Biomolecular Sciences MSc

VU University Amsterdam - Fac. der Aard- en Levenswetenschappen - M Biomolecular Sciences - 2015-2016

The aim of the Master programme Biomolecualr Sciences to equip the student with the knowledge, skills and insight required to operate as an independent professional within the field of biomolecular sciences and to be a suitable candidate for a subsequent course of study leading to a career in research. Having completed the programme, the student should have developed a critical scientific approach and an awareness of the ethical and societal aspects of biomolecular sciences.

The programme is intended for students with a research-oriented profile. It trains students with bachelors ranging from biomedical sciences and biology to (bio)chemistry, physics, mathematics and engineering, for a Master's degree at the interface between these disciplines. Also medical and veterinary doctors, dentists, pharmacists/pharmaceutical scientists can enter the programme. The focus is on the issue how molecules lead to biological function in health and disease. It therewith covers genetics, microbiology, structural biology, cell physiology, molecular biology, biochemistry, biophysics, biomathematics, genomics, bioinformatics, pharmacology, toxicology, spectroscopy, immunology and infection.

The programme offers a choice between two specializations:

-Molecular Cell Biology
-Biological Chemistry

The year schedule can be found at the FALW-website.
Further information about the MSc programme Biomolecular Sciences.
A complete programme description can be found at the FALW-website.

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Expired programme components Biomolecular Sciences

The course programme components presented in the list below will no longer be part of the examination programme in academic year 2014-2014.

Courses:

Name	Period	Credits	Code
Business and Innovation in Life Science		3.0	X_432539
Evolving Networks	Period 2	6.0	AM_1020
Scientific Writing in English	Period 2, Period 5	3.0	AM_471023

Specialisation Biological Chemistry

In this specialisation we focus on the interaction of cells, cellular structures and individual proteins with their "chemical environment". Special focus will lie on the characterization of new drug targets and tools to find small molecules as leads in the development of new medicines. Furthermore, the bioactivation of and cellular responses to drugs will get special attention.
The Masters specialisation Biological Chemistry is organized by Medicinal Chemistry and Molecular Toxicology of the Department of Chemistry and Pharmaceutical Sciences of the Faculty of Sciences (FEW).

This programme gives a thorough grounding in the subjects and methods of the Medicinal Chemistry and Molecular Toxicology as well as providing a solid preparation for one or more research internships.

Capita Selecta are offered on individual basis throughout the year.

Programme components:

- optional modules year 1
- compulsory modules year 1
- choose one of these modules
- modules year 2

optional modules year 1

Courses:

Name	Period	Credits	Code
Biomolecular Screening	Period 4	3.0	X_432542
Biophotonics I: Microspectroscopy	Period 3	3.0	AM_470629
Biophotonics III: Practical Training	Period 3	3.0	AM_470630
Molecular Biology Techniques	Period 3	3.0	X_432540

Molecular Pharmacology	Period 4	3.0	X_432541
Protein Sciences Techniques	Period 3	3.0	AM_470641

compulsory modules year 1

Courses:

Name	Period	Credits	Code
Genomes and Gene Expression	Period 1	6.0	AM_470614
Internship I Biological Chemistry	Ac. Year (September)	30.0	AM_471129
Protein Science	Period 1	6.0	AM_470145
Scientific Writing in English (AM_BMOL)	Period 1	3.0	AM_1156

choose one of these modules

Courses:

Name	Period	Credits	Code
Drug-induced Stress and Cellular Responses	Period 2	6.0	X_432536
Signal Transduction in Health and Disease	Period 2	6.0	X_432535

modules year 2

Courses:

Name	Period	Credits	Code
Chemical Biology	Period 1	6.0	X_432538
Dynamics of Biomolecules and Cells	Period 4	6.0	X_422583
Ethics in Life Sciences	Period 3	3.0	AM_470707
Fundamentals of Bioinformatics	Period 1	6.0	X_405052
Internship II Biological Chemistry	Ac. Year (September)	30.0	AM_471130
Introduction to Systems Biology	Period 1	6.0	X_428565
Microbial Genomics	Period 3	3.0	AM_1021

Project Computational Design and Synthesis of Drugs	Period 4	6.0	X_432734
Structural Bioinformatics	Period 4	6.0	X_405019
Thesis Based on Literature Study	Ac. Year (September)	9.0	AM_471153

Specialisation Molecular Cell Biology

With the Masters Biomolecular Sciences specialisation Molecular Cell Biology, students can further develop their skills and performance in molecular and cellular research and prepare themselves for an (inter) national research position. The Masters programme Molecular Cell Biology has been developed for students with a Bachelors degree in Biology or Biomedical Sciences or any other relevant Bachelor's degree (for instance Biochemistry or HLO) and is organized by the Institute for Molecular Cell Biology (IMC) of the Faculty of Earth and Life Sciences (FALW) in collaboration with the Faculty of Sciences of the VU University Amsterdam and the VU Medical Center (VUmc).

This programme gives a thorough grounding in the subjects and methods of the Department of Molecular Cell Biology (MCB), as well as providing a solid preparation for one or more research internships.

Programme components:

- optional modules year 1 (nader)
- compulsory modules year 1
- Choose one out of three modules
- modules year 2

optional modules year 1 (nader)

Courses:

Name	Period	Credits	Code
Biomolecular Screening	Period 4	3.0	X_432542
Biophotonics I: Microspectroscopy	Period 3	3.0	AM_470629
Biophotonics III: Practical Training	Period 3	3.0	AM_470630
Molecular Biology Techniques	Period 3	3.0	X_432540
Molecular Pharmacology	Period 4	3.0	X_432541
Molecular photobiology	Period 4	3.0	X_432763
Protein Sciences Techniques	Period 3	3.0	AM_470641

compulsory modules year 1

Courses:

Name	Period	Credits	Code
Genomes and Gene Expression	Period 1	6.0	AM_470614
Internship I Molecular Cell Biology	Ac. Year (September)	30.0	AM_471127
Protein Science	Period 1	6.0	AM_470145
Scientific Writing in English (AM_BMOL)	Period 1	3.0	AM_1156

Choose one out of three modules

Courses:

Name	Period	Credits	Code
Cell Structures and Functions	Period 2	6.0	AM_470615
Molecular Infection Biology	Period 2	6.0	AM_470657
Signal Transduction in Health and Disease	Period 2	6.0	X_432535

modules year 2

Courses:

Name	Period	Credits	Code
Developmental Biology	Period 2	6.0	AM_470613
Dynamics of Biomolecules and Cells	Period 4	6.0	X_422583
Ethics in Life Sciences	Period 3	3.0	AM_470707
Extreme Biology	Period 2	6.0	AM_470509
Internship II Molecular Cell Biology	Ac. Year (September)	30.0	AM_471128
Microbial Genomics	Period 3	3.0	AM_1021
Structural Bioinformatics	Period 4	6.0	X_405019
Thesis Based on Literature Study	Ac. Year (September)	9.0	AM_471153

MSc Biomolecular Sciences, Optional courses (elective)

Courses:

Name	Period	Credits	Code
AIMMS Lectures and Seminars	Ac. Year (September)	3.0	X_432764
Caput Cellular Protein Trafficking	Ac. Year (September)	6.0	AM_470605
Caput Epigenetics	Ac. Year (September)	6.0	AM_470606
Caput Molecular Biotechnology	Ac. Year (September)	6.0	AM_470604
Caput Protein Structure as Molecular Basis of Disease	Ac. Year (September)	6.0	AM_470120
Caput Structural Biology	Ac. Year (September)	6.0	AM_470607
Dynamics of Biomolecules and Cells	Period 4	6.0	X_422583
Fundamentals of Bioinformatics	Period 1	6.0	X_405052
Introduction to Systems Biology	Period 1	6.0	X_428565
Microbial Genomics	Period 3	3.0	AM_1021
Structural Bioinformatics	Period 4	6.0	X_405019

AIMMS Lectures and Seminars

Course code	X_432764 ()
Period	Ac. Year (September)
Credits	3.0
Language of tuition	English
Faculty	Faculteit der Exacte Wetenschappen
Coordinator	dr. J.E. van Muijlwijk-Koezen
Examinator	dr. J.E. van Muijlwijk-Koezen
Level	400

Course objective
- To broaden your spectrum of the Human Life Sciences
- To practice your writing skills and capability to order and summarize a lot of new information
- To practice your scientific judgements

Course content
The Amsterdam Institute for Molecules, Medicines and Systems (AIMMS) organizes biweekly the so-called AIMMS-seminars. Next to this, (inter)national researchers are invited for AIMMS Lectures. In this caput, you have to visit six seminars or lectures of your choice.

Summarize the content of the lecture and reflect on each of them in a written report (template available). For one of these seminars an extended report has to be made. All documents have to be uploaded on the Blackboard Course via the corresponding SafeAssignment link. Please send an e-mail to the teacher when you have uploaded a new document so it can be reviewed.

Form of tuition

individual

Type of assessment
writing reports

Course reading
relevant references, suggested by the speakers

Entry requirements
bachelor in life sciences

Target group
mDDS, mBMS, mMNS, mSBI

Registration procedure
standard procedure

Remarks
Please contact the coordinator in advance.

Biomolecular Screening

Course code	X_432542 (432542)
Period	Period 4
Credits	3.0
Language of tuition	English
Faculty	Faculteit der Exacte Wetenschappen
Coordinator	dr. J. Kool
Examinator	dr. J. Kool
Teaching staff	dr. J. Kool
Teaching method(s)	Lecture, Practical
Level	400

Course objective
To learn, understand and work with modern analytical chemistry in the life sciences to identify proteins. More specifically, you will learn ways to find biologically active proteins in mixtures, purify them and finally identify them using proteomics techniques.

Course content
During this course the potential of modern analytical and biological screening techniques used in bioactivity screening of bioactive proteins will be discussed. The emphasis will be on finding bioactive proteins in complex biological samples by LC-MS in combination with post-column bioassays. Protein identification strategies using bottom-up proteomics proteomics approaches will be focused on during this course. You will learn how to find biologically active proteins in complex mixtures and know how to identify these proteins by their (partial) amino acid sequence. Sample treatment and advanced sample preparation techniques will play an important part in this as well as LC-MS, bioassays and database searches with the proteomics data obtained. We will work with natural extracts such as snake venoms as our complex biological samples, which contain potential biopharmaceutical candidate proteins.

Form of tuition
The course starts with a thorough explanation of the course and its contents. Then we will start with the practical work. In between the practical work, lectures will be all given that discuss in more detail and assist the practical work. Relevant literature will be provided via blackboard. All students will (besides their practical report) work on a literature assignment related to a topic in bioactivity profiling in a biopharmaceutical setting.

Type of assessment
The mark given for the literature report will constitute 50% of the final mark. The mark of the practical report also constitutes 50% of the final mark. This mark is given for the insights shown, motivation and other relevant issues such as presence during the course, practical course report, safety considerations and practical results obtained Both marks have to be at least 5.5.
Presence during the practical course days is obligatory.

Course reading
Literature to study is mainly from e-books (chapters) and from academic papers/reviews. All literature needed can be found in the course documents on BlackBoard. Tutorials will be given by the course supervisors during the practical work. All PowerPoint lectures will be placed on BlackBoard at least one day before each lecture. All PDF e-book chapters and other literature (e.g. academic research papers and reviews) can already be found on BlackBoard.

Entry requirements
Basic knowledge of biochemistry, separation sciences and mass spectrometry.

Target group
Master phase practical course

Remarks
A lab coat is required for the practical part.

Biophotonics I: Microspectroscopy

Course code	AM_470629 ()
Period	Period 3
Credits	3.0
Language of tuition	English
Faculty	Fac. der Aard- en Levenswetenschappen
Coordinator	dr. ir. Y.J.M. Bollen
Examinator	dr. ir. Y.J.M. Bollen
Teaching staff	prof. dr. ir. E.J.G. Peterman, dr. ir. Y.J.M. Bollen
Teaching method(s)	Lecture
Level	400

Course objective
To introduce students into various spectroscopic and microscopic techniques.
Students should know the theoretical principles and the applicability in life sciences of:

- absorption spectroscopy
- fluorescence spectroscopy
- light microscopy
- fluorescence microscopy

Course content
Optical spectroscopy and microscopy are widely used in cell biology and biophysics. In this course the principles of many of these techniques, including absorption spectroscopy, various types of fluorescence spectroscopy (e. g. polarization, FRET) and fluorescence microscopy (e. g. confocal, TIRF, lifetime imaging) are explained. Their application in modern biophysics and cell biology research is illustrated by a number of (guest) lecturers.

Form of tuition
Lectures (28 hours), group assignment (8 hours), self-study

Type of assessment
Written exam (75%), oral presentation by group (25%). Both parts need to be passed (with a grade of 5.5 or higher) in order to pass the course.

Course reading
Notes, handouts and papers

Target group
MSc students Biology, Biomolecular Sciences, Biomedical Sciences, Medical Natural Sciences, Physical Sciences, Chemistry, or related.

Remarks
Due to largely overlapping contents this course is NOT intended for students who have taken the FEW BSc course “Microscopische beeldvorming (X_420529)”.
Practical training in the techniques discussed here is offered in Biophotonics 3, for which Biophotonics 1 is required.

Biophotonics III: Practical Training

Course code	AM_470630 ()
Period	Period 3
Credits	3.0
Language of tuition	English
Faculty	Fac. der Aard- en Levenswetenschappen
Coordinator	dr. ir. Y.J.M. Bollen
Examinator	dr. ir. Y.J.M. Bollen
Level	400

Course objective
To introduce students into the application of various optical techniques, mainly fluorescence spectroscopy and microscopy.
Students should be able to:
- plan and conduct experiments using optical techniques
- evaluate results on the basis of theoretical knowledge and recent literature
- present their results in short reports and one journal-style paper

Course content
Optical spectroscopy and microscopy are widely used in cell biology and biophysics. In this course students will obtain hands- on experience with absorption spectroscopy, fluorescence spectroscopy (e. g. FRET and anisotropy) and fluorescence microscopy. The theory behind these techniques is already given in Biophotonics 1, which is required to enter this course. Small groups of students will prepare the experiments, discuss them with the lecturer and carry them out. The group will write a short report on each experiment and one journal-style paper.

Form of tuition
Experiments (±24 hours) are performed in small groups. Experiments need to be prepared and reports need to be written.

Type of assessment
Participation during labwork and discussion (individual; 30%); written report (per group; 70%).

Course reading
Papers and protocols that will be made available through Blackboard

Entry requirements
Biophotonics: Microspectroscopy (AM_470629) or Microscopische beeldvorming (X_420529) are required to enter this course.

Target group
MSc students Biology, Biomolecular Sciences, Biomedical Sciences, Medical Natural Sciences, Physical Sciences, Chemistry or related.

Remarks
The theoretical background of the techniques used here is discussed in Biophotonics: Microspectroscopy (AM_470629).

Business and Innovation in Life Science

Course code	X_432539 ()
Credits	3.0
Language of tuition	English
Faculty	Faculteit der Exacte Wetenschappen
Coordinator	drs. P. van Hoorn
Examinator	drs. P. van Hoorn
Teaching staff	prof. dr. I.J.P. de Esch, drs. P. van Hoorn
Teaching method(s)	Lecture
Level	400

Course content
This course has expired

Target group
Master Bio molecular Sciences (BMS) , Chemistry, Drug Discovery & Safety and Oncology

Caput Cellular Protein Trafficking

Course code	AM_470605 ()
Period	Ac. Year (September)
Credits	6.0
Language of tuition	English
Faculty	Fac. der Aard- en Levenswetenschappen
Coordinator	dr. J.P. van Ulsen
Examinator	dr. J.P. van Ulsen
Level	500

Course objective
The aim of this theoretical course for master students is to study a number of recent, short and state-of-the-art review papers in the area of protein secretion and cellular protein trafficking. The students will get insight into the principles and mechanisms by which prokaryotic and eukaryotic cells target and insert proteins into membranes and target them
them to subcellular organelles and the extracellular environment. The course will highlight the similarities between eukaryotic and prokaryotic organisms in the mechanisms of protein secretion and trafficking.
Furthermore the application of this knowledge and research in medical sciences and in biotechnology is addressed. The emphasis is on bacterial systems. End terms for the student:
- To know and understand the biochemical principles and molecular and cellular processes that play a role in protein targeting to biomembranes
- To know and understand the biochemical principles and the molecular and cellular processes that play a role in the insertion of membrane proteins into biomembranes
- To know and understand the biochemical principles and the molecular and cellular processes that play a role in the transport of proteins through biological membranes and into the extracellular environment.

Course content
Protein trafficking in E. coli:
- Biogenesis of inner membrane proteins in E. coli.
- Targeting and assembly of periplasmic and outer membrane proteins.
- Protein translocation across membranes: secretion systems, their structure, biology, and function.
Protein traffiscking in eukaryotes:
- Biogenesis of membrane proteins in organelles
- intracellular protein trafficking
- vesicle transport in the endosomal system.

Form of tuition
Introductory meeting with course coordinator (1h). Followed by self-study of the literature. An additional meeting for questions and discussion of the literature can be arranged upon request. Questions may also be asked via e-mail.

Type of assessment
Written exam with assay questions

Course reading

As a basis Chapters 12 and 13 of the book "Molecular Biology of the Cell",Alberts et al. Garland Science Ltd (5th edition; 2008) can be studied. The corresponding Chapters of earlier editions are also OK.

Additional reviews:
Walther DM, Rapaport D, Tommassen J. (2009) Biogenesis of beta-barrel membrane
proteins in bacteria and eukaryotes: evolutionary conservation and divergence.
Cell Mol Life Sci. 66:2789-2804
- Integration of proteins into the outer membrane of gram-negative bacteria and the outer membranes of organelles is facilitated by a conserved machinery.

Cross BC, Sinning I, Luirink J, High S. (2009) Delivering proteins for export from
the cytosol. Nat Rev Mol Cell Biol. 10:255-264
- The conserved Sec machinery in pro- and eukaryotes

Wang P, Dalbey RE. (2011) Inserting membrane proteins: the YidC/Oxa1/Alb3 machinery in bacteria, mitochondria, and chloroplasts.
Biochim Biophys Acta. 1808:866-875
- Integration of proteins in the cytoplasmic membrane of bacteria and organelles

Karuppiah V, Berry JL, Derrick JP. (2010) Outer membrane translocons: structural
insights into channel formation. Trends Microbiol. 19:40-48
- Structural Biology of bacterial secretion systems

Ellis TN, Kuehn MJ. (2010) Virulence and immunomodulatory roles of bacterial outer membrane vesicles. Microbiol Mol Biol Rev. 74:81-94
- Vesicle transport in bacteria and their role in virulence

Schmidt K, Stephens DJ. (2010) Cargo loading at the ER. Mol Membr Biol. 27:398-411
- Vesicle transport and insertion of proteins in eukaryotes

This list may be subject to change if more up-to-date articles appear.

Target group
Students of all Master's programmes within Health and Life Sciences

Caput Epigenetics

Course code	AM_470606 ()
Period	Ac. Year (September)
Credits	6.0
Language of tuition	English
Faculty	Fac. der Aard- en Levenswetenschappen
Coordinator	dr. J.M. Kooter
Examinator	dr. J.M. Kooter
Level	500

Course objective

Course objectives:
At the end of the course, the student:
- is able to describe in detail the structure and composition of Chromatin, the post-translational modifications of chromatin proteins, where these modified proteins can be found in chromosomes, and how they are somatically inherited
- is able to indicate the enzymes responsible for the modifications and how they are regulated and targeted to specific genomic regions
- can recognize the dynamic nature of chromatin and epigenetic protein modifications, and is able to identify the 'readers' of the modifications and their consequences
- can describe the biochemical mechanisms of transcriptional regulation, including the process of transcription initiation, elongation and termination
- can describe the various DNA modifications, their biochemistry, and impact on genome maintenance and gene expression in somatic tissues, including brain
- can describe the epigenetic reprogramming events during mammalian embryonic development, parental imprinting, and biological consequences
- recognize cases of genetic - and epigenetic inheritance, and transgenerational inheritance
- can indicate and explain the molecular causes of human diseases, including cancer, that are due to aberrant epigenetic features and defective epigenetic mechanisms
- is able to identify phenomena that are due to environmentally-induced changes in epigenetic genome properties
- can explain the link between nutrition and epigenetic modifications
- can apply currently used experimental approaches and techniques to study epigenetics and is able to interpret the results

Course content

The following topics are discussed:
• Non-Mendelian inheritance of traits
• Biochemistry of DNA methylation and de-methylation
• Composition of chromatin and chromatin remodeling
• Biochemistry of histone modifications and chromatin structure
• Somatic and gametic cell inheritance of epigenetic information
• Cellular memory and chromatin modifications by the polycomb-group proteins
• Role of DM&CM in gene expression and genome maintenance
• Role of epigenetics in cancer and other diseases
• Role of DM&CM in sex-chromosome inactivation and activation
• Parental imprinting and gene dosage compensation
• Epigenetic reprogramming events during mammalian development
• Stem cells and reprogramming
• Functions of non-coding RNAs / RNA interference in DM&CS
• Neurobiology and epigenetics
• Epigenetic effects of diet, nutrition, drugs and environmental 'factors', including toxicants and behavior
• Transgenerational effects: inheritance of epigenetic-based traits
• Does epigenetics play a role in evolution?
• Methods that are currently used to analyze DM&CM

Form of tuition

- No regular lectures, mostly self-study
- Studying recent review and research articles (ca 120 hr)

- Weblectures by experts (ca 10 hr)
- Discussion meetings (1-2 per week) in which the topics of the research and review articles are discussed (ca 15 hr)

Type of assessment
Written exam

Course reading
- Basics: Molecular Biology of the Cell by Alberts et al., sixth edition: Chapters on DM&CM and transcriptional control of gene expression

- Recent Review and Research articles, which will be provided via Blackboard.

Entry requirements
Bachelor level Biochemistry, Molecular Genetics and Molecular Biology

Target group
Master students: Biomolecular Sciences, Biology, Biomedical Sciences, Medical Natural Sciences, Pharmaceutical Sciences and Oncology

Registration procedure
Email to Coordinator: j.m.kooter@vu.nl

Remarks
In exceptional cases, it is possible to develop a more 'personalized' program, depending on previous courses and the knowledge of epigenetics.

Lecturer:
dr. Jan M. Kooter

Caput Molecular Biotechnology

Course code	AM_470604 ()
Period	Ac. Year (September)
Credits	6.0
Language of tuition	English
Faculty	Fac. der Aard- en Levenswetenschappen
Coordinator	dr. S. Luirink
Examinator	dr. S. Luirink
Level	500

Course objective
The aim of this theoretical course is to get insight in the principles, methods, and applications of recombinant DNA technology with respect to the broad field of medical and industrial biotechnology. To this end the students study a book.
Final attainment levels: To know and to understand the fundamental principles of modern molecular biotechnology as well as the most recent developments in that area of science. To know and to understand the newest molecular techniques and biotechnological applications of

microbial and viral systems. To know and to understand the most recent biotech developments, techniques and applications in eukaryotic systems including plants, animals and humans.

Course content
The development of molecular biotechnology; DNA, RNA, and protein synthesis; Recombinant DNA technology; Chemical synthesis, sequencing, and amplification of DNA; Bioinformatics, genomics and proteomics; Manipulation of gene expression in prokaryotes; Recombinant protein production in eukaryotic cells; Directed mutagenesis and protein engineering; Molecular diagnostics; Microbial production of therapeutic agents; Vaccines; Synthesis of commercial products by recombinant microorganisms; Bioremediation and biomass utilization; Plant-growth-promoting bacteria; Microbial insecticides; Large-scale production of proteins from recombinant microorganisms; Genetic engineering of plants: methodology; Genetic engineering of plants: applications; Transgenic animals; Regulating the use of biotechnology; Societal issues in biotechnology

Form of tuition
Initial contact with the lecturer, introduction into the book and self study. Possibly additional contact with the lecturer if required.

Type of assessment
A written exam with essay questions.

Course reading
Molecular Biotechnology; principles and applications of recombinant DNA; Bernhard R. Glick and Jack J. Pasternak. ASM Press, Washington D.C. last version (4th). VU book store or library.

Entry requirements
A bachelor degree in biology, medical biology, biomedical sciences or biochemistry. Basic (bachelor) knowledge of cell biology, microbiology, molecular biology and molecular genetics is required.

Target group
Masterstudents Biomolecular Sciences

Remarks
Lecturer:
S. Luirink

E-mail: s.luirink@vu.nl

Caput Protein Structure as Molecular Basis of Disease

Course code	AM_470120 ()
Period	Ac. Year (September)
Credits	6.0
Language of tuition	English
Faculty	Fac. der Aard- en Levenswetenschappen
Coordinator	dr. D. Bald
Examinator	dr. D. Bald
Level	500

Course objective
Overview of recent advances in research of molecular disease based on protein structure;

Final attainment level:

The student has insight into the relation between protein structure/ (mal-) function;
The student has insight into the relation protein (mal)- function/disease.
The student can screen and evaluate scientific literature and present a structured review of recent advances in a relevant field/topic.

Course content
Suggested topics are:
• Antibiotic action
• Antibiotic Resistance
• Cancer/p53
• Anti-Influenza drugs
• Tuberculosis drug targets
• Anti-aids drugs
Feel free to suggest other topics related to protein structure/function, please ask the lecturer for more information.

Form of tuition
You receive several original publications on a recent topic in protein structure/disease (see above) from the lecturer. You study these papers and collect more information (data-base search etc.) about research in the field. Finally you can either write up your results in a review-style paper or give an oral presentation.

Type of assessment
Oral or written presentation (choice)

Course reading
Literature depends on the topic chosen by the student. Literature search in self-study.

Target group
Masters students Biomolecular Sciences, Biomedical Sciences, Biology, Pharmaceutical Sciences, Medical Natural Sciences

Registration procedure
Send email to Caput coordinator concerning further information and registration

Remarks
This caput can be done in the period from April to June.

Caput Structural Biology

Course code	AM_470607 ()
Period	Ac. Year (September)
Credits	6.0
Language of tuition	English

Faculty	Fac. der Aard- en Levenswetenschappen
Coordinator	dr. ir. Y.J.M. Bollen
Examinator	dr. ir. Y.J.M. Bollen

Course objective
To obtain knowledge about a topic in the field of protein structure and protein dynamics that currently attracts a lot of attention. To learn how to present and discuss scientific research.

Course content
One of the following topics:
- Adaptation of microorganisms to extreme environments
- Prion proteins
- Fluorescent proteins

Form of tuition
Self study, contact with lecturer is possible following an appointment

Type of assessment
Oral discussion with the lecturer

Course reading
A number of recent scientific papers will be provided

Entry requirements
See entry requirements for the specified MSc programs.

Target group
MSc students "Biology", "Biomolecular Sciences" and "Biomedical Sciences"

Remarks
The oral discussion with the lecturer can be done in English or in Dutch.

Cell Structures and Functions

Course code	AM_470615 ()
Period	Period 2
Credits	6.0
Language of tuition	English
Faculty	Fac. der Aard- en Levenswetenschappen
Coordinator	dr. S. Luirink
Examinator	dr. S. Luirink
Teaching staff	dr. S. Luirink
Teaching method(s)	Lecture
Level	400

Course objective
The first aim of the course is to refresh and deepen the knowledge of the students in a number a selected topics of Molecular Cell Biology. These topics include the folding, modification and sorting of proteins in cells. How do proteins fold in their correct and active three-dimensional structure? How do proteins reach their correct destination

in the cell (organelles, plasma membrane)? How do proteins insert and assemble in membranes, how are they translocated across membranes? How are these processes related to disease and drug development? The students will gain insight in the most recent research data and theories. Also, the students will get information on state-of-the-art methods and techniques used in this field such as fractionation of cells, determination of protein structure, proteomics, molecular interaction/crosslinking techniques and visualization of cells and cell components.
Of note, the objective is not to obtain a comprehensive overview of cell biology. After the general "refreshment" and technical part (first week), a few selected topics will be discussed in depth with guest lecturers based on primary research papers (second and third week).
Related to this, the second and most important aim of the course is to learn how to read,
appreciate and discuss reviews and primary research papers on various topics.
Final attainment levels:
-General knowledge of indicated topics
relevant for the course at the level of the "big" "Molecular Biology of the Cell" (Alberts et al.)
-In depth knowledge on the selected topics
provided by guest lecturers
-Ability to interpret and discuss newly acquired primary literature

Course content
See "form of tuition".

Form of tuition
In the first part of the course (one week) students will study and discuss in working groups part III (methods) and part IV (internal organization of the cell) of the book: "Molecular Biology of the Cell" (Alberts et al.). Chapter by chapter the students will be guided through the book and questions will be answered. Excursions will be organized to labs specialized in specific techniques (10 contact hours)
In the second part of the course (about two weeks; 20 contact hours) specific topics (protein trafficking, protein insertion into membranes, membrane protein function, glycosylation and quality control) will be studied and discussed with lecturers from the VU and other universities. Each lecturer will present a seminar and discuss with the students very recent research papers and developments in the particular area of interest. The reviews and papers will be available via blackboard before the lectures.
The third part (last week) of the course will be used to study and to prepare for the exam. The exam will be in "open book" format. There will be 6 questions about the papers presented by the lecturers (presented in week 2 and 3) and 2 questions about the relevant topics in Alberts and cell biology techniques (presented in week 1).

Type of assessment
A written exam with essay questions in which the Alberts book and print-outs of papers discussed by the lecturers can be used (open book exam) as well as a calculator.

Course reading
Molecular Biology of the Cell (Alberts, Johnson, Lewis, Raff, Roberts, Walter) Fifth edition, Garland Sciences.
Research papers presented by the lecturers: links available via blackboard 1 month prior to the course.

Entry requirements
A bachelor degree in biology, medical biology, biomedical sciences or biochemistry. Basic (bachelor) knowledge of cell biology, microbiology, molecular biology and molecular genetics is required.

Target group
Master students Biomolecular Sciences

Remarks
Maximum number of participants: 50
E-mail: s.luirink@vu.nl
Guest lecturers (subject to reservation) Prof. I. Braakman and Dr. P. van der Sluijs (UU), Prof. P. Peters (Universiteit Maastricht) and Prof. T. Sixma (NKI); Prof. C. De
Koster and Dr. B. Distel (UvA); Dr. M. Wilhelmus (VUMC)

Chemical Biology

Course code	X_432538 (432538)
Period	Period 1
Credits	6.0
Language of tuition	English
Faculty	Faculteit der Exacte Wetenschappen
Coordinator	prof. dr. R. Leurs
Examinator	prof. dr. R. Leurs
Teaching staff	prof. dr. R. Leurs
Teaching method(s)	Lecture, Computer lab
Level	400

Course objective
To get students acquainted with modern chemical biology techniques to study proteins and the modulation of their function, with a specific emphasis on drug discovery

Course content
In this course emphasis will be given on the interface between Chemistry and Biology. How can one understand biological processes using small molecules? How can one identify small molecules targeting new biochemical pathways, either by using modern biochemical or cellular assays (e.g. SPR, FRET, BRET, High-content & High resolution analysis), or in silico using the wealth of new information from structural biology? How to detect and/or modulate DNA, RNA and protein expression and/or function with chemical probes? These are the questions that are central to this course.

Form of tuition
lectures, tutorial, consultancy sessions and case study/presentation

Type of assessment
Students will work in small groups on an integrated case study. Based on primary literature, background information from Comprehensive Medicinal Chemistry, interaction with “Protein Champions”, students will work on a “Chemical Biology Protein Report” and oral presentation. Finally, there will be a written examination at the end of the course on the various

topics presented in the course.

Final grades will be based on results of the case study (35%), case presentation and discussion (15%) and final exam (50%). Each part must at least be satisfactory (mark “6 out of 10” or higher).

Course reading
Selected book chapters from Comprehensive Medicinal Chemistry II, 2007, Elsevier, Editors-in-Chief: John B. Taylor and David J. Triggle (available at VU library as e-book) and primary literature.

Entry requirements
Bachelor Pharmaceutical Sciences, Medical Natural Science, Science, Business and Innovation or Chemistry. Portal course MSc Biomolecular Science or Principles of Pharmaceutical Sciences, Signal Transduction in Health and Disease, or equivalent for mBMS students and students with Bsc SBI of Chemistry.

Target group
mBMS-BC, mCh-SBI (2nd year), mDDS-BCCA, mDDS-CMCT, mDDS-DD&S, mDDS-DDSA, mDDS-DDTF,
mDDS-C-var, mDDS-E-var, mDDS-M-var, mPhys-SBI (2nd year)

Registration procedure
Please register as soon as possible online.

Remarks
Presence is obliged at predefined moments of the course (e.g. kick-off meeting, computer practical, presentation session, examination) for finishing the course successfully.

Developmental Biology

Course code	AM_470613 ()
Period	Period 2
Credits	6.0
Language of tuition	English
Faculty	Fac. der Aard- en Levenswetenschappen
Examinator	prof. dr. R.E. Koes
Teaching staff	dr. R.F.G. Toonen, prof. dr. R.E. Koes
Teaching method(s)	Lecture, Seminar, Study Group
Level	600

Course objective
The development of a single cell, the fertilized egg cell, into a complex organism with all its tissue and organs in the right place is one of the most intriguing phenomena in biology. Whereas disciplines like molecular and cell biology aim to unravel the molecular mechanisms of a single cell, developmental biology aims to understand how such mechanisms make cells work together in a coherent way to form an entire organism. The overall aim of this course is to provide insight into these molecular mechanisms, such as the regulation of the expression of master genes and cell-to-cell signaling pathways underlying plant and animal development.

Final attainment levels:
- the student has a basic understanding of morphological events that take place during embryogenesis in animals
- the student can describe and distinguish key-concepts in development, such as (i) pattern formation (ii) determination of cell fate, (ii) differentiation and link that to general phenomena known in molecular biology, such as gene regulation, epigenetic phenomena, cell-signalling etc.
- The student can describe the (dis)similarities in the development of animals as different as fruitflies and vertebrates, in terms of morphological events and underlying molecular mechanisms.
- The student can explain the paradox that development of organisms with very different morphologies is governed by deeply conserved genes, and understands the molecular evidence for the current ideas.
- The student acquires experience in the critical analysis and discussion of experimental data as presented in research papers and the presentation of such data for a large(r) audience.

Course content

The first two weeks will be shared with the MSc course Developmental Neurobiology of the Vertebrate Brain. The first week consists of lectures on general developmental biology. For the second week one of two

paths can be chosen: (1) Development of the brain or (2) Plant development. The first part of the course finishes with a written "mid term exam"

In the third and the fourth week the focus shift to specific "hot topics" and research. Three or four masterclasses will be given by invited speakers/researchers that will give an overview of their own research field and discuss their (recent) experimental results. Furthermore, students (couples) will choose 2-3 recent research papers on a hot topic of their interest that they will study in depth to prepare for a small masterclass at the end of week 4 in which they outline the current status of the chosen subject, and present (and critically evaluate) the latest experimental data. Students can freely choose papers on plant or animal development. This ensures that everyone can follow his/her own preference for animal or plant biology and that, in the end, everyone gets a broad view on what is is currently going on in (plant or animal) developmental biology.

Specific issues that we will address in the first two weeks are:
- General key-concepts in development, such as pattern formation, segmentation, determination of cell fate, with emphasis on the experimental evidence on which our current knowledge is based
- Research strategies that are widely used in developmental biology.
- Molecular mechanisms that govern the development of embryos in insects (Drosophila) and vertebrates
- Elementary aspects of stem cell biology and "reprogramming" of differentiated cells into stems cells
- Evolutionary aspects: how can it be that deeply conserved genes govern the development of organisms with entirely different bodyplans, like fruitflies and vertebrates, or weed plants and trees.
- Late events in embryogenesis, the formation of organs (organogenesis). This will be entirely focused on development of the brain (for students taking the path Brain development)
- Early (embryogenesis) and late events (development of flowers and leaves) in the development of plants. What are similarities and differences with the development of animals?

In the last two weeks we will focus in depth on research concerning particular "topics that are currently "hot" in developmental biology.
Subjects that will be covered by invited speakers are:
- Development and functioning of stem cells and stem cell niches in the intestine.
- Role of Hox genes in the segmentation and later development of vertebrates
- Molecular mechanisms that govern pattern formation in plants
Subjects that wiil be covered in the masterclasses given by student depends on the choices that are made during the course and are, therefore, not entirely predictable beforehand. Some of the subjects that will almost certainly be covered are:
- Reprogramming of differentiated cells into stems cells and dangers/possibilities for use of such cells in therapy
- Intercellular movement of proteins like transcription factors, which were hitherto always believed to act only in the cells where they are synthesized

Form of tuition
Lectures and masterclasses (~ 58 hrs).
Self study (~ 55 hrs)

Type of assessment
Written exam (50%)
Oral presentations and (written) abstract (40%)
Active participation to discussions during masterclasses (10%)

Course reading
There is no specific handbook. You might find it useful to consult, on occasion, a handbook (any) to refresh your memory on some basic cellular processes, like gene regulation, signaling and so on, if that is necessary.
Handouts, incl. PowerPoint files of lectures, pdf files of relevant review and research papers will be provided via the Blackboard site.

Entry requirements
Basic knowledge (level 1/2) of molecular biology in particular mechanisms underlying regulation of gene expression, cell-signalling.
General affection for molecular biology is recommended

Target group
Master students: Biomolecular Sciences, Biology, Biomedical Sciences

Drug-induced Stress and Cellular Responses

Course code	X_432536 (432536)
Period	Period 2
Credits	6.0
Language of tuition	English
Faculty	Faculteit der Exacte Wetenschappen
Coordinator	dr. J.N.M. Commandeur
Examinator	dr. J.N.M. Commandeur
Teaching staff	dr. J.N.M. Commandeur
Teaching method(s)	Lecture

Level	500

Course objective
At the end of this theoretical course, the students are aware of the latest insights of cellular stress responses which can occur after exposure of cells to reactive drugs and/or reactive drug metabolites.

Course content
Exposure of tissues to high levels of drugs and/or drug metabolites in some cases can trigger various biochemical responses. Interaction with sensor proteins can lead to adaptative stress responses which will protect the cell against further damage. If these adaptative stress responses are insufficient, interaction with critical proteins may lead to cell death or exaggerated, fatal pharmacological responses.
The following aspects will be studied in the course drug-induced stress and cellular signaling:
• (types of) adverse drug reactions
• role of biotransformation and drug transport in adverse drug reactions,
• reversible and irreversible interactions of toxic drugs with biological macromolecules,
• cellular adaptation to exposure to reactive intermediates and reactive oxygen species;
• cellular and molecular mechanisms leading to toxic effects,
• genetic toxicology and chemical carcinogenesis,
• role of mitochondria in necrosis and apoptosis,
• impairment of cell proliferation and tissue repair,
• immune-mediated toxicity.

Form of tuition
Lectures and self study.

Type of assessment
Written exam

Course reading
Boelsterli, Mechanistic Toxicology: The Molecular Basis of How Chemicals Disrupt Biological Targets 2nd ed, CRC Press, 2007 (ISBN 0849372720).

Entry requirements
Bachelor Physics, Chemistry, Mathematics, Biology, Medical Biology Pharmaceutical Sciences, Medical Natural Science Biomolecular Science portal course, or equivalent

Target group
mDDS, mBMS

Dynamics of Biomolecules and Cells

Course code	X_422583 ()
Period	Period 4
Credits	6.0
Language of tuition	English
Faculty	Faculteit der Exacte Wetenschappen
Coordinator	dr. J.T.M. Kennis

Examinator	dr. J.T.M. Kennis
Teaching staff	dr. J.T.M. Kennis
Teaching method(s)	Lecture
Level	400

Course objective
Life is, by its very definition, a dynamic quantity. In this course an overview is given of dynamic processes that take place in biomolecules, membranes and cells in relation to biological functionality, and the biophysical methods that are applied to study them.

Course content
The significance of small movements to large-scale and slow reorganizations are being discussed as well the experimental techniques employed.
- DNA processing and dynamics (techniques: optical tweezers, AFM, tethered particle motion, magnetic tweezers). DNA structure and stability, DNA/RNA polymerase, DNA architectural proteins, DNA repair.
- Protein dynamics (techniques: ultrafast spectroscopy, Infrared and Raman spectroscopy, single-molecule fluorescence). Photoactive proteins, light-driven enzymes, Motor proteins, optogenetics.
- Membrane dynamics and remodeling (techniques AFM, single molecule, electron microscopy). Photosynthesis, crowding and membrane protein diffusion, Neuroimaging.
-superresolution microscopy

Form of tuition
Lectures, guest lectures, literature essay, oral literature presentation

Type of assessment
- Essay (literature or research proposal)
- Oral literature presentation
- written Exam

Course reading
Notes, handouts and papers.

Entry requirements
BSc. Physics, BSc. Medical Natural Sciences, BSc Chemistry or comparable

Target group
mMNS-PoL, mPhys-LSBP, mPhys-PLH

Ethics in Life Sciences

Course code	AM_470707 ()
Period	Period 3
Credits	3.0
Language of tuition	English
Faculty	Fac. der Aard- en Levenswetenschappen
Coordinator	prof. dr. J.T. de Cock Buning
Examinator	prof. dr. J.T. de Cock Buning
Teaching staff	prof. dr. J.T. de Cock Buning, dr. J.F.H. Kupper
Teaching method(s)	Lecture, Study Group

Level	400

Course objective
To provide a toolbox of ethical instruments to analyze properly moral problems related (to one's own) research in the life sciences
• To acquire conceptual knowledge of the central concepts in applied philosophy and professional ethics
• To challenge an ethical reflection on one owns life science specialization and to open it for an impartial and constructive discussion
• To exercise a team based project to enter prepare and execute a moral dialogue
• To acquire the necessary skills to handle ethical issues in an accountable manner, as a professional academic beyond one's own inclinations and prejudgments

Course content
Researchers in life sciences generate the knowledge that builds the future of our society. Therefore, professional academics should be accountable for their decisions, experimental designs and presentation of results. In this short course, the principles of justification will be illustrated with cases of technology ethics and medical ethics. The way an ethical review committee on animal research works, is simulated by a role play exercise on an actual research protocol. Finally, as a small group training project, an ethical dialogue is prepared and executed together with another team.

Form of tuition
Ethics in the Life Sciences is a fulltime course of four weeks (3 ECTS).
The total study time is 80 hours.
The different elements have the following study time:
• Lectures: 13 hours
• Work groups: 17 hours
• Group assignment: 24 hours
• Exam: 2 hour
• Presentation : 4 hours
• Self working (reading in the first week): 20 hours
Please note that attendance to the work group meetings is compulsory. Attendance to the lectures is highly recommended. In our experience, relying on self-study alone is insufficient to apply the theory of the lectures in the assignments of the workgroups, and to pass the exam.

Type of assessment
• Degree of intellectual participation in the workgroups (10%)
• exam (50%) has to be passed
• written and verbal execution of the ethical dialogue (40%)

Course reading
Available on Blackboard

Entry requirements
Bsc Biology, Biomedical Sciences, Psychology with profile Biological Psychology or Neuropsychology

Target group
Compulsory course in all FALW Master programmes, except Health Sciences and Neuro Sciences

Remarks
Lectures in English, part of the workgroups are in Dutch. All presentations and plenary discussions in English.
In order to maximize the experience of differences in values and preferences, and this increase meaningful ethical inquiry we will place you randomly in the workgroups. Placement will be communicated after the introduction lecture.

Evolving Networks

Course code	AM_1020 ()
Period	Period 2
Credits	6.0
Language of tuition	English
Faculty	Fac. der Aard- en Levenswetenschappen
Coordinator	dr. D. Molenaar
Examinator	dr. D. Molenaar
Teaching staff	prof. dr. H.V. Westerhoff, prof. dr. B. Teusink, dr. D. Molenaar, prof. dr. F.J. Bruggeman
Teaching method(s)	Lecture, Study Group, Computer lab
Level	400

Course objective
Biological systems consist of complex networks of interacting metabolites, molecules, cells, organisms and populations. We often assume that these networks are highly tuned to perform specific functions. But is that assumption justified? Can we investigate whether a signal transduction network is shaped by natural selection to perform a specific function optimally? Evolutionary experiments with microorganisms and detailed analysis of infection diseases have shown that they are extremely flexible, and can change functions very quickly by mutation or by incorporating large quantities of foreign DNA. In a similar manner, cancer cells carry many mutations, and are selected to perform functions that promote uncontrolled growth in a body.

In this course we will investigate the relationship between interactions in molecular, metabolic and cellular networks, and the presumed function of these networks. On the one hand we will discuss the exciting recent studies that yield detailed views on the mechanisms of mutation and selection in microbial and cancer cell populations and on the other hand we will discuss why particular forms of networks are selected, by trying to understand the relation between network properties, functions, and ultimately fitness.

Course content
• Microevolution in medical, industrial and laboratory setting
• Fitness landscapes and selection in populations
• Predicting optimal network structures by using models, and testing these predictions
• Cancer development from a micro-evolutionary and systems perspective
• Structure and function of signalling networks

Form of tuition

Lectures, computer practicals, and assignments.

Type of assessment
Assessment will take place by practical assignments (20%) and a written exam (80%).

Course reading
An online reader will be provided.

Target group
Master students with a background in Biology, Biomedical Sciences or Bioinformatics, with an interest in systems biology.

Extreme Biology

Course code	AM_470509 ()
Period	Period 2
Credits	6.0
Language of tuition	English
Faculty	Fac. der Aard- en Levenswetenschappen
Coordinator	dr. ir. A.H. de Boer
Examinator	dr. ir. A.H. de Boer
Teaching staff	dr. ir. A.H. de Boer, dr. D. Bald
Teaching method(s)	Lecture
Level	500

Course objective
At the end of this course, the student will be able to describe and explain various aspects of adaptation to extreme environments:
• how cellular structures (e.g. membranes) and individual molecules (proteins/DNA) are affected by physical parameters like temperature, pH, salt, pressure and radiation.
• how nature has solved these problems: what are the general and condition-specific adaptations to extreme conditions,
• what are the limits for life, and its relevance to the development of life on Earth and other planets,
• how can we exploit knowledge on nature’s extreme adaptations: what are its industrial, medical and societal applications
• how to write and present a research proposal on an extremophile topic of choice

Course content
Extreme life is nearer to you than you may think; consider for instance your stomach with a pH of 2. First life on Earth evolved under extreme conditions, at high temperature and without oxygen. Also nowadays extreme conditions can easily develop, for example as the result of drought/salinization and permanent extreme environments are abundant, like the Artics and Antartics. Thus, organisms need to and often can adapt to extreme conditions. The biology of living under extreme environmental conditions (in short extreme biology) has increasingly attracted attention in recent years. Reasons for this interest are diverse: apart from scientific curiosity, understanding how life functions under extreme conditions contributes to a better understanding of evolution of life on earth, and the potential for life on other planets, it is of medical importance (cryobiology, sensor technology,

enzyme technology), deals with major societal concerns (pollution, climate change) and leads to industrial applications (novel enzymes with new applications).
The key question in extreme biology is how extremophiles have adapted their enzymes/membranes/DNA structures etc. that serve the same function as those of ‘normal’ organisms, but operate under very different physical constraints. The course will focus on life forms (mainly microorganisms and plants and some examples from animal and human life) that have developed in environments that we do not experience as ‘normal’. ‘Normal’ relates to environmental factors like temperature, water, oxygen, pressure, radiation, pH, salinity etc. Environments that are extreme with respect to these factors are e.g. hot springs, ice, deep sea, deserts, acidic/alkaline or saline waters or sites polluted by industry. The course will deal with:
• Identification and description of extreme environments, and the most important physical parameters that form a limitation for biological processes.
• Understanding why and how physical parameters affect specific biological processes.
• Describing strategies developed by extremophiles to protect membranes, protein structures and DNA.
• Examples of possible applications of extreme biology in science, industry, medicine, agriculture etc.
• You will apply this knowledge to write a research proposal on a subject of choice that relates to extreme biology.

Form of tuition
The course consists of lectures, workshops and presentations. Lecturers will present and discuss specific topics and recent reviews and research papers will be available for the students. Learning how to write your own research proposal will be an important part of the course. Each student will choose an extremophile topic of his/her choice and submit/defend a research proposal at the end of the course.

Type of assessment
Written exam with essay questions (50%), Journal Club presentations (10%) and
Research Proposal (40%). Grades for all parts must be 5.5 or higher.

Course reading
Selected review and research articles.

Entry requirements
Bsc Biology, Biomedical Sciences

Target group
Master students Biomolecular Science, Biology, Ecology and Biomedical Sciences with an interest in the extra-ordinary forms of life.

Fundamentals of Bioinformatics

Course code	X_405052 (405052)
Period	Period 1
Credits	6.0
Language of tuition	English
Faculty	Faculteit der Exacte Wetenschappen

Coordinator	dr. ir. K.A. Feenstra
Examinator	dr. ir. K.A. Feenstra
Teaching staff	dr. ir. K.A. Feenstra
Teaching method(s)	Lecture, , Computer lab
Level	400

Course objective
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.

Course content
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!

Form of tuition
• 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

Type of assessment
• [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

Course reading
• 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

Recommended background knowledge
Bachelor in any science discipline (including medicine), or strong programming background.
An interest in programming and biological problems.

Target group
mAI, mBio, mCS, mMNS

Genomes and Gene Expression

Course code	AM_470614 ()
Period	Period 1
Credits	6.0
Language of tuition	English
Faculty	Fac. der Aard- en Levenswetenschappen
Coordinator	dr. J.M. Kooter
Examinator	dr. J.M. Kooter
Teaching staff	dr. J.M. Kooter
Teaching method(s)	Lecture, Study Group,
Level	400

Course objective
Course objectives:
The student should be able, at the molecular level, to
- describe the composition of eukaryotic and prokaryotic genomes and identify and indicate the function of the different sequences
- explain and dissect the process of transcription initiation, - elongation and - termination, and how these processes are regulated, mainly in eukaryotes
- describe in detail the structure and composition of chromatin, the post-translational modifications of histone proteins, the enzymatic machinery involved and their control
- distinguish between general and the various types of specific transcription factors, and explain their collaboration to induce or repress gene expression
- describe the various forms of DNA modification, their biochemistry, and impact on genome maintenance and gene expression in various somatic tissues
- describe the epigenetic reprogramming during mammalian embryonic development, parental imprinting, and differentiation
- explain how non-protein encoding RNAs can affect gene expression
- explain the various types of RNA processing and post-transcriptional regulation of gene expressing and design experiments to study these processes
- apply currently-used experimental approaches and techniques to perform gene specific and genome-wide expression studies

Course content

To achieve the course objectives, the following topics will be discussed:
• Genome structure, Transcriptional regulation and Epigenetic mechanisms:
• Genome organization: coding versus non-coding sequences
• Composition and biochemistry of basic transcription machinery
• General and specific transcriptional regulators and their regulation
• Transcription initiation, elongation and termination
• Identification and function of regulatory sequences: promoters, enhancers, suppressors, boundaries
• Epigenetics: Chromatin structure and histone modifications: writers-readers-erasers
• Epigenetics: DNA modifications (e.g. methylation) and their biochemical properties
• Epigenetic reprogramming during mammalian development
• Monoallelic gene expression and its importance for embryonic development and other biological processes
• 3D Nuclear structure and long range DNA interactions
• Transcriptional regulation and chromatin changes in stem cells, during differentiation, and development
• Cellular memory: establishing and maintenance of differentiation status
• Regulatory networks: the various ways by which regulators themselves are regulated
• Short and long non-coding RNAs and the mechanism by which they affect gene expression
• Experimental approaches and Techniques to study gene expression, differentiation and homeostasis

Post-transcriptional regulation
• integration of transcriptional and post-transcriptional control
• RNA processing, including alternative splicing, and its regulation
• Nucleo-cytoplasmic RNA transport
• RNA stability and degradation pathways
• RNA interference (siRNAs)
• Translation regulation and RNA degradation by micro(mi)RNAs
• RNA-editing and its biological importance
• Experimental approaches and Techniques to study post-transcriptional regulation of gene expression

Form of tuition
- Lectures and interactive meetings, including lectures by guest speakers who are working in a
particular field of research that is discussed in the course (ca 45 hr).
- Weblectures by experts (ca 5 hr)
- Self study (ca 100 hr)

Type of assessment
There are 2 sub-exams:
- First exam is half way the course and consists of Multiple Choice question and accounts for 40% of the final mark
- Second exam is at the end of the course and consists of open questions and accounts for 60% of the final mark. For the second exam, knowledge of the first part is needed. Resit of a sub-exam is not allowed.

Course reading
• Book: 'Gene Control' 2nd edition, by David Latchman, Garland Science
• Research and Review articles on specific topics, illustrating the latest developments in the field (from Blackboard site)

• PPT - lecture notes

Entry requirements
Basic concepts in Molecular Biology, Genetics, and Biochemistry

Target group
Master students: Biomolecular Sciences, Biology, Biomedical Sciences, Pharmaceutical Sciences, Oncology, and Medical Natural Sciences.

Registration procedure
Enrollment through studentportal: Vunet.vu.nl

Remarks
Compulsory portal course for MSc students Biomolecular Sciences, all differentiations.

Internship I Biological Chemistry

Course code	AM_471129 ()
Period	Ac. Year (September)
Credits	30.0
Language of tuition	English
Faculty	Fac. der Aard- en Levenswetenschappen
Coordinator	dr. J.M. Kooter
Examinator	dr. H.S. van Walraven
Level	600

Internship I Molecular Cell Biology

Course code	AM_471127 ()
Period	Ac. Year (September)
Credits	30.0
Language of tuition	English
Faculty	Fac. der Aard- en Levenswetenschappen
Coordinator	dr. J.M. Kooter
Examinator	dr. H.S. van Walraven
Level	600

Internship II Biological Chemistry

Course code	AM_471130 ()
Period	Ac. Year (September)
Credits	30.0
Language of tuition	English
Faculty	Fac. der Aard- en Levenswetenschappen
Coordinator	dr. J.M. Kooter
Examinator	dr. H.S. van Walraven
Level	600

Internship II Molecular Cell Biology

Course code	AM_471128 ()
Period	Ac. Year (September)
Credits	30.0
Language of tuition	English
Faculty	Fac. der Aard- en Levenswetenschappen
Coordinator	dr. J.M. Kooter
Level	600

Introduction to Systems Biology

Course code	X_428565 ()
Period	Period 1
Credits	6.0
Language of tuition	English
Faculty	Faculteit der Exacte Wetenschappen
Coordinator	dr. D. Molenaar
Examinator	dr. D. Molenaar
Teaching staff	prof. dr. B. Teusink, dr. D. Molenaar, prof. dr. F.J. Bruggeman
Teaching method(s)	Lecture, Study Group, Seminar
Level	400

Course objective

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. Based on their background, students will be assigned to deficiency 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

Course content

Theory:
- Design principles of biological networks, basic modeling approaches, evolution

Practical:
- Exercises during/in between lectures in which methods of systems biology will be applied to several topics.

Form of tuition
- Lectures (two hour lecture in the morning, two days per week)
- Computer practicals
- Modeling practicals
- Deficiency classes in biology, mathematics and/or programming

Type of assessment
30% Mathematics, Programming or Biology deficiency classes
60% Final exam of the Systems Biology subjects

Course reading
A course syllabus will be provided

Recommended background knowledge
Highschool mathematics

Target group
Students with background in Biology, Bioinformatics, Mathematics, Physics

Microbial Genomics

Course code	AM_1021 ()
Period	Period 3
Credits	3.0
Language of tuition	English
Faculty	Fac. der Aard- en Levenswetenschappen
Coordinator	prof. dr. R. Kort
Examinator	prof. dr. R. Kort
Teaching method(s)	Lecture
Level	500

Course objective
1. After the lecture series the students obtained insight in:

- The historical development of microbiological sciences
- Techniques to explore the human microbiome
- Human – Microbe interactions in Health and Disease
- Metabolic strategies of microorganisms
- Interventions with probiotics, prebiotics and synbiotics

2. Students have gained experience on thinking and writing about the impact of microbes on either our environment, human health, or industrial applications.

Course content
During 10 lectures, the enormous diversity of microbial life will become evident. The lectures will include a number of ways to explore microbial life forms associated with our body, in particular related to health and disease. Applications of our knowledge on the human microbiota for diagnostics, prognostics and interventions will be discussed.

10 lectures (obligatory) including a 4-5 p. perspective

Form of tuition
10 lectures (obligatory) including a 4-5 p. perspective

Type of assessment
Each student will write a perspective (approximately 4-5 pages) for of one of the 10 lectures; the abstract will containing a 1 page summary of the lecture, and 3 pages on the relevance of the microbiological topic for society (with particular emphasis on human heath). The selected lecture will be announced after the final lecture.

Course reading
Selected papers:

Kort R, Caspers M, van de Graaf A, van Egmond W, Keijser B, Roeselers G. Shaping the oral microbiota through intimate kissing. Microbiome. 2014 Nov 17;2:41.

Budding AE, Grasman ME, Lin F, Bogaards JA, Soeltan-Kaersenhout DJ, Vandenbroucke-Grauls CM, van Bodegraven AA, Savelkoul PH. IS-pro: high-throughput molecular fingerprinting of the intestinal microbiota. FASEB J. 2010 Nov;24(11):4556-64

Borgdorff H, Tsivtsivadze E, Verhelst R, Marzorati M, Jurriaans S, Ndayisaba GF, Schuren FH, van de Wijgert JH. Lactobacillus-dominated cervicovaginal microbiota associated with reduced HIV/STI prevalence and genital HIV viral load in African women. ISME J. 2014 Sep;8(9):1781-93.

Dutilh BE. Metagenomic ventures into outer sequence space. Bacteriophage. 2014 Dec 15;4(4):e979664.

Belzer C, Gerber GK, Roeselers G, Delaney M, DuBois A, Liu Q, Belavusava V, Yeliseyev V, Houseman A, Onderdonk A, Cavanaugh C, Bry L. Dynamics of the microbiota in response to host infection. PLoS One. 2014 Jul 11;9(7):e95534.

Entry requirements
Molecular Biology

Recommended background knowledge
General and Molecular Microbiology

Target group
MSc Students BioMolecular Sciences

Remarks
Venue: Artis de Volharding

http://www.artis.nl/ontdek-artis/artis-a-z/monumenten-z/de-volharding/

Announcement of lecture series:

http://www.micropia.nl/nl/ontdek/verdiep-je-in-de-microbiologie/the-huma

Lecture topics and speakers:

Microbiome in Health and Disease
Monday Jan 4 (10.00 – 12.00 u)
Prof. Remco Kort (TNO, VUA). Introduction into the human microbiome.
https://www.linkedin.com/pub/remco-kort/14/547/403
Dries Budding, MD (VUMC). Man and Microbe: a delicate superorganism
https://www.linkedin.com/pub/dries-budding/5/956/78
Tuesday Jan 5 (10.00 u – 12.00 u)
Dr. Douwe Molenaar (VUA). Dealing with big data of the microbiota.
http://www.ibi.vu.nl/sysbio/doku.php/people/douwe_molenaar
Dr. Evgeni Levin-Tsivtsivadze (TNO). Microbial ecology in health and disease: a machine learning approach.
http://www.learning-machines.com/
Friday Jan 8 (10.00 u – 12.00 u)
Dr. Bas Dutilh (UU). Metagenomic ventures into outer sequence space.
https://www.linkedin.com/in/dutilh
Dr. Guus Roeselers (TNO). Microbial ecology of the gastro-intestinal tract.
https://www.linkedin.com/in/roeselers
Monday Jan 11 (10.00 – 12.00)
Prof. Eddy Smid (WUR). The best foods are made by microbes.
https://www.linkedin.com/pub/eddy-j-smid/9/338/9a8
Prof Wilbert Bitter (VUMC) Die hard with a vengeance, strategy of mycobacterial pathogens.
http://www.aimms.vu.nl/en/people/b/bitter.aspx
Tuesday Jan 12 (10.00 – 12.00)
Prof. Janneke van de Wijgert (University of Liverpool, Institute of Infection and Global Health). Microbial ecology of bacterial vaginosis.
https://www.linkedin.com/pub/janneke-van-de-wijgert/7/195/2a0
Prof. Gregor Reid (Canadian Centre for Human Microbiome and Probiotic Research, Lawson Health Research Institute). Fermented milk as a delivery vehicle for probiotics in Africa.

Molecular Biology Techniques

Course code	X_432540 (432540)
Period	Period 3
Credits	3.0
Language of tuition	English
Faculty	Faculteit der Exacte Wetenschappen
Coordinator	J.C. Vos
Examinator	J.C. Vos
Teaching staff	J.C. Vos
Teaching method(s)	Lecture, Practical
Level	400

Course objective
To introduce students into the application of basic techniques, primarily DNA cloning and PCR, to express (mutant) genes.

Course content
Theoretical background on DNA cloning and gene expression.
Laboratory practical work involving, e.g.:
(1) generation and expression of mutant/human cytochrome P450 in E. coli,
(2) cloning and testing of novel gene reporters for stress-response in S. cerevisiae,
(3) cloning of fusion genes for cell biological purposes in S. cerevisiae, or
(4) cloning for aiming at overexpression of particular genes in S. cerevisiae.

Form of tuition
Laboratory work, lectures, tutorials.

Type of assessment
Laboratory work, assignments, written report.

Course reading
Manual and protocols available on Blackboard.

Entry requirements
The course "Genomes and Gene Expression"

Target group
mBMS

Remarks
Maximum number of students is 24.

Molecular Infection Biology

Course code	AM_470657 ()
Period	Period 2
Credits	6.0
Language of tuition	English
Faculty	Fac. der Aard- en Levenswetenschappen
Coordinator	prof. dr. W. Bitter
Examinator	prof. dr. W. Bitter
Teaching staff	prof. dr. W. Bitter
Teaching method(s)	Lecture, Practical
Level	600

Course objective
To understand how the interaction of a pathogen with its host is studied (in vitro studies, use of alternative in vivo models, different approaches of mutant screening)
To understand the variation within microbial pathogens and the effect this variation has on host adaptation.
To understand what virulence factors are and how they are regulated by the pathogen.

To apply the acquired knowledge to interpret scientific literature and scientific hypotheses regarding pathogen-host interactions.

Course content
The recent explosion in genomic data of both microbes and eukaryotic hosts and the continuous progress in molecular biology allows a detailed analysis of the molecular interactions between a pathogen and its host. This knowledge is necessary because we are continuously exposed to new emerging pathogens and the resurgence of old plagues and need new vaccines and anti-microbial compounds. However, which technique should and could be used for a specific problem and how to interpret conflicting outcomes using different experimental strategies? This course aims to provide a thorough understanding and practical experience of molecular biology as it applies to infectious agents. The course covers the application of molecular biology to studying the basic biology of pathogenic bacteria and viruses (their virulence factors, taxonomy and genetic typing) and the genetic susceptibility of the host to infection. It aims to equip students with the specialised knowledge and skills necessary to assess primary literature on medical microbiology.

Form of tuition
The course has three different parts: lectures, practicum and workshop. In the latter part students will discuss with each other opposing views on controversial topics in medical microbiology that recently appeared in the literature.

contact hours:
lectures: 18
Literature Workshop: 17
Practicum: 30-40

Type of assessment
written exam (50% of final mark and should be minimally 5,5)
literature discussion (workshop, 30% of final mark)
practicum (20% of final mark)

Course reading
Reader will be available one week before the start of the course.

Entry requirements
Bachelor's course 'Infectieziekten' and 'Immunologie' or an equivalent course in Microbiology and Molecular Biology with practical skills of handling microorganisms safely

Target group
Students with a keen interest to study the interaction between a pathogen and its host, from a practical as well as a theoretical point of view

Remarks
Guest lectures:
Dr. Peter van der Ley, RIVM Bilthoven, molecular techniques used for vaccine development
Dr. Lia van der Hoek, AMC Amsterdam, identification of novel viral pathogens

Molecular Pharmacology

Course code	X_432541 (432541)
Period	Period 4
Credits	3.0
Language of tuition	English
Faculty	Faculteit der Exacte Wetenschappen
Coordinator	dr. M.H. Siderius
Examinator	dr. M.H. Siderius
Teaching staff	dr. M.H. Siderius, dr. H.F. Vischer
Teaching method(s)	Lecture, Practical
Level	400

Course objective
This course aims to teach the BMS students the basic laboratory techniques in Molecular Pharmacology. This course is suited only for students without prior experience.

Course content
Practical course aimed to train BMS Masterstudents with deficiencies in Mol. Pharmocology techniques (Receptor-Ligand binding studies, ELISA, BRET, Mammalan cell transfections, Reportergene assays)

Form of tuition
Practical course

Type of assessment
Report

Entry requirements
Participation in BMS Portal courses is required.

Target group
BMS master students with deficiencies and a limited amount of DDS Masterstudents (to be selected by course coordinator)

Remarks
This course is open for only 24 students

Molecular photobiology

Course code	X_432763 ()
Period	Period 4
Credits	3.0
Language of tuition	English
Faculty	Faculteit der Exacte Wetenschappen
Coordinator	prof. dr. R. Croce
Examinator	prof. dr. R. Croce
Teaching staff	prof. dr. R. Croce
Teaching method(s)	Lecture, Practical
Level	400

Course objective
To introduce students to multidisciplinary research in molecular photobiology, integrating a set of different techniques of molecular biology, biochemistry and biophysics.
Students should be able to:
- plan and conduct experiments using different techniques
- Perform a research program
- evaluate the results on the basis of theoretical knowledge and literature
- present (and critically discuss) the results in the form of a journal article

Course content
During this course the students will perform a research program focused on the study of photoactive proteins involved in the photosynthetic process. Pigment-proteins will be purified from plants or overexpressed in E.coli and reconstituted in vitro. A series of mutants will also be prepared/analyzed. The pigment-proteins complexes will be studied with a large set of biochemical and spectroscopic techniques (both steady-state and time-resolved). The data will be analyzed in detail and the results of the different experiments integrated to obtain information about the properties of the complexes and the effect of specific mutations.

Form of tuition
Laboratory work Lectures Tutorials

Type of assessment
Lab work (50%), written report (30%) and oral discussion of the results (20%).

Course reading
Course Manual. Literature and study material will be provided by the teacher before the start of the course.

Target group
Master students in biomolecular sciences

Remarks
The course is very intense with at least 7 days full time in the lab (9-17).

Project Computational Design and Synthesis of Drugs

Course code	X_432734 ()
Period	Period 4
Credits	6.0
Language of tuition	English
Faculty	Faculteit der Exacte Wetenschappen
Coordinator	dr. C. de Graaf
Examinator	dr. C. de Graaf
Teaching staff	dr. M. Wijtmans, dr. C. de Graaf, dr. D.P. Geerke
Teaching method(s)	Lecture, Practical
Level	400

Course objective
To gain insight and experience in the molecular modeling tools that enable (rational) drug design and to examine and plan efficient routes to synthesize conceived ligands.

Course content
In the post-genome era, an overwhelming amount of data describing the molecular characteristics of the targets is becoming available. For example, the structure of many proteins is being determined using X-Ray analysis and NMR techniques. Furthermore, high-throughput screening results in massive amounts of data that reveal the molecular properties of the ligands that are able to have interaction with the drug targets. In this project, several techniques that can help to translate this data into novel ligands will be discussed and applied. Specific topics include crystal structure analysis, the building of homology models, docking of ligands, calculating binding free energy and affinity of ligands for the protein, de novo structure generation, and pharmacophore modeling. These techniques generate ideas for novel compounds. Because a design that cannot be synthesized is by definition a useless design, the synthetic feasibility is a key and integral part of the design process. Therefore, it is important to be able to define a synthetic pathway for the preparation of the designed compounds. In this project, this aspect will be covered by lectures on the concept of retrosynthesis and on the incorporation of some biologically relevant moieties, such as heteroatoromatic scaffolds and known affinity-increasers. An online retrosynthetic demonstration with a search engine sets the stage for a case study. For a specific design, a versatile and robust synthesis route has to be defined. A thorough literature search, in combination with detailed study of the reactions involved will result in a report that describes the suggested chemistry in detail.

Form of tuition
Project basis: including lectures, tutorials, self study, assignments and group-work on a case-study.

Teachers: Dr. C. de Graaf, Dr. M. Wijtmans, Dr. D.P. Geerke, Prof. Dr. De Esch.

Type of assessment
Written exam (50%), case study report (50%). Both the exam and the case study report should be passed.

Course reading
Two eBooks contain several chapters of literature. These two books are:

Mason: Volume 4 of Comprehensive Medicinal Chemistry II: Computer-Assisted Drug Design (Mason (Ed.).
http://www.sciencedirect.com/science/referenceworks/9780080450445

Hoffmann: Elements of Synthesis Planning (Hoffmann (Ed))
http://www.springerlink.com/content/j81646

These books are accessible through UBVU at all VU computers. The same holds true for articles and the Reaxys search engine (vide infra). When at home, turn on the VU-proxy (http://www.ub.vu.nl/nl/faciliteiten/thuis-werken/index.asp) and accessibility to all these items is maintained.

The following book (Clayden) is not an eBook accessible through UBVU, but it contains useful background literature on organic chemistry. All students that received their FAR BSc degree at the VU possess this book. It is suggested by us that such students could consider lending this book to others if necessary.

Clayden: Clayden, Organic Chemistry, Oxford University Press, 2001.

In the remainder of the guide, a distinction is made between integral literature and background literature.
Integral literature represents literature that is considered integral to the topic and hence is exam material.
Background literature either constitutes material for certain assignments or offers a wider or alternative discussion of the topic that an interested student can read at his/her own leisure. Background literature is not exam material.

Entry requirements
Knowledge of basic organic chemistry.

Target group
mDDS-BCCA, mDDS-CMCT, mDDS-DD&S, mDDS-DDSA, mDDS-DDTF, mDDS-C-var, mDDS-E-var, mDDS-M-var

Protein Science

Course code	AM_470145 ()
Period	Period 1
Credits	6.0
Language of tuition	English
Faculty	Fac. der Aard- en Levenswetenschappen
Coordinator	dr. D. Bald
Examinator	dr. D. Bald
Teaching staff	dr. M.H. Siderius, prof. dr. ir. E.J.G. Peterman, dr. J.N.M. Commandeur, dr. D. Bald, prof. dr. M.J. Smit
Teaching method(s)	Lecture, Study Group
Level	400

Course objective
The student:
1. knows and understands principles of protein structure,, dynamics, regulation, inhibition, interaction and engineering
2. can explain protein function based on protein structure and the proprties of amino acid residues.
3. can predict the function of (parts of) a protein based on undestanding of its molecular properties
4. knows and understands the principle of current methods for protein investigation (e.g. overproduction, purification, interaction, engineering)
5. can analyze the strong and weak points of Protein Science techniques and can correlate an open question with a suitable technique.
6. can analyze experiments in Protein Science and design new experiments.

Course content
We will start with a repetition of protein structure and function. Subsequently, we will focus on methods in protein science and also on more specialized properties of proteins important in fundamental research, biomedicine or biotechnology. Finally we will deal with case studies on selected proteins.
Lecture topics include:
Protein Structure, Protein Function, Protein Dynamics, Molecular Machines, Control of Protein Function, Protein inhibition, Antibiotic action, Development of antibiotics and antibiotic resistance, Protein over-expression and purification, Protein Interaction, Protein Engineering,
Molecular Modeling and docking
Case studies:
GPCRs as drug target, Cytochrome P450, Chaperones as Protein folding machines,
Molecular Modeling/docking.

Form of tuition
Lectures (30 h) accompanied by work (paper) discussions (6 h) and self study
(individual or in small groups) to prepare for the lectures and to discuss the material presented in lectures/accompanying papers.

Type of assessment
Written exam (100%)

Course reading
No special book required. Useful may be "Protein Structure and Function" by Petsko/Ringe. You can also use any Biochemistry textbook (e.g. Voet and Voet) for repetition. You will receive material (reviews and original articles on relevant topics). Examples of scientific literature: Lee et al. Nature 2010, Bax et al. Nature 2010, and Kumar Exp. Opin. Drug Metab 2010.

Target group
Masters students Biomolecular Sciences, Biomedical Sciences, Biology, Pharmaceutical Sciences and Medical Natural Sciences

Remarks
Visiting lecturer: Dr. Anil Koul, Tibotec J&J

Protein Sciences Techniques

Course code	AM_470641 ()
Period	Period 3
Credits	3.0
Language of tuition	English
Faculty	Fac. der Aard- en Levenswetenschappen
Coordinator	dr. D. Bald
Examinator	dr. D. Bald
Teaching staff	dr. D. Bald
Teaching method(s)	Lecture
Level	400

Course objective
Practice advanced protein science methods that you can apply to answer a wide range of biochemical, biomedical and biotechnical questions.

Final attainment:
The student understands advanced practical approaches for investigation of proteins and can interpret experimental results.

The student is able to apply current methods for protein over-expression, purification, protein labelling, as well as for investigation of protein/protein or protein/drug interaction.

Course content
We will start with a brief repetition of the theoretical background of current protein science techniques. Subsequently, we will focus on application of selected techniques in the lab.
Techniques/practical include:
 Over-expression of proteins;
 Advanced chromatography methods for protein purification;
 Surface Plasmon Resonance Sensing (Biacore) for protein/protein or protein/drug interaction;
 Functionalized Micro-beads for affinity interaction/labeling.

Form of tuition
Laboratory practical (16h) accompanied by a lecture (4h) and self-study to prepare for the practical, evaluate experimental results and write reports.

Type of assessment
Active participation in the practical (50%), written reports (50%). A minimal grade of 5.5 for each part is needed to pass the course.

Course reading
You will receive a course material with background information and experimental protocols.

Entry requirements
Participation in the portal course Protein Science (470145) is required.

Target group
Master students Biomolecular Sciences, Biomedical Sciences, Biology, Pharmaceutical Sciences and Medical Natural Sciences

Remarks
Maximal number of participants is 32. A lab coat is required for the practical.

Scientific Writing in English

Course code	AM_471023 ()
Period	Period 2, Period 5
Credits	3.0
Language of tuition	English
Faculty	Fac. der Aard- en Levenswetenschappen
Coordinator	M. van den Hoorn

Examinator	M. van den Hoorn
Teaching method(s)	Study Group
Level	400

Course objective

The aim of this course is to provide Master's students with the essential linguistic know-how for writing a scientific article in English that is well organized idiomatically and stylistically appropriate and grammatically correct.

At the end of the course students

- know how to structure a scientific article;
- know what the information elements are in parts of their scientific article;
- know how to produce clear and well-structured texts on complex subjects;
- know how to cite sources effectively;
- know how to write well-structured and coherent paragraphs;
- know how to construct effective sentences;
- know what collocations are and how to use them appropriately;
- know how to adopt the right style (formal style, cohesive style, conciseness, hedging)
- know how to avoid the pitfalls of English grammar;
- know how to use punctuation marks correctly;
- know what their own strengths and weaknesses are in writing;
- know how to give effective peer feedback.

Final texts may contain occasional spelling, grammatical or word choice errors, but these will not distract from the general effectiveness of the text.

Course content

The course will start with a general introduction to scientific writing in English. Taking a top-down approach, we will then analyse the structure of a scientific article in more detail. As we examine each section of an article, we will peel back the layers and discover how paragraphs are structured, what tools are available to ensure coherence within and among paragraphs, how to write effective and grammatically correct sentences and how to choose words carefully and use them effectively.

Topics addressed during the course include the following:

- Structuring a scientific article
- Considering reading strategies: who is your readership? How do they read your text? What do they expect? How does that affect your writing?
- Writing well-structured and coherent paragraphs
- Composing effective sentences (sophisticated word order, information distribution).
- Arguing convincingly – avoiding logical fallacies
- Academic tone and style: hedging – why, how, where?
- Using the passive effectively
- Understanding grammar (tenses, word order, etc.)
- Understanding punctuation
- Referring to sources: summarising, paraphrasing, quoting (how and when?)
- Avoiding plagiarism
- Vocabulary development: using appropriate vocabulary and

collocations

Form of tuition
Scientific Writing in English is an eight-week course and consists of 4 contact hours during the first week and 2 contact hours a week for the rest of the course. Students are required to spend at least 6 to 8 hours of homework per week. They will work through a phased series of exercises that conclude with the requirement to write several text parts (Introduction, Methods or Results section, Discussion and Abstract). Feedback on the writing assignments is given by the course teacher and by peers.

Type of assessment
Students will receive the three course credits when they meet the following requirements:
- Students hand in three writing assignments (Introduction, Methods or Results, Discussion) and get a pass mark for all writing assignments;
- Students provide elaborate peer feedback;
- Students attend all sessions;
- Students are well prepared for each session (i.e. do all homework assignments);
- Students actively participate in class;
- Students do not plagiarise or self-plagiarise.

Course reading
Effective Scientific Writing: An Advanced Learner's guide to Better English (A. Bolt & W. Bruins, ISBN 978 90 8659 6171). VU bookstore: €27.95.

Target group
This course is only open to students of the following Master's programmes of the Faculty of Earth and Life Sciences: MSc Biology, Health Sciences, Ecology, Biomolecular Sciences, Biomedical Sciences, Neurosciences, Global Health, Hydrology, and Management, Policy Analysis and Entrepreneurship in Health and Life Sciences.

This course is an alternative for students who are not able to attend Scientific Writing in English in their designated group (this is not applicable for students Hydrology).

Registration procedure
Students should register on time by sending an e-mail to onderwijsbureau.beta@vu.nl, selfregistration in VUnet is not possible. Please note that this
course will only go through with a minimum of 18 participants andmaximum of 24. Students are advised to consult their schedule carefully,since overlap may occur.

If you are registered for a group in VUnet, you are expected to attend all sessions (eight). If you decide to withdraw fromthe course, please do so in time. This all
will avoid a 'fail' on your grade list for not taking part in this course and allows other students to fill in a possible very wanted group spot.

Remarks
- To do well, students are expected to attend all lessons. Group schedules are to be found at rooster.vu.nl and on Blackboard.
- If you (expect to) miss a session, please inform the group trainer as

soon as possible. If you miss a session without notification, you may not be able to finish the course.
- For any questions concerning this course, please contact onderwijsbureau.beta@vu.nl.

Scientific Writing in English (AM_BMOL)

Course code	AM_1156 ()
Period	Period 1
Credits	3.0
Language of tuition	English
Faculty	Fac. der Aard- en Levenswetenschappen
Coordinator	M. van den Hoorn
Examinator	M. van den Hoorn
Teaching method(s)	Study Group
Level	400

Course objective
The aim of this course is to provide Master's students with the essential linguistic know-how for writing a scientific article in English that is well organized idiomatically and stylistically appropriate and grammatically correct.
At the end of the course students
- know how to structure a scientific article;
- know what the information elements are in parts of their scientific article;
- know how to produce clear and well-structured texts on complex subjects;
- know how to cite sources effectively;
- know how to write well-structured and coherent paragraphs;
- know how to construct effective sentences;
- know what collocations are and how to use them appropriately;
- know how to adopt the right style (formal style, cohesive style, conciseness, hedging)
- know how to avoid the pitfalls of English grammar;
- know how to use punctuation marks correctly;
- know what their own strengths and weaknesses are in writing;
- know how to give effective peer feedback.

Final texts may contain occasional spelling, grammatical or word choice errors, but these will not distract from the general effectiveness of the text.

Course content
The course will start with a general introduction to scientific writing in English. Taking a top-down approach, we will then analyse the structure of a scientific article in more detail. As we examine each section of an article, we will peel back the layers and discover how paragraphs are structured, what tools are available to ensure coherence within and among paragraphs, how to write effective and grammatically correct sentences and how to choose words carefully and use them effectively.

Topics addressed during the course include the following:
- Structuring a scientific article

- Considering reading strategies: who is your readership? How do they read your text? What do they expect? How does that affect your writing?
- Writing well-structured and coherent paragraphs
- Composing effective sentences (sophisticated word order, information distribution).
- Arguing convincingly – avoiding logical fallacies
- Academic tone and style: hedging – why, how, where?
- Using the passive effectively
- Understanding grammar (tenses, word order, etc.)
- Understanding punctuation
- Referring to sources: summarising, paraphrasing, quoting (how and when?)
- Avoiding plagiarism
- Vocabulary development: using appropriate vocabulary and collocations

Form of tuition
Scientific Writing in English is an eight-week course and consists of 4 contact hours during the first week and 2 contact hours a week for the rest of the course. Students are required to spend at least 6 to 8 hours of homework per week. They will work through a phased series of exercises that conclude with the requirement to write several text parts (Introduction, Methods or Results section, Discussion and Abstract). Feedback on the writing assignments is given by the course teacher and by peers.

Type of assessment
Students will receive the three course credits when they meet the following requirements:
- Students hand in three writing assignments (Introduction, Methods or Results, Discussion) and get a pass mark for all writing assignments;
- Students provide elaborate peer feedback;
- Students attend all sessions;
- Students are well prepared for each session (i.e. do all homework assignments);
- Students actively participate in class;
- Students do not plagiarise or self-plagiarise.

Course reading
Effective Scientific Writing: An Advanced Learner's guide to Better English (A. Bolt & W. Bruins, ISBN 978 90 8659 6171). VU bookstore: €27.95.

Target group
Students Biomolecular Sciences

Registration procedure
Since this course starts at August 31st, you have to sign in for the course before this date (despite other communication on VUnet).

Important: each group has a minimum of 18 and maximum of 24 participants, so students should register on time through VUnet to ensure a place in one of the (designated) groups. If you have registered for a group in VUnet, you are expected to attend all sessions (eight). If you decide to withdraw from the course, please do so in time. This all will avoid a 'fail' on your grade list for not taking part in this course and allows other students to fill in a possible very wanted group spot.

Each semester, one or more open/general groups also take place (with a minimum of 18 participants), for which students may register instead of the designated group for their master programme. Students are advised to consult their schedule carefully, since overlap may occur. For more information, please check course code AM_471023.

Remarks
- To do well, students are expected to attend all lessons. Group schedules are to be found at rooster.vu.nl and on Blackboard.
- If you (expect to) miss a session, please inform the group trainer as soon as possible. If you miss a session without notification, you may not be able to finish the course.
- For any questions concerning this course, please contact onderwijsbureau.beta@vu.nl.

Signal Transduction in Health and Disease

Course code	X_432535 (432535)
Period	Period 2
Credits	6.0
Language of tuition	English
Faculty	Faculteit der Exacte Wetenschappen
Coordinator	prof. dr. M.J. Smit
Examinator	prof. dr. M.J. Smit
Teaching method(s)	Lecture
Level	600

Course objective
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.

Course content
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.

Form of tuition
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.

Type of assessment
Assignment and presentation, written exam.

Course reading
'Cell signaling', Authors: Wendell Lim, Bruce Mayer, Tony Pawson
ISBN: 9780815342441
Format: Paperback
Publication Date: June 15, 2014

Papers available on Blackboard

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

Target group
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

Structural Bioinformatics

Course code	X_405019 (405019)
Period	Period 4
Credits	6.0
Language of tuition	English
Faculty	Faculteit der Exacte Wetenschappen
Coordinator	dr. ir. K.A. Feenstra
Examinator	dr. ir. K.A. Feenstra
Teaching staff	dr. ir. K.A. Feenstra, dr. S. Abeln
Teaching method(s)	Lecture, Practical
Level	400

Course objective
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.

Course content
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 interaction as a 'computational experiment' (simulation).

Form of tuition
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.

Type of assessment
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 interaction 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 you exam through exercises and paper discussion during the lectures

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

Recommended background knowledge
Bachelor in any science discipline (including medicine).
Basic scripting skills (e.g. Python or Pearl) 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.

Target group
mAI, mBio, mCS, mPDCS, mMNS, mBMOL, mNS, mBIO

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

Thesis Based on Literature Study

Course code	AM_471153 ()
Period	Ac. Year (September)
Credits	9.0
Language of tuition	English
Faculty	Fac. der Aard- en Levenswetenschappen
Coordinator	dr. J.M. Kooter
Examinator	dr. H.S. van Walraven
Level	600