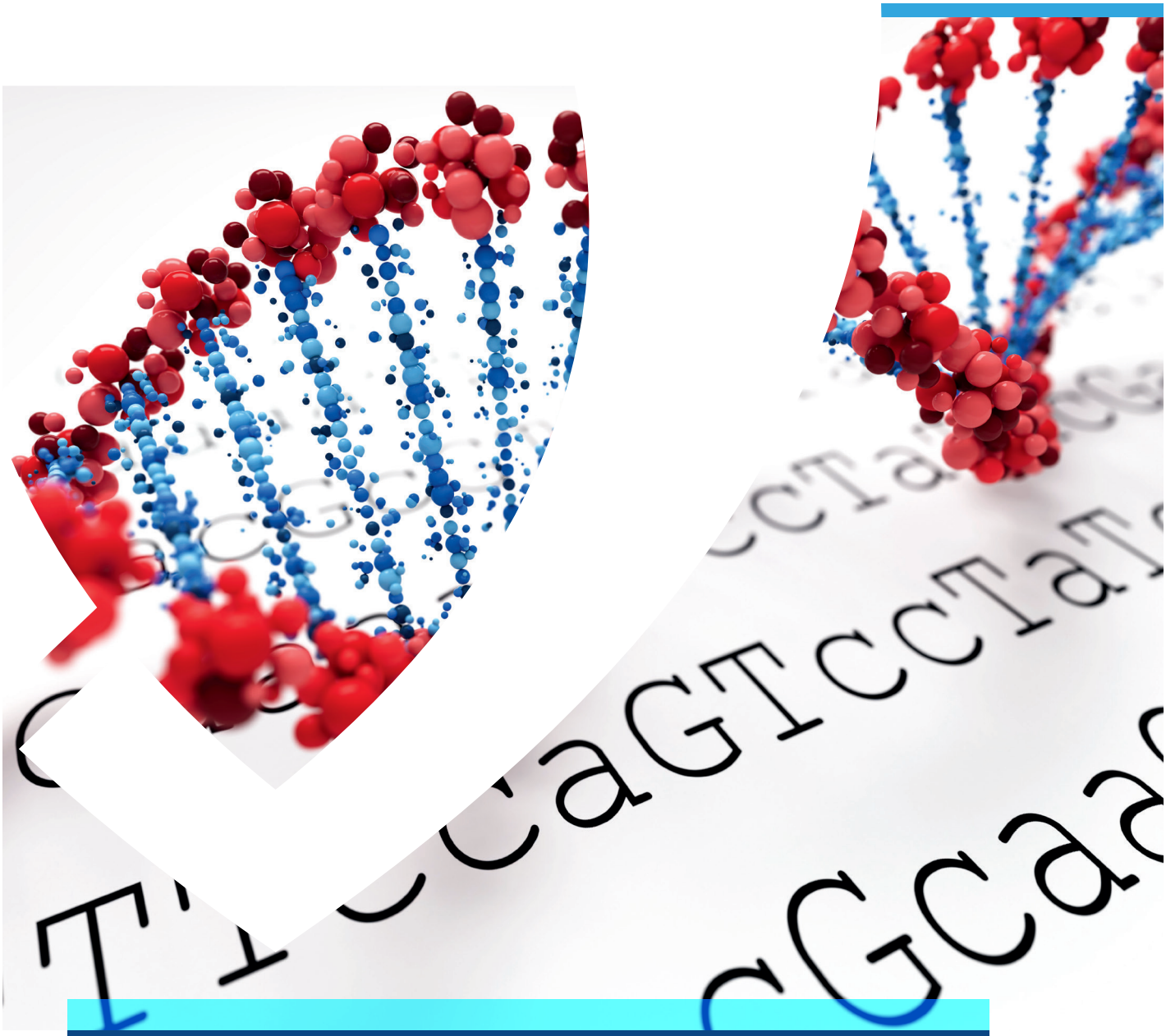

Study Program Handbook

Computational Life Science

Master of Science

Valid for all students starting their studies in fall 2017
Date: 10.07.2017
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1. Program Overview

1.1. Concept

"It is not the goal of Science to tear at the tapestry of the world and pull out the threads to see what colors the threads are. It is the goal of science to see the picture on the tapestry." (Erwin Chargaff 1975)

In recent years, biological research has become increasingly interdisciplinary, focusing heavily on mathematical modeling and on the analysis of system-wide quantitative information. Sophisticated high-throughput techniques pose new challenges for data integration and data interpretation. The Computational Life Science program meets these challenges by covering computational, theoretical and mathematical approaches in biology and the life sciences. Jacobs University has an outstanding expertise in biomedical modeling, systems biology, bioinformatics, computational neuroscience and computational biology. Computational Life Science unites these strengths in a single graduate program.

1.2. Qualification Aims

Studying life sciences from a computational perspective requires interdisciplinary understanding and specialization at the same time. The Computational Life Science program integrates these goals by offering a mixture of theory-oriented lectures, methods courses, computer labs and various forms of guided research projects. In particular, students learn

- to understand that scientific knowledge is constantly evolving;
- to independently obtain and update their knowledge;
- to conduct research in a precise, diligent and reproducible manner;
- to design, understand and critique scientific investigations using mathematical and computational methods;
- to understand the value, challenges and practice of interdisciplinary approaches;
- to develop their personal career perspective.

1.3. Target Audience

The Computational Life Science program is geared towards students who hold a Bachelor's degree in bioinformatics, computer science, life sciences, physics, applied mathematics and related areas.

1.4. Career Options

Students of the Computational Life Science program acquire a wide range of skills in bioinformatics, data analysis, systems biology and biomedical process modeling. They are prepared for a career in biotechnology, biomedicine, medical technology, laboratory diagnostics, and related areas. They usually work in pharmaceutical companies or other areas such as the healthcare or food industry. Graduates of the program are also qualified to move on to a PhD and to a career in academia and research institutions.

1.5. Admission Requirements

In general, applicants need to submit the following documents in order to be considered for admission:

- Letter of motivation
- Curriculum vitae (CV)
- University transcript in English or German
- Bachelor's degree certificate
- Two letters of recommendation
- English language proficiency test with a minimum score of 90 (TOEFL) or 6.5 (IELTS). Alternatively, students may submit a confirmation from their previous university that their education was conducted in English.

Please visit http://www.jacobs-university.de/study/graduate/application-information for more details on the application process.

2. The Curriculum

2.1. The Curriculum at a Glance

The Computational Life Science curriculum is composed of six modules over four semesters (two years). The following table shows an overview of the program structure.

<table>
<tr><td>Semester 4</td><td rowspan="4">CORE 1
Foundations of Computational Life Science
(20 CP)</td><td></td><td rowspan="4">CORE 3
Advanced Topics and Applications
(20 CP)</td><td colspan="2">RESEARCH 2
Master's Thesis (30 CP)</td></tr>
<tr><td>Semester 3</td><td rowspan="3">CORE 2
Electives and Remedial Courses
(15 CP)</td><td rowspan="3">CAREER
Skills and Languages
(15 CP)</td><td rowspan="3">RESEARCH 1
Lab Rotations
(20 CP)</td></tr>
<tr><td>Semester 2</td></tr>
<tr><td>Semester 1</td></tr>
</table>

In order to graduate, students need to obtain 120 ECTS credit points. The ECTS (European Credit Transfer System) is a system defining the student workload required to achieve the objectives of a study program. At Jacobs University, 1 credit point is equivalent to 25 hours of student workload. In each module, students must obtain a minimum amount of credit points (with an average of 30 credit points per semester).

Each module consists of mandatory and/or elective components as outlined below. Please check the course catalogue for detailed course descriptions and current course offerings (see https://campusnet.jacobs-university.de).

2.2. Modules

2.2.1. CORE 1 - Foundations of Computational Life Science

Amount of credit points to be obtained in this module: 20

This module equips all students of Computational Life Science with a common methodological ground and provides an introduction to all topical areas that are represented in the related research groups on campus. The module contains a two-semester lecture series, the central introductory lecture on Systems Biology, as well as a research colloquium.

Course Title	Course No.	Semester	Mandatory	Credits
Introduction to Computational Life Science	550401	1	yes	5
Introduction to Computational Life	550411	2	yes	5

Science: Methods and Applications				
Introduction to Systems Biology	550432	2	yes	2.5
Computational Life Science Colloquium	550402 550404 550414 550424	1 2 3 4	yes (3 of 4)	3 x 2.5 = 7.5

2.2.2. CORE 2 - Electives and Remedial Courses

Amount of credit points to be obtained in this module: 15

The Computational Life Science program attracts students with diverse career goals, backgrounds and prior work experience. This module allows students to make up for missing academic previous knowledge or to strengthen their knowledge in specific areas of Computational Life Science by taking courses from undergraduate or graduate programs at Jacobs University (see list below). Besides the mandatory course, students have to take two out of three mandatory-elective courses, giving 7.5 credit points in total, and one or two further elective courses to cover the remaining 5 credit points. Some examples of elective courses that may be offered are listed in the table below. It is recommended that students focus their studies in CORE 2 and CORE 3 on two of the four specialization areas listed in the appendix (see chapter 4.1.). Should a student intend to take any other courses as electives which are not stated in the table below, this needs to be approved by the program coordinator. Please see CampusNet (see: https://campusnet.jacobs-university.de) for up-to-date course offerings.

Course Title	**Course No.**	**Semester**	**Mandatory**	**Credits**
Introduction to Bioinformatics	JTME-550201	1	yes	2.5
Modelling and Control of Dynamical Systems	340103	1, 3	mandatory -elective	5
Applied Dynamical Systems	CO18-110231	2	mandatory -elective	5
Applied Dynamical Systems Lab	CO18-110233	2	mandatory -elective	2.5
Machine Learning	CO22-320372	2, 4	no	5
Differential Equations I	CAS-100361	2	no	2.5
Differential Equations II [1]	CAS-100472	2	no	2.5
Ribogenetics: Molecular Biology and	CAS-	2	no	2.5

Biotechnology of RNA Molecules	520362			
Molecular Information Pathways	CO03-520224	1, 3	no	5
Immunology	CO02-520322	2	no	5
Statistical Physics	CO13-200212	2	no	5

[1] *Successful completion of the course "Partial Differential Equations I" is a prerequisite for taking the course "Partial Differential Equations II".*

2.2.3. CORE 3 - Advanced Topics, Methods and Applications

Amount of credit points to be obtained in this module: 20

In this module, each student selects elective courses on specific topics of Computational Life Science. It is recommended that students focus their studies in CORE 2 and CORE 3 on two of the four specialization areas listed in the appendix (see chapter 4.1.). Courses that are typically offered within this module are listed in the table below.
Note: Courses with semester numbers in brackets are recommended for the first year of study.

Course Title	**Course No.**	**Semester**	**Mandatory**	**Credits**
Network Approaches in Biology and Medicine[1]	550443	1	no	2.5
Complex Networks – Models and Analysis[1]	550433	3	no	2.5
Theoretical Biology I	550403	1, (3)	no	2.5
Theoretical Biology II[2]	550463	1	no	2.5
Models of Metabolism[1]	530481	1	no	2.5
Models of Gene Regulation[1]	530681	3	no	2.5
Models of Cooperation and Competition[1]	550461	2	no	2.5
Dynamics of Complex Systems and Networks[1]	550451	4	no	2.5
Literature Course RNA Biochemistry[1]	530473	3	no	2.5
Literature Seminar RNA Networks[1]	550452	2	no	2.5
Bioinformatics Applications	550444	2, (4)	no	2.5
Bioinformatics for Next Generation Sequencing[1]	550441	4	no	2.5

Modeling and Analysis of Complex Systems I	550453	1, (3)	no	2.5
Modeling and Analysis of Complex Systems II[3]	550454	1, (3)	no	2.5
Theoretical and Computational Biophysics	550434	2, 4	no	2.5
Advanced Studies in Computational Life Science [4]	550421	Each semester	no	5

[1] *Courses are offered biannually.*
[2] *Successful completion of the course "Theoretical Biology I" is a prerequisite for taking the course "Theoretical Biology II".*
[3] *It is recommended to take the course "Modeling and Analysis of Complex Systems I" before taking the course "Modeling and Analysis of Complex Systems II".*
[4] *The course "Advanced Studies in Computational Life Science" requires (individual or as a project group) registration with a supervisor from a research group and contains seminar elements as well as a small research project.*

2.2.4. CAREER - Skills and Languages

Amount of credit points to be obtained in this module: 15

In this module students acquire skills preparing them for a career in the field of Computational Life Science. Students select language courses and other courses from the "Jacobs Track", a special offer of Jacobs University fostering a broad range of career competencies. The course "Programming in Python" is the only mandatory course within this module. Examples for courses that may be taken from the Jacobs Track are Applied Calculus I+II, Foundations of Linear Algebra I+II, Advanced Programming in Python, German/French/Spanish/Chinese language courses, Econometrics, or Case Study Design. Please see http://language-program.user.jacobs-university.de and https://campusnet.jacobs-university.de for more information and current course offerings.

Course Title	**Course No.**	**Semester**	**Mandatory**	**Credits**
Programming in Python	JTSK-350111	1[1]	yes	2.5
Jacobs Track (various language, methods and skills courses)	depending on courses	1 - 3	elective	12.5 in total

[1] *Alternatively during the Intersession (January).*

2.2.5. RESEARCH 1 - Lab Rotations

Amount of credit points to be obtained in this module: 20

Students take part in two research laboratory rotations between semesters 1 and 3 and, upon agreement, in the surrounding intersession breaks. A lab rotation lasts two months. In each lab rotation, students spend at least two full days per week working in the laboratory of their choice. If applicable, students participate in work group meetings related to their project. The results are communicated in a report and a short oral presentation with discussion in the research group. A detailed schedule for the lab rotations is agreed upon with the respective hosting research group.

Title	Course No.	Semester	Mandatory	Credits
Lab Rotation in Comput. Life Sc. I	550412	1 - 3	yes	10
Lab Rotation in Comput. Life Sc. II	550413	1 - 3	yes	10

2.2.6. RESEARCH 2 - Master's Thesis

Amount of credit points to be obtained in this module: 30

For the Master's thesis, students conduct research in one of the Computational Life Science research groups. Usually, students choose one of the research groups in which they did their lab rotations.

Students have at least one supervisor taking responsibility for progress and mentoring of the thesis, as well as providing guidance on good scientific practice. Supervision can be partially delegated or shared, especially if the thesis is closely associated with an existing project or is part of an interdisciplinary collaboration. In any case, the responsibilities for supervision need to be agreed upon at the start of the thesis.

The Master's thesis is scheduled for the fourth and last semester. Upon agreement with the hosting research group, the thesis may be started earlier than the end of the third semester. It should take six months of full-time workload (including writing the thesis). A detailed schedule is agreed upon with the respective research group.

In the Master's thesis colloquium, students give a comprehensive presentation on their research similar to a contributed talk at a conference. They discuss and defend main results in front of a competent audience, typically the respective research group.

Additional regulations regarding the Master's thesis can be found in § 5.3 of the Policies for Master Studies (http://www.jacobs-university.de/academic-policies).

Title	Course No.	Semester	Mandatory	Credits
Master's Thesis and Colloquium	no number	4	yes	30

3. Computational Life Science Graduate Program Regulations

3.1. Scope of these Regulations

The regulations in this handbook are valid for all students who entered the Computational Life Science graduate program at Jacobs University in fall 2017. In case of conflict between the regulations in this handbook and the general Policies for Master Studies, the latter apply (see http://www.jacobs-university.de/academic-policies).

3.2. Degree

Upon successful completion of the program, students are awarded a Master of Science (MSc) degree in Computational Life Science.

3.3. Graduation Requirements

In order to graduate, students need to obtain 120 credit points. In addition, the following graduation requirements apply:

- In each module, students need to obtain a minimum amount of credit points as indicated in chapter 2 of this handbook.
- Students need to complete all mandatory components of the program as indicated in chapter 2 of this handbook.

Jacobs University Bremen reserves the right to substitute courses by replacements and/or reduce the number of mandatory/mandatory-elective courses offered.

4. Appendix

4.1. Addendum to Specialization Areas

The specialization areas provide a topical clustering of the courses and should guide the student towards a structured course selection that prepares for both the lab rotation areas as well as for the Master's thesis.

In each of the two selected specialization areas it is recommended to obtain at least 5 credit points from courses with central topics (●), and at least 10 credit points from courses marked with (○). The students and their academic advisors may agree on a different course selection if appropriate.

Course Title	**Course No.**	**Credits**	**Semester**	**Specialization Area 1:** Computational Systems Biology, Computational Physics and Biophysics	**Specialization Area 2:** Bioinformatics and RNA Biology, Imaging and Modeling in Medicine	**Specialization Area 3:** Ecological Modeling and Theoretical Biology	**Specialization Area 4:** Applied Mathematics and Numerical Methods
Network Approaches in Biology and Medicine[1]	550443	2.5	1	●	○	○	
Complex Networks – Models and Analysis[1]	550433	2.5	3	●		○	○
Bioinforma-tics Applications	550444	2.5	2, (4)		●		
Theoretical Biology I[2]	550403	2.5	1, (3)	●		●	●
Theoretical Biology II[2]	550463	2.5	1, (3)	●		●	●
Models of Metabolism[1]	530481	2.5	1	○	●		
Models of Gene Regulation[1]	530681	2.5	3	○	●		
Models of Cooperation and Competition[1]	550461	2.5	2	○		●	○
Dynamics of	550451	2.5	4	○		○	●

Complex Systems and Networks[1]							
Literature Course RNA Biochemistry[1]	530473	2.5	3		●		
Literature Seminar RNA Networks[1]	550452	2.5	2		●		
Bioinformatics for Next Generation Sequencing[1]	550441	2.5	4*		●		
Modeling and Analysis of Complex Systems I[3]	550453	2.5	1, (3)	○		●	○
Modeling and Analysis of Complex Systems II[3]	550454	2.5	1, (3)	○		●	○
Theoretical and Computational Biophysics	550434	2.5	2, 4	●			
Advanced Studies in Computational Life Science[5]	550421	5	each semester	○	○	○	○
Introduction to Bioinformatics	JTME-550201	2.5	1		●		
Modelling & Control of Dynamical Systems	340103	5.0	1, 3	○		○	○
Applied Dynamical Systems	CO18-110231	5.0	2	○		○	●
Applied Dynamical Systems Lab	CO18-110233	2.5	2	○		○	●

Partial Differential Equations I[4]	CAS-110472	2.5	2	○		○	●
Partial Differential Equations II[4]	CAS-110473	2.5	2	○		○	●
Machine Learning	CO22-320372	5	2,4	○	○		
Ribogenetics: Molecular Biology and Biotechnology of RNA Molecules	CAS-520360	2.5	2		●		
Molecular Information Pathways	COO3-520224	5	1,3		●		
Immunology	COO2-250322	5	2	○	○		
Statistical Physics	CO13-200212	5	1,3	●			○

[1] Courses are offered biannually.

[2] Successful completion of the course "Theoretical Biology I" is a prerequisite for taking the course "Theoretical Biology II".

[3] It is recommended to take the course "Modeling and Analysis of Complex Systems I" before taking the course "Modeling and Analysis of Complex Systems II".

[4] Successful completion of the course "Partial Differential Equations I" is a prerequisite for taking the course "Partial Differential Equations II".

[5] The course "Advanced Studies in Computational Life Science" requires (individual or as a project group) registration with a supervisor from a research group and contains seminar elements as well as a small research project.