MASTER'S DEGREE PROGRAMME IN BIOINFORMATICS

PROGRAMME DESCRIPTION

The Master's Degree Programme in Bioinformatics offers 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. More information about the programme can be found from the programme webpage http://bioinformatics.fi.

Participating units

This programme offers interdisciplinary education in bioinformatics and is run jointly by the University of Turku and the University of Tampere. Our mission is to train "bilingual" experts, in terms of combined knowledge of information technology and biosciences. Courses are jointly managed by the Department of Information Technology at the University of Turku and the Institute of Medical Technology at the University of Tampere. Each student takes the courses in the university in which she/he is enrolled, and trips to the other university take place only occasionally for special events or meetings.

General programme structure

The degree is normally attained in two years. All students are introduced to the multidisciplinary field of bioinformatics. The studies encompass different aspects of bioinformatics, computer science, information technology, statistics, mathematics, 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 to 5 ECTS credits each. A student attending to a course is expected to participate in classroom work such as lectures and exercises, work on group assignments, web exercises, or individual projects, present a seminar paper, or take an exam, depending on the course. The courses combine different modes of teaching, including 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 the objectives set for a course.

Note: There are some differences in the 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.

Nordic Master School in Innovative ICT

At the University of Turku, Master's Degree Programme in Bioinformatics is part of Nordic Master School in Innovative ICT. NMS iICT is one of the pilot projects awarded by the Nordic Council of Ministers and based on joint development of existing Master Programmes (120 ECTS) at the partner universities, which are Åbo Akademi University, University of Turku, Turku School of Economics, The Royal Institute of Technology (Sweden) and Technical University of Denmark (Denmark). NMS iICT focuses on combining world-leading Nordic ICT -related education with basic skills and tools in innovation and entrepreneurship.

The Bioinformatics student at the University of Turku can decide her-/himself whether or not she/he wants to participate in Nordic Master School. In order to become a NMS student, Innovation and Entrepreneurship -module is an obligatory part of studies. The module is designed especially for students with technical background, taking into consideration their specific needs and interest for I&E studies. These studies are part of optional studies and form a minor subject (25 ECTS). Innovation and Entrepreneurship –module is described at the end of this section. In addition to I&E studies, the student can choose to carry out further studies in one of the partner universities. Every university offers Core Competence -modules (30 ECTS), which are based on their special field of know-how. The student can choose one of these Core Competence –modules according to her/his personal study plan. Mobility is not a compulsory part of studies.

Initial tests

Every student must participate in the initial tests consisting of basic questions about biosciences, mathematics and computer science. The results of the initial tests and previous studies of the student determine the courses to be chosen from the group B.2. below. If a student does not pass the mathematical part of the initial tests, she/he must take the course Supplementary Math and CS Foundations (see Course descriptions).

Personal study plan

Every student prepares with the staff a personal study plan (PSP) (*henkilökohtainen opintosuunnitelma*, HOPS, in Finnish), in order to determine the exact content of her/his studies, depending on previous education and experience and goals. If the applicant has a degree in which the relevant studies in applicable fields are insufficient, the university may require that the student performs additional studies (supplementary studies, max. 60 credits) in addition to Master's degree studies. The supplementary studies will be stated in the PSP.

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

A. MAJOR SUBJECT STUDIES (40 ECTS)

1. Core courses in bioinformatics
2. Other recommended courses

B. OTHER STUDIES (40 ECTS)

1. Language studies 0-8 ECTS
2. Compulsory minor subject studies 0-15 ECTS
3. Optional studies in the major or minor subjects 17-40 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.

STRUCTURE OF THE STUDIES

A. MAJOR SUBJECT STUDIES (40 ECTS)

Major subject studies contain courses from the groups A.1. and A.2. depending on the previous studies of the student. In most cases students must take all the courses from the group A.1. The courses must be approved by the staff and will be defined in the PSP of each student.

A.1. Core courses in bioinformatics

BIOI2080	Introduction to Bioinformatics	4 ECTS
BIOI4200	Expression Data Analysis	4 ECTS
BIOI4210	Bioinformatics in Functional Genomics	4 ECTS
BIOI4220	Systems Biology I	4 ECTS
BIOI4230	Phylogenetics	4 ECTS
BIOI4240	Structural Bioinformatics	4 ECTS
BIOI4260	Biological Data Analysis Project	4 ECTS
BIOI4270	Bioinformatics, Programming Course	4 ECTS
BIOI4280	Algorithms in Bioinformatics	4 ECTS
BIOI4290	Tools for Intelligent Data Analysis	4 ECTS

A.2. Other recommended courses

BIOI4250	Introduction to Statistical Bioinformatics	4 ECTS
BIOI4300	Systems Biology II	4 ECTS
BIOI4320	Advanced Math and CS for Bioinformatics	3 ECTS
BIOI4330	Biological Database Systems	5 ECTS
BIOI4340	Text Mining in the Biomedical Domain	3 ECTS
BIOI4350	Protein Modelling	4 ECTS
BIOI4380	Bioinformatics Project	1-6 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 website 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 (0-15 ECTS)

Every student needs elementary knowledge of the fields below. Each student must take all the courses of the topics not covered in her/his previous studies, or not passed in the initial tests. These courses will be defined in the PSP of each student.

BIOI2210	Introduction to Molecular Biology	3 ECTS
BIOI2220	Introduction to Biochemistry	3 ECTS
BIOI2230	Introduction to Genetics	3 ECTS
BIOI2240	Introduction to Statistical Inference	3 ECTS
BIOI2250	Introduction to Programming	6 ECTS
BIOI2260	Introduction to Computer Science	3 ECTS
BIOI2290	Math and CS for Bioinformatics	3 ECTS

B.3. OPTIONAL STUDIES (17-40 ECTS)

Several optional courses are arranged jointly between Turku and Tampere, and many more are available locally. Bioinformatics courses from the group A are highly recommended as optional studies, but the students may also choose to build up knowledge of methodological sciences (IT, CS, math etc.) or biological sciences. The students may take some optional courses during the first study year, but most of them will be studied during the second year of master's studies. Students are advised to make a preliminary plan of optional studies in the first PSP and decide the details when updating the PSP for the second year.

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.

COURSE DESCRIPTIONS

Note that the latest information is always available at http://bioinformatics.fi

Name: Advanced Math and CS for Bioinformatics
Course Unit Code: BIOI4320
Subject: Bioinformatics
Credits: 3 ECTS
Objectives: Ability to form mathematical modelling using differential equations, explain the models and analyse them qualitatively. Capability to analyse different kinds of functions and specify their type. Ability to derive solution formulas for series of constants and solve this kind of series. Mastering basic numerical methods for interpolation, extrapolation and integration. Ability to formulate linear programming tasks and solve then using graphical methods. Capability to utilize mathematical software for solving and visualizing mathematical problems.
Content: Advanced math and CS methods with applications to bioinformatics: mathematical modelling using differential equations, qualitative methods for ordinary differential equations, basics of analytical geometry, solving series of constants, numerical methods for interpolation, extrapolation and integration, linear programming, mathematical software.
Modes of Study: Lectures (14h), exercises (10h), participation in classroom work, written exam.
Evaluation: 1-5
Organization Responsible: Turku IT
Person in Charge: Hanna Suominen
Previous Studies: Math and CS for Bioinformatics or equivalent.
Recommended Year of Study: 1. year, period 3.
Study Materials: Lecture notes.

Name: Algorithms in Bioinformatics
Course Unit Code: BIOI4280
Subject: Bioinformatics
Credits: 4 ECTS
Objectives: The aim of this course is to provide deeper knowledge on algorithms used in bioinformatics. Students should know how most used methods and algorithms work, like pairwise and multiple alignment, BLAST, FASTA, scoring systems, PGMA clustering, sequencing, PCR, DNA fingerprinting.
Content: 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 phylogenetics.
Teaching Methods: Lectures, independent work.
Modes of Study: Lectures, exercises, written exam.

Evaluation: 1-5
Organization Responsible: Turku IT
Person in Charge: Pentti Riikonen
Previous Studies: Introduction to Bioinformatics (BIOI2080 or BIKE2080).
Recommended Year of Study: 1. year, period 2.
Study Materials: Literature and lecture slides.

Name: Basic Academic Writing Skills
Course Unit Code: KIEN2022
Subject: Language studies/English
Credits: 3 ECTS
Objectives: To practice the basic skills needed to write academically in English and at the same time review the basics of English grammar.
Content: Introduction to REFWORKS (http://www.refworks.com/tutorial/) 1 ECTS + KIEN2022 Basic Academic Writing 2 ECTS. All students will be required to write an essay during the course on a subject of interest in their own field.
Teaching Methods: Individual, pair and group work done both in the classroom and using the Internet.
Modes of Study: Active participation in classroom work (80% attendance), essay.
Evaluation: pass/Fail
Organization Responsible: Turku Language Centre (Kielikeskus).
Person in Charge: Mike Nelson
Previous Studies: -
Recommended Year of Study: 1. year, periods 1-2.
Study Materials: http://users.utu.fi/micnel/basicacademic.htm

Name: Bioinformatics in Functional Genomics
Course Unit Code: BIOI4210
Subject: Bioinformatics
Credits: 4 ECTS
Objectives: Getting familiar with functional genomics, i.e. application of global (genome-wide or system-wide) experimental approaches to assess gene and protein functions and interactions. Knowledge of analysis methods of functional genomics data and skills to perform simple analyses.
Content: Genome-wide sequence data (genomics), and their annotation, genome browsers; gene and genome variations; DNA microarrays; proteomics. The main focus is in bioinformatic methods, but the course provides some material to cover the experimental background, too.
Modes of Study: Independent work (at least 80h) on the Internet course, guided by on-line tutoring and live tutoring sessions. Your work and learning must be documented in a learning diary (within the course tools).
Evaluation: pass/fail
Organization Responsible: Tampere IMT
Persons in Charge: Martti Tolvanen
Previous Studies: Introduction to Bioinformatics (BIOI2080).
Recommended Year of Study: 1. year. Continuous registration during terms at http://bioinf.uta.fi/courses/. The course is open for self-study during holidays, too.
Study Materials: Course material on the Internet; selected scientific journal articles.
Suggested reading: Bioinformatics and Functional Genomics (2003) ISBN: 978-0-471-21004-7, Jona-than Pevsner, Wiley.

Name: Bioinformatics, Programming Course
Course Unit Code: BIOI4270
Subject: Bioinformatics
Credits: 4 ECTS
Objectives: Students will be able to interpret, develop, apply and update small programs used to solve variety of bioinformatics problems.

Content: Perl and Python programming languages, the Bioperl, Biopython and similar programming packages will be discussed. The bioinformatics resources used include GenBank, EMBL, UniProt, and complete genome databases.
Teaching Methods: Lectures, independent work.
Modes of Study: Lectures, exercises, project work, written exam.
Evaluation: 1-5
Organization Responsible: Turku IT
Person in Charge: Pentti Riikonen
Previous Studies: Introduction to Programming and Introduction to Computer Science.
Recommended Year of Study: 1. year, period 3.
Study Materials: Literature and lecture slides.

Name: Bioinformatics Project
Course Unit Code: BIOI4380
Subject: Bioinformatics
Credits: 1-6 ECTS
Objectives: Aimed to students who deepen their skills or study new areas of bioinformatics in such a way that it can not be taken into account in other courses or in master's thesis work. This kind of work can be for example participating to third party seminars or conferences, laboratory work, volunteer research projects, etc.
Content: Individually defined.
Teaching Methods: Independent work.
Modes of Study: Project work.
Evaluation: pass / fail
Organization Responsible: Turku IT, Tampere IMT
Person in Charge: Pentti Riikonen, Martti Tolvanen
Previous Studies: -
Recommended Year of Study: any

Name: Biological Data Analysis Project
Course Unit Code: BIOI4260
Subject: Bioinformatics
Credits: 4 ECTS
Objectives: Students will apply their skills learned in their first year's courses to solve a small Bioinformatics related problem.
Content: Project work.
Teaching Methods: Group work.
Modes of Study: Project work.
Evaluation: pass/fail
Organization Responsible: Turku IT
Person in Charge: Pentti Riikonen
Previous Studies: Introduction to Bioinformatics.
Recommended Year of Study: 1. year, periods 3-4.
Study Materials: -

Name: Biological Database Systems
Course Unit Code: BIOI4330
Subject: Bioinformatics
Credits: 5 ECTS
Objectives: The objective of this course is to introduce students to database systems concepts with focus on design, development and implementation of biological database systems.
Content: Database systems concepts; entity-relationship data model; relational data model; introduction to SQL; XML and XML Schema; web services; relational and XML-based DBMSs; design of biological database systems; entity-attribute-value modeling; model organism databases; integration of biological data; analysis workflows
Teaching Methods: Lectures (28h), tutorials (2h), group work (in groups of two) (60h).
Modes of Study: Lectures, project work, written exam.

Evaluation: 1-5
Organization Responsible: Turku IT
Person in Charge: Denis Shestakov
Previous Studies: Introduction to Programming and Introduction to Computer Science.
Recommended Year of Study: 2. year, periods 2-3.
Study Materials: Course material on the Internet; selected scientific articles. Suggested reading: Silbershatz, A., Korth, H., Sudarshan, S.: Database Systems Concepts, 5th ed., McGraw-Hill, 2005 (ISBN-10: 0072958863); also, see the literature mentioned at http://users.utu.fi/denshe/biodb08/.

Name: Expression Data Analysis
Course Unit Code: BIOI4200
Subject: Bioinformatics
Credits: 4 ECTS
Objectives: The goal of this course is to introduce statistical concepts and tools to analyze expression data. The expression data will be analyzed using the R language.
Content: Introduction to the microarray technology; Introduction to data analysis with R; Primary (or "low-level") analysis of data; Dimension reduction, clustering & visualization; Promoter identification & microarray annotation; Integrated analyses: BioOntologies & Reverse Engineering; Bioconductor packages and expression data analysis.
Modes of Study: Lectures (approx. 20h), practical training, journal club.
Evaluation: 1-5
Organization Responsible: Tampere IMT
Previous Studies: Bioinformatics in Functional Genomics (BIOI4210).
Person in Charge: Bairong Shen
Recommended Year of Study: 2. year, Autumn.
Study Materials: eBook (http://www.csc.fi/csc/julkaisut/oppaat/arraybook_overview).

Name: Finnish for Foreigners: Intensive Beginners' Course
Course Unit Code: KIFF0003
Subject: Language studies/Finnish
Credits: 5 ECTS
Objectives: The aim of the course is to offer the students a basic knowledge of the Finnish language in order to help them cope with various everyday situations and to give them a good start with the grammar. The course concentrates on developing vocabulary and communicational skills.
Content: 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.
Teaching Methods: Lectures; various tasks will be practised both in pairs and as group work.
Modes of Study: Instruction 60 hours, active participation (80% attendance), a lot of homework, intermediary and final exam.
Evaluation: 1-5
Organization Responsible: Turku Language Center (kielikeskus).
Person in Charge: Pirkko Hölttä
Previous Studies: -
Recommended Year of Study: 1. year, periods 1-2.
Study Materials: Textbook will be decided in the beginning of the course.

Name: Introduction to Biochemistry
Course Unit Code: BIOI2220
Subject: Bioinformatics
Credits: 3 ECTS
Objectives: Elementary knowledge of biomolecules and metabolism; Sufficient knowledge of proteins to appreciate protein sequence and structure data.

Content: Revision of chemical concepts; Elementary cell biology; Introduction to proteins and other biomolecules; Concepts of metabolism; Biological membranes, transport and signal transduction.
Modes of Study: Lectures (20h), compulsory on-line assignments, tutorial sessions; intermediate and final examination on the lectures and selected parts of the literature below.
Evaluation: 1-5
Organization Responsible: Tampere IMT
Person in Charge: Martti Tolvanen
Previous Studies: Elementary knowledge of organic chemistry and chemical formulas.
Recommended Year of Study: 1. year, periods 1-2.
Study Materials: Nelson and Cox (2004) Lehninger Principles of Biochemistry, Fourth Edition: chapters 1 to 7 and 11 to 13 OR corresponding parts of Berg, Tymoczko & Stryer (2002) Biochemistry, W.H. Freeman, (approx. ch.1 to 15).

Name: Introduction to Bioinformatics
Course Unit Code: BIOI2080
Subject: Bioinformatics
Credits: 4 ECTS
Objectives: Practical skills to find, retrieve and analyze data from major bioinformatic databases; develop judgement to evaluate analysis results; elementary knowledge of phylogenetics and protein structure visualization.
Content: A wide-sweeping introduction to key areas of bioinformatics: bioinformatic databases, genomics, DNA and protein sequences, protein structures; theory and practice of the most common computational tools used in bioinformatics. The use of a molecular graphics programme (e.g. PyMol) and protein visualization in general.
Modes of Study: Work in the Internet course (estimated 30h), guided by on-line tutoring and live tutoring sessions. The course includes small, obligatory assignments during the self-study period and a larger project in the end (estimated 30h). The project is documented in a written report which is evaluated by the tutor. Learning extra molecular graphics and producing images (estimated 20h).
Evaluation: pass/fail
Organization Responsible: Tampere IMT
Persons in Charge: Csaba Ortutay, Martti Tolvanen and Bairong Shen
Previous Studies: Introduction to Biochemistry and Introduction to Molecular Biology or similar basic knowledge of nucleic acids, genes and proteins.
Recommended Year of Study: 1. year, as soon as possible. Continuous registration during terms http://bioinf.uta.fi/courses/ . The course is open for self-study during holidays, too.
Study Materials: Course material on the Internet.

Name: Introduction to Computer Science
Course Unit Code: BIOI2260
Subject: Bioinformatics
Credits: 3 ECTS
Objectives: The course provides an overview of the most important concepts in computer science.
Content: Basic concepts in machine architecture and data representation are explained, followed by an introduction to essential data structures and operations over them. Further, some of the fundamentals of complexity and computability are presented, together with selected topics from artificial intelligence that are of relevance to bioinformatics.
Teaching Methods: Lectures (18h).
Modes of Study: Exercises, written exam.
Evaluation: 1-5
Organization Responsible: Turku IT
Person in Charge: Filip Ginter
Previous Studies: -
Recommended Year of Study: 1. year, period 1.

Study Materials: Brookshear, J. Glenn: Computer Science: An overview, 2008, ISBN 978-0321524034; lecture notes.

Name: Introduction to Genetics
Course Unit Code: BIOI2230
Subject: Bioinformatics
Credits: 3 ECTS
Objectives: Understanding heritability and evolution; elementary knowledge of experimental methods of genetics.
Content: Basics of classical genetics, cytogenetics, population genetics and medical genetics.
Modes of Study: Lectures (20h), essay(s), tutorial sessions, final examination on lectured topics and selected parts of the books below.
Evaluation: 1-5
Organization Responsible: Tampere IMT
Person in Charge: Martti Tolvanen
Previous Studies: No bioscience background is required.
Recommended Year of Study: 1. year, period 2.
Study Materials: Klug-Cummings (2005) Concepts of Genetics (8th edition), Prentice Hall.

Name: Introduction to Molecular Biology
Course Unit Code: BIOI2210
Subject: Bioinformatics
Credits: 3 ECTS
Objectives: Sufficient knowledge of nucleic acids and molecular biology methods to understand nucleic acid sequence data and gene regulation.
Content: Basics of molecular genetics; Transcription and translation; RNA splicing and alternative splicing; Gene regulation.
Modes of Study: Lectures (20h), assignments and/or essays, tutorial sessions, intermediate and final examination on lectured topics and selected parts of the books below.
Evaluation: 1-5
Organization Responsible: Tampere IMT
Person in Charge: Martti Tolvanen
Previous Studies: No bioscience background is required.
Recommended Year of Study: 1. year, periods 1-2.
Study Materials: Watson-Baker-Bell-Gann-Levine-Losick: Molecular Biology of the Gene (6th Ed., 2008).

Name: Introduction to Programming
Course Unit Code: BIOI2250
Subject: Bioinformatics
Credits: 6 ECTS
Objectives: The students will acquire basic skills in algorithm design and learn to write simple practical programs in Python.
Content: Fundamental concepts such as variables, values, types, expressions, control structures, data structures, modularity and classes. Model problems and their typical algorithmic solutions with particular focus on bioinformatics.
Teaching Methods: Lectures (40h).
Modes of Study: Exercises, written exam. One half of the exercises time is devoted to in-class programming assignments.
Evaluation: 1-5
Organization Responsible: Turku IT
Person in Charge: Filip Ginter
Previous Studies: -
Recommended Year of Study: 1. year, periods 1-2.
Study Materials: Lecture notes; Python documentation.

Name: Introduction to Statistical Bioinformatics
Course Unit Code: BIOI4250
Subject: Bioinformatics
Credits: 4 ECTS
Objectives: Students will learn how to use statistical inference to solve problems with biological sequences. Students are assumed to know how to calculate confidence intervals for model parameters and significance levels for statistical hypotheses on model parameters from data consisting of biological sequences and their statistical models consisting of Markov chain and hidden Markov models.
Content: 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.
Teaching Methods: Lectures.
Modes of Study: Lectures, exercises, project work.
Evaluation: 1-5
Organization Responsible: Turku IT / Department of Statistics
Person in Charge: Esa Uusipaikka
Previous Studies: Introduction to Statistical Inference.
Study Materials: Lecture notes.

Name: Introduction to Statistical Inference
Course Unit Code: BIOI2240
Subject: Bioinformatics
Credits: 3 ECTS
Objectives: Students are assumed to know how to calculate confidence intervals for model parameters and significance levels for statistical hypotheses on model parameters from empirical data and their statistical models consisting of basic models for categorical and continuous responses.
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.
Teaching Methods: Lectures.
Modes of Study: Lectures, exercises, project work.
Evaluation: 1-5
Organization Responsible: Turku IT / Department of Statistics
Person in Charge: Esa Uusipaikka
Previous Studies: -
Recommended Year of Study: 1. year, period 2.
Study Materials: Lecture notes.

Name: Math and CS for Bioinformatics
Course Unit Code: BIOI2290
Subject: Bioinformatics
Credits: 3 ECTS
Objectives: Mastering basics of probability theory (probability, probability axioms, conditional probability, probability density function, cumulative distribution function, expectation, variance, discrete random variable, continuous random variable) and statistics (statistical experiment, descriptive statistics, inference statistics). Ability to calculate with complex numbers and matrices (also determinant, eigenvalues and eigenvectors), and define extremum values of a given function. Cabapility to analyse and solve differential equations.
Content: Essential math and CS methods with applications to bioinformatics. The course content includes probability theory, statistics, complex numbers, matrices, ordinary differential equations, extremum values.
Modes of Study: Lectures (10h), exercises (10h), participation in classroom work, written exam.

Evaluation: 1-5
Organization Responsible: Turku IT
Person in Charge: Hanna Suominen
Previous Studies: Supplementary Math and CS Foundations or equivalent.
Recommended Year of Study: 1. year, period 2.
Study Materials: Lecture notes.

Name: Master's Thesis
Course Unit Code: BIOI4031
Subject: Bioinformatics
Credits: 40 ECTS
Objectives: 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.
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.
Modes of Study: Personal work, Master's thesis, seminar, and maturity examination.
Evaluation: The thesis is evaluated by the supervisor and another teacher. The final acceptance is decided by the department council. Special grade: approbatur, lubenter approbatur, non sine laude approbatur, cum laude approbatur, magna cum laude approbatur, eximia cum laude approbatur or laudatur.
Organization Responsible: Turku IT
Person in Charge: Professor Tapio Salakoski
Previous Studies: Major Subject Studies.
Recommended Year of Study: 2. year.
Study Materials: -

Name: Phylogenetics
Course Unit Code: BIOI4230
Subject: Bioinformatics
Credits: 4 ECTS
Objectives: Phylogenetics is the taxonomical classification of organisms based on how closely they are related in terms of evolutionary differences. The course will familiarize students with different phylogenetics algorithms and practical software applications for biological problems.
Content: Theories of molecular evolution; Reconstruction of phylogenies: distance methods, maximize likelihood methods, parsimony methods, Bayesian methods; Computer-based practical trainings.
Modes of Study: Lectures (approx. 20h), journal club, software demo.
Evaluation: 1-5
Organization Responsible: Tampere IMT
Previous Studies: Introduction to Bioinformatics (BIOI2080)
Person in Charge: Bairong Shen
Recommended Year of Study: 1. year, period 4.
Study Materials: The Phylogenetic Handbook: A Practical Approach to DNA and Protein Phylogeny, Edited by Marco Salemi.

Name: Structural Bioinformatics
Course Unit Code: BIOI4240
Subject: Bioinformatics
Credits: 4 ECTS
Objectives: Getting a solid background in structure-related bioinformatics, including a theoretical background to start protein modeling.

Content: Macromolecular structural research methods and structure data; Analysis of structures; Classification of structures; Structural alignment; Molecular visualization; Homology-based modelling.
Modes of Study: Independent work (at least 80h) in the Internet course, guided by on-line tutoring and live tutoring sessions. Your work and learning must be documented in a learning diary (within the course tools).
Evaluation: pass/fail
Organization Responsible: Tampere IMT
Person in Charge: Martti Tolvanen
Previous Studies: Introduction to Bioinformatics (BIOI2080) and a fair knowledge of protein biochemistry.
Recommended Year of Study: 1. year, periods 3-4. Continuous registration during terms at http://bioinf.uta.fi/courses/. The course is open for self-study during holidays, too.
Study Materials: Course material on the Internet; selected scientific journal articles. Suggested reading: Structural Bioinformatics, (2002) ISBN 0-471-20199-5, Philip E. Bourne, Helge Weissig (eds.), Wiley & Sons.

Name: Supplementary Math and CS Foundations
Course Unit Code: BIOI0010
Subject: Bioinformatics
Credits: 3 ECTS
Objectives: In this course students will practice the basic mathematical skills required to understand other courses. The aim is to master Finnish high school level mathematics.
Content: Review and practice of the school level mathematics (powers, roots, logarithms, quadratic equations, inequalities, function theory, differentiation, integrals, sequences, series, mathematical induction, vectors, etc.).
Modes of Study: Lectures (10h), exercises (10h), participation in classroom work, written exam.
Evaluation: 1-5
Organization Responsible: Turku IT
Person in Charge: Hanna Suominen
Previous Studies: -
Recommended Year of Study: 1. year, period 1.
Study Materials: Lecture notes.

Name: Systems Biology I
Course Unit Code: BIOI4220
Subject: Bioinformatics
Credits: 4 ECTS
Objectives: 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, it is hoped that an understandable model of the whole system can be developed.
Content: Introduction to systems biology; High throughput technologies in biology; Inferring gene networks from microarray data; General analyses of metabolic networks; General analyses of signal transduction networks; SBML and systems biology related algorithms (ODE/LP); Systems biology related databases and tools; Examples and software tutorials.
Modes of Study: Lectures (approx. 20h), journal club, project work.
Evaluation: 1-5
Organization Responsible: Tampere IMT
Previous Studies: Expression data analysis and Bioinformatics in Functional Genomics.
Person in Charge: Bairong Shen
Recommended Year of Study: 2. year, period 3.
Study Materials: Suggested reading: Computational Cell Biology; Springer-Verlag, 2002; ISBN 0-387-95369-8. Systems Biology - Definitions and Perspectives; Alberghina, Lilia; Westerhoff, H.V. (eds.).

Name: Systems Biology II
Course Unit Code: BIOI4300
Subject: Bioinformatics
Credits: 4 ECTS
Objectives: This course will focus on practical applications of systems biology theories and tools to concrete biological problems. The importance of mathematical modeling will be illustrated by examining the results of the modeling and simulation, such as the same model may have different qualitative results.
Content: Graphical representation of biological systems; Graphics model for Jak-Stat pathway; Parameters for biological systems simulation; SBML-supporting software; DEMO1: modeling and simulation of Jak-Stat pathway; Signal transduction pathways and cancer; DEMO2: modeling and simulation of Rel-NF-KB-Ikb pathway; Integrative cancer biology.
Modes of Study: Lectures (approx. 20h), journal club, software demo.
Evaluation: pass/fail
Organization Responsible: Tampere IMT
Person in Charge: Bairong Shen
Previous Studies: Systems biology I
Recommended Year of Study: 1. year, period 4.
Study Materials: sbml.org; Selected Journal Articles.

Name: Text Mining in the Biomedical Domain
Course Unit Code: BIOI4340
Subject: Bioinformatics
Credits: 3 ECTS
Objectives: The course reviews common applications of text mining methods in the biomedical domain from a user perspective.
Content: Literature and ontology resources, text retrieval, information extraction, adaptation of text mining to the biomedical domain.
Teaching Methods: Lectures (2h), independent work (40h). Self-study based course with moderated discussion on Moodle.
Modes of Study: Exam, essay. Examination type dependent on student's activity during the course.
Evaluation: pass/fail
Organization Responsible: Turku IT
Person in Charge: Filip Ginter
Previous Studies: -
Recommended Year of Study: 2. year, period 4.
Study Materials: Ananiadou, Sophia - McNaught, John: Text mining for biology and biomedicine, 2005, ISBN 978-1580539845.

Name: Tools for Intelligent Data Analysis
Course Unit Code: BIOI4290
Subject: Bioinformatics
Credits: 4 ECTS
Objectives: The course aims at delivering an intuitive understanding of the fundamentals and thus the power and limitations of various methods like Artificial Neural Network. SOM, genetic and evolutionary algorithms, Gibss sampling, simulated annealing.
Content: 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.
Teaching Methods: Independent work.
Modes of Study: Exercises, oral exam.
Evaluation: 1-5
Organization Responsible: Turku IT
Person in Charge: Pentti Riikonen
Previous Studies: -
Recommended Year of Study: 1. year, period 4.
Study Materials: Course material on the Internet.

Innovation and Entrepreneurship ─minor subject

Innovation and Entrepreneurship -module is based on long experience on entrepreneurship and innovation research-based teaching and development activities of the Turku School of Economics (TSE). The main idea behind Innovation and Entrepreneurship -module is to give the student a comprehensive picture of current innovation and entrepreneurship issues. Additionally, ICT and related industries are of the module's interest. The modules are constructed in a way that they build themselves on each other, i.e. from general to more specified issues. Additionally, the general idea is to give the student the working tools and understanding of how to start-up a new venture, how to manage it and develop it. Growth and internationalization issues are also of great interest. Therefore, the courses follow the logic of a new venture, from start-up to growth and internationalization.

- Innovation and Entrepreneurship in ICT Context, 5 ECTS
- New Business Models, 5 ECTS
- Business Competence and Innovations, 5 ECTS
- Innovation and Global Growth, 5 ECTS
- Optional course, 5 ECTS

Name: Innovation and Entrepreneurship in ICT Context
Course Unit Code: TKO_5457 / YRm510
Subject: Innovation and Entrepreneurship
Credits: 5 ECTS
Objectives: The students understand the concepts taught during the course.
Content: The course gives the students an introduction to innovation and entrepreneurship as a research field. Additional themes covered in the course are knowledge intensive entrepreneurship, open innovation, and innovation system. The course examines innovation and entrepreneurship in the ICT context. Therefore, themes such as serving the ICT needs of entrepreneurs, ICT as a source for entrepreneurship, and innovations in the ICT sectors are covered. Examples of various types of content and service businesses are used (from the Nordic ICT sector).
Teaching Methods: Lectures and distance learning in a virtual learning environment.
Modes of Study: Exercises
Study Materials: Innovation Management in the ICT Sector: How Frontrunners Stay Ahead. Edward Huizenga. 2004. Edward Elgar Publishing Ltd. 1843765675. Innovation and Entrepreneurship. Peter F. Drucker. Butterworth-Heinemann Ltd; 2Rev Ed edition 2007. 0750685085. Additional required literature will be announced in the beginning of the course.
Period of Teaching: Autumn term, period 1.
Evaluation: 0-5
Person in Charge: Pasi Malinen, Jussi Puhakainen; Turku School of Economics

Name: New Business Models
Course Unit Code: TKO_2053 / YR1
Subject: Innovation and Entrepreneurship
Credits: 5 ECTS
Objectives: The students understand the concepts taught during the course.
Content: Business models are one of the most prominent, yet least understood issues in business research and management. Classical strategic approach relies upon rigid business models, which define the way the actors operate in relation to each other and associated revenue logics. Technological and organisational innovations together with turbulent business environment set, however, new requirements for business model planning. In this course, the students learn to understand these new business models. Consequently, students learn to explain what is the role of a business model. What kinds of business models are suited for various situations? How do we formulate and plan our business model? How does our business model affect strategy and management and vice versa. The course pays attention to potential high-growth niche markets and innovative revenue models/logics.
Teaching Methods: Lectures (24h)

Modes of Study: Exam
Study Materials: Open Innovation. The New Imperative for Creating and Profiting from Technology, Chesbrough, Henry (2003) 1-57851-837-7; Additional required literature will be announced before the start of the course.
Period of Teaching: Autumn term, period 1.
Evaluation: 0-5
Person in Charge: Pasi Malinen, Jussi Puhakainen; Turku School of Economics

Name: Business Competence and Innovations
Course Unit Code: TKO_2040 / YR4
Subject: Technology Entrepreneurship
Credits: 5 ECTS
Objectives: The student understands the concepts taught during the course.
Content: New innovations and new ventures based on new innovations are changing, shaping and developing economies. Therefore, innovations are stressed by international, national and regional innovation policies. Commercialisation of new inventions (=innovation) has been named as one of the greatest challenges in business economics. In knowledge intensive sectors, new business competence is needed together with technology added with open innovation ideology. The course gives all the needed background information on how to start up a new (technology-based) venture. The student learn aspects of business competence when managing an innovation or a new venture, including IPR issues, financing the venture, managing a small company and marketing of new venture. The course familiarizes the student with business planning activities through practical examples.
Teaching Methods: Lectures (24 h)
Modes of Study: Exam
Study Materials: Innovator's Dilemma When New Technologies Cause Great Firms to Fail, Christensen, Clayton M. (1997) 0-87-584585-1; Inside the Tornado: Strategies for Developing, Leveraging and Surviving Hypergrowth Markets, Moore, Geoffrey A. (2004), 9780060745813
Period of Teaching: Sring term, period 3.
Evaluation: 0-5
Person in Charge: Pasi Malinen; Turku School of Economics

Name: Innovations and Global Growth
Course Unit Code: TKO_2058 / YRS8
Subject: Innovation and Entrepreneurship
Credits: 5 ECTS
Objectives: The students understand the concepts taught during the course.
Content: The course focuses on the complex solutions for starting up companies with global potential. It deals with high risk – high potential ventures. Special attention is paid to analysing actual on- going growth businesses. A selection of business managers will also present their cases during the lectures. After completing the course the student has an understanding of the competition, networking, knowledge and business, management as well as financial issues of the development from the business idea into an IPO (InitialPublic Offering).
Teaching Methods: Lectures (24h)
Modes of Study: Exam. The exam is two-fold: The student is to prepare a report on an actual growth company and its competitive situation. There is also an exam that covers the literature and the lectures.
Study Materials: Coburn, Pip (2006) The Change Function. Why Some Technologies Take Off and Others Crash and Burn. A&C Black, London. 1-59184-132-1; Chesbrough, Henry (2006) Open Business Models. How to Thrive in the New Innovation Landscape. Harvard Business School Press. Boston, Mass. 978-1422104279; Gary P. Pisano (2006) Science Business. The Promise, the Reality, and the Future of Biotech. Harvard Business School Press. Boston, Mass. 978-1591398400. Additional reading is to be specified in the beginning of the course.
Period of Teaching: Spring term, period 4.
Evaluation: 0-5
Previous Studies: The following courses are recommended before this course: YR4 Business competence and innovations, YR8 Entrepreneurship and business growth.
Person in Charge: Antti Paasio; Turku School of Economics