

Master's Degree Programme in Bioinformatics

Academic year 2011-2012

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 Biomedical 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 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.

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. Compulsory minor subject studies. If a student does not pass the mathematical part of the initial tests, she/he must take the course Supplementary Mathematics.

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.

Requirements for the MDP in Bioinformatics (120 ECTS)

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
- A.2. Other recommended courses in bioinformatics

B. OTHER STUDIES (40 ECTS)

B.1. Language studies 0-7 ECTS

All foreign students whose native language is not Finnish must pass Finnish language courses (KIFF0003) worth at least 5 credits. All students with Finnish education background (suomenkielinen peruskoulu) are excused for the course and must instead pass virkamiesruotsi (KIRU2321 and KIRU2341) either in their BSc or MSc Degree (Valtion virkamieheltä kaksikielisellä kielialueella vaadittava kielitaito siitä annetun lain (424/2003) 6§:n 1 momentin mukaan.) Courses are arranged by the Language Centre at the University of Turku (see the Language Centre study guide, or website <http://kielikeskus.utu.fi/>).

B.2. Compulsory minor subject studies 0-15 ECTS

Every student needs elementary knowledge of molecular biosciences as well as method sciences (IT, mathematics, statistics). You need to take courses of the topics you have not covered in your previous studies, or not passed in initial tests, as documented in your PSP.

B.3. Optional studies in the major or minor subjects 18-40 ECTS

Optional studies allow focusing on specific topics in bioinformatics and/or provide support in relevant minor subjects. Bioinformatics courses are highly recommended, but you may also choose to build up knowledge of methodological sciences (IT, math, etc.) or biological sciences. Optional courses must be approved by the staff and will be written down in the PSP. The students may take some optional courses during the first year, but most of them will be studied during the second year of master's studies.

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)

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. The need of supplementary studies will be determined by initial tests and previous studies.

Innovation and Entrepreneurship (I&E) study module (20-26 ECTS, optional)

Innovation and Entrepreneurship Study Module is based on a long experience in entrepreneurship and innovation research, teaching and development in the subject of Entrepreneurship at Turku School of Economics and Business and Innovation Development BID unit.

The I&E module is open for all Nordic Master School in Innovative ICT students (NMS iICT) and students participating in the three following Master's degree programmes in University of Turku:

Master's Degree programme in Embedded Computing; Master's Degree Programme in Bioinformatics and Master's Degree Programme in Information Technology. At Turku School of Economics the I&E study module can be chosen as a minor in Global Innovation Technology Management (GITM) master's degree programme.

The study module provides the student with a comprehensive picture of current issues in the field of innovation and entrepreneurship with special emphasis on ICT and related industries. After completing the study module the student is equipped with working tools for business start-up and understanding of business development.

The structure of the studies is presented below. The courses should be taken in the following order:

I&E study module, obligatory courses:

- YRe510 Innovation and Entrepreneurship, 5 ECTS
- YR1 New business models, 5 ECTS
- YR4 Business Competence and Innovations, 5 ECTS
- YRS8 Innovations and Global Growth, 5 ECTS

Optional course:

- YRS5 Specializing course in entrepreneurship, 6 ECTS

See the course descriptions and course timetables at:

<http://www.tse.fi/EN/studying/curriculum/> and

<http://www.tse.fi/EN/units/specialunits/bid/knowhow/ie/Pages/IEStudyModuleContent.aspx>

A. MAJOR SUBJECT STUDIES IN BIOINFORMATICS, 40 ECTS

A.1. Core courses in bioinformatics

BIOI2080 Introduction to Bioinformatics, 4 ECTS

BIOI4200 Expression Data Analysis, 4 ECTS

BIOI4211 Genomics, Transcriptomics and Proteomics, 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 in bioinformatics

BIOI4330 Biological Database Systems, 5 ECTS
BIOI4340 Text Mining in the Biomedical Domain, 3 ECTS
BIOI4350 Protein Modelling, 6 ECTS
BIOI4370 Advanced Data Analysis of Biomedical Problems, 4 ECTS
BIOI4371 Machine Learning, 4 ECTS
BIOI4380 Bioinformatics Project, 1–6 ECTS
BIOI4390 Major Transitions in Evolution, 3 ECTS

B. OTHER STUDIES, 40 ECTS

B.1. Language studies, 0–7 ECTS

KIEN2022 English: Basic Academic Writing, 2 ECTS
KIFF0003 Finnish for Foreigners: Intensive Beginners' Course, 5 ECTS

B.2. Compulsory minor subject studies, 0–15 ECTS

BIOI2210 Introduction to Molecular Biology, 3 ECTS
BIOI2220 Introduction to Biochemistry, 3 ECTS
BIOI2230 Introduction to Genetics, 3 ECTS
BIOI2250 Introduction to Programming, 6 ECTS
BIOI2260 Introduction to Computer Science, 3 ECTS
BIOI2270 Introduction to Statistics, 3 ECTS
BIOI2290 Mathematics for Bioinformatics, 3 ECTS

B.3. Optional studies, 18–40 ECTS

C. MASTER'S THESIS, 40 ECTS

BIOI4031 Master's Thesis, 40 ECTS

Master's Degree Programme in Bioinformatics

A. MAJOR SUBJECT STUDIES IN BIOINFORMATICS 40 ECTS

Objectives

Major subject studies offer interdisciplinary knowledge of bioinformatics.

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 Personal Study Plan of each student.

A.1. Core courses in bioinformatics

BIOI2080 Introduction to Bioinformatics 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; basic understanding of protein structures and protein visualization.

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.

Modes of study: Project / practical work + participation in online teaching.

Further information on modes of studies: Work on the Internet course (estimated 30h), guided by on-line tutoring and optional 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, constitutes a second project (estimated 20h).

Evaluation: 1-5.

Person(s) in charge: Martti Tolvanen

Teaching methods: Independent work web-based 80 h.

Previous studies: Recommended: BIOI2220 Introduction to Biochemistry.

Recommended year of study: 1. year autumn, recommended as soon as possible. Continuous registration during terms <http://bioinf.uta.fi/courses/>. The course is open for self-study even during holidays, but with limited or no tutoring from June to August.

Study materials / literature: Course material on the Internet.

Further information: Organization Responsible: Tampere IBT

BIOI4200 Expression Data Analysis 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: Written exam.

Evaluation: 1-5.

Person(s) in charge: Mauno Vihinen

Teaching methods: Lectures, practical training.

Previous studies: Recommended: BIOI4211 Genomics, Transcriptomics and Proteomics.

Recommended year of study: 2. year

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

Further information: Organization Responsible: Tampere IBT

An alternative course BIOI4201 (SGN-6176) Microarray Data Analysis 5 ECTS is arranged by the Technical University of Tampere.

BIOI4211 Genomics, Transcriptomics and Proteomics 4 ECTS

Objectives: Familiarity with Internet sources for genome-wide data; basic skills in using tools at these web sites; understanding how modern high-throughput methods generate sequence data and gene and protein expression data; practical skill of using genome browsers to access genome data and genome comparison data; understanding gene prediction and genome annotation pipelines; skill of performing individual gene predictions; understanding different levels of variation in human genomes; understanding basic workflows of microarray data analysis and next-generation sequencing data analysis; basic knowledge of experimental methods in proteomics and metabolomics which enables understanding data analysis in these fields; skill of identifying proteins from mass spectroscopic data.

Content: Next-generation sequencing (NGS); Ensembl genome browser and its comparative genomics tools; gene variations and variation databases; metagenomics; transcript expression data from microarrays and NGS, and principles of their analysis; finding over- and under-expressed genes from expression data; clustering of data; concept of functional enrichment; proteomics of protein expression, interactions and structures; and metabolic networks and metabolomics data.

Modes of study: Study journal / learning diary + agreement with teacher.

Further information on modes of studies: In addition to your reflection and summaries, the learning diary will contain exercises and assignments, which will be chosen individually, to be discussed with your tutor. Your learning diary can be written in Finnish if agreed with the web tutor.

Evaluation: 1-5. Your learning will be evaluated separately for the the sections of genomics, transcriptomics and proteomics, based on your learning diary work. Evaluation criteria include demonstrating the understanding of key concepts in your diary text, completing exercises successfully, working in the given 12-week deadline.

Person(s) in charge: Martti Tolvanen, Csaba Ortutay

Teaching methods: Independent work web-based 80 h. The course can be started at any time, with a deadline of 12 weeks after starting.

Previous studies: Compulsory: BIOI2080 Introduction to Bioinformatics.

Recommended year of study: 1. year. First year in MSc or third year in BSc.

Study materials / literature: Internet materials: Course pages and external web sites; original articles.

Further information: Organization Responsible: Tampere IBT

Website: <http://bioinf.uta.fi/courses/>

BIOI4220 Systems Biology I 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: Project / practical work.

Evaluation: 1-5.

Person(s) in charge: Mauno Vihinen

Teaching methods: Lectures, journal club, project work.

Previous studies: Recommended: BIOI4211 Genomics, Transcriptomics and Proteomics.

Recommended year of study: 2. year

Study materials / literature: Suggested reading: Computational Cell Biology; Springer-Verlag, 2002; ISBN 0-387-95369-8. Systems Biology - Definitions and Perspectives; Alberghina, Lilia; Westerhoff, H.V. (eds.).

Further information: Organization Responsible: Tampere IBT

BIOI4230 Phylogenetics 4 ECTS

Objectives: The course will familiarize students with different phylogenetics algorithms and practical software applications for biological problems. They will be able to create phylogenetic trees from multiple sequence alignments choosing a suitable

method for the biological problem. They will be able to interpret different kinds of phylogenetic trees and cladograms which are used most frequently in scientific publications.

- Content:** 1. Introduction and background
2. Characters and parsimony
3. Distance based methods, maximum likelihood
4. Bootstrap trees and consensus trees
5. Bayesian methods
6. Programs and examples

Modes of study: Written exam + weekly exercises.

Further information on modes of studies: Lectures plus independent home work assignments.

Evaluation: 1-5.

Person(s) in charge: Csaba Ortutay

Teaching methods: Lectures 20 h.

Previous studies: Recommended: BIOI2080 Introduction to Bioinformatics.

Recommended year of study: 1. year spring.

Time: Period IV

Study materials / literature: Lecture notes and other material provided by the teacher.

Further information: Organization Responsible: Tampere IBT

BIOI4240 Structural Bioinformatics 4 ECTS

Objectives: Getting a solid background in structure-related bioinformatics, including a theoretical background to start protein modeling. Understanding limits of protein models.

Content: Revision of protein structure; Macromolecular structural research methods and structure data; Analysis of structures; Classification of structures; Structural alignment; Molecular visualization; Homology-based modelling.

Modes of study: Study journal / learning diary.

Further information on modes of studies: Independent work (at least 80h) on the Internet course, guided by on-line tutoring. Work and learning must be documented in a learning diary.

Evaluation: 1-5.

Person(s) in charge: Martti Tolvanen

Teaching methods: Independent work web-based 80 h.

Previous studies: Recommended: BIOI2080 Introduction to Bioinformatics.

Recommended year of study: 1. year. Continuous registration during terms at <http://bioinf.uta.fi/courses/>. The course is open for self-study even during holidays, but with limited or no tutoring from June to August.

Study materials / literature: 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.

Further information: Organization Responsible: Tampere IBT

BIOI4260 Biological Data Analysis Project 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.

Modes of study: Project / practical work.

Evaluation: Pass/fail.

Person(s) in charge: Pentti Riikonen

Teaching methods: Group work.

Previous studies: Recommended: BIOI2080 Introduction to Bioinformatics.

Recommended year of study: 1. year

BIOI4270 Bioinformatics, Programming Course 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.

Modes of study: Exercise(s) + project / practical work + written exam.

Evaluation: 1-5.

Person(s) in charge: Pentti Riikonen

Teaching methods: Lectures 28 h, independent work.

Previous studies: Recommended: BIOI2250 Introduction to Programming, BIOI2260 Introduction to Computer Science.

Recommended year of study: 1. year spring.

Time: Period III

Study materials / literature: Literature and lecture slides.

BIOI4280 Algorithms in Bioinformatics 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.

Modes of study: Exercise(s) + written exam.

Evaluation: 1-5.

Person(s) in charge: Pentti Riikonen

Teaching methods: Lectures 28 h, independent work.

Previous studies: Recommended: BIOI2080 Introduction to Bioinformatics.

Recommended year of study: 1. year autumn.

Time: Period II

Study materials / literature: Literature and lecture slides.

BIOI4290 Tools for Intelligent Data Analysis 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, 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.

Modes of study: Exercise(s) + oral exam.

Evaluation: 1-5.

Person(s) in charge: Pentti Riikonen

Teaching methods: Independent work.

Recommended year of study: 1. year

Study materials / literature: Course material on the Internet.

A.2. Other recommended courses in bioinformatics

BIOI4330 Biological Database Systems 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

Modes of study: Project / practical work + written exam.

Evaluation: 1-5.

Person(s) in charge: Tapio Salakoski

Teaching methods: Lectures 28 h, personal instruction 2 h, group work 60 h. Group work in groups of two

Previous studies: Recommended: BIOI2250 Introduction to Programming, BIOI2260 Introduction to Computer Science.

Recommended year of study: 2. year

Study materials / literature: 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/>.

BIOI4340 Text Mining in the Biomedical Domain 3 ECTS

Objectives: The course reviews common applications of text mining methods in the biomedical domain from a user perspective. The objective is to become acquainted with this relatively new research area within bioinformatics.

Content: Literature and ontology resources, text retrieval, information extraction, adaptation of text mining to the biomedical domain.

Modes of study: Oral exam.

Further information on modes of studies: Self study followed by oral examination.

Evaluation: Pass/fail.

Person(s) in charge: Filip Ginter

Teaching methods: Lectures 2 h, independent work 40 h. Self-study based course with moderated discussion on Moodle.

Recommended year of study: 2. year

Study materials / literature: Ananiadou, Sophia - McNaught, John: Text mining for biology and biomedicine, 2005, ISBN 978-1580539845.

BIOI4350 Protein Modelling 6 ECTS

Objectives: Learning to build protein models based on known structures of homologous proteins. The course aims at practical skills in the use of modelling software and automated modelling servers. Evaluation of models. Advanced protein visualization.

Content: The emphasis is on evaluating, interpreting and visualizing protein models. Hands-on experience in building homology-based models with the software package Discovery Studio is used for understanding the principles of automated modelling software.

Modes of study: Exercise(s) + project / practical work.

Evaluation: 1-5.

Person(s) in charge: Martti Tolvanen

Teaching methods: Lectures and demonstrations. Independent work and essays, approximately 140 h. Teachers will give students the exercises, and students will need to submit the molecular coordinates and visualizations of the final models and a written report on each modelling process.

Previous studies: Compulsory: BIOI4240 Structural Bioinformatics.

Recommended year of study: 1. year spring, 2. year spring. This course is organized every second year, not in the academic year 2010-2011.

BIOI4370 Advanced Data Analysis of Biomedical Problems 4 ECTS

Objectives: To advance on the data analysis skills acquired in other courses. Through practical work attendees will be given the opportunity to apply programming, mathematics and knowledge of biological systems to develop solutions to real world problems and gain an understanding of practical applications of bioinformatics.

Content: Introduction to the analysis of biomedical datasets through the use of various programming languages. Addressing issues of dimensionality of datasets and selecting subsets of features that are the most predictive of disorders. The Analysis of academic journals and the development of solutions based on the contents of these publications. The use of scoring metrics to determine the suitability models.

Modes of study: Participation in classroom work + project / practical work.

Further information on modes of studies: Active participation in class discussions is required and the completion of a project based on the skills taught in class will need to be completed.

Evaluation: 1-5.

Person(s) in charge: Sebastian Okser

Teaching methods: Lectures 20 h, independent work 60 h.

Recommended year of study: 2. year

Study materials / literature: Academic publications to be distributed during lectures.

BIOI4371 Machine Learning 4 ECTS

Objectives: Machine Learning addresses the problems of identifying patterns from data and making decisions based on these patterns. This course aims at delivering an understanding of this discipline.

Content: We will go through the concepts of under and overfitting, and the curse of dimensionality, which are some of the central problems when applying machine learning for high dimensional data often encountered, for example, in the field of bioinformatics. We investigate how these issues are solved using regularization techniques. A special emphasis is also put on the problems of performance evaluation of machine learning algorithms with cross-validation, which is another concept of great importance in biological sciences, where amount of data available for testing is often very low. As example machine learning methods, we will use variations of regularized least-squares, which are a simple but surprisingly efficient machine learning algorithms.

Modes of study: Participation in classroom work + exercise(s) + written exam.

Evaluation: 1-5.

Person(s) in charge: Tapio Pahikkala

Teaching methods: Lectures and exercises.

Recommended year of study: 2. year

BIOI4380 Bioinformatics Project 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

Modes of study: Project / practical work.

Evaluation: Pass/fail.

Person(s) in charge: Pentti Riikonen, Martti Tolvanen

Teaching methods: Independent work.

Recommended year of study: any

BIOI4390 Major Transitions in Evolution 3 ECTS

Objectives: Overview of 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.

Modes of study: Written exam.

Further information on modes of studies: Final examination on the lectures and selected parts of the literature.

Evaluation: 1-5.

Person(s) in charge: Csaba Ortutay

Teaching methods: Lectures 20 h.

Recommended year of study: 1. year spring.

Study materials / literature: Maynard Smith and Szathmáry (1995) *The Major Transitions in Evolution*.

B. OTHER STUDIES 40 ECTS

B.1. Language studies 0-7 ECTS

Objectives

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/>).

KIEN2022 English: Basic Academic Writing 2 ECTS

Objectives: After the course the student should be able to write a short text in an academic style. They should understand the difference between formal and informal language in an academic context and know how academic and other text styles differ. They should have an understanding of the structure of academic paragraphs and be aware of several devices used to make their text flow. They should be able to punctuate well in English.

Content: Topics covered on the course are academic style and vocabulary, punctuation, paragraph structure, articles, clauses and the format and organization of academic texts. A final assignment of a short academic paper is done by the students.

Modes of study: Participation in classroom work + participation in online teaching + weekly exercises + essay.

Further information on modes of studies: For credit, min. 80% attendance and active participation.

There may be differences in courses taught by N.N. and Brett Dellinger.

Evaluation: Pass/fail.

Person(s) in charge: Henno Parks, Brett Dellinger

Teaching methods: Tutorials 20 h, independent work web-based 30 h. Even though this is a classroom course, we do a lot of work on the Internet both in the lessons and out of class.

There may be differences in courses taught by N.N. and Brett Dellinger.

Recommended year of study: Not for first year students.

Study materials / literature: Found online or provided by the teacher.

KIFF0003 Finnish for Foreigners: Intensive Beginners' Course 5 ECTS

Objectives: After the course the student can communicate in simple and routine tasks requiring a simple and direct exchange of information on familiar and routine matters. He/she can e.g. briefly describe events and activities. The student understands the main points in short messages, announcements and stories. He/she can follow speech which is slow and carefully articulated. The student can write short and simple texts on topics which are familiar or of personal interest. He/she can understand short texts that consist of frequent everyday or job-related language.

Content: Themes:

greetings, introducing oneself, countries, languages and nationalities; the seasons and weather, months and days of the week; numbers, expressing time; colours and other adjectives; home and living; family and relatives; food and eating; shopping; buying and paying; travelling and vehicles; work and professions.

Structures:

vowel harmony; the most common noun types; the genitive stems and consonant gradation; possessive structure; the verb types and conjugation in the present tense; asking questions and responding to them; the use of auxiliary verbs with the main verbs; partitive singular; the local cases in the singular form.

Modes of study: Completion in other languages:

In Finnish: Participation in classroom work + exercise(s) + midterm examination + written exam.

Evaluation: 1-5. Active participation, classroom work, exercises, midterm and final examination.

Person(s) in charge: Pirkko Hölttä (autumn semester), Päivi Paukku (spring semester)

Teaching methods: Tutorials 60 h, independent work 60 h. Midterm examination 2 h, final exam 2 h.

Available only for: Major subject students, minor subject students and graduate students

Recommended year of study: 1. year autumn, 1. year spring.

Study materials / literature: Gehring, S. & Heinzmann, S. 2010. Suomen mestari 1. Saarijärvi 2010.

B.2. Compulsory minor subject studies 0-15 ECTS

Objectives

Every student needs elementary knowledge of molecular biosciences as well as method sciences (IT, mathematics, statistics). You need to take courses of the topics you have not covered in your previous studies, or not passed in initial tests, as documented in your Personal Study Plan.

BIOI2210 Introduction to Molecular Biology 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: Participation in online teaching + written exam.

Further information on modes of studies: Intermediate and final examination on lectured topics and selected parts of the books below.

Evaluation: 1-5.

Person(s) in charge: Mauno Vihinen

Teaching methods: Lectures 20 h. Assignments and/or essays, tutorial sessions.

Recommended year of study: 1. year autumn.

Time: Periods I, II

Study materials / literature: Watson-Baker-Bell-Gann-Levine-Losick: Molecular Biology of the Gene (6th Ed., 2008).

Further information: Organization Responsible: Tampere IBT

BIOI2220 Introduction to Biochemistry 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: Written exam + participation in online teaching.

Further information on modes of studies: Intermediate and final examination on the lectures and selected parts of the literature below.

Evaluation: 1-5.

Person(s) in charge: Martti Tolvanen

Teaching methods: Lectures 20 h. Compulsory on-line assignments, tutorial sessions.

Recommended year of study: 1. year autumn.

Time: Periods I, II

Study materials / literature: 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).

Further information: Organization Responsible: Tampere IBT

BIOI2230 Introduction to Genetics 3 ECTS

Objectives: Understanding heritability and evolution; elementary knowledge of experimental methods of genetics.

Content: Basics of classical genetics, cytogenetics, population genetics, evolution and medical genetics.

Modes of study: Participation in classroom work + exercise(s) + written exam.

Further information on modes of studies: In-class exercises, compulsory on-line assignment, final examination on lectured & exercised topics.

Evaluation: 1-5.

Person(s) in charge: Eric Dufour

Teaching methods: Lectures 16 h, exercises 8 h. Lectures, in-class exercises, compulsory on-line assignment

Recommended year of study: 1. year

Time: Period I

Study materials / literature: Will be presented during first lecture.

Further information: Organization Responsible: Tampere IBT

BIOI2250 Introduction to Programming 6 ECTS

Objectives: The course targets students with no prior programming experience. The students will acquire basic skills in algorithm design and programming, learning to write simple, practical programs in the Python programming language. The course is not suitable for students who do have prior programming experience and want to learn Python as an additional language.

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.

Modes of study: Exercise(s) + written exam.

Further information on modes of studies: One half of the exercises time is devoted to in-class programming assignments.

Evaluation: 1-5.

Person(s) in charge: Erkki Kaila

Teaching methods: Lectures 40 h.

Recommended year of study: 1. year autumn.

Time: Periods I, II

Study materials / literature: Lecture notes; Python documentation.

BIOI2260 Introduction to Computer Science 3 ECTS

Objectives: The course targets students with biological background. The objective is to gain basic understanding of fundamental concepts in computer science to facilitate interdisciplinary communication in bioinformatics. The course also provides necessary background for the follow-up courses on algorithms in bioinformatics.

Content: The course provides an overview of the most important concepts in computer science. 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.

Modes of study: Exercise(s) + written exam.

Evaluation: 1-5.

Person(s) in charge: Erkki Kaila

Teaching methods: Lectures 18 h.

Recommended year of study: 1. year autumn.

Time: Period I

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

BIOI2270 Introduction to Statistics 3 ECTS

Objectives: Students 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.

Modes of study: Exercise(s) + project / practical work.

Evaluation: 1-5.

Person(s) in charge: Juho Heimonen

Teaching methods: Lectures, exercises, project work.

Recommended year of study: 1. year spring.

Time: Period III

Study materials / literature: Lecture notes.

BIOI2290 Mathematics for Bioinformatics 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). Ability to calculate with complex numbers and matrices (also determinant, eigenvalues and eigenvectors), and define extremum values of a given function. Capability to analyze and solve elementary differential equations.

Content: Essential mathematics methods with applications to bioinformatics. The course content includes probability theory, complex numbers, matrices, ordinary differential equations, extremum values.

Modes of study: Participation in classroom work + written exam.

Further information on modes of studies: Participation in classroom work (50% of home exercises must be completed) and Moodle activity (at least 4 participations at the course discussion forum in Moodle).

Evaluation: 1-5.

Person(s) in charge: Paula Steinby

Teaching methods: Lectures 14 h, exercises 10 h.

Recommended year of study: 1. year autumn.

Time: Period II

Study materials / literature: Lecture notes and supplementary books.

B.3. Optional studies 18-40 ECTS

Objectives

Optional studies allow focusing on specific topics in bioinformatics and/or provide support in relevant minor subjects. Bioinformatics courses are highly recommended, but you may also choose to build up knowledge of methodological sciences (IT, math, etc.) or biological sciences. Optional courses must be approved by the staff and will be written down in the PSP.

C. MASTER'S THESIS 40 ECTS

Objectives

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

BIOI4031 Master's Thesis 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: Thesis / dissertation + seminar + maturity test.

Evaluation: Approbatur/laudatur. 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.

Person(s) in charge: Tapio Salakoski

Recommended year of study: 2. year