MASTER'S DEGREE PROGRAMME IN BIOINFORMATICS

Program description

The Master's Programme in Bioinformatics is a new programme offering interdisciplinary knowledge of bioinformatics. Education is given in English, and the students of this programme learn to work together with associates from different countries and scientific backgrounds. Applicable fields of prior studies are biosciences and information technology, or other relevant fields where sufficient knowledge of information technology and/or biosciences is achieved for studying in the Master's Degree Programme in Bioinformatics. The Master of Science (MSc) degree gives eligibility for scientific postgraduate studies. Information about entrance qualification can be found from web-page http://bioinformatics.utu.fi

Participating units

This is a jointly run programme between the University of Turku and the University of Tampere offering interdisciplinary education in bioinformatics. Our mission is to train "bilingual" experts, in terms of combined knowledge of information technology and biosciences. Courses are jointly managed by the Institute of Medical Technology at the University of Tampere and the Department of Information Technology at the University of Turku.

General program structure

The MSc degree is attained in two years. All students are introduced to multidisiplinary field of bioinformatics. The studies encompass different aspects of bioinformatics, computer science, information technology, and biosciences, such as biochemistry, genetics, and molecular biology. The 120 ECTS credit curriculum consists of major subject studies (40 ECTS), other studies (40 ECTS), and a Master's Thesis (40 ECTS).

Major subject studies and other studies are arranged as courses typically 3-5 ECTS credits. A student attending to a course is expected to participate in classroom work such as lectures and exercises, work on group assignments or individual projects, present a seminar paper, or take an exam, depending on the course. Studies are based on multi-modal teaching (*monimuoto-opetus* in Finnish) and partially on distance learning. The study methods vary from course to course and are subject to change. The student is expected to take a majority of the courses in the first year, while the Master's Thesis is a personal scientific research project comprising the core of the second year studies.

In the Finnish system, all courses are currently measured in ECTS credits, *opintopiste* (op) in Finnish. One credit refers to an input of approximately 27 hours of work for the attainment of set objectives for a course. Notice that previously, courses were measured in study weeks (approximately 40 hours of work), *opintoviikko* (ov) in Finnish.

General Requirements for the Master's Degree Programme in Bioinformatics (120 ECTS)

A. Major subject studies (40 ECTS)

The core of obligatory studies consists of advanced-level courses in bioinformatics.

B. Other studies (40 ECTS)

1. *Language studies* 0-8 ECTS
2. *Compulsory minor subject studies* 12 ECTS
3. *Optional studies* in the major or minor subjects 20-28 ECTS

C. Master's thesis (40 ECTS)

The Master's Thesis (pro gradu) consists of a theoretical part based on scientific literature, an experimental or practical part (Master's project), and participation in the Seminar.

Note: There are some differences in requirements between the University of Turku and the University of Tampere. Especially local studies such as language studies, orientation courses, and optional courses may differ between universities.

Personal Study Plan

A personal study plan (*henkilökohtainen opintosuunnitelma, HOPS*, in Finnish) will be prepared for every student in order to determine the exact content of his/her studies depending on the previous education and experience.

Structure of the studies

A. MAJOR SUBJECT STUDIES (40 ECTS)

BIOI2080	Introduction to Bioinformatics	4 ECTS
BIOI4250	Introduction to Statistical Bioinformatics	4 ECTS
BIOI4260	Biological Data Analysis Project	4 ECTS
BIOI4270	Bioinformatics, Programming Course	4 ECTS
BIOI4210	Bioinformatics in Functional Genomics	4 ECTS
BIOI4240	Structural Bioinformatics	4 ECTS
BIOI4280	Algorithms in Bioinformatics	4 ECTS
BIOI4290	Tools for Intelligent Data Analysis	4 ECTS
BIOI4220	Systems biology I	4 ECTS
BIOI4230	Phylogenetics	4 ECTS

B. 1. LANGUAGE STUDIES (0-8 ECTS)

All foreign students have to pass Finnish language courses worth at least 5 ECTS. Courses are arranged by the Language Centre at the University of Turku (see the Language Centre study guide, or web-site http://kielikeskus.utu.fi/).

KIFF0003	Finnish for Foreigners	5 ECTS
KIEN2022	Basic Academic Writing Skills in English	3 ECTS

B. 2. COMPULSORY MINOR SUBJECT STUDIES (12 ECTS)

These studies are meant for all students and specified in the student's personal study plan. These introductory courses will complement the student's previos knowledge in the field.

BIOI2210	Introduction to Molecular Biology	3 ECTS
BIOI2230	Introduction to Genetics	3 ECTS
BIOI2220	Introduction to Biochemistry	3 ECTS
BIOI2240	Introduction to Statistical Inference	3 ECTS
BIOI2250	Introduction to Programming	4 ECTS
BIOI2260	Introduction to Computer Science	5 ECTS

B. 3. OPTIONAL STUDIES (20-28 ECTS)
Depending on the student's interests, the optional studies are negotiated when preparing the personal study plan for the student in the second study year. The courses may be arranged jointly between Turku and Tampere or locally. See, e.g. for this Study guide (*opinto-opas* in Finnish) for applicable courses.

C. MASTER'S THESIS (40 ECTS)
The Master's Thesis (pro gradu) consists of a theoretical part based on scientific literature, an experimental or practical part (Master's project), and participation in the Seminar.

SUPPLEMENTARY STUDIES (0-60 ECTS)
In addition to general requirements for the Master's Degree Programme, supplementary studies are required for students whose earlier studies (e.g. polytechnic degree) do not fulfill the prerequisites for advanced studies in Bioinformatics. These studies, when appropriate, are negotiated when preparing the personal study plan for the student.

Course descriptions

The compulsory courses are listed below.

BIOI4280 **Algorithms in Bioinformatics** 4 op / 3 ov (Turku)
Aims and content: The aim of this course is to provide deeper knowledge on algorithms used in bioinformatics. Especially we will focus on algorithms behind the methods introduced in the course Introduction to Bioinformatics. Such algorithms are for instance local and global alignment, sequence assembly, multiple alignment methods, algorithms in phylogeny.
Study methods: Lectures, exercises, exam.
Evaluation: 1-5
Literature: -
Preceding studies: -
Recommended study year: 1. year in Master's Degree Programme
Period: Autumn 2006
Person in charge: Pentti Riikonen

KIEN2022 **Basic Academic Writing Skills** 3 op (Turku)
Aims and content: Introduction to REFWORKS (http://www.refworks.com/tutorial/) 1op + KIEN 2022 Basic Academic Writing 2 op. In this course students will practice the basic skills needed to write academically in English and at the same time review the basics of English grammar. The course is suitable for those writing at Master's level. There are two parallel courses designed to take account of the high demand places on this course have had. Much of the course is internet-based. Course requirements: For credit, min. 80% attendance and active participation. All students will be required to write an essay during the course on a subject of interest in their own field.
Study methods: Active participation (80 % attendance), essay.
Evaluation: Pass/Fail
Literature: Related course materials are available on the Internet at http://users.utu.fi/micnel/
Preceding studies: -
Recommended study year: 1. year in Master's Degree Programme
Period: Autumns 2006
Person in charge: Language center (kielikeskus), Mike Nelson

BIOI4210 **Bioinformatics in Functional Genomics** 4 op / 2 ov (Tampere)
Aims and content: The subject of this course, functional genomics, can be defined as development and application of global (genome-wide or system-wide) experimental approaches to assess gene function. Such experimental approaches include DNA microarrays, for the global study of RNA levels, or proteomics, for studying proteins on a large scale. In addition, genome analysis and annotation, and analysis of gene variations are included. Main focus is in bioinformatic methods, but course provides some material to cover the experimental background, too.
Study methods: Lectures (6h) and independent work (at least 80h) in the Internet course. Main focus is in keeping a private learning diary in the Internet.
Evaluation: pass/fail
Literature: Course material in the Internet. Suggested readings: Bioinformatics and Functional Genomics, Jonathan Pevsner.
Preceding studies: Introduction to Bioinformatics
Recommended study year: 1. year in Master's Degree Programme
Period: Spring 2007
Person in charge: assistant professors Bairong Shen and Martti Tolvanen

BIOI4270 **Bioinformatics, Programming Course** 4 op / 3 ov (Turku)
Aims and content: In this course students will learn to program applications, which are utilizing present sequence and structure databases and bioinformatics applications. Perl and Python programming languages, and the Bioperl and Biopython programming packages will be discussed. The bioinformatics resources used include GenBank, EMBL, UniProt, dbSNP and complete genome databases.
Study methods: Lectures, exercises, programming project, exam.
Evaluation: 1-5
Literature: -
Preceding studies: -
Recommended study year: 1. year in Master's Degree Programme
Period: Spring 2007
Person in charge: Pentti Riikonen

BIOI4260 **Biological Data Analysis Project** 4 op / 2 ov (Turku)
Aims and content: Project work, which targets to solve a real, alltough a small, research problem, and for which the data comes from researcher of bioinformatics or biology. Exercising interaction skills with researchers from different scientific tradition.
Study methods: Groupwork, research report.
Evaluation: Pass/Fail
Literature: -
Preceding studies: -
Recommended study year: 1. year in Master's Degree Programme
Period: Autumn 2006 - Spring 2007
Person in charge: Pentti Riikonen

KIFF0003 **Finnish for Foreigners: Intensive Beginners' Course 5 op** 5 op (Turku)
Aims and content: This course is intended for degree students of the University of Turku. If there is room, exchange students and postgraduate students can also be admitted. Active participation and a motivation for intensive study are required when attending the course. In addition to attending the classes, participants must be prepared to study independently. The course is integrated in nature and covers all the different areas of linguistic skills. In addition to pronunciation and grammar, the course offers tuition in speaking, written work, and listening and reading comprehension.
Study methods: Active participation (80 % attendance), intermediary and final exam.
Evaluation: Pass/Fail
Literature: Textbook Hyvin menee! and vocabulary

Preceding studies: -
Recommended study year: 1. year in Master's Degree Programme
Period: Autumn 2006
Person in charge: Language center (kielikeskus), Pirkko Hölttä

BIOI2220 **Introduction to Biochemistry** 3 op / 1,5 ov (Tampere)
Aims and content: Revision of chemical concepts; Elementary cell biology; Introduction to proteins and other biomolecules; Concepts of metabolism; Biological membranes, transport and signal transduction; Biochemical experimental methods.
Study methods: Lectures (20h); assignments and/or essays; final examination of selected parts of the books below.
Evaluation: 1-5
Literature: Nelson and Cox (2004) Lehninger Principles of Biochemistry, Fourth Edition, chapters 1 to 13 OR Berg, Tymoczko & Stryer (2002) Biochemistry, W.H. Freeman, chapters 1 to 15
Preceding studies: Elementary knowlegde of chemistry
Recommended study year: 1. year in Master's Degree Programme
Period: Autumn 2006
Person in charge: assistant professor Martti Tolvanen

BIOI2080 **Introduction to Bioinformatics** 4 op / 2 ov (Tampere)
Aims and content: A profound introduction to the key areas of bioinformatics: bioinformatic databases; genomics; DNA and protein sequence analysis; use of protein structure data; theory and practice of the most common computational tools used in bioinformatics. This course teaches the use of the current methods and the interpretation of their results. (Same course as Turku-TKO5106 and Tampere-BIKE2080 (3 ECTS), but supplemented with an additional molecular graphics project.)
Study methods: Lectures (6h) and work in the Internet course, including assignments and an independent project. An acceptable written project report and completing all assignments that are required for passing the course.
Evaluation: pass/fail
Literature: Course material in the Internet
Preceding studies: Introduction to biochemistry and Introduction to molecular biology or similar knowledge.
Recommended study year: 1. year in Master's Degree Programme
Period: Autumn 2006/Spring 2007
Person in charge: assistant professors Bairong Shen and Martti Tolvanen

BIOI2260 **Introduction to Computer Science** 5 op / 3 ov (Turku)
Aims and content: Course provides a picture of the dynamic nature of computer science by presenting the most up-to-date research and trends. It engages students with timely topics like bioinformatics and artificial intelligence (AI), and provides coverage of topics like data representation/storage, machine architecture, and machine language.
Study methods: Lectures, exercises, exam.
Evaluation: 1-5
Literature: -
Preceding studies: -
Recommended study year: 1. year in Master's Degree Programme
Period: Autumn 2006
Person in charge: Filip Ginter

BIOI2230 **Introduction to Genetics** 3 op / 1,5 ov (Tampere)
Aims and content: Basics of classical genetics, cytogenetics, population genetics and medical genetics. Introduces concepts and machinery of heritability and evolution and experimental methods of genetics.

Study methods: Lectures (20h); assignments and/or essays; final examination of selected parts of the books below.
Evaluation: 1-5
Literature: Lewin, B (2004) Genes VIII, Prentice Hall; Klug-Cummings (2005) Concepts of Genetics (8th edition) Prentice Hall.
Preceding studies: -
Recommended study year: 1. year in Master's Degree Programme
Period: Autumn 2006
Person in charge: assistant professor Martti Tolvanen

BIOI2210 **Introduction to Molecular Biology** 3 op / 1,5 ov (Tampere)
Aims and content: Basics of nucleic acid biochemistry; Molecular genetics; Introduction to basic experimental methods in molecular biology.
Study methods: Lectures (20h); assignments and/or essays; final examination of selected parts of the books below.
Evaluation: 1-5
Literature: Nelson and Cox (2004) Lehninger Principles of Biochemistry, Fourth Edition; and Lewin, B (2004) Genes VIII, Prentice Hall
Preceding studies: -
Recommended study year: 1. year in Master's Degree Programme
Period: Autumn 2006
Person in charge: assistant professor Martti Tolvanen

BIOI2250 **Introduction to Programming** 4 op / 2 ov (Turku)
Aims and content: Course aims to provide skills in programming concepts and constructs and to learn to make simple applications with Python programming language. These programming concepts are for instance variables, values, types, expressions, controll structures, data structures, modularity and class.
Study methods: Lectures, exercises, exam.
Evaluation: 1-5
Literature: -
Preceding studies: -
Recommended study year: 1. year in Master's Degree Programme
Period: Autumn 2006
Person in charge: Filip Ginter

BIOI4250 **Introduction to Statistical Bioinformatics** 4 op / 2 ov (Turku)
Aims and content: Students will learn how to use statistical inference to solve problems with biological sequences. This course orientates to statistical models like for example Markov chains and hidden Markov models and their applications to biological sequence analysis. The use of statistical inference is demonstrated with real data sets. Both classical and Bayesian methods are applied to our example cases.
Study methods: Lectures, exercises, exam.
Evaluation: 1-5
Literature:
Preceding studies: -
Recommended study year: 1. year in Master's Degree Programme
Period: Spring 2007
Person in charge: Esa Uusipaikka

BIOI2240 **Introduction to Statistical Inference** 3 op / 2 ov (Turku)
Aims and content: Methods of statistical inference are used to find out informative conclusions from data which contains noise and random components. Also it is possible to estimate confidence of these conclusions. For a start we have a real data set and statistical model of it. With

the data set and model it is possible to construct likelihood function, which is used to test the research hypothesis.
Study methods: Lectures, exercises, exam.
Evaluation: 1-5
Literature: -
Preceding studies: -
Recommended study year: 1. year in Master's Degree Programme
Period: Autumn 2006
Person in charge: Esa Uusipaikka

BIOI4031 **Master's Thesis** 40 op / 20 ov (Turku)
Aims and content: The Master's Thesis (pro gradu) consists of participation in the seminar, an experimental or practical part (Master's project), and a theoretical part based on scientific literature. The student also has to pass a maturity examination, related to the thesis work. The Master's thesis seminar helps student to start thesis research and writing work. The student must prove his/her ability to do scientific work, management of research methods, knowledge of the research field, and skill of scientific writing. The goal is to train the student to solve demanding problems of bioinformatics research. Another goal is to increase the student's knowledge about the topic handled in the thesis and lay a basis for continued studies. The thesis is evaluated by the supervisor and another teacher. The final acceptance is decided by the department council. A special grade is given, based on the evaluation.
Study methods: Personal work, Master's thesis, seminar, and maturity examination.
Evaluation: Special grade: approbatur, lubenter approbatur, non sine laude approbatur, cum laude approbatur, magna cum laude approbatur, eximia cum laude approbatur or laudatur.
Literature: -
Preceding studies: -
Recommended study year: 2. year in Master's Degree Programme
Period: -
Person in charge: Professors

BIOI4230 **Phylogenetics** 4 op / 2 ov (Tampere)
Aims and content: Phylogenetics is the taxonomical classification of organisms based on how closely they are related in terms of evolutionary differences. The course covers the following: I Theories of Molecular Evolution, II Reconstruction of Phylogenies, Distance methods; Maximize likelihood methods; Parsimony methods; Bayesian methods, III Computer-based practice (PAUP).
Study methods: Lectures and software tutorials.
Evaluation: 1-5
Literature: The Phylogenetic Handbook: A Practical Approach to DNA and Protein Phylogeny, Edited by Marco Salemi
Preceding studies: -
Recommended study year: 1. year in Master's Degree Programme
Period: Spring 2007
Person in charge: assistant professor Bairong Shen

BIOI4240 **Structural Bioinformatics** 4 op / 2 ov (Tampere)
Aims and content: This course is intended to give a solid background in structure-related bioinformatics, including a theoretical background in protein modeling. The course is an obligatory requirement for entering our practical web course on Protein modelling, but serves as an independent theoretical course, too, for those who want to be thoroughly acquainted with macromolecular structural analyses. Topics: Methods of structure determination; Molecular visualization; Analysis of structures; Structural databanks; Classification databanks.
Study methods: Lectures (6h) and independent work (at least 80h) in the Internet course. Main focus is in keeping a private learning diary in the Internet.

Evaluation: pass/fail
Literature: Course material in the Internet
Preceding studies: Introduction to Bioinformatics (TRE-BINF2080) and fair knowledge of protein biochemistry. Suggested reading: Structural Bioinformatics, (2002) ISBN 0-471-20199-5, Philip E. Bourne, Helge Weissig (edit.)
Recommended study year: 1. year in Master's Degree Programme
Period: Spring 2007
Person in charge: assistant professors Bairong Shen and Martti Tolvanen

BIOI4220 **Systems biology I** 4 op / 2 ov (Tampere)
Aims and content: Systems biology is an academic field that seeks to integrate biological data as an attempt to understand how biological systems function. By studying the relationships and interactions between various parts of a biological system (e.g. organelles, cells, physiological systems, organisms etc.) it is hoped that an understandable model of the whole system can be developed.
We will study systems biology at three levels, 1) to learn basic concepts, theories, and applications by lectures; 2) to extend our knowledge of systems biology by Journal club 3) to make the knowledge helpful to student's future work by practical projects.
Study methods: Lectures, tutorials, special projects (students).
Evaluation: 1-5
Literature: Suggested reading:
I Computational Cell Biology; Springer-Verlag, 2002; ISBN 0-387-95369-8
II Systems Biology - Definitions and Perspectives; Alberghina, Lilia; Westerhoff, H.V. (eds.)
Preceding studies: -
Recommended study year: 1. year in Master's Degree Programme
Period: Spring 2007
Person in charge: assistant professor Bairong Shen

BIOI4290 **Tools for Intelligent Data Analysis** 4 op / 2 ov (Turku)
Aims and content: The course aims at delivering an intuitive understanding of the fundamentals and thus the power and limitations of various common algorithmic and AI methods used in data analysis in many fields of research, including but not restricted to bio and medical informatics. Different data analysis methods and applications are included.
Study methods: Web seminar, exercises, exam.
Evaluation: 1-5
Literature: Course material in the Internet
Preceding studies: -
Recommended study year: 1. year in Master's Degree Programme
Period: Spring 2007
Person in charge: Pentti Riikonen