Why study Systems Biology at Vilnius University?

Interdisciplinary program that prepares highly-qualified scientists for professional career

The interdisciplinary Systems Biology Master's program prepares students to do real world work in rapidly developing fields including, but not limited to, biological systems modeling, bioengineering, synthetic biology, bioinformatics, neurobiology, and data analysis. It is ideal for current and future biologists who wish to take advantage of the most powerful statistical models and programming tools in order to produce quantifiable results in their field of choice.

Rewarding program structure introduces future life-scientists to powerful statistical models and information technologies

As per its interdisciplinary nature, our program is specifically designed to help students from a life sciences background overcome any apprehensions they may have about working with statistical models and scientific programming tools. Upon completion of the program students will have gained a robust understanding of mathematics and computer science, as well as their varied applications to life sciences.

Similarly, students with computational and bioinformatics backgrounds will have a possibility to gain and deepen their knowledge in molecular and cellular biology and master wetlab skills.

Forward-looking curriculum equips scientists for leadership in rapidly emerging fields

Emerging trends in synthetic biology point us to new fields that focus towards quantitative investigation, experimentation and design at the molecular level. As a result, fields in neurobiology, cell programming, and "-omic" sciences create a vast demand for professionals equipped with both a high-level understanding of biological principles and the ability to take advantage of advanced mathematical and statistical models. The Systems Biology Masters program seeks to meet this demand.

Learning Environment

Leading faculty

The Systems Biology Master's program is developed in collaboration with the Faculty of Medicine, Life Sciences Center and Faculty of Mathematics and Informatics, Vilnius University. Courses are taught by faculty members with a breadth and depth of expertise and experience in private and public institutions.

State-of-the-art facilities

Systems biology classes and hands on work will take place in the auditoriums and laboratories of central campus of Faculty of Medicine(MF) at M.K.Čiurlionio 21/27, Vilnius, department of Human and Medical Genetics at Santariškių g. 2, Vilnius, Center of Life Sciences (GMC) at Saulėtekio al. 9, Vilnius and Faculty of Mathematics and Informatics (MIF) at Didlaukio g. 47, Vilnius.

Students accepted into the program will have access to the Life Sciences Centre – a state-of-the-art facility opened in 2016. The Life Sciences Centre provides students and researchers access to cutting-edge equipment, such as X-ray crystallography system, Mass spectrometers and liquid chromatography systems for proteomics analysis, High Pressure liquid chromatography system mass detector (HPLC-MS system), Atomic force microscope, Automated system for cell imaging, sequencing platforms and many others.

Modern and state-of-the-art sequencing and genotyping equipment is available at the department of Human and Medical Genetics such as HiScanSQ System (Illumina), 3730 DNA Analyzer (Applied Biosystems | Hitachi), PCR system ABI PRISMTM 7900HT (Applied Biosystems), Agilent SureScan Microarray Scanner, florescent microscopy system MultiPhor II (GE Healthcare) and other equipment to carry molecular genetics research.

Faculty of Mathematics and Informatics hosts 165 computerized workplaces located through the 11 computer class auditoriums. Students will work with the operating system of their choice - Windows, Linux and Apple iOS. The faculty also has open access computerized workstations. A supercomputer (installed in 2012) is available to students and professors to perform research and high throughput computations either in the cloud or through the access to the specific supercomputing resources and GRID.

International community

Located in the heart of the Lithuanian capital, the Vilnius University campus is a hub for international students and activities, taking in around 700 exchange students each year, along with 30+ international graduate students in the Faculty of Medicine alone.

Learning Outcomes

- Know cell structure and behavioural patterns at the molecular level and the functions of human organs and systems and the mechanisms of physiological regulation
- Be able to analyse, manage and model data from the field of system biology with the aim to develop new technologies
- Be able select an appropriate modelling strategy for a given biological domain or problem, and be able to set-up as well as lead projects for fundamental or applied research with the aim to develop new technologies in order to solve arising issues
- Be able to gather and analyse information on research related to system biology with a critical approach, and to carry out a technological watch
- Know and apply modern research methods in genetics, epigenetics, transcriptomics, proteomics and neurobiology
- Be able to interpret mathematical models describing evolutionary processes of biological systems
- Comprehend advanced data processing and programming techniques
- Be able perform practical calculations using modern high-performance open computing platforms
- Be able to describe evolutionary processes of biological systems in mathematical language
- Be able to perform practical and theoretical work in system biology within the deadlines and in accordance with the bioethics requirements
- Have summarising skills enabling them to communicate in a clear manner with specialists from other fields or the public about professional project, on work results, or about the results of tasks
- Be able to work autonomously and as a part of a multidisciplinary team; act honestly and according to ethical obligations
- Be able to critically analyse their own professional practices with a view to improving them.

Career prospects

The Systems Biology program prepares scientists for lucrative and rewarding professional careers in public and private sectors, as well as for further academic pursuit at the PhD level. Upon completing the program, students can go on to work in roles such as:

- Bioinformatician
- Biological and biomedical information database's curator
- Scientist
- Systems analyst, biomedical data modeller
- High throughput -omics Data analyst
- Cell programmer
- Cell scientist
- Biological technician
- Laboratory manager
- Biomedical engineer
- Biomedical data scientist

  Statisctical genomics and genetics specialist
- Medical and health services manager
- Bioprostetic and rehab equipment engineer

Admission Requirements and Selection Criteria

Requirements:

Bachelor's degree or its equivalent in study areas such as Informatics, Physical, Life or Health sciences;

English language proficiency – the level not lower than B2 (following the Common European Framework of Reference for Languages (CEFR), or TOEFL score 75/IELTS score 6.

Selection Criteria:

CV, prepared according to Europass

Scientific essay – Topics for 2017 Admission

Structure of the programme

Course Type	1st Semester	2nd Semester	3rd Semester	4th Semester
Compulsory Courses	Genomics	Mathematical modelling	Proteomics	Preparation and defence of a master thesis
	Data mining	Epigenomics	Neurobiology	
		Transcriptomics	Mathematical physiology	
		Science forum**	Science forum**	
Elective Courses (Life and Health sciences bachelor)*	GNU / Linux type operating systems			
	Programming for biological data analysis			
	Multivariate statistics with R			
Elective Courses (Informatics and Physical bachelor)*	Human physiology			
	Genome structure			
	Cell biology			

* If a student has excellent knowledge from offered elective courses, in line with the Study program committee, the student can choose other course from MSc programs listed below:

"Biochemistry" (621C73001), Genetics (621C40001), "Computer modelling" (621I10002), "Software Engineering" (621I30001).

Restrictions for the selection: a course should have 5 ECTS; a course should not be taught later in the program.

** Seminars with a critical assessment of the latest and most advanced research articles in certain areas. Recent science news, issues, approaches are addressed. The seminars will be given by invited lecturers, potential employers

Course Descriptions

Genomics

The aim of the present course is to develop the abilities of student to understand the foundations of genomics and to apply knowledge of genomics to the analysis of the normal and pathological characteristics of a human and to the analysis of the personal genomics.

Data mining

The unit aims at providing the basic concepts of data mining, teaching the students how to explore relevant concepts and sources for further development through theoretical lectures, exercises and case studies. The unit is also oriented towards applying the data analysis concepts on real life biomedical datasets.

GNU/Linux type operating systems

The systems biology course aims to teach students the skills to analyse and critically assess large volumes of biological data. Computers are absolutely necessary to handle such amounts of data efficiently. Currently, most popular and powerful computing systems for data analysis and computer simulations (computer clusters, HPC computers) are based on Unix or GNU/Linux operating systems, and good command of these systems is an essential ingredient for efficient learning and later for productive work in the systems biology field.

The purpose of this module is to acquire the necessary skills in working with GNU/Linux operating systems and to perform tasks necessary for biomedical data analysis using these systems. Students should be able to use command line of the GNU/Linux systems efficiently, combine command line tools with visual GUI programs and to master basic data and computation management skills.

Programming for biological data analysis

The course aims to develop programming skills which are necessary for solving problems in systems biology. This course is based on Python programming language and specialized Python tools for data analysis and visualization. After completing the course, students should be able to (1) apply the skills they have learned to tackle problems in their own research and (2) continue programming learning in a self-directed way.

Multivariate statistics with R

The course introduces statistical methods and underlying concepts for data analysis with a focus on systems biology. The course emphasises modern computational approaches using the statistics software R.

The aim of this course is two-fold: first, students will learn to matrix algebra which will be background for multivariate statistics and mathematical modelling. Second, students will learn standard methods from statistics with application to systems biology datasets of medium complexity. In addition, students should gain a good understanding of the underlying principles and concepts in order to be able to choose from the vast set of available statistical tests and methods and critically employ them.

Human physiology

The main objectives of this course are to teach students about the functions of human organs and systems, including the processes of interaction between different physiological systems and the mechanisms of physiological regulation, in order to achieve the required theoretical basis for further studies.

Genome structure

Students will acquire fundamental knowledge about genome structure and organization in prokaryote and eukaryote organisms, develop understanding of essential principles of genome functioning, maintenance, expression and regulation, attain necessary knowledge and understanding of modern experimental molecular and computational bioinformatics techniques to study genomes, develop skills to understand and interpret outputs of experimental techniques studying genomes, develop an advanced understanding of genome biology necessary to follow systems biology program.

Cell biology

The scope of the course unit is to acquire knowledge on cell structure and function at the molecular level.
The main competence to be developed by this course is to know the signal transduction principles, cell molecular and functional changes in response to it.

Mathematical modelling

The purpose of this course unit is to develop key mathematical skills related to theory of differential equations and its applications in mathematical modeling of dynamics of various biological components as well as to graph theory and optimization and their applications to model and solve problems in systems biology.
The students will be introduced to differential equations including initial and boundary value problems, graph theory and search algorithms on graphs, optimization theory and algorithms. In addition, students should gain a good understanding of the underlying principles and concepts in order to be able to choose proper models and algorithms to solve their problems.

Epigenomics

Students will acquire knowledge about epigenetic regulation of the genome and develop competence to discuss and evaluate scientific arguments in Epigenetics and Epigenomics fields, and analyze experimental data.

Transcriptomics

Aim of this course is to acquire knowledge about transcriptomic regulation of the genome and to develop competences in order to discuss and evaluate scientific arguments in transcriptomics and metabolomics fields, and analyse transcriptomic experimental data.

Proteomics

This course will focus on latest advances in proteome science including cutting-edge proteomic approaches and technologies. Students will acquire the basic and novel methods of sample preparation to proteomic analysis, top-down and bottom-up quantitative label-based and label-free differential

proteomics, identification of post-translational modification and subcellular proteome analysis. Major emphasis will be given on proteomic application in basic science of cell biology and clinical research. Student will gain new knowledge in the field of proteome science and will learn how to apply it addressing practical issues of basic and applied science.

Neurobiology

In this course integrating Neurobiology and Neurogenetic students will acquire knowledge on principles and mechanisms of nervous and sensory systems, and foundations of neurogenetics in a human organism, mechanisms of inherited neurological disturbances; develop the abilities to apply knowledge of neurogenetics to the analysis of the normal and pathological characteristics of a human organism.

Mathematical physiology

Ability to describe biological objects by differential equations, make plausible assumptions and analyse solutions obtained.

Tuition, Living Expenses and Funding

Tuition

Systems biology program will have from 4 to 6 government funded positions. Tuition fee for EU/EEA students 3236 EUR/year, as for non-EU/EEA students 7500 EUR/year.

Funding Opportunities

In addition to government funded positions one of the best students will receive a scholarship.

Tuition waver will be awarded to 5 most motivated and competitive international non EU/EEA students applying for Vilnius University Master programmes taught in English or Russian language. This scholarship covers full cost of the tuition fee. More information.

Other funding opportunities might become available through The Education Exchanges Support Foundation and support from industrial partners of Systems Biology program.

Mobility

Students can participate in ERASMUS+ mobility programme or use VU's Bilateral cooperation agreements which gives an opportunity to study at VU's Partner Universities or do internship abroad.

Useful links

Study in Lithuania

Accommodation

More practical information