1. Overview of optional courses

Optional courses account for 15-18 credits. In liaison with the mentor and pending clearance by the Bioinformatics Programme Committee, a student can select from a wide spectrum of optional courses offered by various faculties and centres, such as the IBIVU, and the Biology, Mathematics, Physics, Chemistry and Computer Science Departments at the VU. Available optional courses that have been attended by bioinformatics master students to date are given below. It should be noted that the list is not comprehensive as students also have the opportunity to choose further courses at other departments, also, a likely interesting course like Computational Chemistry organised by the Chemistry department has not been selected so far by students.

Bioinformatics courses:

- **Computational Genomics and Proteomics**
  This Bioinformatics course provides an insight into methods and algorithms for genome analysis and proteomics. The course is intended for students with an exact sciences background and an in interest in algorithmic issues. Subjects covered in the genomics part of the course include sequence comparison, searching large amounts of biological data, detecting genes and motifs, comparative genomics and evolution. The proteomics part includes topics such as high-throughput mass spectrometry data, biomarker detection, computational diagnostics, docking, protein-protein interaction, interaction networks and mesoscopic modelling. At the end of the course students will be familiar with the basic principles of analysing the human genome and high-throughput proteomics data.

- **Statistical Genetics**
  Course presents statistical methods for genomic mapping such as linkage and association analysis. This course is provided by the Department of Mathematics especially for Bioinformatics master students (6 credits).

- **Caput Medical Informatics**
  In this caput, students study aspects of Translational Medicine such as genomics to patient data integration, distributed (federated) databases, data warehousing. Additionally, students practise writing a full fledge research proposal (modelled after EC FP6 research proposals). Students read a number of papers and technical documents while receiving one-to-one advice. A report of the materials studied needs to be provided, as well as a completed research proposal (6 credits).

- **Genome Analysis**
  A 1-month practical course for introduction to genomics and bioinformatics techniques used to analyse and integrate genomics data sets. Also, databases such as COG, EST, SNP, motifs, and disease genome repositories are be covered. At the end of this course, students are able to perform a full-scale genomics analysis using important bioinformatics tools (6 credits).

Biology courses (Faculty of Earth and Life Sciences):

- **Protein Science**
  This course provides understanding of structure, function, dynamics and inhibition of proteins and hands-on experience with associated experimental molecular biological techniques including expression/production within bacteria, purification, spectrometry, affinity-chromatography, etc. (6 credits).

- **Principles of Neuroscience**
  This course provides the master student with a solid basis in cell biology, neurophysiology and functional neuroanatomy (6 credits).

- **Molecular Cell Physiology and Function**
This course deepens the knowledge of students in complex systems and the relation between metabolic routes and signaling pathways. Practical work and mathematical analysis is combined (6 credits).

- **Genomes and Gene Expression**
  This course provides students with the latest facts of gene expression regulation in eukaryotes and prokaryotes. Emphasis is placed on understanding biology of gene expression as well as methods used to study gene expression (6 credits).

- **Modelling: Ab initio models**
  This course covers kinetic models of the cell (chemical reactions, transport processes, gene expression, signal transduction). A number of kinetic models are constructed and used to analyse the behaviour of such systems. A number of important computer programs in the research area are discussed and used by the students (6 credits).

- **Physics of Biological Systems**
  This course provides a thorough schooling in the physical theories and principles underlying both the functioning and study of biological systems. Topics include molecular quantum mechanics, thermodynamics, physical theory underlying experimental methods (NMR, spectrophotometry, x-ray diffraction, etc.) (6 credits).

**Mathematics Courses:**

- **Statistics and Probability Seminar**
  This course provides theory of statistics and probability, including bootstrap methods, statistics for point processes, survival analysis, statistics for genetics, hidden Markov models, and Markov chain Monte Carlo methods (4 credits).

**Computer Science Courses:**

- **Machine Learning**
  This course surveys methods of acquiring and/or modifying theories from observations, including concept learning, general-to-specific ordering, decision tree learning, artificial neural networks, Bayesian learning, instance-based learning, genetic algorithms, reinforcement learning, etc. (6 credits).

- **Evolutionary Computing**
  Course providing a solid basis in computational methods based upon Darwinian principles of evolution. The course provides theory and hand-on experience of evolutionary methods as problem solvers and as simulation or modeling tools (6 credits).

- **Neural Networks**
  This course provides an introduction into the most popular neural network models and their applications. Topics include single-layer perceptrons, LMS algorithm, multilayer perceptrons, radial-basis functional networks, support vector machines, self-organising maps, discrete Hopfield model, and brainstate in-a-box model (6 credits).

- **Data Mining Techniques**
  This course provides a survey of data mining techniques and their applications for solving real life problems. Methods provided include naïve Bayes decision trees, association rules, boosting, co-learning, etc. Applications to marketing, fraud detection, text and Web mining and bioinformatics will be discussed and practiced (6 credits).

- **Parallel Programming**
  Course providing theory of and hands-on experience in writing programs that run in parallel on a large number of processors. Techniques covered include message parsing, parallel object-oriented languages and Tuple Space (6 credits).

- **Scientific Visualisation**
  This is a theoretical and practical course in computational approaches to optimally visualize complex scientific data, e.g. resulting from genomics experiments (6 credits).
• **Self-organising Systems**
  This course provides a solid theoretical and practical basis in complex self-organising systems and their emergence properties (6 credits).

2. **Overview of preparatory courses**

The courses below can be taken by students to address deficiencies.

• **Introduction to Bioinformatics (IBIVU)**
  Students learn about the principles of bioinformatics and selected areas of application (6 credits).

• **Introduction to Programming I (Inleiding Programmeren I) (FEW)**
  Students learn the basic principles of programming and obtain experience using JAVA. This course has to be attended by beginning bioinformatics master students with insufficient programming experience (6 credits).

• **Introduction to Programming I (Inleiding Programmeren I) Practical (FEW)**
  Students actively solve algorithmic problems writing their own code in JAVA. This practical has to be attended by beginning bioinformatics master students with insufficient programming experience (6 credits).

• **Portal Course (FALW-IMC)**
  This course introduces students with a primarily biological background to concepts and methods of physics, chemistry and mathematics, and students with a physics, chemistry and mathematics oriented bachelor to concepts and methods of biology and medical biology (6 credits).