Programme

The programme consists of 30 EC chosen from the subjects listed below. Students put together a personalised programme that suits them best. Below is a short explanation of the content of the electives. Please note that a number of courses have entry requirements. Check whether you have sufficient prior knowledge to take all the courses you have chosen. If in doubt, contact the minor coordinator.

Chemistry students

For Chemistry students, a special package of electives has been composed in which they start with in-depth courses in Molecular Biology and Cell Biology. There are two possibilities. You can follow both *Molecular Biology* and *Cell Biology*. In doing so, you will acquire in-depth theoretical knowledge of, among others: biochemistry, molecular biological techniques, cell biological processes and mechanisms. Another possibility is to follow *Cellular Responses*. Here too, you gain theoretical knowledge in the field of Molecular Cell Biology, with a special focus on membranes and signal transmission between and within cells. In addition, you can then follow *Programming for minor Computational Science* and thereby lay a foundation in programming with Python.

In period 2, you can then choose *Ecogenomics* (genomic ecology). Here, you aim to uncover the genetic and molecular mechanisms that influence the reactions and adaptations of organisms to their natural environment. You can also choose *Experimental Genomics* where you will work on fundamental biomedical research. In this course you will go through the entire process of a transcriptomics study. You will first have to take the *Molecular Techniques* course to gain practical experience in a molecular biology lab. In period 3, you can then follow *Gene Regulation* or *Advanced genomics*, the latter with more emphasis on bioinformatics.

Biology students and Bèta-Gamma students following the Biology major

Biology students can choose in period 1 to follow *Frontiers in Medical Biology* where you learn about fundamental biomedical research and developmental biology. Another option is to follow *Programming for minor Computational Science* and thereby lay a foundation in programming with Python. At the same time, you can follow *Introduction to Machine Learning*, a field with a great future in the molecular life sciences.

In period 2, you can then choose *Ecogenomics*, or Molecular Oncology. In *Ecogenomics*, you aim to uncover the genetic and molecular mechanisms that influence the reactions and adaptations of organisms to their natural environment. In *Molecular Oncology, using* two human tumours as examples, you learn about molecular pathways that play a major role in many types of cancer and the role of epi-genetic modifications in the heterogeneity of tumours. This is followed by *Experimental Genomics Practical* where you will work on fundamental biomedical research, also a transcriptomics study. In period 3, you can then follow *Gene regulation* or *Advanced genomics*, the latter with more emphasis on bioinformatics.

International students

The minor is comprised of four courses: *Frontiers in Medical Biology*, *Ecogenomics, Experimental genomics* and *Gene Regulation* and these courses are taught in English.

Technical information
Here is a short summary of the contents of all elective courses. For more information, please check the study guide.

Molecular Biology
The (macro)molecules in cells determine the functioning of life. How the form and function of the (macro)molecules are related, and with each other determine the essential properties and functioning of cells, is studied in detail in this course. The complexity of this makes it necessary for the student to develop his own, detailed, conceptual model of cellular functioning.

Cell Biology
Structure of the cell membrane and dynamic processes therein. Relationship between the properties of cellular components and their interactions and functions. Interactions between cellular compartments. Signal transmission between cells and within the cell. Lipid-derived signal molecules.

Frontiers in medical biology
The emphasis of this course is on fundamental biomedical research. What are the mechanisms that determine how cells communicate, migrate and ultimately assemble themselves into complex, three-dimensional tissues with various specialised functions? How does research proceed at the boundary between the known and the unknown? What skills and creativity are needed to unravel the mysteries of biology and devise new solutions to health problems?
The course is organised around three of today's biggest societal health challenges: "Cancer", "Ageing" and "Nutrition and the microbiome".

Cellular responses
In this course, we are going to show you how DNA replication and transcription, translation of transcripts into proteins, protein folding, protein modification, protein function and enzymatic catalysis all come together to enable the functioning of a cell in its environment. This means that you will learn some general principles for this functioning, and you will discover how this is regulated at the molecular level. These general principles are applied in many combinations within the cell in order to respond to signals from, or changes in, its environment.

Introduction to Machine Learning I
In this course, you will become familiar with artificial intelligence and machine learning. During this course, we will cover a number of fundamental machine learning algorithms and build them ourselves. This is a broad introductory course, which means that we will not only cover the mathematics, mainly calculus and statistics, that drives these algorithms, but also the philosophical and social consequences of learning systems.

Programming for minor Computational Science
In this course you will learn Python, a programming language that is increasingly used by scientists from all fields. We focus on the absolute basics of programming, which you learn while doing programming problems from different scientific fields. You will work on larger programs and get to know Python a lot better, so you will be ready to learn on your own.

Ecogenomics

The emerging field of ecological genomics aims to uncover the genetic and molecular mechanisms that influence the responses and adaptations of organisms to their natural environment. Achieving this goal requires an understanding of evolution and selection pressure and how this results in natural variation. Using this natural variation to study mechanisms requires a good understanding of both ecologically important phenotypes and species with a well-developed genomic toolkit. Molecular biology and genomic tools have been developed primarily for mammalian and agricultural model organisms (such as yeast and Arabidopsis) that represent a narrow spectrum of phenotypes, while many organisms that are the focus of ecological research have had limited genomic resources.

Gene regulation

To function optimally as a eukaryotic organism, genes must be selectively expressed at the right time and tissue, and transposons must be inactivated. This complex process involves a wide range of molecules, genetic and epigenetic mechanisms, for example regulatory elements, transcription factors, histone and DNA modifications, non-coding RNAs, and chromatin folding. The mechanisms underlying gene regulation are mostly evolutionary conserved, from yeast to plant to human. In this course, knowledge obtained from all these organisms will be discussed with the students in an integrated way. The lectures contain a lot of material from very recent literature.

Molecular techniques

In this course the student develops practical skills in recombinant DNA technology and biochemistry. This includes some commonly used bio-informatics tools.

Molecular Oncology

The course is based on two human tumours: colon cancer and the childhood tumour neuroblastoma. The course covers a number of important molecular signalling pathways that can cause cancer. The various successive steps in the development of colon cancer - from a small polyp to a metastasised malignant cancer - are well described clinically and pathologically. For many stages, the underlying genetic change and the molecular pathways that are activated in the process are now known. Hundreds of defective genes are known in all the different human tumour types. Yet all these genes seem to function in only a limited number of molecular pathways. These 10-15 pathways regulate embryogenesis, stem cell biology and cancer and are also involved in many other diseases.

Experimental Genomics and Advanced Genomics Analysis

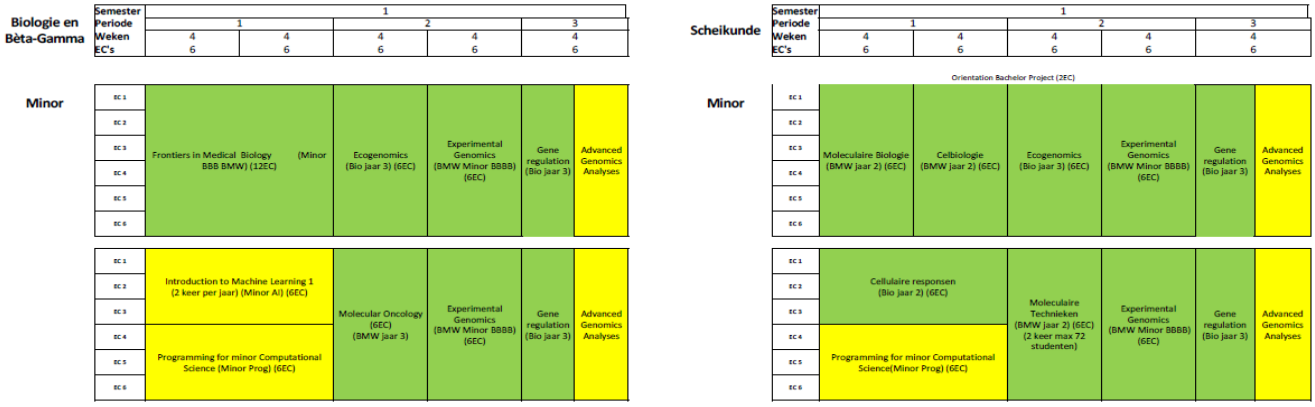
Biomedical research is developing rapidly, especially through the use of 'omics' technologies that generate large data sets, such as Next Generation Sequencing (NGS) and DNA microarrays. These technologies make it possible to analyse which genes are differentially regulated after experimental treatments, or to determine which genes are relevant to diseases. In transcriptomics, for example, these technologies are used to quantify the expression level of all known and predicted genes in the genome. This type of -omics analysis produces large data sets and interpretation of the results requires expertise in data analysis statistics and bioinformatics. For biomedical students, it is very important to gain experience

with omics data analysis. Therefore, we offer a course in which we cover the entire data analysis process, based on a real-life experiment with a model organism.

Table of subjects as listed in study guide. Subjects could be classified by subject here. The picture below will not appear in the final study guide, but gives an overview.

Cups

- (Major) Biology students
  - Molecular biology
  - Molecular techniques and Bioinformatics
- Chemistry students
  - Molecular biology
  - Molecular techniques and Bioinformatics



Registration and admission

The minor Molecular Life Sciences is suitable for (major) biology and chemistry students. Biology students are expected to have successfully completed the first two years of their bachelor's degree, with an extra emphasis on the second-year subjects: *Cellular Responses* and *Challenges in Molecular Life Science*. Chemistry students are expected to have successfully completed the first two years of their bachelor.

Students from outside the UvA and or from other studies are welcome provided they have the appropriate or comparable prior knowledge. When in doubt, please contact the minor coordinator, prof. dr. ir. Rob Schuurink, via email R.C.Schuurink@uva.nl

Contact

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For questions concerning the content of this minor, please contact the minor coordinator prof.dr.ir Rob Schuurink.