TAMPEREEN YLIOPISTO
LÄÄKETIETEELLINEN TIEDEKUNTA

LUONNONTIETEIDEN KANDIDAATIN JA FILOSOFIAN MAISTERIN TUTKINNOT

BIOTEKNOLOGIAN KOULUTUSOHJELMA
MASTER´S DEGREE PROGRAMME IN BIOINFORMATICS

OPINTO-OPAS

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Marjatta Viilo

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SISÄLLYSLUETTELO

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 (M.Sc.) 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 (83 ECTS), Compulsory minor subject studies (3-15 ECTS), General studies (3-6 ECTS), and Optional studies (16-31 ECTS).

Major subject studies and other studies are arranged as courses, typically 3-5 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 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 Tampere and University of Turku. Local studies such as language studies, orientation courses, and optional courses may differ between universities.

Initial tests

Every student must participate in the initial tests consisting of basic questions about biosciences, mathematics and computer science. The result of the initial tests and previous studies of the student determine the courses to be chosen from Compulsory minor subject studies. 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 Regulations Concerning Basic Degrees in Natural Sciences will be published in the web page http://bioinformatics.fi/ .

CONTACT INFORMATION

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Used abbreviations:

IMT	Institute of Medical Technology, University of Tampere
DIT	Department of Information Technology, University of Turku
LANCE	Language Center, University of Tampere
ECTS	European Credit Transfer and Accumulation System

CONTENT OF THE MASTER'S DEGREE

Master of Science (M.Sc.) 120 ECTS credits

Major subject bioinformatics

General studies	3-6	ECTS
Compulsory minor subject studies	3-15	ECTS
Major subject studies	83	ECTS
Optional studies	16-31	ECTS
	120	**ECTS**

GENERAL STUDIES		**3-6 ECTS**	
BIOI0001 Orientation course		3 ECTS	IMT
Elementary Course 1		3 ECTS	LANCE

MAJOR SUBJECT STUDIES IN BIOINFORMATICS		**83 ECTS**	
BIOI2080	Introduction to bioinformatics	4 ECTS	IMT
BIOI4260	Biological data analysis project	4 ECTS	DIT
BIOI4270	Bioinformatics, programming course	4 ECTS	DIT
BIOI4210	Bioinformatics in functional genomics	4 ECTS	IMT
BIOI4240	Structural bioinformatics	4 ECTS	IMT
BIOI4280	Algorithms in bioinformatics	4 ECTS	DIT
BIOI4290	Tools for intelligent data analysis	4 ECTS	DIT
BIOI4220	Systems biology I, video lecture	4 ECTS	IMT
BIOI4230	Phylogenetics	4 ECTS	IMT
BIOI4200	Expression data analysis	4 ECTS	IMT
BIOI4030	Scientific communication	3 ECTS	IMT
BIOI4031	M.Sc. thesis	40 ECTS	IMT
BIOI4032	Maturity test	0 ECTS	IMT

COMPULSORY MINOR SUBJECT STUDIES **3-15 ECTS**

Every student needs elementary knowledge of the following fields. Introduction to statistical inference is obligatory for everyone, except for statistics majors with a good knowledge of the R package. Of the other six courses, you need to take all courses of the topics you have not covered in your previous studies, or not passed in initial tests.

BIOI2210	Introduction to molecular biology	3 ECTS	IMT
BIOI2230	Introduction to genetics	3 ECTS	IMT
BIOI2220	Introduction to biochemistry	3 ECTS	IMT
BIOI2240	Introduction to statistical inference	3 ECTS	DIT
BIOI2250	Introduction to programming	6 ECTS	DIT
BIOI2260	Introduction to computer science	3 ECTS	DIT
BIOI2290	Math and CS for bioinformatics	3 ECTS	DIT

OPTIONAL STUDIES **16-31 ECTS**

Several optional courses are arranged jointly between Turku and Tampere, and many more are

available locally. Bioinformatics courses (from the list below) 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 year of study, 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 personal study plan (PSP) and decide the details when updating the PSP for the second year.

BIOI4250	Introduction to statistical bioinformatics	4 ECTS	DIT
BIOI4320	Advanced math and CS for bioinformatics	3 ECTS	DIT
BIOI4300	Systems biology II	4 ECTS	DIT
BIOI4310	Computational identification of gene regulatory elements	4 ECTS	IMT/DIT
BIOI4330	Biological database systems	5 ECTS	DIT
BIOI4340	Text mining in the biomedical domain	3 ECTS	DIT
BIOI4350	Protein modelling	6 ECTS	IMT
BIOI4360	Major transitions in evolution	3 ECTS	IMT
BIOI4380	Bioinformatics project	1-6 ECTS	IMT/DIT
BIOI4460	Journal Club	2 ECTS	IMT

COURSE DESCRIPTIONS

Note that the latest information and schedules are always available at http://bioinformatics.fi. Enrolment in courses is required via NettiOpsu (http://www.uta.fi/studies/nettiopsu/) unless otherwise stated.

BIOI0001 Orientation course **3 ECTS** **IMT**

Person in charge

Martti Tolvanen

Objectives

Basic survival skills at the University of Tampere and in Finnish society in general. Drafting your personal study plan (PSP).

Content

Part of the course will consist of the general orientation course for foreign students in the university, and part will be specific to IMT and degree programme, including an obligatory introduction to the medical library and library databases.

Modes of study

Lectures, visits, tutoring. Making a reasonable PSP and filing it at the institute is a requirement for passing this course.

Evaluation

pass/fail

Period

1st

Elementary Course 1 (in Finnish language) 3 ECTS LANCE

Objectives

After successful completion of the course students will be able to understand and use short and simply-structured Finnish expressions that concern some of the most common matters and situations related to everyday life (introducing oneself, telling the time, buying and paying, food and menu, asking and answering, commanding and requesting).

Period

1.-2.

SUPPLEMENTARY STUDIES

Supplementary studies are intended to bring your knowledge and skills up to the level of an eligible student, and therefore they can not be included in the minimum of 120 ECTS of your MSc degree. Your need of supplementary studies will be determined by initial tests and by your previous studies.

BIOI0010 Supplementary math and CS foundations 3 ECTS DIT

Person in charge

Hanna Suominen

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 (10 h), exercises (10 h), participation in classroom work, written examination.

Evaluation

1-5

Recommended year of study

1st year

Period

1st

Study materials

Lecture notes.

COMPULSORY MINOR SUBJECT STUDIES

Initial tests and your previous studies determine which of the following you need to take. All courses in the class need to be taken first in your studies.

BIOI2210 Introduction to molecular biology 3 ECTS IMT

Person in charge

Hans Spelbrink

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 (20 h); assignments and/or essays; tutorial sessions; intermediate and final examination on lectured topics and selected parts of the books below.

Evaluation

1-5

Previous studies

No bioscience background is required.

Recommended year of study

1st year.

Study materials

Watson-Baker-Bell-Gann-Levine-Losick: Molecular Biology of the Gene (6th Ed., 2008) ISBN 978-0805395921

Period

1st and 2nd

BIOI2220 Introduction to biochemistry 3 ECTS IMT

Person in charge

Herma Renkema

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 (20 h), compulsory on-line assignments, tutorial sessions; intermediate and final examination on the lectures and selected parts of the literature below.

Evaluation

1-5

Previous studies

Elementary knowlegde of organic chemistry and chemical formulas.

Recommended year of study

1st year

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).

Period

1st and 2nd

BIOI2230 Introduction to genetics 3 ECTS IMT

Person in charge

Martti Tolvanen

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 (20 h); essay(s); tutorial sessions; final examination on lectured topics and selected parts

of the books below.

Evaluation

1-5

Previous studies

No bioscience background is required.

Recommended year of study 1st year.

Study materials

Klug-Cummings (2005) Concepts of Genetics (8th edition) Prentice Hall

Period

2nd

BIOI2240 Introduction to statistical inference 3 ECTS DIT

Person in charge

Esa Uusipaikka

Objectives

Students are assumed to learn 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. It is also 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.

Modes of study

Lectures, exercises, and project.

Evaluation

1-5

Recommended year of study: 1st year

Study materials

Lecture notes and videos.

Period

2nd

BIOI2250 Introduction to programming 6 ECTS DIT

Person in charge

Filip Ginter

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 (40 h)

Modes of study

Exercises, written exam. One half of the exercise time is devoted to in-class programming assignments.

Evaluation

1-5

Recommended year of study

1st year

Study materials

Lecture notes, Python documentation.

Periods

1st and 2nd

BIOI2260 Introduction to computer science 3 ECTS DIT

Person in charge

Filip Ginter

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 (18 h)

Modes of study

Exercises, written exam.

Evaluation

1-5

Recommended year of study

1st year

Study materials

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

Period

1st

BIOI2290 Math and CS for bioinformatics 3 ECTS DIT

Person in charge

Hanna Suominen

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 (10 h), exercises (10 h), participation in classroom work, written exam.

Evaluation

1-5

Recommended year of study

1st year

Study materials

Lecture notes.

Period

2nd

MAJOR SUBJECT STUDIES

BIOI2080 Introduction to bioinformatics 4 ECTS IMT

Person in charge

Martti Tolvanen

Objectives

Practical skills to find, retrieve and analyze data from major bioinformatic databases; develop judgement to evaluate analysis results.

Content

A general 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. Same course as BIKE2080 (3 ECTS), but supplemented with an additional molecular graphics project, which teaches the use of a specialized programme (e.g. PyMol) and protein visualization in general.

Modes of study

Work on the internet course (estimated 30 h), 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. The project is documented in a written report which is evaluated by the tutor. Learning extra molecular graphics and producing images, a second project (estimated 20 h).

Evaluation

pass/fail

Study materials

Course material on the internet

Previous studies

Introduction to biochemistry and Introduction to molecular biology or similar basic knowledge of nucleic acids, genes and proteins.

Recommended year of study

As soon as possible

Period

Continuous registration during terms. The course is open for self-study during holidays, too.

Enrolment

http://bioinf.uta.fi/courses/

BIOI4280 Algorithms in bioinformatics 4 ECTS DIT

Person in charge

Pentti Riikonen

Objectives

The aim of this course is to provide deeper knowledge on algorithms used in bioinformatics. Students will learn to 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

Previous studies

Introduction to bioinformatics

Recommended year of study

1st year

Study materials

Literature and lecture slides.

Period: 2nd

BIOI4260 Biological data analysis project **4 ECTS** **DIT/IMT**

Persons in charge

Pentti Riikonen (DIT) ja Martti Tolvanen (IMT)

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 and individual work.

Modes of study

Project work

Evaluation

Pass/Fail

Previous studies

Introduction to bioinformatics

Recommended year of study

1st year

Study materials

Support and reference material in Moodle.

Periods

3rd and 4th

BIOI4270 Bioinformatics, programming course 4 ECTS DIT

Person in charge

Pentti Riikonen

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, and the BioPerl and BioPython and similar programming packages will be discussed. The bioinformatics resources used include GenBank, EMBL, UniProt, and complete genome databases.

Teaching methods

Lectures, independent project work

Modes of study

Lectures, exercises, project work, written exam.

Evaluation

1-5

Previous studies

Introduction to programming and Introduction to computer science.

Recommended year of study

1st year

Study materials

Literature and lecture slides.

Period

3rd

BIOI4210 Bioinformatics in functional genomics 4 ECTS IMT

Person in charge

Martti Tolvanen

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 80 h) on the internet course, guided by on-line tutoring. Your work and learning must be documented in a learning diary (within the course tools).

Evaluation

pass/fail

Study materials

Course material on the internet; selected scientific journal articles.

Suggested reading

Bioinformatics and Functional Genomics (2003), Jonathan Pevsner, Wiley

Previous studies

Introduction to bioinformatics (BIOI2080)

Recommended year of study

1st year.

Period

Continuous registration during terms. The course is open for self-study during holidays, too.

Enrolment

http://bioinf.uta.fi/courses/

BIOI4290 Tools for intelligent data analysis 4 ECTS DIT

Person in charge

Pentti Riikonen

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, Gibbs 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

Recommended year of study

1st year

Study materials

Course material on the internet.

Period

4th

BIOI4240 Structural bioinformatics 4 ECTS IMT

Person in charge

Martti Tolvanen

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 80 h) on the internet course, guided by on-line tutoring. Your work and learning must be documented in a learning diary (within the course tools).

Evaluation

pass/fail

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.

Previous studies

Introduction to bioinformatics (BIOI2080) and a fair knowledge of protein biochemistry.

Recommended year of study

1st year.

Period

Continuous registration during terms at http://bioinf.uta.fi/courses/. The course is open for self-study during holidays, too.

Enrolment

http://bioinf.uta.fi/courses/

BIOI4230 Phylogenetics 4 ECTS IMT

Person in charge

Csaba Ortutay

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 and Computer-based practical trainings

Modes of study

Lectures (approx. 20 h), Journal Club and Software Demo.

Evaluation

1-5

Study materials

The Phylogenetic Handbook: A Practical Approach to DNA and Protein Phylogeny Edited by Marco Salemi

Previous studies

Introduction to Bioinformatics (BIOI2080)

Recommended study year

1st year.

Period

4th

BIOI4200 Expression data analysis 4 ECTS IMT

Person in charge

Bairong Shen

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 package and expression data analysis.

Modes of study

Web course with live lectures in November 2009, Practical training, Journal Club

Evaluation

1-5

Study materials

eBook (http://www.csc.fi/csc/julkaisut/oppaat/arraybook_overview)

Previous studies

Bioinformatics in Functional Genomics (BIOI4210)

Recommended study year

2nd year.

Period

2nd

BIOI4220 Systems biology I **4 ECTS** **IMT**

Person in charge

Bairong Shen

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

Web course, Journal club, Projects

Evaluation

1-5

Study materials

Computational Cell Biology; Springer-Verlag, 2002; ISBN 0-387-95369-8

Systems Biology - Definitions and Perspectives; Alberghina, Lilia; Westerhoff, H.V. (eds.)

Previous studies

BIOI4200 Expression data analysis; BIOI4210 Bioinformatics in Functional Genomics.

Recommended study year

2nd year.

Period

3rd and 4th

BIOI4030 Scientific communication **3 ECTS** **IMT**

Person in charge

Martti Tolvanen

Objectives

To learn effective scientific communication and delivery of research results

Content

Lectures, poster preparation and presentation, seminar speech preparation and presentation. Scientific discussion based on posters and seminars.

Modes of study

Participation to a scientific meeting, where the students present results based on their thesis work as a poster and a seminar. Some students will also act as chairmen. The principles of presentations will be provided in lectures.

Evaluation

pass/fail

Previous studies

Major Subject Studies

Recommended year of study

2nd year.

BIOI4031 M.Sc. thesis **40 ECTS** **IMT**

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 of the thesis.

Content

The Master's thesis (pro gradu) consists of participation in the Scientific communication 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 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 grades: approbatur, lubenter approbatur, non sine laude approbatur, cum laude approbatur, magna cum laude approbatur, eximia cum laude approbatur or laudatur.

Person in charge

Mauno Vihinen

Previous studies

Major Subject Studies

Recommended year of study

2nd year.

OPTIONAL STUDIES

BIOI4250 Introduction to statistical bioinformatics 4 ECTS DIT

Person in charge

Esa Uusipaikka

Objectives

Students will learn how to use statistical inference to solve problems with biological sequences. Students are assumed to learn how to calculate: 1) confidence intervals for model parameters and 2) significance levels for statistical hypotheses on model parameters from data consisting of biological sequences and their statistical models consisting of Markov chains and hidden Markov models.

Content

This course orientates to statistical models, such as Markov chains and hidden Markov models, and their applications to biological sequence analysis. The use of statistical inference is demonstrated with real data sets.

Modes of study

Lectures, exercises, and project.

Evaluation

1-5

Previous studies

BIOI2240 Introduction to statistical inference or similar statistics studies

Recommended year of study

1st year

BIOI4320 Advanced math and CS for bioinformatics 3 ECTS DIT

Person in charge

Hanna Suominen

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

Previous studies

Math and CS for Bioinformatics or equivalent

Recommended year of study

1st year

Period

3rd

Study materials

Lecture notes.

Note

The course is NOT arranged in the academic year 2009-2010.

BIOI4300 Systems biology II 4 ECTS IMT

Person in charge

Bairong Shen

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 re-

sults.

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

Web course, Journal Club and Software Demo

Evaluation

pass/fail

Study materials

sbml.org; Selected Journal Articles

Preceding studies

Systems biology I (BIOI4220)

Recommended study year

2nd year.

Period

2nd

NOTE

The course will be arranged next time in the autumn term 2010.

BIOI4310 Computational identification of gene regulatory elements 4 ECTS IMT/DIT

Persons in charge

Martti Tolvanen and Eija Nordlund

Objectives

The course will familiarize students with gene regulatory elements as well as different analysis strategies and current software tools to identify most probable functional elements in DNA sequences.

Content

Different levels of gene regulation; transcription factor binding sites and their matrix representation; regulatory modules; promoter databases; navigating in genome browsers and retrieving data from genome databases; various tools to analyze promoter sequences of coexpressed or related genes; comparative genomics approaches to identify conserved non-coding regions and conserved binding sites in orthologous genomic sequences.

Modes of study

Lectures (approx.10 h), independent Internet work and exercises, reporting in an on-line learning diary.

Evaluation

pass/fail

Previous studies

Introduction to bioinformatics (BIOI2080), Bioinformatics in Functional Genomics (BIOI4210).

Recommended year of study

2nd year

Study materials

Course material on the internet, on-line manuals and articles as specified before and during the course.

Period

To be announced.

BIOI4330 Biological database systems 5 ECTS DIT

Person in charge

Denis Shestakov

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 modelling, model organism databases, integration of biological data, analysis workflows

Teaching methods

Lectures (28 h), tutorials (2 h), group work (in groups of two) (60 h)

Modes of study

Lectures, project work, written exam

Evaluation

1-5

Previous studies

Introduction to programming and Introduction to computer science.

Recommended year of study

2nd year

Period

2nd-3rd

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/biodb/.

BIOI4340 Text mining in the biomedical domain 3 ECTS DIT

Person in charge

Filip Ginter

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 (4 h), independent work (40 h). 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

1-5

Recommended year of study

2nd year

Period

4th

Study materials

Ananiadou, Sophia - McNaught, John: Text mining for biology and biomedicine, 2005, ISBN 978-1580539845

BIOI4360 Major transitions in evolution 3 ECTS IMT

Person in charge

Csaba Ortutay

Objectives

Overview of the most important events in molecular evolution of life.

Content

Formation of life; Forming of replicators; Forming of chromosomes; Switch from RNA to DNA; The Prokaryotes - Eukaryotes transition; Origin of sexuality; Multicellular organisms; Formation of colonies, societies and the case of languages.

Languages of instruction

English

Teaching methods

Lectures 20 h.

Modes of study

Written exam.

Further information on modes of study

Final examination on the lectures and selected parts of the literature.

Evaluation

1-5

Recommended year of study

1. year spring.

Further information on previous studies

Elementary knowledge of molecular machinery of inheritance (base pairing, transcription, translation). A concept on mechanism of selection and basic knowledge about natural history of life.

Study materials

Maynard Smith and Szathmáry (1995) The Major Transitions in Evolution.

BIOI4380 Bioinformatics Project 1–6 ECTS IMT/DIT

Persons in charge

Martti Tolvanen ja Pentti Riikonen

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.

Languages of instruction

English

Further information on teaching methods

Independent work

Modes of study

Project / practical work.

Further information on modes of study

Project work.

Evaluation

Pass/fail

Further information on recommended year of study

Any.

Further information

Turku DIT, Tampere IMT

BIOI4460 Journal Club 2 ECTS IMT

Person in charge

Martti Tolvanen

Objectives

Practice on how to give a talk on a scientific topic in

English and how to discuss scientific findings, with an emphasis on bioinformatics. Learn how to present the topic so that people with different backgrounds (IT or bioscience) and just an elementary knowledge in bioinformatics can all understand. Learn about new findings

and how bioinformatic methods have been applied and/or proven useful in each case.

Content

Selected journal articles which either a focus on

bioinformatics, or have used bioinformatic methods, or contain discoveries otherwise relevant to bioinformatics.

Modes of study: A series of presentations given by students on recent journal articles. Each student is required to give two short talks (15-20 minutes), with slides, and attend to at least 75 % of the meetings. In the end of the course you must hand in a small learning diary, with summaries of a at least a few sentences of each presentation, or half a page of your own presentations and the presentations you missed, plus a self-evaluation.

Languages of instruction

English

Teaching methods

Study Group.

Modes of study

In Finnish: Oral presentation + study journal / learning diary.

Evaluation

1-5

Recommended year of study

2. year autumn.

Further information on recommended year of study

After BSc or in final stages of BSc studies.