

# 1 Masters program Biomolecular Sciences - BioMolecular Integration / Systems Biology (topmasters variant)

## 1.1 General aspects

The masters program Biomolecular Sciences (*Biomoleculaire Wetenschappen*) is a masters program for students with a research-oriented profile. It trains students with bachelors ranging from biomedical sciences and biology to chemistry, physics, mathematics and engineering, for a master's degree at the interface between these disciplines. The focus is on the issue how molecules lead to biological function in health and disease. It therewith covers genetics, genomics, structural biology, molecular biology, biophysics, biomathematics, biochemistry, cell physiology, bioinformatics, immunology, parasitology, and human physiology.

The program offers a choice between two variants:

1. Masters program Cellbiology.
2. Top Masters program Biomolecular Integration / Systems Biology.

These two program variants are described in two different chapters of the FALW study guide.

The topmasters variant BioMolecular Integration / Systems Biology focuses on the issue of how a functioning living cell arises from the collaboration of inanimate molecules and herewith depends more on fundamental biophysics, biochemistry and biomathematics. It is organized by the Institute for Molecular Cell Biology and the Centre for Research on BioComplex Systems of the VU and involves collaboration between groups at the Faculties of Earth and Life Sciences (FALW) and of Exact Sciences (FEW). The science area of the Master's program BioMolecular Integration / Systems Biology is explicitly trans- and interdisciplinary. Students will come from various bachelor curricula from inside and outside the European Union. Influx from mathematics, informatics, physics, chemistry, biochemistry, biophysics, biology, medical biology, and biomedical sciences is aimed for. The diversity of the influx of students will be cultivated in order to come to a scientific melting pot from which the students learn to help each other by intensive collaboration.

The coordinator of the masters program variant Biomolecular Integration / Systems Biology is Dr. K. Krab ([Klaas.krab@falw.vu.nl](mailto:Klaas.krab@falw.vu.nl)). Its director is Prof. dr. H.V. Westerhoff ([Hans.Westerhoff@falw.vu.nl](mailto:Hans.Westerhoff@falw.vu.nl)). Its addresses are: Websites: [www.systembiology.net/topmaster](http://www.systembiology.net/topmaster) (up-to-date) and [www.falw.vu.nl](http://www.falw.vu.nl) (general, formal). E-mail: [hw@bio.vu.nl](mailto:hw@bio.vu.nl), please mention 'topmaster' on the *subject* line. Tel: +31 20 4447228. Fax: +31 20 4447229. Snail-mail: Prof. dr. H.V. Westerhoff, Director Topmaster Biomolecular Integration / Systems Biology, CRBCS-VUA, De Boelelaan 1087, NL-1081 HV Amsterdam, The Netherlands, EU. Visiting address: Sciences building Free University, room M236.

## 1.2 End qualifications

The end credentials of this topmaster curriculum are those of the basic variant (Cell Biology) of the master biomolecular sciences. The qualified master:

- has knowledge about terminology, state of the art of theory and research topics in the biomolecular and cell biological discipline of specialisation
- can apply this knowledge in the design of research and in solving emerging problems
- has the ability to use the principles from the different disciplines (such as mathematics, physics, chemistry and biochemistry) to tackle molecular- and cell biological problems
- has insight in the place of molecular cell biology and biomolecular sciences in biology, biomedical science and science in general
- has familiarity with general scientific journal such as Nature, Science or PNAS, and international journals in the fields of biochemistry, molecular biology and cell biology.
- has insight in the scientific and social relevance of current research in biomolecular sciences
- can design and execute experiments in the different fields and analyze the results
- is able to note down and report on the results of these experiments
- can collaborate with other researchers from the same and other disciplines
- has sufficient knowledge of mathematical and statistical methods applicable to the field
- has command of the use of computer software relevant for the field
- has command of advanced research techniques and laboratory procedures
- is able to acquire independently biological or medical biological information, (with emphasis on biomolecular and cell biological aspects) and can analyze, summarize and critically evaluate this information
- can select and order information, distinguish between major and minor points, and recognize connections.
- can think multidisciplinary
- can analyze and evaluate independently and critically planning, execution and results of research
- can design and write research plans
- can report orally and in written form on research
- can apply scientific knowledge on issues in society
- contributes to scientific discussions about plans, results and consequences of research
- can evaluate his or her own functioning, both by reflection and in discussions with others
- can reflect on ethical aspects of research and applications of research and on implications in decision making.

In addition to these, the qualified topmaster:

- has proven excellence as researcher in the quantitative life sciences and systems biology
- has proven understanding of physical chemical and organizational principles of life
- has proven expertise with the modern experimental, conceptual and modeling methods for the Biomolecular Sciences and Systems Biology
- has insight in the most important biomathematical, biophysical, biochemical, biological, and biomedical topics of the moment, and in how these can be approached
- has an unique and excellent profile at the interface between the exact sciences and the life sciences
- will participate in a local and international network of young life scientists with an interest in BioMolecular Integration or Systems Biology

### 1.3 Admission (see also [www.systembiology.net/topmaster](http://www.systembiology.net/topmaster))

The entry criteria are tripartite; (i) proven excellence in the bachelor phase in one of the above disciplines, (ii) potential excellence at the level of the other disciplines, to be proven in the first two months of the master's program (*i.e.* in its portal phase), and (iii) proven profound motivation for scientific top research.

(i) will be verified on the basis of a diploma of (a) the Free University Amsterdam bachelors of Biology, Medical Biology, Medical Natural Sciences, Chemistry, Physics and Astronomy, Mathematics or Pharmaceutical sciences with an average grade exceeding 7, (b) a bachelor program of one of the five international sister schools with comparable grades, (c) a bachelor of the University of Amsterdam, or Hogeschool Windesheim in Biology, Biomedical sciences, Chemistry or Mathematics and Natural sciences with an average grade of 7 or higher, (d) a comparable bachelor from another European institution for higher education (University or Higher Technical School [HBO]), in any of the above disciplines with an average grade of 8 or higher or equivalent, (e) any education that is demonstrably equivalent to any of the above, (f) a successful entry exam (Please, contact the coordinator for details: [klaas@bio.vu.nl](mailto:klaas@bio.vu.nl)). The entry exam will be facilitated through an individual preparatory phase, in which the capabilities of the prospective student will be assessed and necessary study material will be suggested. Long distance exams will be offered, which will be finalized by local exams when the student arrives at the CRBCS. Verification of criterion (ii) will be accomplished by the exam at the end of the portal phase of the Master's program, in which potential excellence in all mentioned basic disciplines should be demonstrated by the student. Failing this second criterion the student may switch to one of the basic master curricula of the Free University Amsterdam, in particular to that of the basic variant of the Master's Biomolecular Sciences, Biomedical Sciences, or Medical Natural Sciences. The third criterion will be assessed

through an interview/exam after the portal phase in which two top scientist plus a psychological/didactic expert will be present.

The exam committee may allow the student access to the topmaster before having completed the bachelor exam, provided that at least 150 ECTS of the bachelor curriculum have been completed successfully, and that the bachelor is completed within a year.

#### 1.4 Exam program: aspects in common wit all masters

A number of components are compulsory for all Master students of FALW-VU Master programs. The Master Biomolecular Integration / Systems Biology also adheres to this rule. These components are (for a complete description of the program, see [www.systembiology.net/topmaster](http://www.systembiology.net/topmaster)):

- History of Life Sciences (3 ECTS, part of the 'Reflection' part of the program)
- Scientific writing in English (3 ECTS; part of the 'Science Communication aspect of the program)
- Ethics (3 ECTS; part of the 'Reflection' part of the program)
- Research traineeship (65 ECTS; corresponds to the International research project)
- Literature study (8 ECTS; part of 'Orientation on future research project of the program)

The former three of these have been programmed for 2005-2005 as:

Time period	Part	ECTS
parallel	Scientific writing in English, 1 afternoon per week	3
January	Ethics	3
2005	History of life sciences	3

#### 1.5 Exam program: specific for the topmasters variant Biomolecular Integration / Systems Biology

##### 1.5.1 Program principles

The topmaster program aims for the integration of the training of students with diverse backgrounds to a well-defined set of abilities for the interdisciplinary area Biomolecular Integration / Systems Biology. Accordingly, the program is in principle homogeneous and all its elements are defined (*i.e.* compulsory). Because the backgrounds are diverse it is possible that some of the courses overlaps for some of the students with courses they followed in their earlier studies. In these cases, in consultation with the exam committee an alternative may be chosen from what is available and of sufficient quality in FALW and FEW.

##### 1.5.2 Curriculum (2 year, 120 ECTS; 2004-2005)

Portal course

Central course: molecules integrating into living systems	33
Scientific communication techniques	3
Reflection (ethics, history of science)	6
International research project	65
Preparation for final comprehensive exam	4

### 1.5.3 Courses

Portal course: entry course of mathematics and physics for the biologist and medical student, and biology for the physics/chemistry/mathematics bachelor (9 ECTS)

Central course: from molecules through integration to life. This central course contains the following elements:

Proteins: structures, folding and dynamics (Van der Vies, Vermeulen *et al.* 5 ECTS)

Molecular Microbiology (Oudega *et al.* 6 ECTS)

Biological Fluorescence – Interactions of Biomolecules (Lill *et al.*; 6 ECTS)

Intracellular networks (Westerhoff *et al.*; 5 ECTS)

Sequence Analysis (Heringa *et al.*; 5 ECTS)

Self-organization and emergence (Westerhoff *et al.*; 3 ECTS)

Current topics in systems biology (international professors, e.g. Heinrich *et al.*; 3 ECTS)

### 1.5.4 International research project

One research exchange project in two laboratories (partly in Amsterdam and partly in one of the collaborating International Centers of Excellence), on Biomolecular Integration / Systems Biology:

Orientation future research project (incl literature thesis)	11	ECTS
Refereeing of similar research proposals	2	ECTS
8 months' actual scientific research	45	ECTS
Scientific article about research project	5	ECTS
Scientific conference (co-organizing, reporting)	2	ECTS

### 1.5.5 Examinations

Each part of the course will be subject to examination. The grade obtained at the end of the portal course should be sufficient in order to continue with the rest of the Master curriculum. At the end of the curriculum all grades should be sufficient. In addition there will be a comprehensive exam at the end of the curriculum in which the student will be challenged to be able to integrate all course material in the light of the research executed during her/his traineeship.

### 1.5.6 Time schedule (other elements of the program run in parallel mode).

Code of course	Name of course	Responsible	EC TS.	Period
	Portal course part 1	Krab	5	06-09-2004 / 01-10-2004
	Molecular microbiology	Oudega	6	04-10-2004 / 29-10-2004
	Sequence Analysis	Heringa	5	01-11-2004 / 24-12-2004
	Portal course part 2	Krab	4	01-11-2004 / 24-12-2004
	Ethics, history of science	General course	5	03-01-2005 / 28-01-2005
	Biological Fluorescence –	Lill	6	07-02-2005 / 04-03-2005

	Interactions of Biomolecules			
	Proteins: structures, folding and dynamics	Vermeulen/Va der Vies	5	07-03-2005 / 01-04-2005
	Intracellular networks	Westerhoff	5	04-04-2005 / 29-04-2005
	Self-organization and emergence of function	Westerhoff Kooi	3	02-05-2005 / 13-05-2005
	Scientific writing in English	General course	3	
	International research project	Westerhoff	65	June 2005, September 2005-June 2006
	Comprehensive exam	Westerhoff	4	June 2006