



Bioinformatics MSc

Vrije Universiteit Amsterdam - Faculteit der Exacte Wetenschappen - M Bioinformatics - 2013-2014

Research in Bioinformatics in its broadest definition concerns the analysis of informational processes within living systems with the help of computers. To do this successfully, Bioinformatics actively uses and integrates contributions from areas such as Mathematics, Computer Science, Chemistry, Medicine and Biology. Bioinformatics has recently become one of the keywords in the life sciences as well as in Biotechnological and Pharmaceutical industries. Although in essence the field exists for over two decades and bioinformatics techniques developed over the years have come of age, the field has gained major prominence relatively recently, owing mostly to the world-wide human genome projects and subsequent structural and functional genomics initiatives. While the complete human genome sequence has been obtained at relatively little cost of around two billion Euros, the current investments in for example proteomics industries amount to orders of magnitude more. Also other genomic technologies, aimed at gaining insight in human physiological functioning such as microarray (gene chip) technology, have attracted multi-billion Euro investments both in industry and academia. Currently, many new small/medium enterprises (SMEs) and large international biotechnological and pharmaceutical companies are actively recruiting bioinformaticians, but experience hardship in doing so due to the lack of individuals with proper training. Similar problems are encountered at national academic centres in The Netherlands, particularly in microarray centres. As the interpretation of the data coming from all the above large-scale projects is crucially depending on the application and creation of new bioinformatics techniques, it is clear that a broad based and integrative master's curriculum in bioinformatics at the Vrije Universiteit is timely.

It is possible to study for a Master's degree at the Vrije Universiteit as of September 2003. The international Bioinformatics Master study takes 2 years and is organised by the Integrative Bioinformatics Institute VU (IBIVU), a multidisciplinary centre within the Vrije Universiteit in which three faculties (Faculty of Sciences; Faculty of Earth and Life Sciences; and the Faculty of Psychology) and the VU Medical Centre take part. To prepare for the Bioinformatics master course, various Bachelor programmes at the Vrije Universiteit offer integral courses in Bioinformatics, such as Medical Natural Sciences and Biomolecular Sciences. These Bachelor programmes (taking 3 years) are dedicated to providing the student with a broad and thorough basis in each of their areas of study, which is indispensable for starting the Bioinformatics Master programme. The Bioinformatics Master's provides the student with an opportunity to deepen his/her knowledge of the various aspects of Bioinformatics, while the student has ample possibility to specialise in one or a few areas of choice. It is expected that the breadth and flexibility of the masters programme resulting from the multi-disciplinary setup of the Integrative Bioinformatics Institute as well as the emphasis on creating bioinformatics tools from the strong embedding in the Informatics department (e.g. AI, Computer Systems) will be attractive for students.

The Bioinformatics Master studies are currently organised by the Faculty of Sciences and the Faculty of Earth and Life Sciences. The latest information can always be found at: <http://www.ibivu.cs.vu.nl/>.

Depending on the individual furnishing of his/her Master programme, the student can attend lectures in other faculties and centres, for example Biology or the Centre for Neurogenomics and Cognitive Research (CNCR). Graduation projects can vary from practical to rather fundamental, depending on the preferences and capacities of the students. Students can also go to companies, research institutes or universities either in The Netherlands or abroad.

Study advice is open to all. Advisor prof. dr. Jaap Heringa can be contacted at all times. Furthermore, the website <http://www.ibivu.cs.vu.nl/> contains information regarding the international Bioinformatics Master programme.

[Formal_procedures_during_your_master](#)

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Compulsory optional Courses Systems Biology Major

Vakken:

Naam	Periode	Credits	Code
Statistics with R	Periode 5	6.0	AM_470637
Synthetic Biology and Biomedicine	Periode 4	6.0	X_418125

Optional Courses

Note: Every programme, including the choice of optional courses, has to be discussed and agreed upon with the master coordinator or a personal mentor and approved by the Examination Board.

Vakken:

Naam	Periode	Credits	Code
Calculus	Periode 1+2	6.0	X_400617
Data Mining Techniques	Periode 5	6.0	X_400108
Machine Learning	Periode 4	6.0	X_400154
Molecular Microbial Physiology (UvA)		6.0	AM_470632UvA
Signal Transduction in Health and Disease	Periode 2	6.0	X_432535

Compulsory Courses

The Master program Bioinformatics and Systems Biology is a 2 year full-time course, comprising 120 credits from the European Credit Transfer System (ECTS). This approximately entails 10 months of course work (60 ECTS) and 10 months of practical research (60 ECTS).

Within the Master program of Bioinformatics and Systems Biology a choice between a Systems Biology major and Bioinformatics major needs to be made. It is also possible to choose both majors.

The classes consist of:

- * Compulsory courses 42 credits
- * Optional courses 18 credits
- * First internship (Major) 30-42 credit
- * Second internship (Minor) 18-30 credits

Note: Every programme, including the choice of optional courses, has to be discussed and agreed upon with the master coordinator or a personal mentor and approved by the Examination Board.

Vakken:

Naam	Periode	Credits	Code
Biosystems Data Analysis	Periode 3	6.0	X_437001
First internship (Major)	Ac. Jaar (september)	42.0	X_405027
Fundamentals of Bioinformatics	Periode 1	6.0	X_405052
Introduction to Systems Biology	Ac. Jaar (september), Periode 1	6.0	AM_470631
Second Internship (Minor)	Ac. Jaar (september)	18.0	X_405032
Seminar Series and Writing a Research Proposal	Ac. Jaar (september)	6.0	X_400594

Compulsory Courses Bioinformatics Major

Vakken:

Naam	Periode	Credits	Code
Algorithms in Sequence Analysis	Periode 2	6.0	X_405050
Bioinformatics for Translational Medicine	Periode 5	6.0	X_405092
Structural Bioinformatics	Periode 4	6.0	X_405019

Compulsory Courses Systems Biology Major

Vakken:

Naam	Periode	Credits	Code
Basic Models of Biological Networks	Periode 4	6.0	AM_470633
Systems Biology in Practice (VU/UvA)	Periode 2	6.0	AM_470634

Algorithms in Sequence Analysis

Vakcode	X_405050 (405050)
Periode	Periode 2
Credits	6.0
Voertaal	Engels
Faculteit	Faculteit der Exacte Wetenschappen
Coördinator	prof. dr. J. Heringa
Docent(en)	prof. dr. J. Heringa
Lesmethode(n)	Hoorcollege, Werkcollege
Niveau	400

Doel vak

Have you ever wondered how we can track a gene across 3 billion years of evolution? Sequence alignment can be used to compare genes from humans and bacteria, using a dynamic programming algorithm. Here we focus on algorithms that can be applied to real scientific problems in biology.

Students will obtain an in depth knowledge about the theory of sequence analysis methods.

Students will also develop understanding and skills to apply the algorithms to protein and DNA sequences. We would like to stress that no biological knowledge is required to enter this course.

Goals

- At the end of the course, the student will be aware of the major issues, methodology and available algorithms in sequence analysis.
- At the end of the course, the student will have hands-on experience in tackling biological problems using sequence analysis algorithms and applying the general statistical framework of Hidden Markov Models.
- At the end of the course, the student will be able to implement several of the most important algorithms in sequence analysis.

Inhoud vak

Theory:

- Dynamic programming, database searching, pairwise and multiple alignment, probabilistic methods including hidden markov models, pattern matching, entropy measures, evolutionary models, and phylogeny.

Practical:

- Programming own alignment algorithm based on dynamic programming
- Reverse translation and dynamic programming
- Homology searching and pattern recognition using biological and disease examples
- Multiple alignment of biological sequences
- Entropy-based functional residues prediction
- Programming own implementation of Hidden Markov Models

Onderwijsvorm

13 Lectures: 2 two-hour lectures per week

6 computer practicals and associated assignments: 2 two-hour hands-on sessions per week

Toetsvorm

The final grade for this course will consist of 50% practical work (see above) and 50% theoretical assessment.

The theoretical assessment will be an oral and/or written exam (depending on number of students).

Literatuur

Course material on bb.vu.nl

Books: Durbin, R., Eddy, S.R., Krogh, A., Mitchison, G.. Biological Sequence Analysis. Cambridge University Press, 1998, 350 pp., ISBN 0521629713.

Recommended reading: Marketa Zvelebil and Jeremy O. Baum Understanding Bioinformatics Garland Science 2008 ISBN-10: 0-8153-4024-9

Vereiste voorkennis

Bachelor in any science discipline (including medicine).

Basic programming skills and an interest in biological problems.

Doelgroep

mAI, mBio, mCS

Overige informatieSigning up via bb.vu.nl is mandatory.

The course is taught in English.

Basic Models of Biological Networks

Vakcode	AM_470633 ()
Periode	Periode 4
Credits	6.0
Voertaal	Nederlands
Faculteit	Fac. der Aard- en Levenswetenschappen
Docent(en)	prof. dr. J. Hulshof, prof. dr. B. Teusink, prof. dr. F.J. Bruggeman
Lesmethode(n)	Hoorcollege, Computerpracticum, Werkgroep

Doel vak

The aim of this course is to introduce the students to basic mathematical modeling approaches for the molecular networks that play a role in cell biology, i.e. signaling networks, gene networks, and metabolic networks. In modern cell biology and systems biology, mathematical models are used to understand how molecular properties of enzymes and regulatory proteins give rise to emergent, functional properties of molecular networks, such as the sensitivity of signaling networks to signals, the control of flux through metabolic pathways, and the regulation of gene expression. The final attainment levels are; the students will have a basic understanding of:

- mass-action and enzyme kinetics
- thermodynamic equilibrium and steady states
- diffusion processes and rate constants
- mass balances (ordinary differential equations)
- stoichiometric network analysis
- flux balance analysis
- stability of steady states and elementary bifurcations

Inhoud vak

- mass balances, mass-action kinetics
- steady state versus thermodynamic equilibrium
- diffusion and second-order rate constants
- enzyme kinetics, cooperative enzymes, allosteric regulation
- stoichiometric network analysis
- left and right nullspace of stoichiometric matrix
- linear programming and flux balance analysis
- elementary stability analysis and bifurcations

Onderwijsvorm

Lectures (3x a week; 4.5 hours/week)

Computer practical (1x week; 2 hrs/week)

Work group (exercises) (2x week; 4 hrs/week)

Toetsvorm

Written exam

Literatuur

Syllabus

Aanbevolen voorkennis

Basic mathematics: ordinary differential equations, calculus, linear algebra

Doelgroep

Master students in cell biology, systems biology, bioinformatics, biochemistry, biophysics
Bachelor students in mathematics and theoretical physics

Overige informatie

Course co-ordinator: dr. F.J. Bruggeman

Bioinformatics for Translational Medicine

Vakcode	X_405092 ()
Periode	Periode 5
Credits	6.0
Voertaal	Engels
Faculteit	Faculteit der Exacte Wetenschappen
Coördinator	dr. S. Abeln
Docent(en)	prof. dr. J. Heringa
Lesmethode(n)	Hoorcollege, Practicum
Niveau	400

Doel vak

Observations from biological high-throughput experiments will allow us to improve diagnosis and give a personalised treatment plan for patients. However, integrating data from several sources and using this data for predictions is non-trivial.

This is a theoretical and practical Bioinformatics course on computational methods for Translational Medicine; we will focus on Bioinformatics algorithms that are used to predict the clinical outcome for patients and analysis methods to obtain deeper understanding of complex diseases, by combining data from various high-throughput experiments such as proteomics, microarrays and next-generation sequencing as well as existing biological databases.

goals

- At the end of the course, students will be aware of Bioinformatics methods that are applicable to the area of Translational Medicine.
- Students should be able to combine these methods to come to a creative solution to get new insights from large scale biological experiments.
- At the end of the course, students will have hands-on experience in handling large biological datasets, and will understand the complexity of the biological data both from high-throughput experiments and existing biological databases.
- The student will become familiar with a few in depth research topics that lie within the expertise area of several (Bioinformatics)

researchers at the VU, UvA and VUMC.

Inhoud vak

Theory

- Computational analysis of molecular profiling techniques, such as: proteomics, RNA sequencing, exome sequencing, arraCGH.
- Computational methods include: normalisation, feature selection, classification, read mapping, clustering.
- All data analysis is relevant in a clinical setting, for diagnosis, treatment decisions or biomarker discovery.

Practical:

- Classification Assessment of Tumor Subtypes (CATS): This is a large assignment for which you have to build a classifier that can discriminate different tumor subtypes based on arrayCGH profiles. You need to hand in predictions (class contest), write a paper and give a presentation. Note that this is a group project.

Three small data analysis practicals are also given on:

- Exome sequencing
- RNA sequencing
- Proteomics

Onderwijsvorm

- 13 Lectures (2 two-hour lectures per week)
- 12 computer practicals (2 two-hour sessions per week)

Toetsvorm

The final grade for this course will consist of 65% practical work (see above) and 35% theoretical assessment.

Practical assessment (65%):

- CATS assignment (35%)
- 3 data analysis assignments (30%)

Theoretical assessment: (35%)

- Oral or written exam (depending on number of course students).
- As part of the exam a research paper on a Bioinformatics method needs to be analysed in detail and you need to write a small research proposal based on the paper.

Literatuur

- course material on bb.vu.nl
- Marketa Zvelebil and Jeremy O. Baum Understanding Bioinformatics Garland Science 2008 ISBN-10: 0-8153-4024-9

Aanbevolen voorkennis

An interest in Biological problems.

Doelgroep

mAI, mBio, mCS

Overige informatie

Signing up via bb.vu.nl is mandatory.
The course is taught in English.

- Compulsory course for students in MSc of Bioinformatics.

- Optional course for students with Bachelor Physics, Chemistry, Mathematics, Computer Science, Biology, or Biomedical Sciences.

Biosystems Data Analysis

Vakcode	X_437001 (437001)
Periode	Periode 3
Credits	6.0
Voertaal	Engels
Faculteit	Faculteit der Exacte Wetenschappen
Niveau	400

Inhoud vak

The course description is available at

<http://studiegids.uva.nl/web/uva/sgs/en/c/12461.html>

Doelgroep

mBio, mCh

Overige informatie

Course registration at the UVA is compulsory at least 4 weeks before the start of the semester via <https://www.sis.uva.nl>

Calculus

Vakcode	X_400617 ()
Periode	Periode 1+2
Credits	6.0
Voertaal	Nederlands
Faculteit	Faculteit der Exacte Wetenschappen
Coördinator	drs. J.A. Los
Docent(en)	dr. C.M. Quant, drs. J.A. Los
Lesmethode(n)	Hoorcollege, Werkcollege, Deeltoets extra zaalcapaciteit
Niveau	100

Doel vak

Kunnen toepassen van basale calculustechnieken in vraagstukken. Vertalen van een eenvoudige praktijkbeschrijving naar een calculusopgave. Zelfstandig bestuderen van wiskundetekst in de Engelse taal.

Inhoud vak

Complexe getallen, ongelijkheden, goniometrie, functies van één reële veranderlijke: limiet, continuïteit, afgeleide met toepassingen, l'Hospital, primitieve, substitutie en partiële integratie, eenvoudige differentiaalvergelijkingen.

Toetsvorm

Twee deeltentamens en wekelijkse digitale toetsen. De precieze regeling wordt via blackboard bekend gemaakt.

Literatuur

Adams, Robert A and Essex, Christopher, Calculus: a complete course, 8th Edition, Pearson, 2013. Let er bij de eventuele aanschaf van een

tweedehands exemplaar op dat de kaart die toegang geeft tot de MyMathLab Global toetsomgeving bij het boek aanwezig is en nog niet gebruikt is!

Overige informatie

Voor 1 jrs SBI, Far en MNW begonnen in 2010/2011: Dit vak vervangt Basiswiskunde (X_401069) en Calculus 1 (X_400300)

Dit vak maakt deel uit van de Minor Bioinformatics and Systems Biology

Bij dit vak is deelname aan de werkcolleges verplicht (de exacte regeling wordt bekend gemaakt in de studiehandleiding).

Data Mining Techniques

Vakcode	X_400108 (400108)
Periode	Periode 5
Credits	6.0
Voertaal	Engels
Faculteit	Faculteit der Exacte Wetenschappen
Coördinator	dr. M. Hoogendoorn
Docent(en)	dr. M. Hoogendoorn
Lesmethode(n)	Hoorcollege
Niveau	500

Doel vak

The aim of the course is that students acquire data mining knowledge and skills that they can apply in a business environment. How the aims are to be achieved: Students will acquire knowledge and skills mainly through the following: an overview of the most common data mining algorithms and techniques (in lectures), a survey of typical and interesting data mining applications, and practical assignments to gain "hands on" experience. The application of skills in a business environment will be simulated through various assignments of the course.

Inhoud vak

The course will provide a survey of basic data mining techniques and their applications for solving real life problems. After a general introduction to Data Mining we will discuss some "classical" algorithms like Naive Bayes, Decision Trees, Association Rules, etc., and some recently discovered methods such as boosting, Support Vector Machines, and co-learning. A number of successful applications of data mining will also be discussed: marketing, fraud detection, text and Web mining, possibly bioinformatics. In addition to lectures, there will be an extensive practical part, where students will experiment with various data mining algorithms and data sets. The grade for the course will be based on these practical assignments (i.e., there will be no final examination).

Onderwijsvorm

Lectures and compulsory practical work. Lectures are planned to be interactive: there will be small questions, one-minute discussions, etc.

Toetsvorm

Practical assignments (i.e. there is no exam). There will be three assignments mostly done in groups of three. There is a possibility to

get a grade without doing these assignments: to do a real research project instead (which will most likely to involve more work, but it can also be more rewarding).

Literatuur

Ian H. Witten, Eibe Frank, Mark A. Hall, Data Mining: Practical Machine Learning Tools and Techniques (Third Edition). Morgan Kaufmann, January 2011
ISBN 978-0-12-374856-0

Aanbevolen voorkennis

Kansrekening en Statistiek of Algemene Statistiek (knowledge of statistics and probabilities) or equivalent. Recommended: Machine Learning.

Doelgroep

mBA, mCS, mAI, mBio

First internship (Major)

Vakcode	X_405027 (405027)
Periode	Ac. Jaar (september)
Credits	42.0
Voertaal	Engels
Faculteit	Faculteit der Exacte Wetenschappen
Coördinator	prof. dr. J. Heringa
Niveau	400

Doel vak

The first internship (Major) can consist of 30 till 42 credits in steps of 3 credits. The Major and Minor internships together will account for a total of 60 credits.

During the major internship, students will carry out a large in-depth project, thereby learning to work in a consistent and goal-oriented way, whilst enhancing their communication and scientific reporting skills in English, both written and orally.

The Integrative Bioinformatics Centre's (IBIVU) broad, multidisciplinary structure allows you to work on a wide variety of subjects at the VU. External internships, nationally or internationally, in academic institutions, academic hospitals, or R&D departments in industry are also possible. There is no mandatory order of the internships, students can either start with a Major or a Minor internship.

Inhoud vak

Depending on the student's profile, i.e. bioinformatics or systems biology, projects can be chosen in fundamental bioinformatics or systems biology research. Projects may also can be more applied, but are required to have a dominant bioinformatics or systems biology component.

Students in the master's Bioinformatics and Systems Biology have the possibility to arrange their major and minor internships within the Atlantis financed CanSys programme, which is an exchange programme, with a focus on cancer, between the VU, the University of Luxembourg, and the Roswell Cancer Centre in Buffalo, USA. Students in this programme carry

out a 3-month minor internship in Luxembourg, and a 7-month major internship in Buffalo.

Onderwijsvorm

The student will have a daily supervisor, with whom interaction takes place according to a master-apprentice model, and a formally responsible supervisor from the VU.

Toetsvorm

The internship will be assessed on three components: (i) project progress, (ii) written report, and (iii) final presentation, which will count for 1/2, 1/3 and 1/6, respectively. After one to three months, depending on the duration of the internship, the student will present an initial seminar, explaining the structure of the project and the major research question(s).

Literatuur

Course reading will be advised by the host institution.

Aanbevolen voorkennis

It is mandatory that students in the bioinformatics and systems biology master's programme have completed their conversion classes in programming (bioinformatics profile) or mathematics (systems biology profile) before embarking on their major or minor internship.

Doelgroep

MSc Bioinformatics and Systems Biology

Overige informatie

The internship should be approved by the study mentor prior to commencement, and an internship contract, stipulating the expected number of hours of supervision per week, should be signed by the host institution and the VU.

Note: Every programme, including the choice of optional courses, has to be discussed and agreed upon with the master coordinator or personal mentor and approved by the Examination Board.

Fundamentals of Bioinformatics

Vakcode	X_405052 (405052)
Periode	Periode 1
Credits	6.0
Voertaal	Engels
Faculteit	Faculteit der Exacte Wetenschappen
Coördinator	dr. ir. K.A. Feenstra
Docent(en)	dr. ir. K.A. Feenstra
Lesmethode(n)	Hoorcollege, Werkcollege, Deeltoets extra zaalcapaciteit, Computerpracticum
Niveau	400

Doel vak

Interested in Bioinformatics? Or you want to find out how biology can make an exciting application domain? Or you want to learn how what more you could do with your data, and with less effort? Enter here to start!

Fundamentals of Bioinformatics (FoB) is the starting course of the Bioinformatics master. It aims to give a broad overview of important topics relevant to the field, with a focus on current open problems. Students will be made aware of these open problems during practical sessions that aim to let the student 'stumble upon' these problems by him/her self. Based on their background, students will be assigned to separate classes where they will be working to fill gaps in their background knowledge in programming and/or biology.

Goals:

- To make the students aware of gaps in their own background knowledge.
- The student will be aware of the major issues, methodology and available algorithms in bioinformatics.
- To work together in a group of diverse backgrounds.
- To gain hands-on experience in scripting and handling basic mathematical equations as a means of solving bioinformatics problems.
- To develop a basic understanding of major concepts in genomics and molecular cell biology that are relevant to current topics in bioinformatics.

Inhoud vak

Theory:

- Evolution, Genomes, Sequences, Blast/PSI-Blast, Semantic Web, Multi-omics, Next-generation Sequencing

Practical:

- Exercises during/in between lectures
- Project in groups to solve a major bioinformatics problem. The groups will be composed to include each of the three major background areas: bioinformatics, biology and computer science. Success of the group project will depend on the level of cooperation!

Onderwijsvorm

- 12 Lectures (two hour lecture in the morning, two days per week)
- 12 Computer practicals (two hour sessions following the morning lectures, two days per week), partially supervised.
- Project work

Toetsvorm

- [30%] Programming or Biology classes
- [30%] Project and group work
- [40%] Oral or written exam (depending on number of course students) to assess:

Exercises

Project results (individual)

Lecture topics

Literatuur

- course material (slides, scientific papers) on bb.vu.nl
- Marketa Zvelebil and Jeremy O. Baum Understanding Bioinformatics Garland Science 2008 ISBN-10: 0-8153-4024-9

Aanbevolen voorkennis

Bachelor in any science discipline (including medicine), or strong programming background.

An interest in programming and biological problems.

Doelgroep

mAI, mBio, mCS

Overige informatieSigning up via bb.vu.nl is mandatory.**Introduction to Systems Biology**

Vakcode	AM_470631 ()
Periode	Ac. Jaar (september), Periode 1
Credits	6.0
Voertaal	Engels
Faculteit	Fac. der Aard- en Levenswetenschappen
Coördinator	dr. D. Molenaar
Docent(en)	prof. dr. B. Teusink, dr. D. Molenaar, prof. dr. F.J. Bruggeman, prof. dr. R. Kort
Lesmethode(n)	Hoorcollege, Werkgroep, Computerpracticum

Doel vak

Introduction to Systems Biology is the starting course of the Bioinformatics and Systems Biology master (together with Fundamentals of Bioinformatics). It aims to give a broad overview of important topics relevant to the field of Systems Biology, with a focus on current open problems. Students will be made aware of these open problems during practical sessions that aim to let the student 'stumble upon' these problems by him/her self. Based on their background, students will be assigned to separate classes where they will be working to fill gaps in their background knowledge in mathematics, programming and/or biology.

Goals:

- To make the students aware of gaps in their own background knowledge.
- To make the student acquainted with the major issues, concepts and methodology in systems biology (to be studied in more detail in the master)
- To develop a basic understanding of major biological concepts in genomics and cell biology that are relevant to current topics in systems biology
- To work together in a group of diverse backgrounds
- To gain hands-on experience in basic modeling as a means of solving systems biology problems

Inhoud vak

Theory:

- (Design principles of) biological networks, basic modeling approaches, evolution

Practical:

- Exercises during/in between lectures
- Project in groups to apply systems biology to a specific topic of choice (combined literature and modeling). The groups will be composed to include each of the three major background areas: bioinformatics, biology and computer science, Cooperation will be encouraged and graded (!).

Onderwijsvorm

- Lectures (two hour lecture in the morning, two days per week)
- Computer practicals (three hour sessions in the afternoon following the morning lectures, two days per week), partially supervised.
- Refreshment classes in biology, mathematics and/or programming
- Project work

Toetsvorm

- [30%] Mathematics, Programming or Biology classes
- [30%] Assignments and exercises
- [40%] Project plus presentation

Literatuur

course material (slides, scientific papers) on bb.vu.nl

Machine Learning

Vakcode	X_400154 (400154)
Periode	Periode 4
Credits	6.0
Voertaal	Engels
Faculteit	Faculteit der Exacte Wetenschappen
Coördinator	dr. E.W. Haasdijk
Docent(en)	dr. E.W. Haasdijk
Lesmethode(n)	Hoorcollege, Werkcollege
Niveau	300

Doel vak

The goal of this course is to present the dominant concepts of machine learning methods including some theoretical background. We'll cover established machine learning techniques such as Decision Trees, Neural Networks, Bayesian Learning, Instance-based Learning and Evolutionary Algorithms as well as some statistical techniques to assess and validate machine learning results.

Inhoud vak

Machine Learning is the study of how to build computer systems that learn from experience. It is a very active subfield of Artificial Intelligence that intersects with statistics, cognitive science, information theory, and probability theory, among others. Recently, Machine Learning has gained great importance for the design of search engines, robots, and sensor systems, and for the processing of large scientific data sets. Further applications include handwriting or speech recognition, image classification, medical diagnosis, stock market analysis, bioinformatics, etc.

Onderwijsvorm

The course will be taught in two parts; the first part consists of lectures with written examination. The second part of the course will have a more do-it-yourself character (e.g., practical assignment and/or literature research) and result in a report and/or presentation.

The course will be taught in English.

Literatuur

NNB

Doelgroep

3BA, 3BA-D, 3CS, 3LI, 3IMM, mBio

Molecular Microbial Physiology (UvA)

Vakcode	AM_470632UvA ()
Credits	6.0
Voertaal	Nederlands
Faculteit	Fac. der Aard- en Levenswetenschappen

Doel vak

To get acquainted with the theoretical background on bacterial growth, energetic, and signal transduction and on the underlying mechanisms at the molecular level.

Inhoud vak

The focus will be on how to integrate biochemical principles and molecular mechanisms in order to understand microbial behavior and performance. With the theory of steady state growth in chemostat cultures as framework, growth kinetics and the bioenergetics of microbial growth will be treated, including yield values and flux analysis. Adaptive responses will be treated at the molecular level by lectures on signal perception, signal transduction and finally signal processing. Further, it will be demonstrated that knowledge of the mechanisms of adaption and their physiological effects is essential to rationally design new metabolic pathways in synthetic biology and to maximize the performance of microorganisms.

Onderwijsvorm

Lectures, self-study, scientific publications

Toetsvorm

Written exam and presentations

Literatuur

Course syllabus and papers

Second Internship (Minor)

Vakcode	X_405032 (405032)
Periode	Ac. Jaar (september)
Credits	18.0
Voertaal	Engels
Faculteit	Faculteit der Exacte Wetenschappen
Coördinator	prof. dr. J. Heringa
Niveau	400

Doel vak

The second internship (Minor) can consist of 18 till 30 credits in steps of 3 credits. The Major and Minor internships together will account for a total of 60 credits.

During the major internship, students will carry out a large in-depth project, thereby learning to work in a consistent and goal-oriented way, whilst enhancing their communication and scientific reporting skills in English, both written and orally. The minor internship should be different from the major internship, and should be hosted by a different department, section or group, if taking place at the same institution hosting the major internship.

The Integrative Bioinformatics Centre's (IBIVU) broad, multidisciplinary structure allows you to work on a wide variety of subjects at the VU. External internships, nationally or internationally, in academic institutions, academic hospitals, or R&D departments in industry are also possible.

Inhoud vak

Depending on the student's profile, i.e. bioinformatics or systems biology, projects can be chosen in fundamental bioinformatics or systems biology research. Projects may also be more applied, but are required to have a dominant bioinformatics or systems biology component.

Students can choose to assemble a team and together enter the International Genetically Engineered Machine (iGEM) competition. This is a worldwide synthetic biology competition that was initially aimed at groups of undergraduate university students, but has since expanded to include divisions for high school students and entrepreneurs. Preparatory work for iGEM will take place during the summer and will count as a minor internship.

Students in the master's Bioinformatics and Systems Biology have an additional possibility to arrange their major and minor internships within the Atlantis financed CanSys programme, which is an exchange programme, with a focus on cancer, between the VU, the University of Luxembourg, and the Roswell Cancer Centre in Buffalo, USA. Students in this programme carry out a 3-month minor internship in Luxembourg, and a 7-month major internship in Buffalo.

Onderwijsvorm

The student will have a daily supervisor, with whom interaction takes place according to a master-apprentice model, and a formally responsible supervisor from the VU.

Toetsvorm

The internship will be assessed on three components: (i) project progress, (ii) written report, and (iii) final presentation, which will count for 1/2, 1/3 and 1/6, respectively. After one to three months in the project, depending on the duration of the internship, the student will present an initial seminar, explaining the structure of the project and the major research question(s).

Literatuur

Course reading will be advised by the host institution.

Aanbevolen voorkennis

It is mandatory that students in the bioinformatics and systems biology master's programme have completed their conversion classes in programming (bioinformatics profile) or mathematics (systems biology profile) before embarking on their major or minor internship.

Doelgroep

MSc Bioinformatics and Systems Biology

Overige informatie

The internship should be approved by the study mentor prior to commencement, and an internship contract, stipulating the expected number of hours of supervision per week, should be signed by the host institution and the VU.

Note: Every programme, including the choice of optional courses, has to be discussed and agreed upon with the master coordinator or personal mentor and approved by the Examination Board.

Seminar Series and Writing a Research Proposal

Vakcode	X_400594 (400594)
Periode	Ac. Jaar (september)
Credits	6.0
Voertaal	Engels
Faculteit	Faculteit der Exacte Wetenschappen
Coördinator	dr. ir. K.A. Feenstra
Lesmethode(n)	Hoorcollege
Niveau	500

Doel vak

You have a brilliant research idea, and would need about a million euro's to try it out – how do you communicate the idea in your mind to others, and make them enthusiastic enough that they will trust you with their money? You will write a real proposal on a current open bioinformatics problem of your own choosing, and defend it in front of an expert and experienced review committee.

Seminar Series and Writing a Research Proposal is intended to make students acquainted with the academic practice of writing and defending research proposals.

Goals:

- * The student will be aware of the major issues and methodology in a selected bioinformatics topic area.
- * The student will have hands-on experience in writing a Bioinformatics research proposal.
- * The student will have some exposure to a semi-realistic proposal procedure.

Inhoud vak

Theory:

- * A short induction into research proposals (calls, budgets, Gantt)

Practical:

- * Attendance of a minimum of three scientific seminars on bioinformatics topics, and short report
- * Design of a one million euro research proposal on a selected bioinformatics topic
- * Defense of the proposal in front of an ad-hoc committee of bioinformatics experts

* Revision of the proposal based on the feedback received after the defense

Onderwijsvorm

on individual basis, possibly with an introductory lecture depending on the number of students

Toetsvorm

[50%] Work (proposal writing)

[33%] Proposal (report)

[17%] Oral proposal defence (10 minutes presentation, 20 minutes questions) in front of a mock committee.

Literatuur

manual and further material on

http://wiki.cs.vu.nl/mp/index.php/Bioinformatics_and_Systems_Biology_Research_Proposal

Aanbevolen voorkennis

All compulsory courses in the MSc Bioinformatics and Systems Biology programme, including those of the chosen profile.

A good grasp of major bioinformatics research themes, open questions and methods is recommended; in practice this means this course is best taken after one or both internships.

Doelgroep

Students in the MSc Bioinformatics and Systems Biology only.

Overige informatie

To start the course please make an appointment with the coordinator.

Signal Transduction in Health and Disease

Vakcode	X_432535 (432535)
Periode	Periode 2
Credits	6.0
Voertaal	Engels
Faculteit	Faculteit der Exacte Wetenschappen
Coördinator	prof. dr. M.J. Smit
Docent(en)	dr. M.J. Smit
Lesmethode(n)	Hoorcollege
Niveau	600

Doel vak

At the end of this theoretical course, the students are aware of the latest insights of cellular signal transduction in both healthy and pathological conditions.

Inhoud vak

This course will link human genetic variation (somatic and inherited mutations) to the development of disease and will focus on pathological signaling, mutant signaling proteins in disease and possible treatment of resulting disease (small compounds, biologicals, gene therapy). Modern pharmacological concepts, including constitutive receptor activity, receptor regulation, allosteric modulation and dimerization

will be addressed in light of signal transduction in health and disease. A special focus will be on signal transduction resulting in pathologies such as Alzheimer, Parkinson's disease, inflammatory diseases and cancer.

Onderwijsvorm

Lectures, self-study.

Students will do a case study in groups on a receptor/protein family linked to disease. Molecular mechanisms underlying pathology will be addressed and presented.

Toetsvorm

Assignment and presentation, written exam.

Literatuur

Marks e.a., Cellular Signal Processing. Garland Sci (ISBN 0-8153-4215-2).

Papers available on Blackboard

Aanbevolen voorkennis

Bachelor Biology, Medical Biology, Pharmaceutical Sciences, Medical Natural Sciences, Biomolecular Science portal course or equivalent

Doelgroep

mBMS-BC, mDDS-BCCA, mDDS-CMCT, mDDS-DD&S, mDDS-DDSA, mDDS-DDTF, mDDS-C-var, mDDS-E-var, mDDS-M-var, mMNS-MCD, mMNS-MPy

Statistics with R

Vakcode	AM_470637 ()
Periode	Periode 5
Credits	6.0
Voertaal	Engels
Faculteit	Fac. der Aard- en Levenswetenschappen
Coördinator	dr. D. Molenaar
Docent(en)	dr. W.F.M. Roling, dr. D. Molenaar
Lesmethode(n)	Hoorcollege, Computerpracticum

Doel vak

The goal of the course is to obtain practical skills in the programming environment R for statistical analyses. The course will provide hands-on experience in the treatment and investigation of (biological) datasets. familiarize the students with the intricacies of the modern techniques for data generation and analysis. As a bonus, students will become acquainted with some concepts of higher order programming.

Inhoud vak

Systems biologists often have to handle, analyze, and present analysis results of large sets of biological data, originating from genomics, transcriptomics, proteomics, and metabolomics experiments. In many cases, these tasks cannot be performed using standard "press the button" commercial statistical packages. A popular solution to this problem is the use of the open source statistical programming environment R (<http://www.r-project.org/>). R is intensively used and developed in the community of experimental biologists, and most newly published data

analysis techniques are first available as R-packages. This course focuses on obtaining the practical skills to perform data handling and analysis tasks from small to large data sets, and to graphically display and interpret the results. Statistical analyses will center on uni- and multivariate analysis (e.g. ANOVA, correlation, regression, clustering, and ordination). Examples of the generation and interpretation of large data sets will be presented from the various fields of biology, ranging from cell biology to ecology. The items treated during the lectures will be studied in computer practical sessions using R.

Onderwijsvorm

Lectures, tutorials, computer practical work, self-study

Toetsvorm

Computer assignments

Literatuur

A course syllabus with theory and computer exercises

Doelgroep

Master students with a background in Biology, Biomedical Sciences, Bioinformatics, Physics or Mathematics with an interest in the analysis of large datasets.

Structural Bioinformatics

Vakcode	X_405019 (405019)
Periode	Periode 4
Credits	6.0
Voertaal	Engels
Faculteit	Faculteit der Exacte Wetenschappen
Coördinator	dr. ir. K.A. Feenstra
Docent(en)	dr. ir. K.A. Feenstra, dr. S. Abeln
Lesmethode(n)	Hoorcollege, Practicum
Niveau	400

Doel vak

Why Structural Bioinformatics?

Generally speaking, the function of a protein is determined by its three dimensional structure, and therefore structural information is crucial for understanding the working of proteins. However, experiments, prediction and simulation of protein structures remain difficult. This course will provide you an overview of existing computational techniques, to validate, simulate, predict and analyse protein structures. More importantly, it will provide practical knowledge about how and when to use such techniques.

Goals:

- Being able to evaluate protein structures with knowledge of their experimental source and validation techniques
- Being able to compare different protein structures, and evaluate similarity
- Learning how and when to use structure prediction methods
- Being able to create scripts that connect different Structural Bioinformatics methods.

- Being able to compare different simulation techniques for biological macro-molecules, and be able to analyse the simulated data computationally.
- Reading and understanding scientific papers in the field of Structural Bioinformatics.

Inhoud vak

Theory:

- Protein and DNA structure sources
- Experimental methods
- Structure validation
- Protein fold prediction (from homology modelling to ab initio prediction)
- Structural classification and structural alignment
- Protein folding and energetics
- Molecular Dynamics simulation, & Monte Carlo simulation
- Function from structure

Practical:

- Obtaining geometric features from PDB files
- Homology modelling with Modeller
- Protein unfolding as a 'computational experiment' (simulation).

Onderwijsvorm

13 Lectures (2 two-hour lectures per week)

12 computer practicals (2 two-hour sessions per week)

Feedback (theoretical and practical) will be given during the computer practical sessions.

Toetsvorm

The final grade for this course will consist of 50% practical work and 50% theoretical assessment.

Practical Assignments: (50%)

- (1) Obtaining geometric features from PDB files
- (2) Homology modelling with Modeller (including structural alignment)
- (3) Protein unfolding as a 'computational experiment' (simulation).

Theoretical: (50%)

- Oral or written exam (depending on number of course students).
- As part of the exam a research paper on a Structural Bioinformatics topic needs to be analysed in detail.
- You will be prepared for your exam through exercises and paper discussion during the lectures

Literatuur

- course material on bb.vu.nl

- Marketa Zvelebil and Jeremy O. Baum Understanding Bioinformatics Garland Science 2008 ISBN-10: 0-8153-4024-9

Aanbevolen voorkennis

Bachelor in any science discipline (including medicine).

Basic scripting skills (e.g. Python or Perl) and an interest in biological problems. Note that at the start of the course a small scripting practical will be given, this means that in practice students without scripting experience can follow the course if they are motivated to learn during the course.

Doelgroep

mAI, mBio, mCS

Overige informatie

- Compulsory course for students in Bioinformatics Profile of MSc Bioinformatics & Systems Biology (mBIO).
- Optional course for mAI, mCS, mPDCS, mMNS, mBMOL, mNS, mBIO

Synthetic Biology and Biomedicine

Vakcode	X_418125 ()
Periode	Periode 4
Credits	6.0
Voertaal	Engels
Faculteit	Faculteit der Exacte Wetenschappen

Inhoud vak

<http://studiegids.uva.nl/web/uva/sgs/nl/c/14399.html>

Overige informatie

Opgave via <https://www.sis.uva.nl> tot 4 weken voor aanvang van het semester is verplicht

Course registration at the UVA is compulsory at least 4 weeks before the start of the semester via <https://www.sis.uva.nl>

Systems Biology in Practice (VU/UvA)

Vakcode	AM_470634 ()
Periode	Periode 2
Credits	6.0
Voertaal	Nederlands
Faculteit	Fac. der Aard- en Levenswetenschappen
Coördinator	dr. D. Molenaar
Docent(en)	dr. F.C. Boogerd, prof. dr. B. Teusink, dr. D. Molenaar
Lesmethode(n)	Hoorcollege

Doel vak

To get acquainted with the practicalities of Systems biology: obtaining proper data sets, and subsequent data analysis

Inhoud vak

In the first month, students will practice laboratory and basic mathematical and modeling techniques, and use these in a large experiment that is carried out in the second month. Specifically, the relation between the activity of metabolic routes and gene expression will be studied. Students will learn to combine quantitative experiments and mathematical analysis to understand the interplay between the levels of transcription, translation and metabolism in the cell. As an example, the phenomenon of stress, and the regulation of stress responses in cells will be studied. Stress is a common phenomenon in all species, and can, for instance, be caused by oxygen radicals, by suboptimal osmolarity or temperature or by nutrient starvation. Oxidative (radical)

stress is also a cause of tumors formation. Microorganisms have to cope with various types of stress as well. In this course we study a relatively simple organism, like yeast, to understand the complex molecular mechanisms of adaptation to stress. We will discuss the causes of stress and how cells respond. The changes taking place at the molecular level will be studied, and the various mechanisms will be integrated by mathematical analysis and computer modeling. Experimental methods like quantitative PCR, high performance liquid chromatography, enzymatic assays, Western blotting and chemostat culturing will be used.

Onderwijsvorm

Lectures, self-study, practical work, computer modeling tutorials

Toetsvorm

Written exam, written reports and oral presentations of both practical and literature study, results of computer assignment

Literatuur

A course syllabus with recent reviews and papers presented by the lecturers and guest researchers (max. 15 euros)