Programme-specific Section of the Curriculum for the MSc Programme in Bioinformatics at the Faculty of Science, University of Copenhagen

2017 (rev. 2020)

Contents

1 Title, affiliation and language

A shared section that applies to all BSc and MSc Programmes at the Faculty of Science is linked to this programme-specific curriculum.

1.1 Title

The MSc Programme in Bioinformatics with a specialisation in Computational Biology leads to a Master of Science (MSc) in Bioinformatics with specialisation in Computational Biology with the Danish title: *Cand.scient. (candidatus/candidata scientiarum) i bioinformatik med specialisering i Computational Biology*.

The MSc Programme in Bioinformatics with a specialisation in Computer Science leads to a Master of Science (MSc) in Bioinformatics with the specialisation in Computer Science with the Danish title: *Cand.scient. (candidatus/candidata scientiarum) i bioinformatik med specialisering i Computer Science*.

1.2 Affiliation

The programme is affiliated with the Study Board for the Biological Area and the students can both elect, and be elected, to this study board.

1.3 Corps of external examiners

The following corps of external examiners is used for the central parts of the MSc Programme:

- Corps of External Examiners for Computer Science (*datalogi*) with possibility of bringing in examiners from Corps of External Examiners for Biology (*biologi).*

1.4 Language

The language of this MSc Programme is English.

2 Academic profile

2.1 Purpose

The MSc Programme in Bioinformatics aims to qualify students to work on an interdisciplinary scientific basis with bioinformatics in both the public and private sectors. The specialisations Computational Biology and Computer Science will focus on biological data analysis and method and algorithm development, respectively.

2.2 General programme profile

The first year the student follow both compulsory courses in bioinformatics and courses that complement their competences from their BSc. Hereby, all students will have competences in both molecular biology (biochemistry and biology) and computer science (mathematics and statistics). In addition, the student follows supplementary courses that prepare them for a specialisation during their thesis thereby creating an individual academic profile.

Bioinformatics is the key subject area of the programme. Bioinformatics uses mathematical, statistical and computational techniques in DNA sequence analysis, protein and RNA structural analysis, genomics and analysis of high-output data to solve biological problems.

2.3 General structure of the programme

The MSc Programme is set at 120 ECTS.

The MSc Programme in Bioinformatics consists of the following elements:

- Specialisation, 120 ECTS, including the thesis.

The student must choose one of the following specialisations:

- Computational Biology
- Computer Science

2.4 Career opportunities

The MSc Programme in Bioinformatics qualifies students to become professionals within business functions and/or areas such as:

- A PhD programme
- Pharmaceutical and biotech companies.
- Hospitals.
- Research institutions, public and private, and in universities.

3 Description of competence profiles

Students following the MSc Programme acquire the knowledge, skills and competences listed below. Students will also acquire other qualifications through elective courses and other study activities.

3.1 Computational Biology

On completion of the programme, an MSc in Bioinformatics with a specialisation in Computational Biology has acquired the following:

Knowledge about:

- The fields of biological sequence analysis, molecular phylogeny, structural bioinformatics, systems biology and the bioinformatics aspects of gene expression and proteomics data.
- A wide range of computer programs used in bioinformatics.
- Relevant aspects of genetics, molecular biology, cell biology, mathematics, statistics, computer science and machine learning.
- Bioinformatics scientific literature and latest research and knowledge within the subject area.
- The industrial and medical applications of the subject's results.
- The use of computer science methods in molecular biology and how the two fields are integrated

Skills in/to:

- Process, interpret and evaluate large biological datasets.
- Identify and extract information about complex biological processes from data and identify computational and statistical issues associated with the analysis of such data.
- Use information technology, including databases, scripting languages and programs, in an efficient and appropriate manner, and develop small programs.
- Apply techniques described in the bioinformatics scientific literature and assess their applicability to a given biological problem
- Understand biological and biomedical experiments and research questions and suggest appropriate bioinformatics and experimental analyzes.
- Communicate knowledge and build bridges in interdisciplinary groups.
- Independently formulate new biological questions, and design computational protocols to systematically address them.

Competences in/to:

- Manage work and development situations that are complex, unpredictable and require new model solutions.

- Independently initiate and implement academic and interdisciplinary partnerships, and assume professional responsibility.
- Taking independent responsibility for their own academic development and specialisation.
- Develop computer programs or scripts for bioinformatics analyses.
- Acquire new computational skills needed for a specific bioinformatics problem.
- Read and understand scientific articles concerning computational methods and machine learning methods.
- Take independent responsibility for their own academic development and specialisation

3.2 Computer Science

On completion of the programme, an MSc in Bioinformatics with a specialisation in Computer Science has acquired the following:

Knowledge about:

- The fields of biological sequence analysis, molecular phylogeny, structural bioinformatics, systems biology and the bioinformatics aspects of gene expression and proteomics data.
- A broad range of standard algorithms used in Bioinformatics, in particular in the analysis of biological sequences.
- Relevant aspects of genetics, molecular biology, cell biology, mathematics, statistics, computer science and machine learning.
- Scientific literature and latest research and knowledge within the subject area of Bioinformatics.
- The algorithmic basis for a wide range of popular bioinformatics methods.
- Relevant techniques in machine learning, algorithms, statistical modelling and large scale data analysis.
- The use of machine learning, algorithms and probabilistic models in bioinformatics
- Algorithms relevant to bioinformatics.
- Machine learning relevant to bioinformatics.
- How molecular biology and computer science are integrated in modern scientific practice.

Skills in/to:

- Process, interpret and evaluate large biological datasets.
- Identify and extract information about complex biological processes from data and identify computational and statistical issues associated with the analysis of such data.
- Use information technology, including databases and programs, in an efficient and appropriate manner, and develop small programs.
- Apply techniques described in the bioinformatics scientific literature and assess their applicability to a given biological problem.
- Independently analyze, implement and improve on bioinformatics methods.
- Scaling of existing methods and software for large amount of data.
- Apply and implement modern machine learning methods to bioinformatics problems.
- Design and implement algorithms and machine learning solutions to problems in bioinformatics.
- Read and understand scientific articles in the field of bioinformatics and molecular biology.

Competences in/to:

- Manage work and development situations that are complex, unpredictable and require new model solutions.
- Independently initiate and implement academic and interdisciplinary partnerships, and assume professional responsibility.
- Take independent responsibility for his/her own academic development and specialisation.
- Develop computer programs or scripts for bioinformatics analyses.
- Communicate and collaborate with biologists and biochemists.
- Search and gain new knowledge on the relevant biology needed to solve a problem in bioinformatics.
- Design new bioinformatical methods, using modern machine learning methods and algorithms were needed, to address biological problems.
- Evaluate the computational complexity of various solutions a problem in bioinformatics.
- Take independent responsibility for their own academic development and specialisation

4 Admission requirements

There is no BSc Programme with reserved access for this programme.

4.1 Applicants with a closely related Bachelor's degree

Applicants with a Bachelor's degree in the following are directly academically qualified for admission to the MSc programme in Bioinformatics:

- Applicants with a Bachelor's degree in Biology, Biology-Biotechnology, Biochemistry, Computer Science, Machine Learning and Data Science, Mathematics, Molecular Biomedicine, Natural Sciences and IT or Physics from the University of Copenhagen.

4.2 Applicants with a Bachelor's degree within the field of science or technical science

Applicants with a Bachelor's degree within the field of science or technical science from the University of Copenhagen or other Danish or international universities may also be admitted if the programme includes the following:

- Courses in molecular biology, genetics and biochemistry corresponding to a minimum of 30 ECTS.

or

- Courses in statistics, computer science, mathematics and physics corresponding to a minimum of 30 ECTS.

4.3 Other applicants

The Faculty may also admit applicants who, after an individual academic assessment, are deemed to possess educational qualifications equivalent to those required in Subclauses 4.1-3.

4.4 Language requirements

Applicants must as a minimum document English language qualifications comparable to a Danish upper secondary school English B level or English proficiency corresponding to the tests and scores required. Accepted tests and required minimum scores are published online at www.science.ku.dk.

4.5 Supplementary subject elements

The qualifications of an applicant to the MSc program are assessed exclusively on the basis of the qualifying bachelor's degree. Supplementary subject elements passed between the completion of the bachelor's program and the admission to the MSc program cannot be included in the overall assessment.

However, subject elements passed before the completion of the bachelor's program may be included in the overall assessment. This includes subject elements completed as continuing education as well as subject elements completed as part of a former higher education program. A maximum of 30 ECTS supplementary subject elements can be included in the overall assessment.

Subject elements passed before completing the BSc programme which are to form part of the MSc programme to which the student has a legal right of admission (§9-courses) cannot be included in the overall assessment.

5 Prioritisation of applicants

If the number of qualified applicants to the programme exceeds the number of places available, applicants will be prioritised as follows:

1) Applicants with a Bachelor's degree in Machine Learning and Data Science from the University of Copenhagen.
2) Applicants with a Bachelor's degree within the field of science or technical science based on grades and courses taken (biology, molecular biology, biochemistry, mathematics, physics and computer science) relevant to bioinformatics. If different grading systems make comparison impossible, applicants will be prioritised on the basis of an individual evaluation by the Admission Committee.
3) Applicants with a Bachelor's degree within the field of science or technical science based on the interdisciplinary nature of their education, i.e. priority will be given to applicants whose Bachelor's degree include courses in biology, molecular biology, biochemistry, mathematics, physics and computer science.
4) Other applicants.

If the number of qualified applicants within a category exceeds the number of places available, applicants will be prioritised according to the following criteria (listed below in prioritised order):

- Number of ECTS taken in courses relevant for bioinformatics.
- Applicants with a Bachelor's degree age of more than 5 years have low priority.

6 Structure of the programme

The compulsory subject elements, restricted elective subjects elements and the thesis constitute the central parts of the programme (Section 21 of the Ministerial Order on Bachelor and Master's Programmes (Candidatus) at Universities).

Before the beginning of the MSc Programme the student must choose a specialisation.

6.1 Computational Biology

The specialisation is set at 120 ECTS and consists of the following:

- Compulsory subject elements, 52.5 ECTS
- Restricted elective subject elements, 22.5 ECTS

- Elective subject elements, 15 ECTS
- Thesis, 30 ECTS

6.1.1 Compulsory subject elements

All of the following subject elements are to be covered (52.5 ECTS)			
• NBIA05008U	Biological Sequence Analysis	Block 1	7.5 ECTS
• NBIB20000U	Python Programming for Data Science	Block 1	7.5 ECTS
• NBIA05014U	Structural Bioinformatics	Block 2	7.5 ECTS
• NMAK14029U	Statistics for Bioinformatics and eScience	Block 2	7.5 ECTS
• NDAK16003U	Introduction to Data Science	Block 3	7.5 ECTS
• NBIA09043U	Population Genetics	Block 3	7.5 ECTS
• NBIA07023U	Bioinformatics of High Throughput Analyses	Block 4	7.5 ECTS

6.1.2 Restricted elective subject elements

22,5 ECTS are to be covered as subject elements from the following list:			
• NBIK10017U	RNA Biology	Block 1	7.5 ECTS
• NDAK14008U	Programming Massively Parallel Hardware	Block 1	7.5 ECTS
• NDAK15014U	Advanced Topics in Machine Learning	Block 1	7.5 ECTS
• NDAK10005U	Medical Image Analysis	Block 1	7.5 ECTS
• NDAA09023U	Advanced Algorithms and Data Structures	Block 1	7.5 ECTS
• NBIK14031U	Molecular Biology for Non-life Scientists	Block 1	7.5 ECTS
• NBIK20004U	Advanced Bioinformatics for Next-Generation Sequencing	Block 1	7.5 ECTS
• NDAK14009U	Parallel Functional Programming	Block 2	7.5 ECTS
• NDAK15007U	Machine Learning	Block 2	7.5 ECTS
• NDAK10009U	Computational Geometry	Block 3	7.5 ECTS
• NDAA09009U	Numerical Optimization	Block 3	7.5 ECTS
• NDAK14007U	Applied Programming	Block 4	7.5 ECTS
• NDAK14005U	Randomized Algorithms	Block 4	7.5 ECTS
• NBIK10005U	Bioinformatics Project 1	Block 1-5	7.5 ECTS
• NBIK10008U	Bioinformatics Project 2	Block 1-5	7.5 ECTS
• NBIK10009U	Bioinformatics Project 3	Block 1-5	7.5 ECTS
• NBIK10010U	Bioinformatics Project 4	Block 1-5	7.5 ECTS
• NBIK10013U	Individual Project in Bioinformatics	Block 1-5	15 ECTS

6.1.3 Elective subject elements

15 ECTS are to be covered as elective subject elements.
All subject elements at MSc level may be included as elective subject elements in the MSc Programme.

BSc subject elements corresponding to 15 ECTS may be included in the MSc Programme.

Projects outside the course scope may be included in the elective section of the programme with up to 15 ECTS. The regulations are described in Appendix 5 to the shared section of the curriculum.

Projects in practice may be included in the elective section of the programme with up to 15 ECTS. The regulations are described in Appendix 4 to the shared section of the curriculum.

Thesis preparation projects may be included in the elective section of the programme with up to 7.5 ECTS. The regulations are described in Appendix 6 to the shared section of the curriculum.

Projects outside the course scope, projects in practice and thesis preparation projects may not exceed 30 ECTS of the programme

6.1.4 Thesis

The MSc Programme in Bioinformatics with a specialisation in Computational Biology includes a thesis corresponding to 30 ECTS, as described in Appendix 2 to the shared curriculum. The thesis must be written within the academic scope of the MSc programme.

6.1.5 Academic mobility

The curriculum makes it possible to follow subject elements outside the Faculty of Science.

The academic mobility for the MSc Programme in Bioinformatics with a specialisation in Computational Biology is placed in block 1+2 of the 2nd year.

Academic mobility requires that the student follows the rules and regulations regarding pre-approval and credit transfer.

In addition the student has the possibility to arrange similar academic mobility in other parts of the programme.

6.2 Computer Science

The specialisation is set at 120 ECTS and consists of the following:

- Compulsory subject elements, 37.5 ECTS
- Restricted elective subject elements, 37.5 ECTS
- Elective subject elements, 15 ECTS
- Thesis, 30 ECTS

6.2.1 Compulsory subject elements

All of the following subject elements are to be covered (37.5 ECTS):			
• NBIA05008U	Biological Sequence Analysis	Block 1	7.5 ECTS
• NBIK14031U	Molecular Biology for Non-life Scientists	Block 1	7.5 ECTS
• NDAA09023U	Advanced Algorithms and Data Structures	Block 1	7.5 ECTS
• NBIA05014U	Structural Bioinformatics	Block 2	7.5 ECTS
• NDAK15007U	Machine Learning	Block 2	7.5 ECTS

6.2.2 Restricted elective subject elements

37.5 ECTS are to be covered as subject elements from the following list:			
• NBIK10017U	RNA Biology	Block 1	7.5 ECTS
• NDAK14008U	Programming Massively Parallel Hardware	Block 1	7.5 ECTS
• NDAK15014U	Advanced Topics in Machine Learning	Block 1	7.5 ECTS
• NDAK10005U	Medical Image Analysis	Block 1	7.5 ECTS
• NDAK14003U	Discrete Optimization	Block 1	7.5 ECTS
• NBIK20004U	Advanced Bioinformatics for Next-Generation Sequencing	Block 1	7.5 ECTS
• NMAK14029U	Statistics for Bioinformatics and eScience (StatBIE)	Block 2	7.5 ECTS
• NDAK14009U	Parallel Functional Programming	Block 2	7.5 ECTS

• NDAK10009U	Computational Geometry	Block 3	7.5 ECTS
• NDAA09009U	Numerical Optimisation	Block 3	7.5 ECTS
• NBIA09043U	Population Genetics	Block 3	7.5 ECTS
• NDAK14007U	Applied Programming	Block 4	7.5 ECTS
• NDAK14005U	Randomized Algorithms	Block 4	7.5 ECTS
• NBIA07023U	Bioinformatics of High Throughput Analyses	Block 4	7.5 ECTS
• NBIK10013U	Individual Project in Bioinformatics	Block 1-5	15 ECTS
• NBIK10005U	Bioinformatics Project 1	Block 1-5	7.5 ECTS
• NBIK10008U	Bioinformatics Project 2	Block 1-5	7.5 ECTS
• NBIK10009U	Bioinformatics Project 3	Block 1-5	7.5 ECTS
• NBIK10010U	Bioinformatics Project 4	Block 1-5	7.5 ECTS

6.2.3 Elective subject elements

15 ECTS are to be covered as elective subject elements.
All subject elements at MSc level may be included as elective subject elements in the MSc Programme.

BSc subject elements corresponding to 15 ECTS may be included in the MSc Programme.

Projects outside the course scope may be included in the elective section of the programme with up to 15 ECTS. The regulations are described in Appendix 5 to the shared section of the curriculum.

Projects in practice may be included in the elective section of the programme with up to 15 ECTS. The regulations are described in Appendix 4 to the shared section of the curriculum.

Thesis preparation projects may be included in the elective section of the programme with up to 7.5 ECTS. The regulations are described in Appendix 6 to the shared section of the curriculum.

Projects outside the course scope, projects in practice and thesis preparation projects may not exceed 45 ECTS of the programme

6.2.4 Thesis

The MSc Programme in Bioinformatics with a specialisation in Computer Science includes a thesis corresponding to 30 ECTS, as described in Appendix 2 to the shared curriculum. The thesis must be written within the academic scope of the MSc programme.

6.2.5 Academic mobility

Academic mobility requires that the student follows the rules and regulations regarding pre-approval and credit transfer.

The academic mobility for the MSc Programme in Bioinformatics with a specialisation in Computer science is placed in block 3+4 of the 1st year. This means that the curriculum makes it possible to follow subject elements outside the Faculty of Science.

In addition the student has the possibility to arrange similar academic mobility in other parts of the programme.

7 Exemptions

In exceptional circumstances, the study board may grant exemptions from the rules in the curriculum specified solely by the Faculty of Science.

8 Commencement etc.

8.1 Validity

This subject specific section of the curriculum applies to all students enrolled on the programme – see however Appendix 2.

8.2 Transfer

Students enrolled on previous curricula may be transferred to the new one as per the applicable transfer regulations or according to an individual credit transfer by the study board.

8.3 Amendment

The curriculum may be amended once a year so that any changes come into effect at the beginning of the academic year. Amendments must be proposed by the study board and approved by the Dean.

Notification about amendments that tighten the admission requirements for the programme will be published online at www.science.ku.dk one year before they come into effect.

If amendments are made to this curriculum, an interim arrangement may be added if necessary to allow students to complete their MSc Programme according to the amended curriculum.

Appendix 1 Tables

Table - MSc Programme in Bioinformatics with a specialisation in Computational Biology

	Block 1	Block 2	Block 3	Block 4
1st year	Python Programming for Data Science	Statistics for Bioinformatics and eScience	Population Genetics	Restricted elective
	Biological Sequence Analysis	Structural Bioinformatics	Introduction to Data Science	Bioinformatics of High Throughput Analyses
2nd year	Restricted elective	Restricted elective	Thesis	
	Elective	Elective		

Compulsory
Restricted elective
Elective

The table illustrates the recommended academic progression. The student is allowed to plan an alternative progression within the applicable rules.

Table - MSc Programme in Bioinformatics with a specialisation in Computer Science

	Block 1	Block 2	Block 3	Block 4
1st year	Molecular Biology for Non-life Scientists	Machine Learning	Restricted elective	Restricted elective
	Biological Sequence Analysis	Structural Bioinformatics	Restricted elective	Restricted elective
2nd year	Advanced Algorithms and Data Structures	Restricted elective	Thesis	
	Elective	Elective		

Compulsory
Restricted elective
Elective

The table illustrates the recommended academic progression. The student is allowed to plan an alternative progression within the applicable rules.

Appendix 2 Interim arrangements

The Shared Section of the BSc and MSc Curricula for Study Programmes applies to all students.

The interim arrangements below only consist of parts where the current curriculum differs from the rules and regulations that were previously valid. Therefore, if information about relevant rules and regulations are missing, it can be found in the curriculum above.

Different competence profiles may apply to students admitted to the programme in different academic years. Competence profiles applicable to previous admissions can be found in Revision History for Competence Profiles at SCIENCE.

1 General changes for students admitted in the academic year 2019/20 or 2018/19

Students admitted to the MSc Programme in the academic year 2019/20 or 2018/19 must finish the programme as listed in the curriculum above with the following exceptions.

1.1 Specialisation in Computational Biology

Structure of the programme

The specialisation is set at 120 ECTS and consists of the following:

- Compulsory subject elements, 52.5 ECTS
- Restricted elective subject elements, 22.5 ECTS
- Elective subject elements, 15 ECTS
- Thesis, 30 ECTS

Table - MSc Programme in Bioinformatics with a specialisation in Computational Biology

	Block 1	Block 2	Block 3	Block 4
1st year	***Linux and Python Programming***	**Statistics for Bioinformatics and eScience**	**Population Genetics**	**Restricted elective**
	Biological Sequence Analysis	**Structural Bioinformatics**	**Introduction to Data Science**	**Bioinformatics of High Throughput Analyses**
2nd year	**Restricted elective**	**Restricted elective**	**Thesis**	
	Elective	**Elective**		

Compulsory | Restricted elective | Elective

The table illustrates the recommended academic progression. The student is allowed to plan an alternative progression within the applicable rules.

Subject elements in italics has been discontinued. See course specific changes below.

Restricted elective subject elements

22.5 ECTS are to be covered as subject elements from the following list:			
• Restricted elective subject elements offered as part of the specialisation in Computational Biology in this curriculum (see above)			
• NBIK15022U	Advanced Topics in Bioinformatics	Discontinued*	7.5 ECTS

1.2 Specialisation in Computer Science

Restricted elective subject elements

37.5 ECTS are to be covered as subject elements from the following list:
• Restricted elective subject elements offered as part of the specialisation in Computer Science in

this curriculum (see above)			
• NBIK15022U	Advanced Topics in Bioinformatics	Discontinued*	7.5 ECTS

* See course specific changes below.

2 General changes for students admitted in the academic year 2017/18

Students admitted to the MSc Programme in the academic year 2017/18 must finish the programme as listed in the curriculum above with the following exceptions.

2.1 Specialisation in Computational Biology

Structure of the programme

The specialisation is set at 120 ECTS and consists of the following:

- Compulsory subject elements, 52.5 ECTS
- Restricted elective subject elements, 22.5 ECTS
- Elective subject elements, 15 ECTS
- Thesis, 30 ECTS

Table - MSc Programme in Bioinformatics with a specialisation in Computational Biology

	Block 1	Block 2	Block 3	Block 4
1st year	***Linux and Python Programming***	**Statistics for Bioinformatics and eScience**	**Population Genetics**	**Restricted elective**
	Biological Sequence Analysis	**Structural Bioinformatics**	**Introduction to Data Science**	**Bioinformatics of High Throughput Analyses**
2nd year	**Restricted elective**	**Restricted elective**	**Thesis**	
	Elective	**Elective**		

Compulsory | Restricted elective | Elective

The table illustrates the recommended academic progression. The student is allowed to plan an alternative progression within the applicable rules.

Subject elements in italics has been discontinued. See course specific changes below.

Restricted elective subject elements

22.5 ECTS are to be covered as subject elements from the following list:			
• Restricted elective subject elements offered as part of the specialisation in Computational Biology in this curriculum (see above)			
• NDAK14003U	Discrete Optimization	Block 1**	7.5 ECTS
• NDAK15017U	Interactive Data Exploration	Discontinued*	7.5 ECTS
• NBIK15022U	Advanced Topics in Bioinformatics	Discontinued*	7.5 ECTS

* See course specific changes below.

**The course is not offered in the academic year 2020/21.

2.2 Specialisation in Computer Science

Restricted elective subject elements

37.5 ECTS are to be covered as subject elements from the following list:			
• Restricted elective subject elements offered as part of the specialisation in Computational Biology in this curriculum (see above)			
• NDAK15017U	Interactive Data Exploration	Discontinued*	7.5 ECTS
• NBIK15022U	Advanced Topics in Bioinformatics	Discontinued*	7.5 ECTS

* See course specific changes below.

3 Course specific changes

Discontinued course	Interim arrangement
Advanced Topics in Bioinformatics (NBIK15022U), 7.5 ECTS	The course was a restricted elective course on “Computer Science” and “Computational Biology” in the academic year 2019/20, 2018/19 and 2017/18. Offered for the last time: 2019/20 The course is identical to Advanced Bioinformatics for Next-Generation Sequencing (NBIK20004U), 7.5 ECTS
Interactive Data Exploration (NDAK15017U), 7.5 ECTS	The course was a restricted elective course on “Computer Science” and “Computational Biology” in the academic year 2017/18. Offered for the last time: 2017/18 Last exam if applicable (cf. SCIENCE's Teaching and exam rules): 2018/19
Linux and Python Programming (NBIK14032U), 7.5 ECTS	The course was compulsory on the specialisation in Computational Biology in the academic year 2019/20, 2018/19 and 2017/18. Offered for the last time: 2019/20 Last exam if applicable (cf. SCIENCE's Teaching and exam rules): 2020/21 In this curriculum Python Programming for Data Science (NBIB20000U), 7.5 ECTS ECTS replaces the course.

Appendix 3 Description of objectives for the thesis

After completing the thesis, the student should have:

Knowledge about:

- Solid interdisciplinary knowledge in the fields of biological sequence analysis, molecular phylogeny, structural bioinformatics, systems biology and the bioinformatics aspects of gene expression and proteomics data.
- Knowledge at the highest international level within an area of specialisation.
- Knowledge of relevant aspects of genetics, molecular biology, cell biology, mathematics, statistics, computer science and machine learning.
- Understanding of bioinformatics scientific literature, and are able to reflect scientifically on knowledge within the subject area and identify scientific problems.
- Familiarity with the industrial and medical applications of the subject's results.

Skills in/to:

- Process, interpret and evaluate large biological datasets.
- Identify and extract information about complex biological processes as well as computer science and statistical issues.
- Use information technology, including databases and programs, in an efficient and appropriate manner, and develop small programs.
- Evaluate and apply techniques described in bioinformatics scientific literature.
- Communicate knowledge and build bridges in interdisciplinary groups.

Competences in/to:

- Manage work and development situations that are complex, unpredictable and require new model solutions.
- Independently initiate and implement academic and interdisciplinary partnerships, and assume professional responsibility.
- Taking independent responsibility for their own academic development and specialisation.