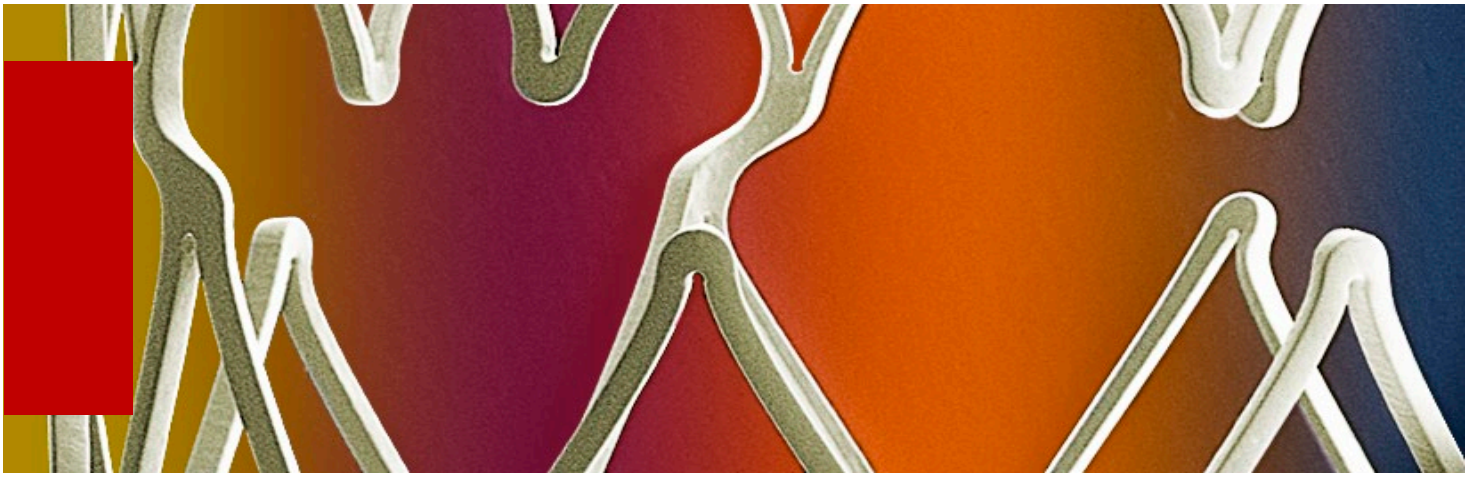
Module Handbook
Master of Science in Life Sciences



Specialisations offered by the School of Life Sciences FHNW:

- Analytical Chemistry
- Applied Cell Biology
- Bioanalytics
- Biotechnology
- Chemical Engineering
- Environmental Technologies
- Organic and Supramolecular Chemistry
- Pharmatechnology

June 2023

The Essentials
Master of Science in Life Sciences FHNW

- a coordinated master programme in Life Sciences conducted by the Swiss Universities of Applied Sciences
- designed for motivated students interested in applied research
- provides improved and additional career opportunities in research, development and production
- specialisations offered by the University of Applied Sciences and Arts Northwestern Switzerland:

  Analytical Chemistry
  Applied Cell Biology
  Bioanalytics
  Biotechnology
  Chemical Engineering
  Environmental Technologies
  Organic and Supramolecular Chemistry
  Pharmatechnology

- three semesters full-time study, 90 ECTS credits
- part-time study possible
- master thesis: 40 ECTS credits, modules: 50 ECTS credits
- admission: good bachelor degree in a relevant subject
- good knowledge of English required
- admission deadlines: April 30th (autumn semester) and November 30th (spring semester)
- start of studies: mid-September and mid-February
- tuition fee: CHF 700.- per semester (Swiss, Liechtenstein), CHF 1000 (EU), otherwise CHF 5000.-

Curriculum

The School of Life Sciences FHNW offers nine specialisations: **Analytical Chemistry, Applied Cell Biology, Bioanalytics, Biotechnology, Chemical Engineering, Environmental Engineering, Organic and Supramolecular Chemistry and Pharmatechnology.**

The Core Competence modules and the Cluster-specific modules are provided jointly by the Swiss Universities of Applied Sciences.

The Master Thesis (40 ECTS credits) is conducted at one of the institutes of the School of Life Sciences FHNW or externally in cooperation with companies or other institutes.

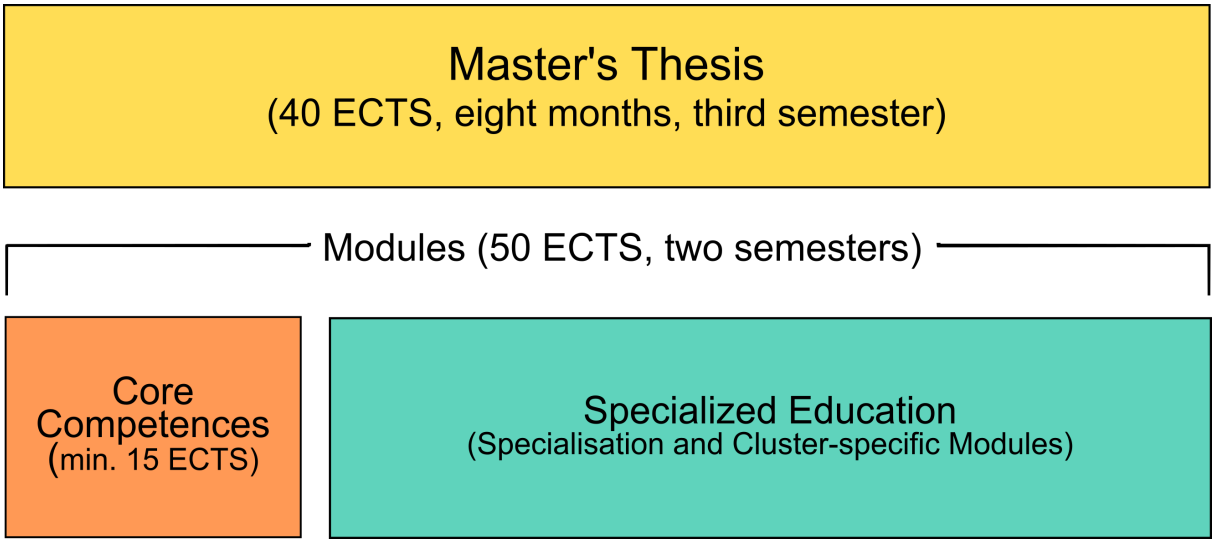


Figure 1: Organisation of the study programme (full-time)
Every student chooses at least five modules à 3 ECTS of the Core Competences. Another fourteen modules à 3 ECTS are chosen from the Specialisation and Cluster-specific Modules. Each student has to take three cluster-specific modules preferably from the cluster their specialisation belongs to. In addition, each student has to fulfil the module groups of its specialisation.
The study programme finishes with a Master Thesis which is conducted at the School of Life Science FHNW or in cooperation with a company during the third semester. One ECTS (European Credit Transfer System) credit is equivalent to a student work load of 30 hours. In case of lecture one ECTS credit is equivalent a lesson per week for one semester; the remaining time is for self-study.
Part-time students have more time to visit the modules, e.g. four semesters.

Compulsory Elective Modules for each Specialisation

All Specialisations

Module Group Core Competences (4 out of 8 required)

Handling and Visualizing Data
Design and Analysis of Experiments
Modelling and Exploration of Multivariate Data
Data and Ethics
Business Administration for Life Sciences
Management and Leadership for Life Sciences
Innovation and Project Management
Politics and Society

Analytical Chemistry

Module Group Analytical Chemistry (4 out of 5)

Advanced NMR Spectroscopy
Biostructures and Solid State Sciences
Advanced Mass Spectrometry
Molecular & Translational Imaging
Proteomics and Protein Analytics

Module Group Electives (4 out of 8)

Bio-interfaces and Bio-conjugate Chemistry
Cellular Imaging
Genomics
Biomarker
Modern Technologies in Organic Synthesis
Laboratory Automation in the Pharmaceutical Industry
Process Analytical Technology
Supramolecular Chemistry and Nanochemistry

Module Group Cluster-Specific (3 out of 7)

Compound Profiling in Pharmaceutical Drug Discovery
Physicochemical Principles in Pharmaceutics
Surface Characterisation
Bioanalytics in a regulated Environment
Green Chemistry
Foodomics
Chemistry and Energy

Applied Cell Biology

Module Group Applied Cell Biology (4 out of 5)

Advanced Cell Culture Systems
Cellular Imaging
Gene- and Cell-Therapeutics
Bioassays: engineered Cells, Tissues, Organisms
Laboratory Automation in the Pharmaceutical Industry

Module Group Electives (3 out of 6)

Bio-interfaces and Bio-conjugate Chemistry
Chromatography and Mass-Spectrometry
Genomics
Biomarker
Molecular & Translational Imaging
Proteomics and Protein Analytics

Module Group Cluster-Specific (3 out of 5)

Compound Profiling in Pharmaceutical Drug Discovery
Physicochemical Principles in Pharmaceutics
Bioanalytics in a regulated Environment
Physiology and Immunotherapies
Tissue Engineering for Drug Discovery

Bioanalytics

Module Group Bioanalytics (5 out of 7)

Cellular Imaging
Chromatography and Mass-Spectrometry
Genomics
Bioanalytics in a regulated Environment
Bioassays: engineered Cells, Tissues and Organisms
Biomarker
Proteomics and Protein Analytics

Module Group Electives (5 out of 10)

Biostructures and Solid State Sciences
Molecular & Translational Imaging
Bio-interfaces and Bio-conjugate Chemistry
Advanced Mass Spectrometry
Formulation of Biologics and Routes of Drug Delivery
Environmental Risk Assessment
Compound Profiling in Pharmaceutical Drug Discovery
Physiology and Immunotherapy
Process Analytical Techniques

Gene-and Cell Therapeutics

At least three Cluster-specific Modules must be chosen.

Biotechnology

Module Group Biotechnology (5 out of 6)
Chromatography and Mass-Spectrometry for Bioanalytics
Continuous Biomanufacturing
Gene- and Cell-Therapeutics
Formulation of Biologics and Routes of Drug Delivery
Process Analytical Technology
Process Automation
Module Group Electives (3 out of 7 required)
Advanced Cell Culture Systems
Advanced NMR Spectrometry
Cellular Imaging
Genomics
Pharmaceutical Production Facilities
Laboratory Automation in the Pharmaceutical Industry
Proteomics and Protein Analytics
Module Group Cluster-Specific (3 out of 5)
Design of Biopharmaceutical Production Facilities
Bioanalytics in a Regulated Environment
Physiology and Immunotherapies
Tissue Engineering for Drug Discovery
Regulatory Affairs

Chemical Engineering

Module Group Chemical Engineering (4 out of 5)
Sustainable Process Development
Process Transfer and Scale-Up
Reaction Technology
Process Development and Technology
Process Automation
Module Group Electives (4 out of 8)
Continuous Biomanufacturing
Continuous Pharmaceutical Production
Pharmaceutical Production Facilities
Process Technology for Industrial Pollution Control
Valorization of Biomass Waste and Side Streams

Costs and Benefits of Sustainbale Production
Modern Technologies in Organic Synthesis
Process Analytical Technology

Module Group Cluster-Specific (3 out of 5)

Materials Science
Physicochemical Principles of Pharmaceutics
Green Chemistry
Chemistry and Energy
Industrial Chemistry Process Safety

Environmental Technologies

Module Group Environmental Technologies (6 out of 7)

Process Technology for Industrial Pollution control
Remediation
Valorization of Biomass Waste and Side Streams
Costs and Benefits of Sustainable Production
Environmental Risk Assessment
Solid Waste Management
Water and Wastewater Treatment

Module Group Cluster-Specific (3 out of 5 required)

Life Cycle Assessment
Green Chemistry
Sustainable Natural Ressource Management
Water Management in Households, Industry and Agriculture
Chemistry and Energy

Organic and Supramolecular Chemistry

Module Group Organic & Supramolecular Chemistry (4 out of 5)

Advanced Organic Chemistry
Bio-interfaces and Bio-conjugate Chemistry
Modern Technologies in Organic Synthesis
Reaction Technology
Supramolecular Chemistry and Nanochemistry

Module Group Electives (4 out of 7)

Biostructures and Solid State Sciences
Continuous Biomanufacturing
Sustainable Process Development
Biomarker
Formulaton of Biologics and Routes of Drug Delivery
Proteomics and Protein Analytics

Process Development and Technology

Module Group Cluster-Specific (3 out of 5)

Materials Science

Surface Characterisation

Physicochemical Principles of Pharmaceutics

Polymers and Applications

Green Chemistry

Pharmatechnology

Module Group Pharmatechnology (5 out of 6)

Continuous Pharmaceutical Production

Pharmaceutical Production Facilities

Materials Science

Physicochemical Principles of Pharmaceutics

Drug Formulation and Delivery for Solid Dosages Forms

Formulation of Biologics and Routes of Drug Delivery

Module Group Electives Analytics (3 out of 7)

Biostructures and Solid State Sciences

Chromatography and Mass-Spectrometry

Compound Profiling in Pharmaceutical Drug Discovery

Design of Biopharmaceutical Production Facilities

Bioanalytics in a Regulated Environment

Process Analytical Technology

Proteomics and Protein Analytics

Laboratory Automation in the Pharmaceutical Industry

Module Group Electives Production (3 out of 7)

Process Technology for Industrial Pollution control

Process Transfer and Scale-up

Sustainable Process Development

Costs and Benefits of Sustainable Production

Process Automation

Process Development and Technology

Regulatory Affairs

At least three Cluster-specific Modules must be chosen.

Grading

All modules are graded with the Swiss grading system (1 through 6 with 6 being the best grade). The rounded grades 4.0, 4.5, 5.0, 5.5 and 6.0 are passing grades, the rounded grade 3.5 ("FX") can be improved to grade 4.0 provided an extra work as requested by the lecturer is offered; the rounded grades 3.5 and below are non-passing grades.

Students who fail a module have the opportunity to resit the examination a year later. In general, there is no obligation to revisit the module. However, the subject of the module might have changed and it is highly recommended to visit the lecture again.

Students may visit additional modules. If more modules than required are passed all the modules are listed with the grade in the transcript of records and are used for the calculation of the final grade of the master studies. If an extra module is failed, the course and its grade are not listed in the transcript of records; however they appear as a failed module in the semester record.

The final grade of the master studies is calculated from the grades obtained in the modules (2/3) and from the grade of the MSc thesis (1/3). The final grade will be expressed with the rank grade of the ECTS system (grade A through E, with A the top 10% of students) provided that the statistical basis is given.

eLearning platform

The courses of the master programme are deposited on the Moodle eLearning platforms (https://moodle.fhnw.ch/course/category.php?id=75 and https://mslscommunitycentre.ch). Registration is required for most courses.

Index of Core Competence Modules

Index of Specialisations Modules

Controlled release technologies (Georgios Imanidis, 18 lessons)
Per-oral drug delivery and formulations of poorly water-soluble drugs (Martin Kuentz, 12 lessons)
Biopharmaceutical modeling and simulation (T. Guentert, 12 lessons)

Index of Cluster-specific Modules

Index of lectures at University Basel Pharmaceutical Sciences

Compilation of module descriptions

Core Competence and Cluster-specific Modules:
Compiled by Coordination Office Master of Science in Life Sciences, ZHAW, CH-8820 Wädenswil
Carolina Spitz, spit@zhaw.ch
Care has been taken to compile the module descriptions of the cooperation modules. Legally binding are the version published on https://mslscommunitycentre.ch/

Specialisation Modules:
Compiled by University of Applied Sciences and Arts Northwestern Switzerland, School of Life Sciences, CH-4132 Muttenz
Prof. Dr. Georg Lipps, Dean of Master Programme, +41 61 228 54 52, georg.lipps@fhnw.ch

CORE COMPETENCES MODULES

Module title	**Business Administration for Life Sciences**
Code	B1
Degree Programme	Master of Science in Life Sciences
Workload	3 ECTS (90 student working hours) - Asynchronous and synchronous distance learning, local teaching: 32 h - Self-study: 58 h (10 h self-study before module starts)
Module Coordinator	**Name**: Sandra Schweizer, Wendy Karli **Phone**: +41 31 848 58 09 / +41 31 910 29 41 **Email**: sandra.schweizer@bfh.ch / wendy.karli@bfh.ch **Address**: Bern University of Applied Sciences, HAFL, Länggasse 85, 3052 Zollikofen
Lecturers	• Gisela Maurer, BFH • Sandra Schweizer, BFH • Wendy Karli, BFH
Entry requirements	Pre-course reading assignments will be up-loaded on Moodle. Preparation for the module is mandatory.
Learning outcomesand competences	After completing the module, students will be able to: • define the role of enterprises and forms of organization • define SMART objectives to manage / control a (business) entity • understand the functions in enterprises and its organisation • evaluate the enterprise's environment and its impact on the enterprise • describe the basics of financial and cost accounting, "read" and interpret the three financial statements presented in a regular annual report, differentiate overhead from direct costs and take basic decisions based on break-even analyses • understand the concept of Business Modell Canvas to shape an own basic businessmodel • compare and evaluate possible financing instruments
Module contents	• The enterprise and the meaning of business models - The St. Gall Management Model: - Three levels of management - Founding an enterprise and legal structures in Switzerland • The enterprise's environment (outside view): e.g. impact of trends, methodology foranalysis (e.g. SWOT-Analysis) • Analysis of an enterprise's strengths and weaknesses (inside view) incl. respectivemethodologies • Markets - What is a market? Basics on demand and supply - The role, position and possible influence of an enterprise within defined markets(Porters 5 Forces Analysis / Competitors analysis) - Value chains • The enterprise 's objectives and strategy - Introduction to strategy • Marketing - Definition of the relevant market(s) / segment(s) - the 4P model (product, price, place, promotion) according to McCarthy • Production process, outsourcing and quality - Make or buy vs. outsourcing - Quality as a concept of thinking - Different concepts of quality assurance / continuous improvement process,Process optimization • Organization

	- Process organization vs. structural organization - Different processes: management vs. core vs. support processes • Sourcing - Supply Chain Management • Basics in financial accounting - Reading and understanding a corporate balance sheet / income statement • Basics in cost accounting - Differentiation of direct vs. overhead cost - Break-even analysi
Teaching / learningmethods	**Central teaching**: Taught content is grouped along the St. Gallen Business Model. Methods employed: Pre-reading assignments, didactic teaching, group assignments, case studies, discussion, family tables. An (existing) company serves as transfer model. **Local teaching**: single or group assignments: Case studies: application & transfer of learned analysis and decision-making tools (e.g. PESTEL-Analysis, SWOT etc.) for a specific company – coaching for application of content / methodology
Assessment of learning outcome	Online final exam, written, closed book with a self-written summary of 1 A4 page printed on both sides or 2 A4 pages printed on one side. (100%)
Format	7 weeks
Timing of the module	For ZHAW and FHNW: Spring semester, CW 8 – 14 For BFH and HES-SO: Autumn semester, CW 38 – 44
Venue	Central Teaching: Online / Local Teaching: at respective school
Bibliography	**Mandatory:** Steingruber P, Capaul R, 2013. Business Studies - An introduction to the St. Gallen ManagementModel (2nd edition). Cornelsen Verlag, Berlin. Chapters are the same for ebook (4th edition) and hard copy (2nd edition) version. There are no significant differences between the 2nd and 4th edition. **Advised:** Dyson J, 2017. Accounting for Non-Accounting Students 9th edition).
Language	English
Links to other modules	The introductory lectures of B1 will be required in B2.
Comments	Pre-reading assignments / preparation is mandatory and required for class. Contents treated during local teaching will be included in the exam.
Last Update	27.03.2023

Module title	**Management and Leadership for Life Sciences**
Code	B2
Degree Programme	Master of Science in Life Sciences
Workload	3 ECTS (90 student working hours) - Central teaching, local teaching: 21 h - Distance learning programs, class preparation, self-study: 70 h
Module Coordinator	**Name**: Daniel Spinnler **Phone**: +41 31 910 29 03 **Email**: Daniel.spinnler@bfh.ch **Address**: Bern University of Applied Sciences, HAFL, Länggasse 85, 3052 Zollikofen
Lecturers	• Management & Leadership: Daniel Spinnler, BFH • Corporate Values: Evelyn Markoni,, Christine Jurt, Isabel Häberli BFH • Controlling: Thomas Längin Daniel Longeron, BFH
Entry requirements	Introduction in B1 Business Administration in Life Sciences. Pre-course reading assignments will be up-loaded on Moodle. **Preparation for the module/classes is mandatory.**
Learning outcomes and competences	After completing the module, students will be able to: • differentiate levels of management – normative, strategic, operational • differentiate forms of leadership: indirect vs. direct • differentiate management from leadership • differentiate vision and mission and evaluate their importance for and impact on the corporate culture and success of a company • apply the basics of a strategy definition process • link strategy with budgeting, describe the benefits of budgeting and create a simple budget • acquire the basics of the HRM cycle and the role of an executive (focus on staffing) • assess the impact of an executive on staff members – leadership styles and their impact on leadership • develop a personalized toolbox to be used as a future executive
Module contents	Whether there is a difference in management and leadership is widely discussed in theory. For sure they have a strong interdependency; they are interlinked and sometimes hard to differentiate. In this module we will differentiate the abilities and skills required to run a company from abilities and skills that are required to lead people. We will show how management and leadership are related and that skills in management and leadership are required to successfully run a company. <u>Treated topics on indirect Leadership: Management – how to run an enterprise</u> General • Leading people vs. managing an enterprise Planning: Corporate Culture, Strategy, Goals and Budgeting • Different management levels and respective goals • Introduction to strategic management – differentiation of corporate vs. business strategy • Strategy development process: Learning along the methodology and tools: • Tools for strategic analyses - The role of norm strategies (BCG-Portfolio, SWOT-Matrix, etc.) - Vision, mission and the role of goals and company culture - Breaking down strategy and goals to one's own business unit - Capital budgeting vs. operating budgeting • Staffing and Human Resource Management - Role of HRM and the HR-Manager in the company and its support for team leaders - "HR-Cycle"

	• Controlling: Means and measures - Calculation, cost estimation and cost controlling - Comparison of planned vs. actual expenses - Balanced score card and other KPI-systems <u>Topics treated on (direct) Leadership – how to interact with people</u> • Leadership: Basics, people in companies and support from indirect leadership • Impact of corporate values, vision and mission on direct leadership • Psychology: on behavior, incentives, motivation, job satisfaction • Concepts of leadership, styles of management • Self-organization/management, time management • Basics in labor law and workplace security • Recruiting: Assessment of job applications and job interview • Professional management of (difficult) leadership situations (appraisal interview vs. feedback, termination conversation etc.)
Teaching / learning methods	**Central teaching:** advanced organizers / case studies / group assignments / distance learning programs (asynchronous) **Decentral teaching:** case studies / single and group assignments / role play
Assessment of learning outcome	1. Final written exam (evaluation of specific situations/cases in companies), open book (100%)
Format	7 weeks
Timing of the module	For ZHAW and FHNW: Spring semester, CW 08-14 For BFH and HES-SO: Autumn semester, CW 38-44
Venue	Central online teaching / decentral teaching at respective school
Bibliography	Mandatory: Steingruber P, Capaul R, 2014. *Business Studies - An introduction to the St.Gallen Management Model (4th edition – e-Book). Cornelsen Verlag, Berlin, 576 p.* Dyson J, 2017. Accounting for Non-Accounting Students (9th edition). Financial Times Prentice Hall, New Jersey, 512 p. Additional: Kühn R, Fuhrer U, 2017. Marketing – Analysis and Strategy. 1st edition. Werd Weder Verlag, Thun, 152 p. Northouse PG, 2021. Leadership: Theory and practice (9th edition). SAGE, Thousand Oaks, 600 p. Rosenberg M.B., 2015. Nonviolent Communication: A Language of Life: Life-Changing Tools for Healthy Relationships (3rd edition). Puddledancer Press, Encinitas CA, 264p. Welch J, 2005. Winning. HarperCollins Publishers, 372 p. Drucker P F, 2006. The Effective Executive: The Definitive Guide to Getting the Right Things Done (18th edition). Harperbusiness Essentials, New York, 182 p. Gordon T, 2001. Leader Effectiveness Training. Berkeley Publishing Group, New York, 306 p. Allen D, 2015. Getting Things Done – the art of stress-free productivity. Penguin Books, New York, 317 p.
Language	English
Links to other modules	B1 is a prerequisite to B2 B2 provides the basis for B3.
Comments	Pre-reading assignments / preparation is mandatory and required for class. Contents treated during local teaching will be included in the exam.
Last Update	12.04.2023

Module title	**Innovation and Project Management**
Code	B3
Degree Programme	Master of Science in Life Sciences
Workload	3 ECTS (90 student working hours) - Asynchronous and synchronous centralized distance learning: 21 h - Decentralized local teaching: 11 h - Assignments: 32 h - Self-study: 26 h
Module Coordinator	**Name**: Dr. Robert Vorburger **Phone**: +41 58 934 54 72 **Email**: robert.vorburger@zhaw.ch **Address**: ZHAW Life Sciences und Facility Management, Schloss 1, 8820 Wädenswil
Lecturers	Dr. Robert Vorburger, ZHAW
Entry requirements	Module B1 “Business Administration for Life Sciences” recommended Module B2 “Management and Leadership for Life Sciences” recommended
Learning outcomes and competences	After completing the module, students will be able to: • differentiate between creativity, invention, and innovation • understand the role of innovation management within a company • apply internationally approved project management methodologies • apply internationally approved requirements engineering techniques • understand the role of quality management • include patent law and intellectual property rules in new business opportunities.
Module contents	• *Creativity Techniques*: Different methods to encourage creativity, including techniques for idea generation and divergent thinking • *Innovation Management*: How to shape a creative idea into a product or business model. The role of innovation management within a company • *Requirements Engineering*: Identify and specify the needs as soon and as exact as possible. General techniques of requirement engineering such as phrasing, categorising, and tracing of requirements • *Project Management*: Internationally approved sequential as well as agile project management methodologies, e.g., waterfall model and SCRUM, respectively. *Quality Management*: International standards, validation and verification, common ground with risk management
Teaching / learning methods	A project builds the core of the module. The mission is to develop and manage a product or a service. During the centralized teaching lessons, techniques, methods, and concepts are presented and discussed. Additional material for self-study will be provided to build a deeper understanding of the topics. In line with the topics covered in the centralized lessons, a project is implemented in the decentralized lessons. The students work together in small groups. In a first phase, the students will apply innovation techniques to come up with a product/service idea and will compile a business model canvas around the product/service. In the second phase, project management techniques will be applied to plan the development and production of the product. The role of the teacher shifts in the decentralized local lessons from a lecturer to a coach.
Assessment of learning outcome	1. Final written exam, open book (on methodologies) (80%) 2. Three group assignments during the module in the decentralized teaching; to be handed in within 2 weeks each (20%)

Format	7-weeks
Timing of the module	For ZHAW and FHNW: Spring semester, CW 15-21 For BFH and HES-SO: Autumn semester, CW 45-51
Venue	centralized teaching online / decentralized teaching at respective school
Bibliography	Project Management Handbook Kuster, J., Huber, E., Lippmann, R., Schmid, A., Schneider, E., Witschi, U., Wüst, R Springer-Verlag, 2015 The Art of Innovation: Lessons in Creativity from IDEO, America's Leading Design Firm Kelly Tom, Crown Publishing Group, 2007
Language	English
Links to other modules	
Comments	Material treated during local teaching is relevant for the exam.
Last Update	02.04.2023

Module title	**Politics and Society**
Code	B4
Degree Programme	Master of Science in Life Sciences
Workload	3 ECTS (90 student working hours) - Asynchronous and synchronous distance learning, decentralised teaching: 32 h - Self-study: 58 h (20 h self-study before module starts)
Module Coordinator	**Name**: Dr Ian Jennings **Phone**: +49 152 5456 5915 **E-mail:** ian.jennings@fhnw.ch **Address**: Brückenstr. 5, D-79541 Lörrach, Germany
Lecturers	• Ian Jennings • Guest lecturer(s)
Entry requirements	Several pre-course readings for the B4 module in pdf or mp4 form will be provided at the beginning of the semester.
Learning outcomes and competences	After completing the module, students will be able to: • examine critically the fundamental assumptions underlying the politics and culture of today's Western-style democracies, and, in particular • explain how these assumptions affect - the actual practices of today's Western-style democracies and - the professional practices of life scientists, • explain how global political issues affect the professional practices of life scientists, • respond in writing in a structured, critical, and ethical manner to the dilemmas and assumptions encountered in the study of local and global politics and culture and their effects on the professional practices of life scientists.
Module contents	This module seeks to bring students to an understanding of the interconnected nature of professional practice as a life scientist, the local political system in which such practice functions, the global political system in which the local political system functions, and the ethical and philosophical commitments and assumptions which shape the practices of politics and business. In line with these objectives the module has four pillars: First "How Modern Western-Style Democracies Function". This section provides an introduction to the theory and practice of Democracy from its origins up to the 21st century. Second "How Modern Western-Style Democracies Think". The major issue discussed in this part of the course is the concept of Human Rights. Third "Globalised Political Issues". These issues include Migration and various forms of Globalisation. Fourth "How the Life Sciences are Affected" – an examination of the practical effects of the political context on the Life Sciences professions, in which various contemporary examples and cases will serve as material for discussion, exercises, and debates. Three or four cases/issues serve as the primary focus of the decentralised classes. Examples are the political response to the covid-19 crisis, the controversy regarding the misuse and marketing of the opioid drug OxyContin, and ethical and regulatory questions arising from the use of cell therapy techniques such as Kymriah.
Teaching / learning methods	• Lectures (centralised), including those of guest lecturers • Tutorial-style (decentralised) classes, which include exercises and debates • Written essays, premised on student research The 58 hours of self-study will be taken up by a combination of pre-course reading (and the viewing of video material), the readings required for the centralised and decentralised sequences, participation in teamwork projects, and the research and writing necessary for turning in the short individual essay (which

	will be submitted at the halfway point of the course). Close guidance will be given in all cases, and the students' progress will be monitored.
Assessment of learning outcome	1. Short individual essay (approximately 500 words; an application of the module material to contemporary issues affecting the Life Sciences professions), to be handed in during the module (35%) 2. Final written exam (closed book, combination of short and longer questions) (35%) 3. Class presentations in the decentralised teaching (30%)
Format	7 weeks
Timing of the module	For ZHAW and FHNW: Spring semester, CW 15-21 For BFH and HES-SO: Autumn semester, CW 45-51
Venue	online / decentralised teaching at respective school
Bibliography	Extracts from the following books will be used in the module: Adam Briggle and Carl Mitcham *Ethics and Science* (Cambridge UP 2012) Andrew Clapham *Human Rights* (2ed) Oxford UP (2015) Andrew Heywood *Politics* Palgrave MacMillan (4ed) (2013) Manfred Steger *Globalization* (4ed) Oxford UP (2017) Shorter articles and extracts on various topics will also be provided.
Language	English
Links to other modules	
Comments	
Last Update	18.04.2023

Module title	**Handling and Visualising Data**
Code	D1
Degree Programme	Master of Science in Life Sciences
Workload	3 ECTS (90 student working hours) - Asynchronous and synchronous distance learning, decentralized teaching: 32 h - Self-study: 58 h (20 h self-study before module starts)
Module Coordinator	**Name**: Dr. Manuel Gil **Phone**: +41 (0)58 934 57 44 **Email**: manuel.gil@zhaw.ch **Address**: ZHAW Life Sciences und Facility Management, Schloss 1, 8820 Wädenswil
Lecturers	• Dr. Manuel Gil, ZHAW • Dr. Simone Ulzega, ZHAW
Entry requirements	1. **Basic statistics** experience at the bachelor level is necessary, including: descriptive statistics, basics of probability theory, probability distributions, basic hypothesis testing, and correlation measures. Prior to the course, students will be provided with a detailed list of topics and corresponding references to learning materials. 2. Students require some **experience with the software R**. Prior to the course (one month in advance) preparatory e-learning material will be provided as part of the self-study. Students are expected to work through the material before the course starts and will be evaluated with an entry test. 3. The following open source **software has to be installed** on the students' notebooks: • RStudio • Apache Open Office Base Details (download and installation instructions) will be provided on Moodle prior to the course.
Learning outcomes and competences	After completing the module, students will be able to: • apply programming structures in R (variables, if-statement, loops, functions) • organise data, control data quality, • work with relational databases with graphical user interfaces (GUI), • understand the application of semantic web concepts (triple stores, ontologies) for biological data integration, • reformat, prepare and process data for further analysis, • import data (into statistics software), • handle missing data (imputation), • describe data, check skewness, outliers or unequal variance and quantify these phenomena, • use robust measures of location and scatter to protect from outliers, • understand the grammar of graphics (and apply it with ggplot2), • produce quick exploratory plots as well as publication quality plots of the data, • use different types of plots, adapted to the data type (independent or correlated data such as time series or spatial data, univariate and multivariate data), • weigh advantages and disadvantages of different plot types (e.g. what is hidden/glossed over in a particular plot, what is the minimal/maximal

	sensible sample size for a particular plot, what plot is suited to illustrate which type of relation, etc.), • produce "meaningful" plots, suited to visualize the answer to the research question (e.g. integrating regression lines into scatter plot) or to display the extracted information, • apply principles of good graph design.
Module contents	Introduction to R *(self-study with e-learning)* • Basic R (import/export of data, command line, basic plotting, basic commands) • Programming structures (variables, if-statement, loops, functions) Introduction to the topic "Handling and visualising data" *(lecture)* Organising data *(lectures and exercises)* • Flat files and redundant data • Relational databases (concepts and querying with a GUI) • Semantic Web technology (Triple, RDF, Ontologies) • Tidy data in R • Classifying and treating missing data Exploring and describing Data *(lectures and exercises)* • Measures of location and scatter • Skewness, outliers, unequal variance Visualising data *(lectures and exercises)* • Grammar of graphics • Plots in R with *ggplot2* • Design characteristics of good plots Project work *(self-study)* • Apply and reinforce the material
Teaching / learning methods	The central teaching will consist of lectures, exercises and a group project. During the local coaching the students will continue/complete the work on the exercises and projects from the central teaching. Thus, the local coaching will supplement the central teaching and allow the students to interact personally with a coach to ask questions and obtain closer supervision. Local coaching can be timed flexibly, subject to taking place between the central teaching slots. The self-study will consist of e-learning units (in particular to prepare for the entry requirements), online tutorials, additional reading, and a project work. For the *Introduction to R* e-learning unit, beginners will require 15-25 hours to work carefully through the tutorial. About 10h are reserved for the completion of the *project work,* and 10h for exam preparation.
Assessment of learning outcome	- Entry exam on preparatory self-study exercises (open book, 25%) - The final assessment of learning outcome contributes 75% and will either be a written exam, or a project work. This will be decided one month before module starts. Both cases are individual and open book.
Format	7-weeks
Timing of the module	For ZHAW and FHNW: Autumn semester, CW 38-44 For BFH and HES-SO: Spring semester, CW 8-14

Venue	online / decentralized teaching at respective school
Bibliography	Pre-course work Peter Kauf, R online course, provided on Moodle Course material Wickham, Hadley, 2014. "Tidy data." *Journal of Statistical Software*59.10: 1-23. Wickham, Hadley, 2010. "A layered grammar of graphics." *Journal of Computational and Graphical Statistics* 19.1: 3-28. Wickham, Hadley, 2016. *ggplot2: elegant graphics for data analysis*. Springer. Tufte, Edward, and P. Graves-Morris, 2014. "The visual display of quantitative information.; 1983."
Language	English
Links to other modules	This module is the basis for module D2 “Design and Analysis of Experiments” and module D3 “Modelling and Exploration of Multivariate Data”.
Comments	Material treated during local teaching is relevant for the exam.
Last Update	18.04.2023

Module title	**Design and Analysis of Experiments**
Code	D2
Degree Programme	Master of Science in Life Sciences
Workload	3 ECTS (90 student working hours) - Asynchronous and synchronous distance learning, decentralized teaching: 32 h - - Self-study: 58 h (10 h self-study before module starts)
Module Coordinator	**Name**: tba **Phone**: tba **Email**: tba **Address**: tba
Lecturers	tba
Entry requirements	Attending the module "Handling and Visualizing Data" is highly recommended and advanced knowledge of R is required. Prior to this module, additional preparatory materials will be made available to facilitate student preparation for the module. Students are advised to start five weeks before the module with the preparatory work.
Learning outcomes and competences	After completing the module, students will be able to: • apply the basics of statistical inference (estimation, testing, confidence regions) in the course setting, • identify common and important types of experimental designs with respective advantages and disadvantages, • choose an appropriate design in a given research setting, • perform a correct statistical analysis of different types of designs, including unbalanced data sets, • perform post hoc tests, • interpret the model and report the findings scientifically.
Module contents	• Introduction to statistical inference (population and sample, statistical hypothesis testing, confidence regions) • General principles of experimental design (blocking, randomization) • Important particular experimental designs (e.g. fully randomized designs, randomized block designs; incomplete designs; factorial designs, fractional factorial designs; split-plot designs); when to use which design • Statistical analysis of all the particular designs that were introduced (including interpretation of e.g. block effects or interaction effects, adapted to the design) • Post hoc tests (also for ordinal factors) e.g. to compare subsets of treatments to each other • Interpretation and visualization of the results; scientific reporting of the results, back-translation from statistical terminology to the original research question
Teaching / learning methods	In the weeks before module start, students are expected to do preparatory work to prepare themselves for the module: preparations for the statistical topics as well as a brush-up of the course software R. The students receive preparatory as well as follow-up self-study work for each course day (regardless of whether it is a central or local day). The self-study consists e.g. of preparatory reading/videos, follow up exercises, examining case studies, etc. Central teaching is offered in a distance learning mode consisting of a combination of asynchronous activities (e.g. script, videos) and live online sessions. Local coaching consists of physical presence sessions where students actively solve exercises together with the local coaches. These exercises are meant to deepen the understanding of the material, give an opportunity to practice, provide extensions etc.

Assessment of learning outcome	Final written individual exam (open book, using individual laptop computers to run statistical analyses using the course software) (100%)
Format	7-weeks
Timing of the module	For ZHAW and FHNW: Autumn semester, CW 45-51 For BFH and HES-SO: Spring semester, CW 15-21
Venue	Distance learning (central teaching) and in-presence teaching at respective school (local coaching)
Bibliography	Material will be provided on Moodle.
Language	English
Links to other modules	This module builds on module D1 “Handling and Visualising Data” and complements the module D3 “Modelling and Exploration of Multivariate Data”.
Comments	Material treated during local teaching is relevant for the exam. Students have to make sure that an updated version of R is installed. Details will be communicated in advance.
Last Update	18.04.2023

Module title	**Modelling and Exploration of Multivariate Data**
Code	D3
Degree Programme	Master of Science in Life Sciences
Workload	3 ECTS (90 student working hours) - Asynchronous and synchronous distance learning, decentralized teaching: 32 h - Self-study: 58 h (10 h self-study before module starts)
Module Coordinator	**Name**: tba **Phone**: tba **Email**: tba **Address**: tba
Lecturers	• tba
Entry requirements	Advanced knowledge of R (level D1) is required. Attending the module "Handling and Visualizing Data" is highly recommended. Prior to the module, additional mandatory preparatory reading, exercises and other material (videos, tests) will be made available to facilitate students preparation for the module. Students are advised to start five weeks before the module with the required preparatory work;
Learning outcomes and competences	After completing the module, students will be able to: • explore multivariate data by means of suitable visualisation and dimensionality reduction techniques • explore and describe the structure of multivariate data using clustering • explore and describe time series data on the basis of suitable visualisations and analysis methods analogue to multivariate data analysis • interpret, visualise and communicate the results of the analyses • use multiple regression models to answer research questions, understand their advantage over univariate methods; fit these models with R and quantify the fit of the model, describe the limitations of precision and reliability of inferential results; test the model assumptions; apply counter measures in case of problems with model assumptions • use elementary nonparametric regression methods to estimate the shape of not necessarily linear regression curves, understand the advantages and limitations of such flexible methods and apply related tools • perform elementary model selection and understand associated problems; test hypotheses, construct confidence and prediction intervals • identify typical pitfalls and amend these problems • understand typical statements in empirical research articles.
Module contents	This module introduces exploratory methods and regression models for data analysis. Exploratory part: • Basic plots to characterise and visually inspect multivariate data and time series data • Dimensionality reduction techniques (principal component analysis, multi-dimensional scaling) • Clustering methods (k-means clustering and related approaches, hierarchical clustering, evaluation methods) Modelling part: • Simple linear regression (including transformations) • Nonparametric regression (regression splines, local regression) • Multiple linear regression (including regression diagnostics) • Model selection (linked to hypothesis tests and p values) and inference (especially confidence intervals, prediction intervals) • Model diagnostics: assessment the validity of the model assumptions, reflect on the tools used to do this assessment

	• Possible strengths and limitations of parametric models (link to the exploratory part) Both parts: • Interpretation and visualisation of the results using suitable graphical representations of the data and the results (e.g. 3D scatter plots with regression surface or biplots) • Scientific reporting of the results, backtranslation from statistical methods to answer the original research questions to the data
Teaching / learning methods	In the weeks before module start, students are expected to do preparatory work to level prior knowledge. The workload is expected to be roughly 10 hours. The students receive preparatory and/or follow-up self-study work for each course day. The self-study consists e.g. of preparatory reading/videos, follow up exercises, examining case studies, etc. Central teaching is offered in a distance learning mode, consisting of asynchronous material such as videos and live consultation sessions. Details will be communicated one month before the start of the module. Local teaching consists of physical presence sessions where students actively solve exercises together with the local teachers. These exercises are meant to deepen the understanding of the material, give an opportunity to practice, provide extensions etc. The main type of tasks will be case studies which illustrate and exemplify the application of the material from central teaching to real life data sets and real problems. All the course contents come with comprehensive lecture notes and additional videos for an individual study and/or online learning.
Assessment of learning outcome	Project-based assignment. Details about the project will be communicated one month in advance. Students have the opportunity to earn bonus points during the local sessions to the extent of max. 6.6% of the points they receive in the project. These points are not required to achieve the maximal mark of 6. The requirement is that a student attends at least 3 out of 7 local sessions and presents her/his solution for at least one of the assignments/exercises to the other students.
Format	7-weeks
Timing of the module	For ZHAW and FHNW: Autumn semester, CW 45-51 For BFH and HES-SO: Spring semester, CW 15-21
Venue	online / decentralized teaching at respective school
Bibliography	Material will be provided on Moodle.
Language	English
Links to other modules	This module builds on module D1 “Handling and Visualising Data” and complements the module D2 “Design and Analysis of Experiments”.
Comments	Material treated during local teaching is relevant for the exam. Students have to make sure that an updated version of R is installed. Details will be communicated in advance.
Last Update	18.04.2023

Module title	**Data and Ethics**
Code	D4
Degree Programme	Master of Science in Life Sciences
Workload	3 ECTS (90 student working hours: 42 lessons contact = 28 lessons online, 14 lessons on-site)
Module Coordinator	**Name:** Dr. Pascal Moriggl **Phone:** +41 61 279 18 16 **Email:** pascal.moriggl@fhnw.ch **Address:** FHNW, HSW, Peter Merian-Strasse 86, 4052 Basel
Lecturers	Prof. Dr. Petra Maria Asprion (PMA) Dr. Pascal Moriggl (PM)
Entry requirements	Each participant has a general understanding of cybersecurity and awareness of cyber-risks, including basic terms and knowledge about risks. A self-study must be completed no later than two weeks after the start of the course and must be evidenced by a multiple-choice test on Moodle.
Learning outcomes and competences	After completing the module, students will be able to … • understand the essentials of information and cybersecurity and its relevance to the personal, corporate, and research domain • understand the legal background that drives information/cybersecurity and data privacy. The latter from two perspectives as a duty to adhere to by a legal entity and as a right to be claimed by an individual • understand the risks to prioritize information/cybersecurity by learning about the malicious actor perspective (motivation and attack vectors) • secure their individual, digital footprint on a smartphone or personal computer (end user level) • understand and apply a data stewardship approach for research data • understand data ethics considerations, its implications for society design an ethics policy for a workplace in life sciences.
Module contents	***Theme 1 – Personal Security*** *(PMA/PM, 2 lessons)* • Overall relevance of the topic • General threat situation • Securing personal environments (e.g., PC, Smartphone, Networks) ***Theme 2 –Information Security & Cybersecurity*** *(PM/PMA, 4 lessons)* • Information-/Cybersecurity risks in Organizations focused on Life Science • Compliance, governance and management perspectives • Encryption/decryption strategies • Best practices, frameworks, and policies ***Theme 3 – Data Stewardship*** *(PM/PMA, 4 lessons)* • Data governance • Roles and responsibilities • Implementation, Documentation, Standardization • FAIR guiding principles ***Theme 4 –Data Ethics*** *(PM, 2 lessons))* • Data ethics in clinical research and drug development • Research Requirements • Data Ethics Canvas ***Theme 5 –Privacy*** *(PM, 2 lessons))* • Regulatory considerations

	• Anonymization vs. pseudonymization • Licensing: Open Source, Creative Commons, etc.
Teaching / learning methods	lecture, literature seminar and practical exercises

Assessment of learning outcome	• Entry exam to be done within the first two module weeks (20%)
	• Learning journal, to be submitted one week after module end (80%), containing the following applied elements:
	  ○ Introduction in the Topic and Relevance
	  ○ Information Security Policy
	  ○ Data Management Plan
	  ○ FAIR Guiding Principles Template
	  ○ Data Ethics Canvas
	  ○ Reflection

Format	7-weeks
Timing of the module	For ZHAW and FHNW: Autumn semester, CW 38-44 For BFH and HES-SO: Spring semester, CW 8-14
Venue	online / decentralized teaching at respective school
Bibliography	Entry Level Preparation Before the module starts, a script will be provided in the company with the technical environment setup required for the personal security theme. Course Materials Data Ethics Canvas https://theodi.org/wp-content/uploads/2021/07/Data-Ethics-Canvas-English-Colour.pdf Data Stewardship https://www.elsevier.com/books/data-stewardship/plotkin/978-0-12-822132-7 Information Security Policy https://www.routledge.com/Information-Security-Policies-Procedures-and-Standards-A-Practitioners/Landoll/p/book/9780367669966#
Language	English
Links to other modules	This module is indirectly linked to the other data modules.
Comments	If a student fails the entry test, the preconditions for handing in the learning journal will not be met, and the journal will not be graded. There is no limit to how often the test is being taken.
Last Update	18.04.2023

ANALYTICAL CHEMISTRY

Module title	**Advanced Mass Spectrometry**
Code	M-SLS-MSC 0220
Degree program	Master of Science in Life Sciences
Workload	3 ECTS (90 student working hours: 42 lessons contact = 32 h; 58 h self-study)
Module coordinator	**Name** Stefan Gaugler **Phone** 079 711 71 32 **Email** stefan.gaugler@fhnw.ch **Address** FHNW, HLS, Hofackerstrasse 30, 4132 Muttenz
Lecturers	Stefan Gaugler, Katharina Grafinger, Christian Lanshoeft, Simon Hauri,
Entry requirements	• Bachelor level of chemistry and analytical chemistry • Knowledge of fundamentals of MS
Learning outcomes and competences	After completing the module, students will be able to: • understand the theoretical and practical aspects of combining of chromatography and mass spectrometry • understand the differences and advantages of various hyphenated chromatographic techniques and relations to the type of different instrumentation • Design a metabolomics or proteomics experiment to help solve a biological question • Express and critically evaluate the use of different methods for metabolomics and proteomics • Understand integration of metabolomics and proteomics data with other types of data
Module contents	*Fundamentals and technological aspects of mass spectrometry (Stefan Gaugler, 9 lessons)* • Advanced MS-Ionization methods • Low and high resolution mass spectrometry • Assigning sum formula by accurate mass, data bases • Hyphenated instruments • MS instrumentation for OMICS applications *Application fields of mass spectrometry (other, 21 lessons)* • Forensic toxicology and anti doping, including ICP-MS (KG, 3h) • Clinical and new born screening (SG, 6h) • Pharma I: Quantification of small molecules and proteins (intact, subunit und peptide level in various matrices) (CL, 3h) • Pharma II: Metabolite Profiling of small molecules, including Ion Mobility (CL, 3h) • Pharma III: Biotransformation of therapeutic proteins through high resolution mass spectrometry (SH 3h) *Trends and future of mass spectrometry (Stefan Gaugler,12 lessons)* • Current concepts in mass spectrometry, trends and developments in mass spectrometry • Student presentation of recent applications in mass spectrometry
Teaching / learning methods	Lecture, blended learning, case studies, student presentations
Format	3 lessons per week, whole semester

Assessment of learning outcome	• Student presentation (25 %) • Closed book examination at the end of the semester (75 %)
Bibliography	Jürgen H Gross, Mass Spectrometry, A Textbook, Springer International Publishing AG, 2017, https://doi.org/10.1007/978-3-319-54398-7
Link to other modules	Proteomics and Protein Analytics (Bioanalytics): focus in Mass Spectrometry module will be more on the concepts and technologies used for different OMICs applications
Comments	1st semester
Last update	January 25, 2023

Module title	**Advanced NMR Spectroscopy**
Code	M-SLS-MSC 0221
Degree program	Master of Science in Life Sciences
Workload	3 ECTS (90 student working hours: 42 lessons contact = 32 h; 58 h self-study)
Module coordinator	**Name** Daniel Varón Silva **Phone** +41 61 228 51 73 **Phone** daniel.varon@fhnw.ch **Address** FHNW, HLS, Hofackerstrasse 30, 4132 Muttenz
Lecturers	Stefan Gaugler, Thomas Müntener, Daniel Häussinger
Entry requirements	• Bachelor level of chemistry and analytical chemistry • Knowledge of basic principles of NMR
Learning outcomes and competences	After completing the module, students will be able to: • Understand the function principle of 2D NMR spectroscopy and its application in chemistry, medicine, and pharmaceutical research. • Understand the importance of pulsed field gradients in modern NMR spectroscopy. • Express concepts of fast data acquisition techniques. • Comprehend principles of NMR tools for structure-based lead discovery. • Give an overview of methods to study protein-ligand interactions. • Understand NMR experiments based on product operator formalism.
Module contents	*Advanced concepts in NMR spectroscopy (Stefan Gaugler, Thomas Müntener, Daniel Häussinger, 12 lessons)* • theoretical background in advanced NMR spectroscopy • principles of selected one- and two-dimensional NMR experiments with complex pulse sequences using the vector model • polarization transfer experiments • introduction to product operator formalism (POF) *Gradient enhanced spectroscopy (Daniel Häussinger, 6 lessons)* • principles and applications of pulsed field gradients in NMR • Experiments to probe mobility, applications of diffusion ordered spectroscopy (DOSY) *Fast data acquisition methods (Thomas Müntener, 6 lessons)* • Non-uniform sampling (NUS) • NMR supersequences, NMR by ordered acquisition by 1 H detection (NOAH) *NMR methods to study protein-ligand interactions (Daniel Varón, Daniel Häussinger, 12 lessons)* • NMR methods for structure- and fragment-based lead discovery (protein and ligand observed methods, like STD and WaterLOGSY) • NMR experiments for the assignment of proteins, Triple resonance experiments • Paramagnetic NMR *Labor Biozentrum: Application of previously discussed concepts on real samples (Stefan Gaugler, Thomas Müntener, 6 lessons)* • NMR Spectrometer operations • Basic 1D and 2D heteronuclear correlation experiments • T1 and T2 relaxation experiments • Fast acquisitions and triple-resonance experiments

Teaching / learning methods	Lecture, blended learning, case studies, group work, students' presentations
Format	3 lessons per week, whole semester
Assessment of learning outcome	• Final written examination
Bibliography	
Link to other modules	
Comments	
Last update	July 23, 2023

Module title	**Biostructures and Solid State Sciences**
Code	M-SLS-MSc 0222
Degree program	Master of Science in Life Sciences
Workload	3 ECTS (90 student working hours: 42 lessons contact = 32 h; 58 h self-study)
Module coordinator	**Name** Patrick Shahgaldian **Phone** 061-228-54-87 **E-Mail** patrick.shahgaldian@fhnw.ch **Address** FHNW, HLS, Hofackerstrasse 30, 4132 Muttenz
Lecturers	Michael Hennig, Alessandro Prescimone, Timm Maier, Alfred Ross
Entry requirements	• bachelor level of chemistry and analytical chemistry … • Knowledge of principles of spectroscopic techniques
Learning outcomes and competences	After completing the module, students will be able to: • Understand concepts in crystallography • Differentiate theoretical and experimental aspects of the various x-ray diffraction methods • Be familiar with modern X-ray diffractometers, instrumental optics and experiment strategies • Understand applications of X-ray diffraction/Crystallography and their relevance in biomolecular research and material sciences • Understand the concept of Polymorphism. • Have a sound understanding of methods used to produce and analyze different polymorphic states.
Module contents	*Crystallography and Powder X-Ray (Alessandro Prescimone, 15 lessons)* • theoretical aspects of Crystallography and the interaction between X-ray radiation and matter • Fundamentals of crystallography (symmetry, groups, lattice theory) • Crystal growth, precipitant and phase diagram, crystal morphology, symmetry and space groups, crystallogenesis • theoretical aspects of X-ray diffraction (Generation of X-rays, interaction with matter, principles of interference functions and diffraction, scattering of periodic arrays, fourier transform and structure factors) • X-rays, X-ray sources, X-ray diffraction, Bragg's law, reciprocal lattice and Ewald-sphere construction • X-ray diffraction by electrons, Fourier analysis and synthesis • Powder X-ray *Applications in Structure Biology (Michael Hennig, Timm Maier, 15 lessons)* • Applications of X-Ray crystallography and cryo EM in structure biology • Protein structure determination by X-ray diffraction, crystallographic phase problem, molecular replacement (MR), multiple isomorphous replacement (MIR), multi-wavelength anomalous diffraction (MAD… • Electron Microscopy *Solid State Characterization (Alfred Ross, 12 lessons)* • What is a Polymorph? Properties of materials depend not only on chemical-structure but also on polymorphism. • How are polymorphic materials produced? (Urs Schwitters, Roche) • Computational Method to predict polymorphism (Joost van den Ende, Roche) • Analytical methods to characterize Polymorphism (X-ray, XPS, IR, Solid State NMR, Thermal Analysis)
Teaching / learning methods	Lecture, blended learning, case studies
Format	3 lessons per week, whole semester

Assessment of learning outcome	• Final written exam (100%)
Bibliography	
Link to other modules	Surface characterization (M-SLS-MSc C2)
Comments	
Last update	June 7, 2022

Module title	**Molecular & Translational Imaging**
Code	M-SLS-MSc 0223
Degree program	Master of Science in Life Sciences
Workload	3 ECTS (90 student working hours: 42 lessons contact = 32 h; 58 h self-study)
Module coordinator	**Name** Oya Tagit **Phone** 061-228-57 01 **E-Mail** oya.tagit@fhnw.ch **Address** FHNW, HLS, Hofackerstrasse 30, 4132 Muttenz
Lecturers	Basil Künnecke (Roche)
Entry requirements	• Bachelor level of (bio-)chemical analytics • Calculus relevant for application to biophysical methods
Learning outcomes and competences	After completing the module, students will be able to: • understand the concepts of molecular & translational imaging • differentiate current translational and molecular imaging modalities and understand the basics of the underlying physical principles of imaging • appreciate the scope and limitations of translational and molecular imaging • differentiate basic contrast modalities and have a good grasp of their main domains of application • express concepts of optical imaging technologies • understand multi-modal imaging advantages in diagnosis and monitoring of diseases
Module contents	*Concepts of Molecular & Translation Imaging (Oya Tagit, 3 lessons)* • General principles of molecular imaging o Scopes of molecular and translational imaging in biomedicine and pharmaceutical research • Electromagnetic radiation and ultrasound at different wavelengths for translational imaging o Energy, wavelength, penetration, attenuation, resolution o Absorbers, scatterers • Overview on current key imaging modalities for molecular and translational imaging including PET, SPECT, x-ray, NIRF, MRI, US, optical and o Association of imaging modalities with radiation wavelength/energy, ionizing and non-ionizing radiation *Optical imaging (Oya Tagit, 9 lessons)* • Fluorescence and bioluminescence o Bioluminescent reporter genes, fluorescent probes o Near-infrared imaging in 1st and 2nd NIR windows • Intraoperative fluorescence imaging o Fluorescence-guided surgery o Clinically approved contrast agents and applications • Molecular endoscopic imaging o Molecular probes and endoscopy devices o Examples in cancer imaging • Intravital microscopy (IVM) o Sources of contrast o Correlative IVM • Raman scattering o Basic theory o Surface-enhanced Raman scattering (SERS) o SERS with nanoparticles o Contrast-enhanced Raman imaging *Positron emission tomography (Basil Künnecke, 9 lessons)* • Fundamentals of positron emission tomography (PET) and single photon emission tomography (SPECT)

	○ Radionuclides, tracers, decay, emitter, annihilation, detectors, collimators, pinholes ○ Electron diffusion, scatter, attenuation ○ Data acquisition ○ Image reconstruction, back-projection and beyond, de-noising ○ Image quantification, standardised uptake value (SUV), arterial input, reference region, resolution, signal-to-noise (SNR), dosimetry • Probe chemistry ○ Specific probes for specific molecular entities ○ Physicochemical properties ○ Radionuclides, half-lives, radiochemistry, radiation exposure • PET/SPECT for quantitative molecular imaging in small- and large-molecule drug discovery and development ○ Typical equipment ○ Target distribution ○ Target occupancy ○ Rare cases of target engagement *Magnetic resonance imaging (Basil Künnecke, 9 lessons)* • Fundamentals of magnetic resonance imaging (MRI) and spectroscopy (MRS) ○ Nuclear spin and magnetic moment (a light touch on quantum mechanics) ○ Magnetic field, Boltzmann distribution, equilibrium magnetization, energy absorption and emission, sensitivity ○ Generating and detecting transverse magnetization, Larmor frequency, resonance, rotating frame ○ Chemical shift and spin coupling, quantitation, water and more, an excursus to NMR spectroscopy ○ Fourier transformation and FFT ○ Gradients for spatial encoding (read, phase and slice gradients) ○ Image reconstruction, concept of reciprocal space, walking the k-space, point-spread function ○ Image quantification, data filtering, magnitude/phase images, resolution, signal-to-noise (SNR) ○ Manipulating magnetization, basic MRI sequences (GRE and SE) • Key contrast modalities in MRI and MRS ○ Transversal and longitudinal relaxation ○ Relaxation mechanisms, MR contrast agents ○ Linking basic MRI sequences to contrast modalities ○ Examples in biomedical imaging ○ Typical equipment • MRI and MRS for quantitative translational imaging in drug discovery and development ○ Drug research and development journey ○ Value of translational imaging in R&D (with focus on PET and MRI) ○ Examples of MRI for quantitative evaluation of structure, microstructure, function and metabolism ○ PET and MRI: complementary and amalgamated *Ultrasound and photoacoustic imaging (Oya Tagit, 6 lessons)* • Ultrasound imaging ○ Ultrasound fundamentals and contrast agents ○ Pulse sequencing, instrumentation • Photoacoustic imaging, PA ○ Principles of PA ○ Novel molecular probes and applications *Multimodal imaging and theranostics (Oya Tagit, 3 lessons)* • Multi-modal molecular and functional imaging and theranostics of the tumor microenvironment ○ Imaging tumor hypoxia ○ Imaging tumor pH ○ Imaging the extracellular matrix ○ Imaging tumor-associated immune cells ○ Simultaneous imaging and therapy: theranostics

	Student presentation (Oya Tagit, 3 lessons) • Presentations • Discussion
Teaching / learning methods	Lecture with some Seminar and Case Study elements, Student presentations
Format	3 lessons per week, whole semester
Assessment of learning outcome	• Final written exam (60%) • Group work/presentations (40%)
Bibliography	Books: Molecular Imaging: Principles and Practice, Ed. Brian Ross, Sanjiv Gambhir
Link to other modules	Cellular Imaging (Autumn Semester), Medical Imaging and Image Processing (Spring Semester)
Comments	
Last update	May 16, 2023

APPLIED CELL BIOLOGY

Module title	**Bioassays: Engineered Cells, Tissues and Organisms**
Code	M-SLS-MSC 0120
Degree program	Master of Science in Life Sciences
Workload	3 ECTS (90 student working hours: 42 lessons contact = 32 h; 58 h self-study)
Module coordinator	**Name** Laura Suter-Dick **Phone** 079 9493470 **Email** laura.suterdick@fhnw.ch **Address** FHNW, HLS, Hofackerstrasse 30, 4132 Muttenz
Lecturers	Armin Zenker, Eric Kübler, René Prétot
Entry requirements	Bachelor Degree in Life Sciences Courses on bioanalytics, pharmacology, drug discovery, biochemistry, molecular biology and pharmacokinetics
Learning outcomes and competences	After completing the module, students will be able to… • understand the process of using tailor made cell based assays for the detection of biological activity • identify and define molecular biology strategies to generate suitable cell systems (cell engineering approaches) • understand the concepts of bioassays applied to high throughput screening • design potential experimental approaches using in vitro and in vivo methods to address specific biological questions • understand the applications of mammalian and non-mammalian animal models for efficacy and toxicity testing • understand the concepts of higher tier tests
Module contents	*Cell engineering for bioassays (Eric Kübler, Réne Prétôt, 14 lessons)* • Cell engineering for bioassays: CRISPR / Cas system, TALEN, Zinc Finger Nucleases • History of CRISPR / Cas system discovery and application development • Non cell engineering purposes of CRISPR / Cas systems • CRISPR / Cas paper discussions • Concepts of optogenetics and their applications • Commercially available cells and instrumentation • Application of optogenetics in cell based assays for development and routine testing such as quality control *Application of cell -based bioassays for drug development (Laura Suter-Dick, 14 lessons)* • Mammalian, tissue specific cell cultures • Advanced cell culture systems for drug development • Concept of organotypical cultures, 3D-cultures, co-cultures, bioprinting • Examples: cell cultures for disease modelling and toxicity assessment. • Bioassay refinement using additional alternative endpoints • Implementation of specific cell culture systems for drug discovery (robustness, throughput, cost, etc) *Use of animal models for bioassays (Armin Zenker, 14 lessons)* • Use of non-mammalian organisms to increase the level of complexity (eg. Zebra fish) • Rodent and non-rodent in vivo assays • Multigenerational and alternative test systems • Bioassay refinement using additional alternative endpoints

Teaching / learning methods	Lecture, discussion of current literature, guest speakers, group assignment
Format	3 lessons per week, whole semester
Assessment of learning outcome	• Written exam, individual (75%) • Group work and presentation during the course (25%)
Bibliography	Entry level: • Alberts, B, et al.“*Molecular Biology of the Cell”,* 6th (2014) or 7th Edition (2022), New York: Garland Science. Course material: • Original literature and review papers • Scripts
Link to other modules	
Comments	
Last update	January 24, 2022

Module title	**Cellular Imaging**
Code	M-SLS-MSc 0125
Degree program	Master of Science in Life Sciences
Workload	3 ECTS (90 student working hours: 42 lessons contact = 32 h; 58 h self-study)
Module coordinator	**Name** Johannes Mosbacher **Phone** 061-228 6149 **Email** johannes.mosbacher@fhnw.ch **Address** FHNW, HLS, Hofackerstrasse 30, 4132 Muttenz
Lecturers	Theodor Bühler, Martin Rausch
Entry requirements	Basics in Cell Biology: structure, morphology, function Basics in Optics: Photons, electromagnetic waves, wavelength and frequency of visible light, fluorescence, absorbance, polarization, phase, coherence, laser, lenses, mirrors Basics in Microscopy: Light microscopy, Raman spectroscopy, Surface plasmons, Magnetic Resonance Imaging, Abbe´s law, diffraction limit
Learning outcomes and competences	After completing the module, students will be able to… • Know classical and state-of-the-art cell imaging approaches from confocal, Raman, high-content, time-lapse imaging to super-resolution molecular imaging and light-sheet imaging in cleared organs • Select appropriate imaging methods for specific biological and pharmacological questions • Understand image analysis approaches to quantify image features like ROI, thresholding, tracing, scripting up to AI approaches in image analysis • Apply basic image analysis methods for selected applications (ROI, time-lapse, co-localization) • Interpret imaging data and related publications
Module contents	*Cellular Imaging: The Basics (Martin Rausch, Johannes Mosbacher; 12 lessons)* • Physics of imaging: IR, light, UV, Abbe´s law, microscopy, scattering, photo-bleaching, luminescence, fluorescence, polarization, scintillation, phase contrast, stimulated emission, FRET, Ratiometric imaging, … • Optical properties of biological matter (absorption, scattering, auto-fluorescence), effects of lipids, proteins, nucleotides, extracellular matrix • Short insights into alternatives to light: micro-PET, SPECT, micro-MRI, ultrasound, EIS (impedance), AFM, STM, EM, … • Image acquisition and processing: Multi-channel analysis, ROI-analysis, thresholding, co-localization, migration, machine-learning algorithms *Cellular Imaging: The Arts (Martin Rausch; Johannes Mosbacher, 12 lessons)* • Concepts of modern imaging technologies: Confocal, Multi-photon, Super-Resolution Imaging, TIRF, Nanobiophotonics, SNOM, QPI, … • Molecular imaging: Optical probe design, Quantum dots, BRET, quenching, FLIM, CLEM, • Cellular imaging in organoids and tissue:: tissue clearing, light-sheet imaging, organoid imaging *Raman imaging (Theodor Bühler; 6 lessons)* • Theory and concept of Raman imaging • Applications and limitations • Multi-modal approaches of Raman and Light imaging in Life Sciences *Case studies: cellular imaging applications (Martin Rausch & Johannes Mosbacher; 12 lessons)*

	• Selected Cell imaging applications from technology partners and companies: - HCS, PPI studies, biomarkers, migration assays, toxicology assays, tissue engineering, tissue analysis, sub-cellular imaging, immune-cell imaging, organoid imaging, drug quantification in tissue, bio-sensors, … - Image analysis examples: ISH, IHC, HCS, time-lapse, trafficking, migration, wound healing, …
Teaching / learning methods	Lecture, case studies, some lectures could be demos (ca 25%) of technology partners / pharma companies; and "hands-on" image acquisition/analysis (either self-acquired or pre-registered data files)
Format	3 lessons per week, whole semester
Assessment of learning outcome	• Team presentation on a demo or publication describing an imaging application in drug discovery and life sciences (50%) • Final written exam: (50%)
Bibliography	**Entry level** Toomre, D., & Bewersdorf, J. (2010). A new wave of cellular imaging. Annual review of cell and developmental biology, 26, 285–314. https://doi.org/10.1146/annurev-cellbio-100109-104048 Lang, P., Yeow, K., Nichols, A. et al. (2006). Cellular imaging in drug discovery. Nat Rev Drug Discov 5, 343–356. https://doi.org/10.1038/nrd2008 Zhang, Y., Hong, H., & Cai, W. (2010). Imaging with Raman spectroscopy. Current pharmaceutical biotechnology, 11(6), 654–661. https://doi.org/10.2174/138920110792246483 **Preparation** Martinez, N. J., Titus, S. A., Wagner, A. K., & Simeonov, A. (2015). High-throughput fluorescence imaging approaches for drug discovery using in vitro and in vivo three-dimensional models. Expert opinion on drug discovery, 10(12), 1347–1361. https://doi.org/10.1517/17460441.2015.1091814 Dean, K. M., & Palmer, A. E. (2014). Advances in fluorescence labeling strategies for dynamic cellular imaging. Nature chemical biology, 10(7), 512–523. https://doi.org/10.1038/nchembio.1556 Godin, A. G., Lounis, B., & Cognet, L. (2014). Super-resolution microscopy approaches for live cell imaging. Biophysical journal, 107(8), 1777–1784. https://doi.org/10.1016/j.bpj.2014.08.028 **Course materials** tba
Link to other modules	Complementary with cluster-specific module "Medical Imaging and Image processing" (M-SLS-MSc BECS3)
Comments	
Last update	May 15, 2023

Module title	**Advanced Cell Culture Systems**
Code	M-SLS-MSc 0126
Degree program	Master of Science in Life Sciences
Workload	3 ECTS (90 student working hours: 42 lessons contact = 32 h; 58 h self-study)
Module coordinator	**Name** Laura Suter-Dick **Phone** 061-228 5956 **Email** laura.suterdick@fhnw.ch **Address** FHNW, HLS, Hofackerstrasse 30, 4132 Muttenz
Lecturers	Olivier Frey
Entry requirements	Basics in Cell Biology: Characteristics of tissues, role and composition of the extracellular matrix (ECM), cell-cell contacts, cell-ECM contacts Knowledge of drug metabolism (hepatic metabolism) Basics in Tissue Engineering: 2D and 3D cell culture systems, application of cell cultures for drug discovery Knowledge on in vitro toxicity assessment and in vitro metabolism Basics in Cell analytics: Microscopy, Phase-contrast, Fluorescence,
Learning outcomes and competences	After completing the module, students will be able to… • Know the concept of microphysiological systems (MPS), organ on chip (OOC) and body on chip for complex, organ typical cultures • Know commonly used materials and fabrication process of MPS devices • Know basic fluid dynamics and their application in microphysiological systems • Select appropriate methods to maintain architecture of multicellular tissues and multi-tissue culture systems • Understand the impact of chip-design (materials, architecture, mechanical stimuli) on cultured tissues • Understand current technical and biological limitations (e.g. cell sources, media composition, allometry, material functionalization) • Know read out methods their interface to MPS incl. sensor integration • Interpret published data
Module contents	*Areas of implementation of MPS in research (Laura Suter-Dick, 13 lessons)* • Social-, 3R-, Pharma/biotech pressure to advance in vitro methods, rational and motivation to develop microphysiological systems MPS and organ on chips (OOC) • Evolution of MPS as a result of advances in microsystems technology and 3D tissue engineering • Tissues for MPS: Revision relevant aspects of anatomy and physiology of tissues commonly used in Organ on Chips (OOC) • Selection of cell sources, matrices and scaffolds • Application of OOC and multi-tissue MPS for DMPK, pharmacological investigations and disease modeling *Technical aspects on Microphysiological Systems (Olivier Frey, 17 lessons)* • Basics of microfluidics and governing laws in OOC • Microfluidic systems, mechanical and biochemical stimuli: generation of shear stress, gradients, liquid-air interfaces, etc. • Materials commonly used for the fabrication of MPS: Optimization of rheological characteristics, adsorption of chemicals, cell-friendliness, cost • Methods for fabrication and operation of MPS and OOC • Interfaces to analytical systems (e.g. imaging) and integration of sensors and actuators • Considerations for scaling (HTS), robust handling and implementation to routine use of MPS and OOC *Practical examples for use of Microphysiological Systems (different*

	guests/interviews, Laura Suter-Dick & Olivier Frey; 12 lessons) • Examples and current state of OOC and multi-tissue MPS • Application in research and industry • Outlook: towards a Body on a Chip
Teaching / learning methods	Lecture, interviews with technology developers and end-users, selected current publications
Format	3 lessons per week, whole semester
Assessment of learning outcome	• Presentation(s) during the course (40%) • Final written exam (60%)
Bibliography	**Preparation** **Course materials** tba
Link to other modules	Compound Profiling in Pharmaceutical Drug Discovery (M-SLS-MSc BP1) Bioassays: Engineered Cells, Tissues and Organisms (M-SLS-MSC 0120)
Comments	
Last update	November 24, 2021

Module title	**Laboratory Automation in the Pharmaceutical Industry**
Code	M-SLS-MSc 0127
Degree program	Master of Science in Life Sciences
Workload	3 ECTS (90 student working hours: 42 lessons contact = 32 h; 58 h self-study)
Module coordinator	**Name** Johannes Mosbacher **Phone** 061-228 6149 **Email** johannes.mosbacher@fhnw.ch **Address** FHNW, HLS, Hofackerstrasse 30, 4132 Muttenz
Lecturers	Oliver Peter, Rochdi Bouhelal
Entry requirements	Basics in Cell Biology: Cell cycle, adherent / non-adherent cells, morphology, surface markers, heterologous expression, Cell lysis, Basics in Pharmacology: Drug-Receptor-Interaction, EC50, IC50, Agonists and Antagonists, in vitro assay design, time-dependent assays Basics in Cell analytics: Microscopy, Phase-contrast, Fluorescence, Absorbance, Colorimetric read-out, FACS, Viability, Growth rates, Impedance (prior BP1 course)
Learning outcomes and competences	After completing the module, students will be able to… • Know lab automation applications in pharma industry • Understand limitations of performance of systems (accuracy, throughput, timing-constraints, machine-learning, sustainability, costs, etc.) • Understand algorithms and feedback-loops in lab automation up to closed-loop drug design infrastructures • Apply know-how to establish a standard automation protocol for a basic lab bench work like dilution series, liquid transfer, serial sampling etc.
Module contents	*Lab Automation: The Basics (Johannes Mosbacher; 12 lessons)* • General principles of automated systems: From electronic pipettes to automated screening systems • General automation concepts: robotics, liquid handling, feedback loops, sensors, ANSI/SLAS standards, quality controls • General intro into lab automation programming: Concepts, scripts, standards, guidelines, regulations *High throughput screening (Rochdi Bouhelal or NIBR colleagues; 9 lessons)* • Automated high throughput screening: Compound library handling, Cell production, assay transfer from manual lab to roboter, screening hardware, screening software, automated data handling *Automation applications (Johannes Mosbacher and guests; 12 lessons)* • Automated compound characterization in pre-clinical drug discovery: Selected examples with insights into theoretical concepts and practical solutions from assays like - High content screening - Automated bioanalytics - Drug permeability assays: PAMPA, caco-2 - Drug metabolism assays: microsomes, hepatocytes - Drug toxicity assays: cardiotox assays, AMES test - Automated ex vivo assays: PBMC-FACS, IHC, vessel / smooth-muscles force assays - Automated in vivo assays: Zebrafish larvae, Drosophila assays, rodent open field assays • Visits or virtual visits with “real live” examples of productive lab automation • A virtual visit of a “lab automation” exhibition & conference

	The future of automation: Closed-loops (Oliver Peter; 9 lessons) • Design – Make – Test – Learn cycles, Machine Learning in drug discovery, data integration • Closed-loop drug design platforms • Human-like lab robots for un-supervised individual lab routine tasks
Teaching / learning methods	Lectures, case studies and “hands-on” examples with planned lab visit (Idorsia, Novartis, Roche, ..)
Format	3 lessons per week, whole semester
Assessment of learning outcome	• Presentation, teams of 2 (40%) • Written exam including an automation task case study (60%)
Bibliography	**Entry level** Rutherford, M. L., & Stinger, T. (2001). Recent trends in laboratory automation in the pharmaceutical industry. Current opinion in drug discovery & development, 4(3), 343–346. Chen, T. (2009). A Practical Guide to Assay Development and High-Throughput Screening in Drug Discovery (1st ed.). CRC Press. https://doi.org/10.1201/9781420070514 Chapman T. (2003). Lab automation and robotics: Automation on the move. Nature, 421(6923), 661–666. https://doi.org/10.1038/421661a **Preparation** Saunders K. C. (2004). Automation and robotics in ADME screening. Drug discovery today. Technologies, 1(4), 373–380. https://doi.org/10.1016/j.ddtec.2004.11.009 Nierode, G., Kwon, P. S., Dordick, J. S., & Kwon, S. J. (2016). Cell-Based Assay Design for High-Content Screening of Drug Candidates. Journal of microbiology and biotechnology, 26(2), 213–225. https://doi.org/10.4014/jmb.1508.08007 Montanez-Sauri, S. I., Sung, K. E., Puccinelli, J. P., Pehlke, C., & Beebe, D. J. (2011). Automation of three-dimensional cell culture in arrayed microfluidic devices. Journal of laboratory automation, 16(3), 171–185. https://doi.org/10.1016/j.jala.2011.02.003 **Course materials** tba
Link to other modules	BP1: Compound Profiling in Pharmaceutical Drug Discovery Potential overlap with “Process Automation” (M-SLS-MSc 0243)
Comments	
Last update	November 19, 2021

BIOANALYTICS

Module title	**Proteomics and Protein Analytics**
Code	M-SLS-MSC 0100
Degree program	Master of Science in Life Sciences
Workload	3 ECTS (90 student working hours: 42 lessons contact = 32 h; 58 h self-study)
Module coordinator	**Name** Georg Lipps **Phone** 061-228-5452 **Email** georg.lipps@fhnw.ch **Address** FHNW, HLS, Hofackerstrasse 30, 4132 Muttenz
Lecturers	Oliver Germershaus
Entry requirements	bachelor level of biochemistry
Learning outcomes and competences	After completing the module, students will be able to… • understand the mass spectra of peptides and proteins • comprehend the technique of protein identification • understand the principle of protein quantification by mass-spectroscopy experiments • understand analytical methods relevant for assessment of the thermodynamic and colloidal stability of therapeutic proteins • comprehend the relevance of analytical characterization in the context of drug product stability, safety and compatibility
Module contents	*Proteomics (Georg Lipps, 21 lessons)* • peptide mass fingerprinting • protein identification by mass spectroscopy • sample preparation and typical workflows for proteomic experiments • quantification with isotope labels and label-free • analysis of posttranslational modifications *Analytical assessment of Biopharmaceuticals (Oliver Germershaus, 21 lessons)* • Static and dynamic light-scattering • Analytical ultracentrifugation • Analytical field flow fractionation • Flow microscopy • Turbidimetry/Nephelometry • Laser Doppler anemometry • Fourier transform infrared spectroscopy • Fluorescence and UV-VIS spectroscopy of proteins • CD spectroscopy of proteins • Calorimetry (DSC, ITC)
Teaching / learning methods	lecture
Format	3 lessons per week, whole semester
Assessment of learning outcome	• final module examination, closed book (100%)
Bibliography	Entry Level • Garrett, R., and Grisham, C.M. (2013). Biochemistry (Belmont, CA: Brooks/Cole, Cengage Learning). Optional

	• Rehm, H., and Letzel, T. (2016). Der Experimentator: Proteinbiochemie/Proteomics (Berlin, Heidelberg: Springer Berlin Heidelberg). • Letzel, T. (2011) Protein and peptide analysis by LC-MS: experimental strategies (Cambridge: RSC Publ). • Jameel, Hershenson: Formulation and Process Development Strategies for Manufacturing Biopharmaceuticals, Wiley • Jiskoot, Crommelin: Methods for Structural Analysis of Protein Pharmaceuticals, Springer
Link to other modules	
Comments	
Last update	March 19th 2018

Module title	**Genomics**
Code	M-SLS-MSC 0110
Degree program	Master of Science in Life Sciences
Workload	3 ECTS (90 student working hours: 42 lessons contact = 32 h; 58 h self-study)
Module coordinator	**Name** Dominik Meinel **Phone** 061 22 86 256 **Email** dominik.meinel@fhnw.ch **Address** FHNW, HLS, Hofackerstrasse 30, 4132 Muttenz
Lecturers	Boris Kolvenbach
Entry requirements	bachelor level of molecular biology, biochemistry and bioinformatics; in particular a good understanding of the realisation of genetic information
Learning outcomes and competences	After completing the module, students will be able to… • select the sequencing technique and strategy for a given sequencing task, • understand how whole genome association studies are carried out and analysed, • understand how an RNAseq experiment is carried out and where the data can be retrieved from public databases, • have an insight into the structure of chromatin and its impact on gene regulation, • know how the genome sequence can be specifically changed.
Module contents	*Next generation sequencing and its applications (Dominik Meinel, 20 lessons)* • Sequencing techniques (dideoxysequencing, Illumina, long read technologies), sequencing of the human genome, genome browser • whole genome sequencing, hybrid methods and genome finishing • targeted sequencing • DNA encoded libaries • SNP analysis, population genetics, whole genome association studies • Transcriptome analysis • Chromatin analysis • Functional genomics • Applications in Microbiology and epidemiology *Practical exercise: Next Generation Sequencing (Boris Kolvenbach, 12 lessons)* • Preparation of the experimental protocol based on the instructions of the test kit • Carrying out the bacterial whole genome sequencing • Analysis of the sequencing data for antimicrobial resistance *Genome engineering (Dominik Meinel, 10 lessons)* • Student presentations on seminal publications on genome engineering of bacteria, yeast and mammalian cells
Teaching / learning methods	lecture, group work, student presentations and practical exercise
Format	3 lessons per week, whole semester
Assessment of learning outcome	• Student presentations, groups of 2-3 (20 %) • Report of the practical exercise (20 %) • Closed book examination at the end of the semester (60 %)
Bibliography	Entry level: • Campbell, N.A., et al. (2016) *Biologie*, 10th Edition, Pearson, Chapters 14, 16-18, 20, 21. Course material:

	• Dunbar, Cynthia E., et al. (2018) 'Gene Therapy Comes of Age'. *Science* 359 (6372): eaan4672. https://doi.org/10.1126/science.aan4672. • Carroll, Dana (2014) 'Genome Engineering with Targetable Nucleases'. *Annual Review of Biochemistry* 83 (1): 409–39. https://doi.org/10.1146/annurev-biochem-060713-035418
Link to other modules	
Comments	The date of the practical exercise will be announced at the beginning of the lecture.
Last update	September 14th, 2022

Module title	**Chromatography and Mass Spectrometry**
Code	M-SLS-MSc 0115
Degree program	Master of Science in Life Sciences
Workload	3 ECTS (90 student working hours: 42 lessons contact = 32 h; 58 h self-study)
Module coordinator	**Name** Olaf Boernsen **Phone** - **Email** klausolaf.boernsen@fhnw.ch **Address** FHNW, HLS, Hofackerstrasse 30, 4132 Muttenz
Lecturers	-
Entry requirements	Bachelor level of biochemistry
Learning outcomes and competences	After completing the module, students will be able to… • understand the fundamentals of modern HPLC and CE separations • understand the fundamentals of modern mass spectrometers • understand strategies of hyphenated LC-MS methods • understand the basic principles of mass spectra interpretation • recognize the potential of sample pre-treatment methods in the analysis of biofluids • understand the potential of instrumental analytics
Module contents	*Fundamentals of chromatographic separations (Olaf Boernsen, 12 lessons)* • Principals of instrumental chromatography (HPLC) • Method optimization: columns, detectors, solvents, gradients and pumps • 2D separation techniques and column switching • Set up of a nano HPLC (sensitivity and resolution) • Different sample pre-treatment strategies of biofluids • Nano and UPLC separation methods • Separations by capillary electrophoresis (CE) *Fundamentals of mass spectrometry (Olaf Boernsen, 12 lessons)* • Modern MS and MSMS instruments • Ionization methods (ESI, APCI, DESI, MALDI, EI) • MS imaging methods • Nano-ESI • Sample pre-treatment for direct MS-measurements • LC-MS coupling *Applications of bioanalytical mass spectrometry (Olaf Boernsen, 18 lessons)* • How to read a mass spectrum • H/D Exchange experiments • Isotopic dilution and absolute quantitative determination of drugs • MS spectra of single molecules from small to large • Infusion MS examples • LC-MSMS with radioactive labels in metabolism studies
Teaching / learning methods	lecture with exercises; 10 min paper review (presentation)
Format	3 lessons per week, whole semester
Assessment of learning outcome	• Final module examination, closed book (100%)
Bibliography	**Mass Spectrometry**; Jürgen H Gross; Springer International Publishing; 2017; ISBN-13: 9783319543970 **LC/MS**; Marvin McMaster; John Wiley & Sons; 2005; ISBN-13: 9780471736578

	Introduction to Mass Spectrometry; J. Throck Watson, O. David Sparkman; John Wiley & Sons; 2013; ISBN-13: 9781118681589 **Capillary Electrophoresis - Mass Spectrometry**; De Jong, Gerhardus; Wiley-VCH, 2006, ISBN-13: 9783527693818 **Introduction to Modern Liquid Chromatography**; Lloyd R. Snyder, Joseph J. Kirkland, John W. Dolan; John Wiley & Sons; 2011; ISBN-13: 9781118210390 **The HPLC-MS Handbook for Practitioners**; Kromidas, Stavros; Wiley-VCH; 2017; ISBN-13: 9783527809172 **Dictionary of Mass Spectrometry**; Anthony I. Mallet, Steve Down; John Wiley & Sons; 2010; ISBN-13: 9780470027615
Link to other modules	
Comments	
Last update	April 28, 2023

Module title	**Biomarker**
Code	M-SLS-MSc 0116
Degree program	Master of Science in Life Sciences
Workload	3 ECTS (90 student working hours: 42 lessons contact = 32 h; 58 h self-study)
Module coordinator	**Name** Abdullah Kahraman **Phone** 061 22 86 223 **Phone** Abdullah.kahraman@fhnw.ch **Address** FHNW, HLS, Hofackerstrasse 30, 4132 Muttenz
Lecturers	Oya Tagit, Abdullah Kahraman
Entry requirements	Bachelor level in molecular biology, biochemistry, basic understanding in statistics and bioinformatics, bioanalytical tools and techniques
Learning outcomes and competences	After completing the module, students will be able to… • know the most important classes of biomarkers in cancer and other diseases • understand the process of biomarkers discovery • learn biomarkers in different diseases • know applications of biomarkers in clinical studies and diagnostics • know common biomarker detection methods in medical diagnostics

Module contents	*Fundamentals of Biomarkers (O. Tagit, 6 lessons)*
	• Definitions and Applications
	• Types of Biomarker
	  ○ diagnostic, monitoring, imaging pharmacodynamic/response, predictive, prognostic, safety, and susceptibility/risk biomarkers
	• Traditional vs novel biomarkers types: e.g. serology, liquid biopsies, transcriptomics and digital biomarkers
	• Surrogate biomarkers
	
	Biomarker Detection Techniques (O. Tagit, A. Kahraman, 13 lessons)
	• Sequencing Assay Types in the Clinics
	  ○ Sanger (Single Gene vs Gene Panel)
	  ○ NGS (IonTorrent vs Illumina)
	  ○ Liquid Biopsy
	  ○ Panel vs Exome vs Whole Genome
	• Proteomics
	• Optical, electrochemical, magnetic
	• Immunoassays (homogeneous, heterogeneous, advantages and applications of both)
	• Imaging
	• In-vitro diagnostic tests, POD devices
	
	Biomarker in Disease (A. Kahraman, 10 lessons)
	• Cancer
	  ○ Introduction to Cancer Biology and Cancer Genomics
	  ○ Cancer Hallmarks
	  ○ Etiology and Mechanism of Mutational Events
	  ○ Types of Cancer Mutations, Genes and Mutational Signatures
	  ○ Genomic Signatures
	• Other diseases
	
	From Bench to Market (A. Kahraman, 7 lessons)
	• Data formats, Standard, Guidelines and Databases for Variant Interpretation
	• Reporting
	• Validation of biomarkers

	• Medical value of biomarkers *Literature Review (O. Tagit, A. Kahraman, 6 lessons)* • Student presentation on publications illustrating identification, validation, and application of biomarkers
Lecture	Lecture, group work and student presentations
Format	3 lessons per week, whole semester
Assessment of learning outcome	• Group work and presentation (40%) • Final module examination, closed book (60%)
Bibliography	Will be given in Moodle
Link to other modules	Genomics (M-SLS-MSc 0110) Proteomics and Protein Analytics (M-SLS-MSc 0100) Human Genetik
Comments	
Last update	January 17, 2023

BIOTECHNOLOGY

Module title	**Process Analytical Technology**
Code	M-SLS-MSc 0242
Degree program	Master of Science in Life Sciences
Workload	3 ECTS (90 student working hours: 42 lessons contact = 32 h; 58 h self-study)
Module coordinator	**Name** Thomas Villiger **Phone** 061-228-52 46 **Email** thomas.villiger@fhnw.ch **Address** FHNW, HLS, Hofackerstrasse 30, 4132 Muttenz
Lecturers	Oliver Steinhof (Biogen), Lorenz Liesum (Roche)
Entry requirements	• Bachelor level of bioprocess technology, biotechnology, (bio-) chemical engineering, pharmaceutical technology • Basic knowledge in bio and chemical processes, basic knowledge in (bio)analytical chemistry, basic knowledge in mathematics and statistics
Learning outcomes and competences	After completing the module, students will be able to: • Describe principles and tools of process analytics • Understand reasons behind the Process Analytical Technologies (PAT) initiative • Describe how PAT fits within the framework of Quality-by-Design (QbD) • Know online, at-line and online process analytical technologies for (bio)pharmaceutical processes • Analyse risk and opportunities of process analytics in regulated environment • Understand different options of control and release strategies within the (bio)pharmaceutical industries
Module contents	*Overview of process analytical toolbox (Oliver Steinhof, Lorenz Liesum, 12 lessons)* • Introduction to process spectroscopy and chemometrics (In-line and online analytical instruments) • PAT as enabler for an advanced control strategy • Implementing PAT in development and manufacturing *Process analytical technology in biotechnology (Oliver Steinhof, Lorenz Liesum, 20 lessons)* • Dedicated PAT solutions for specific unit operations (Upstream, Downstream, Formulation) • PAT related to continuous processes • Multivariate statistical process control (MPSC) and opportunities for process modelling *Practical case studies and industrial insights (Oliver Steinhof, Lorenz Liesum, 10 lessons)* • Introduction to regulatory requirements for validating and controlling manufacturing processes • Case studies from industry
Teaching / learning methods	Lecture, selected publications, case-studies from industry
Format	3 lectures per week, whole semester
Assessment of learning outcome	• Written exam (100%)

Bibliography	NA
Link to other modules	Continuous Pharmaceutical Production (M-SLS-MSc 0130) Continuous Biomanufacturing (M-SLS-MSc 0241) Process Automation (M-SLS- MSc 0243)
Comments	NA
Last update	November 30, 2021

Module title	**Continuous Biomanufacturing**
Code	M-SLS-MSc 0241
Degree program	Master of Science in Life Sciences
Workload	3 ECTS (90 student working hours: 42 lessons contact = 32 h; 58 h self-study)
Module coordinator	**Name** Thomas Villiger **Phone** 061-228-52 46 **Email** thomas.villiger@fhnw.ch **Address** FHNW, HLS, Hofackerstrasse 30, 4132 Muttenz
Lecturers	Thomas Müller-Späth
Entry requirements	• Bachelor level of bioprocess technology, biotechnology or (bio-) chemical engineering • Knowledge of fundamentals of biotechnological manufacturing processes (material will be provided prior to the lecture for students lacking the fundamentals of biotechnological manufacturing processes). • Basic programming knowledge in python (an online tutorial will be provided prior to the lecture for students lacking basic programming knowledge in python).
Learning outcomes and competences	After completing the module, students will be able to… • Know the concept of intensified and continuous bioprocess units of different biopharmaceutical products • Understand different concepts of integrated continuous biomanufacturing (ICB) and their advantages and challenges • Know approaches to different organisms and modalities • Understand the concepts of multi column chromatography • Understand current biological, technical, and regulatory limitations (e.g. cell physiology, media consumption, residence time distribution, viral inactivation, batch definition, …) • Evaluate new case studies from industry
Module contents	*Overview of continuous biomanufacturing approaches (Thomas Villiger, 12 lessons)* • Equipment and concepts for continuous upstream and downstream units • Approaches to integrated continuous biomanufacturing *Continuous process units in biotechnology (Thomas Villiger, Thomas Müller-Späth, 15 lessons)* • Continuous process units in upstream and downstream • Product quality considerations of integrated continuous biomanufacturing • Control strategies of integrated continuous biomanufacturing *Practical case studies and industrial insights (Thomas Villiger, Thomas Müller-Späth, 15 lessons)* • Process economics of continuous processes • introduction to regulatory aspects of integrated continuous biomanufacturing • Implementation and case studies from industry
Teaching / learning methods	Lecture, group work, student presentations and practical exercise and case studies from industry
Format	3 lectures per week, whole semester
Assessment of learning outcome	Oral exam (100%)
Bibliography	NA

Link to other modules	Continuous Pharmaceutical Production (M-SLS-MSc 0130) Process Analytical Technology (M-SLS-MSc 0242) Process Automation (M-SLS- MSc 0243)
Comments	Continuous Pharmaceutical Production (CPP) is about continuous process of small molecules, this course is about continuous production of biopharmaceuticals such as antibodies.
Last update	April 28, 2023

Module title	**Gene- and Cell Therapeutics Systems**
Code	M-SLS-F-0240
Degree program	Master of Science in Life Sciences
Workload	3 ECTS (90 student working hours: 42 lessons contact = 32 h; 58 h self-study)
Module coordinator	**Name** Ulrich Siler **Phone** 0612286326 **Email** ulrich.siler@fhnw.ch **Address** FHNW, HLS, Hofackerstrasse 30, 4132 Muttenz
Lecturers	Ulrich Siler
Entry requirements	• Bachelor level in cell biology: Locations of protein synthesis, transport of membrane proteins to the cell surface, export of proteins • Basic knowledge in molecular biology: DNA, RNA, gene expression
Learning outcomes and competences	After completing the module, students will be able to… • understand the mechanisms of gene therapy vectors • design basic gene expression cassettes for gene therapy vector construction • have an overview of the challenges and risks in gene therapy • have an overview of technical methods applied in gene therapy • have an overview of pre-clinical development required prior to clinic • can assess the quality of gene therapy publications • deepen their knowledge for easy entering into ongoing gene therapy research or developmental projects
Module contents	*Recapitulation immunology, molecular biology and cell biology* • Basics of immunology with relevance to interactions between cells and gene therapy vehicle components. • Introduction into molecular biology and cell biology with respect to transgene cassette design *Viral gene therapy & Genome editing* • Viral gene therapy: From basic definitions to approved gene therapy products including examples. • Genome editing and its application in gene therapy • Assessment of the risk potential using the example of side effects in animal studies and examples of severe adverse events observed in clinical gene therapy studies. *Translation into clinics* • Pre-clinical developmental steps required to prepare a clinical trial
Teaching / learning methods	Lecture
Format	3 lectures per week, whole semester
Assessment of learning outcome	• Presentation on quality and reproducibility of gene therapy literature examples, groups of 2 to 4 depending on the number of participants (20%) • Presentation on transgene cassette design, groups of 2 to 4 depending on the number of participants (20%) • Closed book examination at the end of the semester (60 %)
Bibliography	• preparation: – Arabi et al. (2022) Gene therapy clinical trials, where do we go? An overview. DOI: 10.1016/j.biopha.2022.113324, https://pubmed.ncbi.nlm.nih.gov/35779421/ – Wu et al. (2022) Development and clinical translation of ex vivo gene therapy. DOI: 10.1016/j.csbj.2022.06.015, https://pubmed.ncbi.nlm.nih.gov/35782737/

	– Zhou et al (2022) Current landscape of gene-editing technology in biomedicine: Applications, advantages, challenges, and perspectives. doi: 10.1002/mco2.155, https://www.ncbi.nlm.nih.gov/pmc/articles/PMC9283854/ Further course materials will be provided.
Link to other modules	
Comments	Potential contributions of industrial guest speakers will be announced.
Last update	May 5, 2023

Module title	**Process Automation**
Code	M-SLS-MSc 0243
Degree program	Master of Science in Life Sciences
Workload	3 ECTS (90 student working hours: 42 lessons contact = 32 h; 58 h self-study)
Module coordinator	**Name** Andreas Zogg **Phone** 061-228- 58-25 **Email** andreas.zogg@fhnw.ch **Address** FHNW, HLS, Hofackerstrasse 30, 4132 Muttenz
Lecturers	Andreas Zogg, Thomas Villiger
Entry requirements	• Basic skills in programming with Matlab, Python or R. • Basics of heat transfer. • Basics of spectroscopy and chemometrics.
Learning outcomes and competences	After completing the module, students will be able to … • Know applications of automation and control concepts within their area of expertise such as chemical, pharmaceutical, and biotechnological processes • Create and apply dynamic and multivariate models to control processes. • Carry out theoretical and experimental identification of dynamic systems. • Understand basic concepts of PID control and the implantation into Matlab-Simulink.
Module contents	*Case Study I (Andreas Zogg 27 lessons)* • Identification of dynamic systems based on experimental data and / or physical and chemical understanding. Focus: Heat transfer and temperature measurement. • Implementation of PID controllers using Matlab Simulink. • **Practical work**: Identify a Matlab-Simulink model to control the internal temperature of an agitated vessel based on practical experiments: Different pilot and lab reactors are available. Simulate the impact of a chemical reaction *Case Study II (Thomas Villiger 15 lessons)* • Implementation of a chemometric model into an industrial automation system. • **Practical work**: Control of metabolite using a spectroscopic probe (Raman)
Teaching / learning methods	Lecture with case studies Practical implementation of the case studies in lab and/or pilot scale.
Format	Lectures focusing on the realization of the two different case studies. Practical part on site in the process technology centre in Muttenz (block of 6 lessons. The final schedule will be set during the first lectures).
Assessment of learning outcome	• Entry exam on first module day, individual (20%) • Presentation on the case study of 20 minutes on last day, groups of max. 3 (40%) • Paper on the case study, groups of max. 3, to be submitted 2 weeks after module end (40%)
Bibliography	
Link to other modules	Process Analytical Technology (M-SLS-MSc 0242) Laboratory Automation in the Pharmaceutical Industry (M-SLS-MSc 0127) Reaction Technology (M-SLS-MSc 0090)
Comments	
Last update	April 30, 2023

CHEMICAL ENGINEERING

Module title	**Reaction Technology**
Code	M-SLS-MSC 0090
Degree program	Master of Science in Life Sciences
Workload	3 ECTS (90 h: Contact 42 lectures (32 h); Self-study 58 h)
Module coordinator	**Name** Andreas Zogg **Phone** 061 228 58 25 **Email** andreas.zogg@fhnw.ch **Address** FHNW, HLS, Hofackerstrasse 30, 4132 Muttenz
Lecturers	Andreas Zogg
Entry requirements	Bachelor level in Physical Chemistry, Heat and Mass-Transport, Reaction Kinetics and Process modelling
Learning outcomes and competences	After completing the module, students will be able to … • understand and apply state-of-the-art principles of reaction kinetics, heat-transfer, and thermal process safety to scale up chemical reactions in ideal reactors (agitated vessel or plug flow reactor). • apply those principles using dynamic Matlab models • choose the appropriate reactor setup (batch, semi-batch, continuous) to carry out a chemical reaction in production scale. • carry out a criticality assessment of a standard chemical reaction based on reaction calorimetry and differential scanning calorimetry data.
Module contents	*Thermal Safety of Chemical Processes (6 lessons)* • Reaction calorimetry & thermal analysis: Differential Scanning Calorimetry. • Criticality assessment of chemical processes (cooling failure scenario). *Heat transport for the scale-up of ideal reactors (6 lessons)* • Calculation of heat transfer coefficients. *Fundamental design rules for ideal chemical reactors (6 lessons)* • Ideal agitated vessel: Batch, semi-batch, and continuous operation (continuous stirred tank reactor, cascade reactor). • Ideal tubular reactor: Continuous operation (plug flow reactor). *Dynamic Matlab models applied in different case studies: (17 lessons)* • Fitting of reaction and decomposition kinetics into given heat flow data. • Adiabatic runaway: Model based simulation of the time to maximum rate (TMRad) and the adiabatic decomposition temperature (ADT24). • Dynamic models for non-isothermal, ideal reactors combining reaction kinetics and heat flow calculations. • Simulation of ideal batch, semi-batch and continuous reactor setups. • Matlab-Simulink: PID controller to heat and cool a reactor. *Practical work in the process lab (6 lessons)* • Measure the reaction kinetics of a self-chosen chemical reaction using Differential Scanning Calorimetry. Use this data to design a production plant (continuous and semi-batch). *Short introduction into prototype reactors developed at the FHNW: (1 lesson)* • Scale-Down-Reactor, explosion reactor, g/l reactors for oxidation, 3D printed reactors.
Teaching / learning methods	Lecture, practical exercises with Matlab, practical work in the process lab.

Format	3 lessons per week, whole semester
Assessment of learning outcome	• Practical exercises with Matlab during the semester, individual (50 %) • Presentation of a case study at the end of the module based data gathered during the lab work, individual (50 %).
Bibliography	- Chemical Reaction Engineering, Octave Levenspiel, 1998, Wiley; 3rd edition, ISBN 978-0-471-25424-9 - Thermal Safety of Chemical Processes, Francis Stoessel, 2008, Wiley-VCH Verlag GmbH & Co. KGaA, ISBN 9783527317127. - VDI Heat Atlas, Springer, 2010.
Link to other modules	Process Development and Technology (M-SLS-MSc 0080) Industrial Chemical Process Safety (M-SLS-MSc C6)
Comments	
Last update	April 30, 2023

Module title	**Process Development and Technology**
Code	M-SLS-MSC 0080
Degree program	Master of Science in Life Sciences
Workload	3 ECTS (90 h: Contact 42 lectures (32 h); Self-study 58 h)
Module coordinator	**Name** Wolfgang Riedl **Phone** 061-2285551 **Email** wolfgang.riedl@fhnw.ch **Address** FHNW, HLS, Hofackerstrasse 30, 4132 Muttenz
Lecturers	Arndt Arns
Entry requirements	Bachelor level in Process Technology, Chemical Engineering, Environmental Technology, Pharma Technology, Biotechnology, Food Processing
Learning outcomes and competences	Students learn the basics and rationales which are required to develop and design new processes or to improve existing ones in such leading industries like chemistry, (bio-)pharmatechnology and consumer health care. They will know key technologies and their use and co-assembly for process development and optimization under economical, ecological, social and regulatory affairs. Case studies and group work support the students learning and will be supplemented by oral presentations rounds incorporating also the basics for technology marketing and sales. After completing the module, students will be able to… • Describe and quantify technical processes • Design processes under specific conditions like environmental and energy requirements, food print, innovative and robust technologies etc. • Solve mass- and energy balances • apply batch, semi-batch and continuous processes on demand • Apply best-suited in- and online process measurement and control • Have an overview about Process parameters and technologies in harmonization with current regulation affairs • Present their concept study to an expert group (pitch @“Board meeting”)
Module contents	*Separation principles / Rationales and Process Design (36 lessons)* • Using Physical and chemical Data for the general process Design: from Data sheet to Process Sheet and from Design of experiment to excellent design • Mass and energy balances: generation of complete balances from educt to final product and transfer into unit operation design (dimensions, foot-print) • Impact on operational mode on separation effort: (semi-)batch vs. continuous operation (concentration profile, time-depended quality of product etc.) • Time & Motion Studies: Combination of unit operations step-by-step and its optimization • Hand-shakes between unit operations: definition the interfaces (process parameter settings) • Cost estimation / TCO • Regulatory affairs - Room requirements: Ex- and protection Zone definition (Clean room classes, Containment) *Process Control and Automation (6 lessons)* • (Inline-)Measurement Technologies (principles and devices), combination of signals for the generation of a better process understanding (density, refractometric index, (partial) gas pressure, mass-flow etc.) • Software tools for process control and regulation • IOT: Using internet of things for preventive maintenance
Teaching /	Lecture incl. exercises and practical work

learning methods	
Format	3 lessons per week, whole semester
Assessment of learning outcome	• Final module examination (50%) • Project presentation during semester (50%)
Bibliography	• Ullmann's Encyclopedia of Industrial Chemistry, 6th edition,, Wiley-VCH, Weinheim 2002 • Green, D.; Perry,R.; Perry's Chemical Engineers' Handbook, 8th ed., McGraw-Hill, New York 2007 • Himmelblau, D.M., Riggs, J.B.; Basic Principles and Calculations in Chemical Engineering, 8th ed., Prentice-Hall, Upper Saddle River, 2012 • Shuler, M.L., Kargi, F.; Bioprocess Engineering (Basic Concepts), Prentice Hall PTR, 2002
Link to other modules	Chemical Engineering, Material Recovery, Continuous Pharma Production, Cost Effectiveness of Sustainable Production and Risk Reduction in Industries, Pharmaceutical Production Facilities
Comments	
Last update	November 16, 2021

Module title	**Sustainable Process Development**
Code	M-SLS-MSc 0085
Degree program	Master of Science in Life Sciences
Workload	3 ECTS (90 student working hours: 42 lessons contact = 32 h; 58 h self-study)
Module coordinator	**Name** Andreas Zogg **Phone** 061-228 58 25 **Email** andreas.zogg@fhnw.ch **Address** FHNW, HLS, Hofackerstrasse 30, 4132 Muttenz
Lecturers	Dirk Hengevoss
Entry requirements	Bachelor level in thermodynamics Bachelor level in either life cycle assessment or process simulation
Learning outcomes and competences	After completing the module, students will be able to… • Generate a mass and energy balance for a given process with CHEMCAD • Carry out a life cycle based on a CHEMCAD model with SimaPro • Carry out a cost estimation based on a CHEMCAD model.
Module contents	During the first weeks the students will have to suggest and present a process (e.g. Power to X, renewable fuels, etc.) for their case-study. During the following lectures the students will learn how to assess their process using tools of process simulation and life cycle assessment. In parallel to the lectures, the students get time to work on their case-studies. *Process Simulation (Andreas Zogg, 18 lessons,)* • Block diagrams & process flow diagrams (PFD). • Mass and energy balances using Excel and CHEMCAD. • Introduction into process simulation with CHEMCAD based on the absorption of CO_2. • Introduction into sizing of an equipment using Matlab and Excel. *Life Cycle Assessment (Dirk Hengevoss, 21 lessons)* • For each process alternative, a life cycle assessment is carried out using the software SimaPro. Basis: Mass and energy balances from the CHEMCAD simulation. *Cost estimation (Andreas Zogg, 3 lessons)* • Introduction into CAPEX estimation and calculation of total production costs.
Teaching / learning methods	Lecture and practical exercises to evaluate process alternatives for the specific case study.
Format	3 lessons per week, whole semester
Assessment of learning outcome	• Entry exam on first module day, individual (20%) • Presentation on intermediate results of 20 minutes during the lecture, groups of 2 (40%) • Paper on a self-chosen process, individual, to be submitted 2 weeks after module end (40%)
Bibliography	
Link to other modules	Reaction Technology (M-SLS-MSc 0090) Process Technology and Development (M-SLS-MSc 0080) Materials recovery technologies Industrial Chemical Process Safety (M-SLS-MSc C6)
Comments	

Last update	April 30, 2023

Module title	**Process Transfer and Scale-up**
Code	M-SLS-MSc 0086
Degree program	Master of Science in Life Sciences
Workload	3 ECTS (90 student working hours: 42 lessons contact = 32 h; 58 h self-study)
Module coordinator	**Name** Wolfgang Riedl **Phone** 061-228 5551 **Email** wolfgang.riedl@fhnw.ch **Address** FHNW, HLS, Hofackerstrasse 30, 4132 Muttenz
Lecturers	
Entry requirements	Bachelor level in Thermodynamics, Heat-Transport and Process modelling Sustainable Process Development
Learning outcomes and competences	After completing the module, students will be able to: • Transfer processes from fundamental research level towards piloting and production level • Scale-up and optimize processes in a sustainable matter (meet ecological economic and social aspects)
Module contents	*Tech-transfer rationals (12 lessons)* • Sound process understanding and description via mass- and energy bilances and key-performance indicators • Determination of boundary layers and environmental analysis • Review of design of experiment (DOE) for scale-up • Incorporation of and match with (intended) production philosophy • Plausibility check / open-item disclosure *Case study with experimental part (24 lessons)* • Short track Tech-transfer and scale-up and with reduced-to-the-minimum effort will be trained by a case-study with experimental part (group work) *Reporting and presentation (6 lessons)* • Generation of a concept study / process review and oral presentation
Teaching / learning methods	Lecture and practical exercises to evaluate process alternatives
Format	Block lecture with practical aspects
Assessment of learning outcome	• Presentation on Case study / concept study results, groups of 2-3 (50%) • Final examination (50%)
Bibliography	Process Technology – an Introduction (A.B. de Haan, De Gruyter) Practical Process Research and Development (N. Anderson, Elsevier / AP)
Link to other modules	
Comments	
Last update	November 29, 2021

ENVIRONMENTAL TECHNOLOGIES

Module title	**Costs and Benefits of Sustainable Production**
Code	M-SLS-MSC 0161
Degree program	Master of Science in Life Sciences
Workload	3 ECTS (90 student working hours: 42 lessons contact = 32 h; 58 h self-study)
Module coordinator	**Name** Christoph Hugi **Phone** +41 61 228 55 84 **Email** christoph.hugi@fhnw.ch **Address** FHNW, HLS, Hofackerstrasse 30, 4132 Muttenz
Lecturers	Dirk Hengevoss, Guest speakers from industry
Entry requirements	Basic understanding of environmental technologies and industrial process cycles including basic knowledge about water resources management
Learning outcomes and competences	After completing the module, students will be able to… • to understand concepts to estimate financial and non-financial costs and benefits of sustainable production and risk reduction measures. • to apply net present value (NPV), cost-effectiveness (CEA) and cost-benefit (CBA) analysis in decision support for environmental protection, risk reduction and fostering resilience. • to calculate, create and discuss graphs of effect-cost-efficiency, efficiency frontiers and pareto-optimality of improvement options.
Module contents	*Introduction and financial and non-financial cost and benefit concepts (Christoph Hugi, Dirk Hengevoss, 12 lessons)* • Introduction to sustainable production and risk reduction in industries • Decision making concepts for environmental protection measures especially Net Present Value (NPV), Cost-Effectiveness Analysis (CEA), Cost-Benefit-Analysis (CBA), and Multi Criteria Analysis (MCA) *Application of concepts to sustainable production, prevention, and circular economy measures (Christoph Hugi, Dirk Hengevoss, 18 lessons)* • Estimating costs of air and water protection measures • Estimating effects and benefits of air and water protection measures • Costs and benefits of circular economy measures to treat relevant and emerging waste streams • Costs and benefits of risk reduction and resilience measures *Sustainable production and resource recovery case studies (Dirk Hengevoss, Christoph Hugi, 12 lessons)* • Calculation and presentation of effect-cost-efficiency, efficiency frontiers and pareto-optimality for measures (tools and exercises) • Group work on industrial examples
Teaching / learning methods	Lecture, literature seminar, practical exercises, group work, and presentations
Format	3 lessons per week, whole semester
Assessment of learning outcome	• Writing assignment and case study presentation (50%) • Final examination (50%)
Bibliography	• The Green Book - Central Government Guidance on Appraisal and Evaluation; https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/685903/The_Green_Book.pdf

	• Sigma - natural catastrophes and man-made disasters sigma 1/2018: Natural catastrophes and man-made disasters in 2017: year of record-breaking losses | Swiss Re • EU Best Available Techniques Reference documents (BREFs) http://eippcb.jrc.ec.europa.eu/reference/ • OECD (2019), Good Governance for Critical Infrastructure Resilience, OECD Reviews of Risk Management Policies, OECD Publishing, Paris. https://www.oecd.org/governance/good-governance-for-critical-infrastructure-resilience-02f0e5a0-en.htm
Link to other modules	• Valorization of Biomass Waste and Side Streams (M-SLS-MSc 0205) • Process Technology for Industrial Pollution Control (M-SLS-MSc 0181) • Solid Waste Management (M-SLS-MSc 0206) • Water and Wastewater Treatment (M-SLS-MSC 0190)
Comments	-
Last update	May 16, 2023

Module title	**Process Technology for Industrial Pollution Control**
Code	M-SLS-MSC 0181
Degree program	Master of Science in Life Sciences
Workload	3 ECTS (90 student working hours: 42 lessons contact = 32 h; 58 h self-study)
Module coordinator	**Name** Michael Thomann **Phone** 061-228 53 34 **Email** michael.thomann@fhnw.ch **Address** FHNW, HLS, Hofackerstrasse 30, 4132 Muttenz
Lecturers	NN
Entry requirements	Bachelor level of chemical, environmental or mechanical engineering, food/pharma technology
Learning outcomes and competences	After completing the module students will be able: • to understand major technologies applied for industrial pollution control in the field of sustainable production • to solve environmental process engineering tasks in the field of industrial water pollution control • to identify and propose options for pollution prevention and resource recovery in industries based on objectives and assessments for decision makers.
Module contents	*Industrial environmental technologies (Michael Thomann, 42 lessons)* • Basic principles and requirements for industrial pollution control • Air: emission reduction measures, off-gas treatment processes • Water: industrial water use, reuse and emission control • Industrial water treatment technologies: Heavy metal removal, ion-exchange processes, membrane processes for industrial pollution control, disinfection processes, oxidation processes, activated carbon adsorption processes for industrial applications • Resource efficiency measures in industry
Teaching / learning methods	Lectures, home exercises, tutorials, self-study and assessment based on books and papers
Format	3 lessons per week, whole semester
Assessment of learning outcome	• Final written examination (100%)
Bibliography	Course material: • EU Best Available Techniques reference documents (BREFs) http://eippcb.jrc.ec.europa.eu/reference/ • MWH: Water treatment – principles and design 3rd edition (2012), ISBN 978-0-470-40539-0 • Original literature and review papers
Link to other modules	Material recovery from inorganic waste streams is covered in “Solid Waste management”. (M-SLS-MSc 0206) Material recovery from biological waste streams is covered in “Valorization of Biomass and Side Streams”. (M-SLS-MSc 0205) Circular economy and sustainable production are covered in “Costs and Benefits of Sustainable Production”. (M-SLS-MSc 0161)
Comments	
Last update	November 22, 2021

Module title	**Valorization of Biomass Waste and Side Streams**
Code	M-SLS-MSC 0205
Degree program	Master of Science in Life Sciences
Workload	3 ECTS (90 student working hours: 42 lessons contact = 32 h; 58 h self-study)
Module coordinator	**Name** Luca Loreggian **Phone** 061-228 55 68 **Email** luca.loreggian@fhnw.ch **Address** FHNW, HLS, Hofackerstrasse 30, 4132 Muttenz
Lecturers	Philippe Corvini, Wolfgang Riedl, invited lecturers
Entry requirements	Bachelor level of chemical, environmental or mechanical engineering, food/pharma technology
Learning outcomes and competences	After completing the module students will be able: • understand principles in the field of resource recovery towards sustainable production and circular economy. • understand the major technologies applied in the field of resource recovery from wastewater and other sidestreams
Module contents	*Introduction (Luca Loreggian; 3 lessons)* • General introduction to wastewater (generation, composition, and potential value in wastewater) and circular economy *Nutrients recovery and water reuse (Luca Loreggian; 12 lessons)* • Nitrogen and phosphorus in wastewater, their cycles, and recovery technologies • Water reuse (water scarcity, and the role of water reuse), types of water reuse (treatment requirements, and advance treatment technologies) *Separation and conversion technologies (Philippe Corvini, Wolfgang Riedl; 12 lessons)* • Pre-treatment of biological product streams (mechanical and thermal treatment) • Conversion technologies (enzymatic/whole cell processes, homogeneous/heterogeneous catalysis) • Mid-& downstream processing (capturing and polishing: filtration/centrifugation, extraction, chromatography, diafiltration, crystallization, drying) *Recovery examples (Philippe Corvini, Wolfgang Riedl, Luca Loreggian, invited lecturers; 15 lessons)* • lignin, heavy metals, solvents, algae/agro-waste • nitrogen, phosphorus, and water reuse
Teaching / learning methods	Lectures, home-exercises, self-study and assessment based on books and papers, site-visits, student group work
Format	3 lessons per week, whole semester
Assessment of learning outcome	• Student presentation of a case study (20%) • Module exam, individual (80%)
Bibliography	Entry level: • MWH: Water treatment – principles and design ISBN 978-0-470-40539-0 • Resource recovery from water - principles and application, IWA publishing • D.W. Green & R.Perry (2008) “Perry´s Chemical Engineers Handbook”,8th Edition, McGraw-Hill • K. Schwister & V Leven (2014) “Verfahrenstechnik für Ingenieure” 2nd Edition, Hanser Verlag

	Course material • The European Green Deal- Communication from the commission to the European parliament, the European council, the council, the European committee, and the committee of the regions (2019) available at EUR-Lex. • World Economic Forum (2014) “Towards the Circular Economy: Accelerating the scale-up across global supply chains”, WEF, Geneva, CH • Scriptum • Original literature and review papers
Link to other modules	Material recovery from inorganic waste streams is covered in “Solid Waste management”. (M-SLS-MSc 0206) Sustainable production is covered in “Costs and Benefits of Sustainable Production”. (M-SLS-MSc 0161) Specific environmental treatment technologies (e.g., membrane treatment, ion-exchange) are covered in “Process Technology for Industrial Pollution Control”. (M-SLS-MSc 0181)
Comments	-
Last update	June 1, 2023

Module title	**Water and Wastewater Treatment**
Code	M-SLS-MSC 0190
Degree program	Master of Science in Life Sciences
Workload	3 ECTS (90 student working hours: 42 lessons contact = 32 h; 58 h self-study)
Module coordinator	**Name** Michael Thomann **Phone** 061-228 53 34 **Email** michael.thomann@fhnw.ch **Address** FHNW, HLS, Hofackerstrasse 30, 4132 Muttenz
Lecturers	Michael Thomann, Rita Hochstrat, Luca Loreggian
Entry requirements	Basic understanding of environmental technologies and the water cycle including basic knowledge about water supply and wastewater treatment.
Learning outcomes and competences	After completing the module students will be able: • to understand the basic treatment technologies applied in the different phases of the water cycle • to solve environmental process engineering tasks in the field of drinking water treatment and wastewater treatment • to perform simple lab tests for water and wastewater treatment
Module contents	*Introduction and basic principles (Michael Thomann, Luca Loreggian, Rita Hochstrat, 12 lessons)* • Basic principles of water and wastewater treatment • Major water quality parameters, drinking water, wastewater disposal • Regulatory requirements • Basic principles of water chemistry • Basic principles of wastewater and drinking water microbiology *Water and wastewater treatment processes (Michael Thomann, 21 lessons)* • Wastewater process engineering (biological carbon, nitrogen and phosphorus removal processes, sedimentation, anaerobic digestion) • Activated carbon adsorption (powdered activated carbon processes, filtration with granular activated carbon) • Process trains for organic micropollutant removal in wastewater treatment plants *Lab experiments (Michael Thomann, 9 lessons)* • Wastewater treatment processes • Activated carbon adsorption
Teaching / learning methods	Lectures, home exercises, tutorials, self-study and assessment based on books and papers
Format	3 lessons per week, whole semester
Assessment of learning outcome	Final written examination (100%)
Bibliography	Course material: • Wastewater engineering, treatment and reuse 5th edition (2013), ISBN 978-0-07-340118-8 • MWH: Water treatment – principles and design 3rd edition (2012), ISBN 978-0-470-40539-0 • Original literature and review papers
Link to other modules	Linked to the lecture “Process technology for industrial pollution control”
Comments	

Last update	November 22, 2021

Module title	**Environmental Risk Assessment**
Code	M-SLS-MSC 0200
Degree program	Master of Science in Life Sciences
Workload	3 ECTS (90 student working hours: 42 lessons contact = 32 h; 58 h self-study)
Module coordinator	**Name** Miriam Langer **Phone** 061-228 58 83 **Email** miriam.langer@fhnw.ch **Address** FHNW, HLS, Hofackerstrasse 30, 4132 Muttenz
Lecturers	Miriam Langer, Markus Zennegg, Philippe Corvini, Johannes Ranke, Lothar Aicher, Marion Junghans, Verena Christen
Entry requirements	Bachelor level of environmental life sciences, toxicology and physiology
Learning outcomes and competences	After completing the module, students will be able to… • describe relevant environmental pollutants, the sampling and analysis of environmental samples, • explain the fate of pollutants in water, wastewater, soil, sediment and air, • describe how effects are determined in Ecotoxicology with *in vivo* and *in vitro bioassays* • Understand the (Eco)toxicology and health aspects of environmental chemicals and to delineate mechanisms of toxicity, • apply the concept of risk assessment • apply different approaches for mixture toxicity concepts • analyze the challenges in risk communication
Module contents	*Environmental Chemistry 1 (Markus Zennegg, 9 lessons)* • overview of anthropogenic organic environmental pollutants • Principles of environmental sampling in water, sediment and soil • In-depth cases with PCBs, dioxins, PFCs *Fate (Philippe Corvini, 6 lessons)* • General aspects on the fate of micropollutants • Fate key processes: volatilisation, sorption, partitioning, Log Kow, Interactions of micropollutants with the matrices, transformation processes, bioavailability, metabolism by microorganisms) *Fate exercise (Johannes Ranke, 3 lessons)* • Kinetic evaluation of chemical degradation data: Theory and exercises *Effects and Risk Assessment (Miriam Langer, Verena Christen 18 lessons)* • Levels and mechanisms of effects: How to detect effects • Possibilities and limitations of *in vivo* and *in vitro* bioassays • Introduction to toxikokinetic and toxikodynamics • Basic principles of risk assessment • Why to trust data: OECD Guidelines, GLP and Technical guidance documents in risk assessment • Different approaches in prospective and retrospective risk assessment: methods and challenges • REACH • Transcriptomics in honey-bees • Cancerogenesis, Endocrine disruption, Mutagenicity • Toxicity of nanoparticles *Mixtures and Risk Communication (Marion Junghans, Lothar Aicher, 6 lessons)* • Mixture concepts • Risk perception and communication

	• Case study: evaluation of pesticide mixtures risks
Teaching / learning methods	lecture, student presentations, group work, case studies
Format	3 lessons per week, whole semester
Assessment of learning outcome	• Student presentations, groups of 2 (20 %) • Closed book examination at the end of the semester (80 %)
Bibliography	*Lecture scripts* *Environmental toxicology, an open online textbook* https://www.merlot.org/merlot/viewMaterial.htm?id=501319930
Link to other modules	Bioassays, Water and Wastewater Treatment Technologies, Environmental Bioremediation, Environmental Remediation
Comments	
Last update	May 16, 2023

Module title	**Remediation**
Code	M-SLS-MSc 0221
Degree program	Master of Science in Life Sciences
Workload	3 ECTS (90 student working hours: 42 lessons contact = 32 h; 58 h self-study)
Module coordinator	**Name** Markus Lenz **Phone** 0612 285 686 **Email** markus.lenz@fhnw.ch **Address** FHNW, HLS, Hofackerstrasse 30, 4132 Muttenz
Lecturers	Boris Kolvenbach
Entry requirements	Bachelor level of environmental sciences / engineering
Learning outcomes and competences	After completing the module, students will be able to: • Comprehend the legal framework of contaminated site management and remediation • Understand biogeochemical processes that determine contaminant fate • Understand chemical properties that determine contaminant fate • Select appropriate physical / chemical remediation strategies • Understand principles and bottlenecks of advanced and emerging technologies
Module contents	*Management of contaminated sites (Markus Lenz; 3 lessons)* • Main relevant regulatory frameworks (EPA, CSO, OIS, …) • Procedure of contaminated site management *Biogeochemical basics of remediation (Markus Lenz, Boris Kolvenbach; 12 lessons)* • Types / sources of major contaminants (organic, inorganic) • Important chemical properties in remediation (solubility, vapor pressure, (bio)degradability, …) • Transport / sequestration processes (sorption, precipitation, transport by colloids, …) • Thermodynamic modelling of contaminated sites *Remediation technologies (Markus Lenz, Boris Kolvenbach; 21 lessons)* • Physical remediation technologies (sparging, venting, vacuum-enhanced recovery, thermal desorption, vitrification, …) • Chemical remediation technologies (injection based remedies, permeable reactive walls, …) • Bioremediation technologies (natural monitored attenuation, biostimulation, bioaugmentation) *Practical exercise (Markus Lenz, 6 lessons)* • Themodynamic equilibrium modelling in remediation
Teaching / learning methods	Lecture and practical exercise
Format	3 lessons per week, whole semester
Assessment of learning outcome	• Questions during the practical exercise (20 %) • Closed book examination at the end of the semester (80 %)
Bibliography	Entry level • Jones and Atkins (2000) Chemistry: Molecules, Matter and Change 4th Edition. Chapters 1, 2, 11, 16.

	Course materials • Suthersan et al. (2016). Remediation Engineering: Design Concepts, 2nd Edition, CRC press.
Link to other modules	Preventive technologies (treatment of landfill leachates, flue gas, industrial wastewaters…) is covered in “Process Technology for Industrial Pollution Control”. (M-SLS-MSc 0181) Management and treatment of solid wastes in general are covered in the module “Solid Waste Management”. (M-SLS-MSc 0206)
Comments	The date of the practical exercise will be announced at the beginning of the lecture.
Last update	May 21st, 2021

Module title	**Solid Waste Management**
Code	M-SLS-MSC 0206
Degree program	Master of Science in Life Sciences
Workload	3 ECTS (90 student working hours: 42 lessons contact = 32 h; 58 h self-study)
Module coordinator	**Name** Markus Lenz **Phone** 0612 285 686 **Email** markus.lenz@fhnw.ch **Address** FHNW, HLS, Hofackerstrasse 30, 4132 Muttenz
Lecturers	Michael Thomann
Entry requirements	Bachelor level of environmental sciences / engineering
Learning outcomes and competences	After completing the module, students will be able to… • Understand the basic principles of solid waste management and circular economy (generation, collection, sorting, processing and disposal) • Understand drivers and incentives for solid waste management • Understand the impact of modern solid waste management for climate protection and supply security
Module contents	*Introduction to solid waste management (Markus Lenz, 12 lessons)* • Classification of solid wastes (e.g. excavation / quarry waste, demolition waste, municipal waste, hazardous wastes,…) • Waste quantities and waste composition • Organisation of the Swiss waste system • Recycling of major waste classes (e.g. paper+cardboard, drinking bottles, tyres, aluminum cans, batteries) • Role of waste management in the circular economy • Circularity of the Swiss waste system (status, indicators, potential for improvements) • Solid waste recycling for supply of critical raw materials *Environmental Laws and Regulatory Drivers (Markus Lenz, 6 lessons)* • National regulation (e.g. Environmental Protection Act EPA, Waste Ordinance ADWO, Ordinance on Movements of Waste OMW,…) • Legal bases on EU and international level *Process technology of solid waste management (Michael Thomann, Markus Lenz, 21 lessons)* • Physical treatment (sorting, shredding, …) • Thermal treatment processes (incl. pyrometallurgy and waste-to-energy) • Hydrometallurgical treatment processes (leaching, solvent extraction, ion exchange, precipitation, advanced membrane filtration, electrowinning) • Waste management technologies for household waste, construction waste, paper and cardboard, plastics, ……. *Case study from metal recovery in Switzerland (external expert, 3 lessons)*
Teaching / learning methods	Lecture
Format	3 lessons per week, whole semester
Assessment of learning outcome	• Closed book examination at the end of the semester (100%)
Bibliography	• Handbook of Solid Waste Management (McGraw-Hill Handbooks), ISBN 978-0071356237. Recovery of Materials and Energy from Urban Wastes (Springer), ISBN: 978-1-4939-7849-6.

Link to other modules	Material recovery from biological waste streams is covered in “Valorization of Biomass and Side Streams”. (M-SLS-MSc 0205) Contaminated sites are covered in “Remediation”. (M-SLS-MSc 0221) Side stream treatment (e.g. landfill leachates, flue gas treatment) is covered in “Process Technology for Industrial Pollution Control”. (M-SLS MSc 0181)
Comments	The date of the practical exercise will be announced at the beginning of the lecture.
Last update	May 2, 2023

ORGANIC AND SUPRAMOLECULAR CHEMISTRY

Module title	**Bio-interfaces and Bio-conjugate Chemistry**
Code	M-SLS-MSc 0051
Degree program	Master of Science in Life Sciences
Workload	3 ECTS (90 student working hours: 42 lessons contact = 32 h; 58 h self-study)
Module coordinator	**Name** Patrick Shahgaldian **Phone** 061-228-54-87 **Email** patrick.shahgaldian@fhnw.ch **Address** FHNW, HLS, Hofackerstrasse 30, 4132 Muttenz
Lecturers	Oya Tagit
Entry requirements	Scientific background in chemistry, biochemistry and analytical chemistry.
Learning outcomes and competences	After completing the module, students will be able to… • Express advanced concepts in surface chemistry • Express concepts of molecular adsorption on surfaces • Explain different state-of-the-art biosensing, bioimaging, and drug delivery methods and technologies • Understand the main parameters to be integrated to design bioactive surfaces (biocatalytic, biomolecular recognition). • Explain the main bioconjugation methods (incl. antibody-drug conjugate production) • Give an overview of the applications of microfluidics in the context of life sciences (e.g., organ-on-a-chip) • Understand techniques for surface modification and structuring. • Understand advanced materials (incl. their biocompatibility and design) used in medicinal and pharmaceutical technologies. • Understand the selection criteria of advanced materials for specific applications considering their chemical, mechanical and biological behaviour
Module contents	*Core concepts of surface chemistry and structuring (Patrick Shahgaldian, Oya Tagit,, 14 lessons)* • General concepts - Interfaces of biomaterials: wettability, surface tension, surface energy, roughness, hydrophobicity. Biomacromolecules: Proteins, carbohydrates, nucleic acids; intermolecular forces and self-assembly • Chemical surface modification - Surface cleaning, physisorption, chemisorption (self-assembled monolayers on gold surfaces, modification of oxides, sol-gel chemistry, layer by layer coating) • Surface structuring in the context of life sciences (advanced photolithographic methods, scanning beam lithography, soft lithography, PVD/CVD, plasma spraying, anodization, alkali treatment, hydrophilization, pegylation) • Organ-on-a-chip - Chip design, advanced microfluidic systems, relevant examples of chip organs *Bioconjugate Chemistry (Patrick Shahgaldian, 14 lessons)* • Protein bioconjugation - Protein labelling and functionalization, antibody-drug conjugates design (chemical, biocatalytic) • Surface bioconjugation - General structural and functional features of biomolecules in the context of bioconjugation (protein 3D structure, DNA hybridization), chemical strategies to attach biomolecules on surfaces incl. cross coupling mechanisms, bioconjugation on nanoparticles • Molecular recognition at interfaces: Biosensing - Methods (e.g., surface plasmon resonance, quartz crystal microbalance), methodology

	(experimental design, data analysis, multiplexing), DNA microarray (concept, chemistry and data analysis) • Biocatalytic surfaces- Design and industrial applications. *Interface between synthetic materials and biological systems (Oya Tagit, 14 lessons)* • Biomaterials, biocompatibility and bio-interfaces, importance of surface (bio)chemistry and surface topography • Surface engineering towards superhydrophobicity, hydrophilicity, adhesion, and biocompatibility • Mechanical surface modifications, mechanical patterning and probing of surfaces (bioAFM) • Biointerfacing systems in drug delivery and imaging
Teaching / learning methods	Lecture, Seminar, student presentation and case studies (literature review on selected topic) Lecture and blended learning: Contact lessons • Lectures, Q&A-sessions • Group exercises • Individual project studies • Demonstrations Self-study • Learning videos • Individual Project Studies • Interactive simulations Literature review on a lecture-relevant topic
Format	3 lessons per week, whole semester
Assessment of learning outcome	• Written assessment (60 %) • Presentation on a selected research manuscript of 15 minutes on last day, groups of 3 (20%) • Individual written mini-review (2 pages), with the possibility to receive a written feedback on a first draft, to be submitted 2 weeks after module end (20%)
Bibliography	Preparation: • Supramolecular Chemistry, From Concepts to Applications. Kubik, S.; de Gruyter Publishing, 2020 [Chap. 3. Understanding molecular interactions]. • Fundamental of Protein Structure and Function, 2nd Edition, Buxbaum, E.; Springer, 2015. Course material: • *Bioconjugate Techniques*, 3rd Edition, Hermanson, G. T.; Academic Press, Cambridge, 2013. • Buddy D. Ratner, Allan S. Hoffman, Frederick J. Schoen and Jack E. Lemons, *Biomaterials Science. An Introduction to Materials in Medicine: An Introduction to Materials in Medicine,* 2004. Interactive simulations (https://phet.colorado.edu/en/simulations/category/new)
Link to other modules	Material Sciences (M-SLS-MSc C1) Surface Characterisation ((M-SLS-MSc C2)
Comments	none
Last update	July 18, 2023

Module title	**Advanced Organic Chemistry**
Code	M-SLS-MSC 0061
Degree program	Master of Science in Life Sciences
Workload	3 ECTS (90 student working hours: 42 lessons contact = 32 h; 58 h self-study)
Module coordinator	**Name** Daniel Varón Silva **Phone** 061-2285173 **Email** daniel.varon@fhnw.ch **Address** FHNW, HLS, Hofackerstrasse 30, 4132 Muttenz
Lecturers	Sebastian Wendeborn, Raphael Dumeunier
Entry requirements	Bachelor level of organic chemistry Basics in Organic Chemistry according to P. Vollhardt, N. Schore, Neil, Springer, 2018, ISBN/GTIN978-1-319-18771-2, or Klein's Organic Chemistry, 3rd Edition, Global Edition, David R. Klein, ISBN: 978-1-119-45105-1; 2018
Learning outcomes and competences	After completing the module, students will be able to: • Analyze and understand the structure of organic molecules based on conformational and electronic effects. • Predict stereoselectivity in Aldol condensation reactions and other C-C bond forming reactions. • Understand and apply synthetic transformations to efficiently build molecular complexity • Understand the chemistry of important large scale industrial processes • Understand the strategies in natural product synthesis • Understand and apply the concepts of chemical optimization of hits and leads to increase target specific biological activity • Propose chemical synthetic approaches to complex organic molecules
Module contents	*Molecular structure (Sebastian Wendeborn, 6 lessons)* • Principles of structure and electronic effects in organic chemistry • Advanced stereoelectronic effects applied to conformational analysis – examples: fluorination and hydroxylation of proline, substituent effects in acyclic and cyclic sulfonamides and amides, ring-strain in medium-sized rings *Chemical methodology (Daniel Varón Silva, Sebastian Wendeborn, 18 lessons)* • Enantioselective C-C bond forming reactions (including Modern Aldol-chemistry) • Pericyclic reactions, [2+2]-, [2+3]- and [2+4]-cycloadditions, sigmatropic rearrangements (Claisen, Cope, Ireland, and others) • Multicomponent reactions (Ugi, Passerini, Strecker, Hantzsch,..) • Ring closing reactions for the synthesis of macrocycles *Industrial applications & case studies (Sebastian Wendeborn, Raphael Dumeunier, 15 lessons)* • Case studies of industrial large-scale synthesis of selected chemicals, chemical feedstock (ethylene, propylene, xylenes, vinyl chloride monomer (VCM), styrene, butadiene, and ethylene oxide, and polymerization reactions, synthesis of solvents (CH2Cl2, CHCl3, THF, MeTHF, dioxane, ethylene glycol, cyclohexane) • Case study of a natural product synthesis • Case studies of design and synthesis of pharmaceutical molecules • Large scale synthesis and properties of Vitamins (Vit-E and -C) *Presentation by students (Daniel Varón Silva, Sebastian Wendeborn, 3 lessons)* • Presentation (propose a synthesis for a medium complex natural product)

Teaching / learning methods	Lecture, seminars, case studies, and presentations
Format	3 lessons per week, whole semester
Assessment of learning outcome	• Presentation on natural product synthesis (20%) • Module exam, individual (80%)
Bibliography	*Recommended references to attain entry level*: • Organic Chemistry according to P. Vollhardt, N. Schore, Neil, Springer, 2018, ISBN/GTIN978-1-319-18771-2 (Chapters 1-23) • Klein's Organic Chemistry, 3rd Edition, Global Edition, David R. Klein, ISBN: 978-1-119-45105-1; 2018. *Material for further reading and content of the lectures:* • Organic Chemistry, J. Clayden, N. Greeves, S. Warren, 2nd Edition, Oxford University Press, 2012, ISBN: 9780199270293 • Advance Organic Chemistry, F.A. Carey, R.J. Sundberg, 5th Edition, Parts A and B, Springer, ISBN: 9780387683546 • Modern Aldol Reactions, R. Mahrwald, Wiley-VCH Verlag, 2004, ISBN:9783527307142, DOI:10.1002/9783527619566 • Stereoelectronic effects, A.J. Kirby, Oxford University Press, 1996, ISBN: 9780198558934
Link to other modules	It is recommended to complete this module (Advanced and Applied Organic Chemistry) before participating in the module Modern Technologies in Organic Synthesis.
Comments	
Last update	November 3, 2021

Module title	**Modern Technologies in Organic Synthesis**
Code	M-SLS-MSc 0065
Degree program	Master of Science in Life Sciences
Workload	3 ECTS (90 student working hours: 42 lessons contact = 32 h; 58 h self-study)
Module coordinator	**Name** Sebastian Wendeborn **Phone** 061-228 5545 **Email** sebastian.wendeborn@fhnw.ch **Address** FHNW, HLS, Hofackerstrasse 30, 4132 Muttenz
Lecturers	Daniel Varón Silva, Claudio Battilocchio
Entry requirements	Bachelor level of organic chemistry Basics in Organic Chemistry according to P. Vollhardt, N. Schore, Neil, Springer, 2018, ISBN/GTIN978-1-319-18771-2, or Klein's Organic Chemistry, 3rd Edition, Global Edition, David R. Klein, ISBN: 978-1-119-45105-1; 2018
Learning outcomes and competences	After completing the module, students will be able to: • Explain the basic concepts of electrochemistry and electrosynthesis and give examples of electrochemical reactions in organic synthesis. • Explain the concepts of photochemistry and photocatalysis for the synthesis of organic molecules. • Understand the concepts, techniques, parameters, and requirements for the synthesis of organic molecules in continue flow systems. • Understand and communicate the main concepts of reactivity involved in organocatalyzed reactions. • Give an overview of several different modern experimental techniques in organic chemistry and how to apply them in the synthesis of complex organic structures and macromolecules. • Give an overview of several different systems for the chemical synthesis of macromolecules using automated processes (synthesis of DNA, Peptides, Carbohydrates).
Module contents	*Photochemistry (Sebastian Wendeborn, 10 lessons)* • Concepts and basic principles in photochemistry and photocatalysis (absorption, fluorescence, singlet- and triplet state). Description and concepts in some important photoreactions and synthetic applications (Norrish-Yang, Paternó-Büchi, [2+2]-Cycloadditionen, etc). *Electrochemistry (Daniel Varon Silva, 10 lessons)* • Principles of electrochemistry. Examples of construction of electric cells, basic electrochemical organic reactions, concepts of electrochemistry in protecting groups, redox reactions. Advanced applications (mediated electrosynthesis, electroenzymatic reactions, etc.). Industrial and combinatorial electrosynthesis *Synthesis in Flow Systems (Claudio Battilocchio, 7 lessons)* • Theory and practical fundaments of reactions in continuous flow synthesis. Examples of catalytic reactions in flow, conversion of natural vegetable oil into biodiesel. Combination of experimental techniques in flow, including purification by extraction, evaporation, acid-base extraction, an in-line analysis. *Organocatalysis and Biocatalysis (Sebastian Wendeborn, 8 lessons)* • Principles of organocatalysis. Type of activation in organocatalyzed reactions, including asymmetric reactions. Examples of modern covalent and non-covalent organocatalysis (Iminium-, enamine-, SOMO-, Photoredox-, and carbenecatalysis, H-bonding and phasentransfer catalysis)

	• Overview of biocatalysts and the use of enzymes in kinetic resolution. Examples from the Industry and research, kinetic microbial reactions, bioreaction techniques, identification of kinetic, and concepts for reactions optimization *Automated and Solid Phase Synthesis (Daniel Varon Silva, 4 lessons)* • Principles in solid phase synthesis of macromolecules and complex molecules (building blocks, resins, linkers, coupling reactions, cleavage reagents).
Teaching / learning methods	lecture, literature seminar and practical exercise
Format	3 lessons per week, whole semester
Assessment of learning outcome	• Presentation of a case study of 15 minutes, (20%) • Module exam, individual (80%)
Bibliography	• Modern Molecular Photochemistry of Organic Molecules, Nicholas J. Turro et al, University Science Books, Sausalito, California, 2010, ISBN 978-1-891389-25-2 • Biocatalysis – Biochemical Fundamentals and Applications, Peter Grunwal, World Scientific, 2018, ISBN 978-1-783-269082 • Biocatalysis in Organic Synthesis – The Retrosynthesis Approach, Nicholas J. Turner & Luke Humphreys, Royal Society of Chemistry, 2018, ISBN 978-1-78262-530-8 • Continuous-Flow Chemistry in the Research Laboratory, Toma Glasnov, Springer, Switzerland 2016, ISBN 978-3-319-32194-3 • Electrochemistry- The Basics with examples, Christine Lefrou, Pierre Fabry and Jean-Claude Poignet, Springer-Verlag Berlin Heidelberg 2012, ISBN 978-3-642-30249-7 • Solid-Phase Organic Synthesis, Edited by Patrick H. Toy and Yulin Lam, John Wiley & Sons, Inc., Hoboken, New Jersey 2012, ISBN 978-0-470-59914-3
Link to other modules	It is recommended to complete the module Advanced and Applied Organic Chemistry before participating in the module Modern Technologies in Organic Synthesis.
Comments	Further important information regarding the module that do not fit under any of the above headings
Last update	November 16, 2021

Module title	**Supramolecular Chemistry and Nanochemistry**
Code	M-SLS-MSc 0066
Degree program	Master of Science in Life Sciences
Workload	3 ECTS (90 student working hours: 42 lessons contact = 32 h; 58 h self-study)
Module coordinator	**Name** Patrick Shahgaldian **Phone** 061-228-54-87 **Email** patrick.shahgaldian@fhnw.ch **Address** FHNW, HLS, Hofackerstrasse 30, 4132 Muttenz
Lecturers	Sebastian Wendeborn, Daniel Varon Silva
Entry requirements	Scientific background in chemistry, biochemistry and analytical chemistry.
Learning outcomes and competences	After completing the module, students will be able to: • Express advanced concepts in supramolecular chemistry. • Understand the main parameters to be integrated to design functional supramolecular systems. • Explain the use of different state-of-the-art analytical methods used in supramolecular chemistry. • Explain protein-protein interactions and their importance in medicinal chemistry • Give an overview of methods for the study and inhibition of protein-protein interactions in the context of medicinal chemistry • Explain the use of protein scaffolds for the design of artificial metalloenzymes. • Give an overview of the applications of supramolecular chemistry in drug delivery, bioanalytics and environmental remediation.
Module contents	*Advanced concepts of Supramolecular Chemistry (NN, 14 lessons)* • Single crystal X-ray diffraction for the study of supramolecular interactions – method, database and structure study. • Advanced supramolecular interactions (halogen bonding, aromatic interactions) • Chemical complementarity and pre-organization • Multivalency • Thermodynamics of supramolecular interactions • Reversible covalent bonds • Supramolecular catalysis (organic catalysis, artificial metalloenzymes) *Supramolecular Medicinal Chemistry (NN, 14 lessons)* • Self-assembling prodrugs • Combinatorial drug discovery • Protein-protein interactions in the context of Medicinal Chemistry. • Protein-protein interactions study (alanine screening, fluorescence polarization, yeast 2-hybrid assay) • Protein-protein interactions inhibition - concept, analysis, secondary structures, protein mimetics, helical synthetic inhibitors, macrocycles *Applications of Supramolecular Chemistry (NN, 14 lessons)* • Applications in drug delivery: host-guest inclusion systems, self-assembled nanocarriers (vesicles, micelles, nanoparticles), photodynamic therapy. • Applications in Environmental chemistry (oil spill remediation, extraction of radionuclides from nuclear waste, chemical warfare sensing and remediation) • Supramolecular advanced materials (self-healing rubbers, supramolecular adhesives, fibrillar networks, supramolecular gels and liquid crystals from supramolecular interactions

Teaching / learning methods	Lectures, Seminars Case studies: - Single crystal X-ray structure study (non-covalent interaction, molecular geometry, molecular packing, host-guest interactions) - Protein-drug interaction mapping, protein-drug interaction study
Format	3 lessons per week, whole semester
Assessment of learning outcome	• Final written examination at the end of the semester
Bibliography	Preparation: • Supramolecular Chemistry, *From Concepts to Applications*. Kubik, S.; de Gruyter Publishing, 2020 [Chap. 3. Understanding molecular interactions]. • *Fundamental of Protein Structure and Function*, 2nd Edition, Buxbaum, E.; Springer, 2015. Course material: • *Protein Protein Interactions Regulators*, Roy, S.; Fu, H.; eds; RSC Publishing, Cambridge, 2020 (Chap. 1: Protein-Protein Interaction Interfaces and their Functional Implications). • Supramolecular Chemistry: from Molecules to Nanomaterials, Gale, P. A.; Steed, J. W.; John Wiley & Sons, Chichester, 2012 (Volume 7: Soft Matter and Volume 8: Nanotechnology). Molecular interactions studies : The Cambridge Crystallographic Data Center (CCDC) : https://ccdc.cam.ac.uk
Link to other modules	Material Sciences (M-SLS-MSc C1) Surface characterization (M-SLS-MSc C2) Bio-interfaces and Bio-conjugate Chemistry (M-SLS-MSc 0051)
Comments	
Last update	December 13, 2021

PHARMATECHNOLOGY

Module title	**Continuous Pharmaceutical Production**
Code	M-SLS-MSC 0130
Degree program	Master of Science in Life Sciences
Workload	3 ECTS (90 student working hours: 27 lessons contact = 20 h; 9 lessons training = 7 h, 6 lessons presentations = 5 h, 58 h self-study)
Module coordinator	**Name** Berndt Joost **Phone** 061-228-5558 **Email** berndt.joost@fhnw.ch **Address** FHNW, HLS, Hofackerstrasse 30, 4132 Muttenz
Lecturers	Andreas Schreiner
Entry requirements	bachelor level of pharmaceutical, chemical or foods technology or equivalent process engineering; in particular a good understanding of production lines
Learning outcomes and competences	After completing the module, students will be able to… • understand the interface between drug substance to drug product, • identify, formulate, and solve engineering problems, • design and master selected pharmaceutical processes, • define requirement and performance specifications for technical equipments and • master the process chain of pharmaceutical production units.
Module contents	*Continuous production of solid forms and hot melts (Andreas Schreiner, 27 lessons)* • Drug substance to drug product interface • Crystallization and isolation • Drying units and auxiliary installations • Milling units • Mixing units • Granulation and auxiliary installations • Tableting and coating units • Introduction to extrusion and extruders • Production of hot melt extrudates • Hot melt granulation *Case studies (Andreas Schreiner, Berndt Joost)* • Continuous tablet production - from dispensing to tabletting (9 lessons) • Student presentations on selected production units (6 lessons)
Teaching / learning methods	lectures, exercises, workshop, presentations, and industrial site visit(s)
Format	3 lessons per week, whole semester, one full day lab course
Assessment of learning outcome	• Student presentations (15 %) • Report of hands-on training (25 %) • Closed book examination at the end of the semester (60 %)
Bibliography	Entry level: • Mersmann, A (2001), Crystallization Technology handbook, Marcel Deckker, NY • Rushton, A (1996), Solid-liquid filtration and separation technology, VCH Weinheim • Tsotsas E (2007), Modern Drying Technology, Wiley • Kleinebudde P (2017), Continuous Manufacturing of Pharmaceuticals (Advances in Pharmaceutical Technology), Wiley

	• Douroumis D (2012), Hot-Melt Extrusion: Pharmaceutical Applications, Wiley Course material: • Course scripts
Link to other modules	Pharmaceutical Production Facilities
Comments	The date of the hands-on training will be announced at the beginning of the lecture.
Last update	November 12th, 2021

Module title	**Pharmaceutical Production Facilities**
Code	M-SLS-MSC 0140
Degree program	Master of Science in Life Sciences
Workload	3 ECTS (90 student working hours: 42 lessons contact = 32 h; 58 h self-study)
Module coordinator	**Name** Berndt Joost **Phone** 061-228-5558 **Email** berndt.joost@fhnw.ch **Address** FHNW, HLS, Hofackerstrasse 30, 4132 Muttenz
Lecturers	Andreas Schreiner, Bernd Sessler
Entry requirements	bachelor level of pharmaceutical, chemical or foods technology or equivalent process engineering; in particular a good understanding of production lines
Learning outcomes and competences	After completing the module, students will be able to… • identify, formulate, and solve engineering problems. • understand and master the design process of selected processes and installations. • define requirement and performance specifications for relevant technical equipment. • understand qualification and validation of implemented technical installations • master the implementation process of technical systems.
Module contents	*General aspects of pharmaceutical production facilities (Andreas Schreiner, 14 lessons)* • General aspects of pharmaceutical production • Process and cleaning validation of pharmaceutical processes • Containment systems for highly active compounds *Introduction to facility management (Bernd Sessler, 14 lessons)* • WFI and purified water systems • Design and generation of clean media and clean steam • Planning and realization of utility systems • Maintenance and monitoring of utility systems • Site visit with tour to media system facilities *Cleanroom technology (Andreas Schreiner, 14 lessons)* • Basics and concepts • Volume flow and room pressure control • Air monitoring • HVAC systems (filters - testing and monitoring, dehumidifier and humidifier) • Site visit(s) with tour to cleanrooms and RABS
Teaching / learning methods	lectures, exercises, lab course, and industrial site visit(s)
Format	3 lessons per week, whole semester
Assessment of learning outcome	• Closed book examination at the end of the semester (100 %)
Bibliography	Entry level: • Nash R, (2003), Pharmaceutical process validation, Drugs and the pharmaceutical sciences, Vol. 129 • ISPE-Good Practice Guide: Commissioning and Qualification of Pharmaceutical Water and Steam Systems • Gail, Gommel, Hortig: Reinraumtechnik, Springer Verlag 2012 • Maas & Peither, Good Manufacturing Practice, GMP-Verlag

	• ISPE-Baseline Pharmaceutical Engineering Guide Series (www.ispe.org) • ISPE-Good Practice Guide: Heating, Ventilation, and Air Conditioning Course material: • ISPE Containment manual (2016), ISPE D/A/CH COP CON, 2016 • Course scripts
Link to other modules	Continuos Pharmaceutical Production (M-SLS-MSc 0130)
Comments	The date of the site visits will be announced at the beginning of the course.
Last update	November 12th, 2021

Module title	**Formulation of Biologics and Routes of Drug Delivery**
Code	M-SLS-MSC 0150
Degree program	Master of Science in Life Sciences
Workload	3 ECTS (90 student working hours: 42 lessons contact = 32 h; 58 h self-study)
Module coordinator	**Name** Georgios Imanidis **Phone** 061-228-5636 **Email** georgios.imanidis@fhnw.ch **Address** FHNW, HLS, Hofackerstrasse 30, 4132 Muttenz
Lecturers	Oliver Germershaus, Marc Sutter, Marcel Schneider, Peter van Hoogevest, Christian Schoch
Entry requirements	Defined entry level Bachelor level liquid pharmaceutical dosage forms, sterile dosage forms, galenics, chemistry and biochemistry
Learning outcomes and competences	After completing the module, students will be able to… • Understand the concepts of formulation and delivery of biologics • Develop formulations for biological drugs • Work in a drug development team for biologics • Understand the concepts of possible delivery routes for chemical and biological active pharmaceutical ingredients (API) • Work in a team for the development of pharmaceutical dosage forms
Module contents	*Formulation of biologics (Oliver Germershaus 21 lessons, Marc Sutter, 6 lessons)* • Structure, therapeutic proteins and monoclonal antibodies • Physical and chemical instabilities • Analytical methodologies • Delivery issues • Controlled delivery • Delivery of nucleic acids • Formulation development, liquid forms • Formulation development, dried forms • Processing • Primary packaging • Devices *Routs of drug delivery (Georgios Imanidis, 6 lessons, Marcel Schneider, Peter van Hoogevest, Christian Schoch, 9 lessons)* • Per-oral delivery • Implants • Ocular delivery • Pulmonary delivery • Transdermal delivery • Liposomes and drug targeting
Teaching / learning methods	lecture, case studies
Format	3 lessons per week, whole semester
Assessment of learning outcome	• Final written examination with practical examples and case reports
Bibliography	• E.J. McNally. Protein formulation and delivery • K.L. Audus, T.J. Raub. Biological barriers to protein delivery • C. van der Walle. Peptide and protein delivery

	• S. Mitragotri et al. Nature reviews 13 (2014 655.
Link to other modules	Drug Formulation and Delivery for Solid Dosage Forms
Comments	
Last update	April 6, 2018

Module title	**Drug Formulation and Delivery for Solid Dosage Forms**
Code	M-SLS-MSc 0155
Degree Programme	Master of Science in Life Sciences
Group	Bio/Pharma
Workload	3 ECTS (90 student working hours: 42 lessons contact = 32 h; 58 h self-study)
Module Coordinator	**Name**: Dr. Georgios Imanidis **Phone**: +41 (0)61 228 56 36 **Email**: georgios.imanidis@fhnw.ch **Address**: School of Life Sciences FHNW, Hofackerstrasse 30, 4132 Muttenz
Lecturers	Martin Kuentz,T. Guentert, Private consultant (ex. Roche), Böckten
Entry requirements	Bachelor's Degree in Life Sciences (or equivalent) in Pharma Technology, Chemistry, Process Technology, or Food Technology. Preparation of the topic "basic pharmacokinetics" is essential, including the self-test on Moodle. In addition, study of relevant literature.
Learning outcomes and competences	After completing this module, students: • know the formulation strategies for poorly water-soluble active pharmaceutical ingredients, • know formulation concepts of solid dosage forms for per-oral drug delivery, • understand the principles and mechanisms of controlled drug release and delivery, • can evaluate the blood plasma concentration profiles and therapeutic effects of controlled drug delivery based on pharmacokinetic principles, • can develop pharmaceutical dosage forms (after acquiring relevant practical experience), • are able to work in interdisciplinary teams of drug development.
Module contents	*Controlled release technologies (Georgios Imanidis, 18 lessons)* • Fundamentals of controlled release and examples thereof; theory of drug diffusion, kinetics, crystals, particles, membrane & matrix systems, hydrogels, lipogels, multi-phasic, swellable, erodable, biodegradable, monolithic/particulate, micro-/nano-particulate, osmotic, stimuli responsive systems, devices, pumps, eluting stents. *Per-oral drug delivery and formulations of poorly water-soluble drugs (Martin Kuentz, 12 lessons)* • Intestinal absorption, models, theory of solubility, principles of solubilization, the requirement for the active ingredient and formulation technologies including lipid-based, solid dispersion and particulate systems. *Biopharmaceutical modeling and simulation (T. Guentert, 12 lessons)* • Basic principles and application of LADME in time-controlled delivery; physiological transport, pharmacokinetic models, compartmental and physiologically based modeling, pharmacokinetic profile for different drug delivery kinetics, data analysis exercises.
Teaching / learning methods	Lecture, theoretical workshop, literature search, computer modelling exercises
Assessment of learning outcome	• Written final examination, closed book (100%)
Format	3 lessons per week, whole semester
Timing of the module	
Bibliography	D.L. Wise: Handbook of Pharmaceutical Controlled Release Technology

	M.J. Rathbone, J. Hadgraft, M.S. Roberts, M.E. Lane: Modified-Release Drug Delivery Technology, Volume 1 & 2 M. Grassi et al.: Understanding drug release and absorption mechanisms M. Rowland & T.N. Tozer: Clinical pharmacokinetics - concepts and applications S.A. Peters: Physiologically based pharmacokinetic (PBPK) modeling and simulations - principles, methods, and applications in the pharmaceutical industry
Language	English
Links to other modules	Specialisation module FHNW “Formulation of biologics and routes of drug delivery”
Comments	The homework assignments can be used to round up the grade in the respective part of the exam.
Last Update	March 31, 2021

CLUSTER-SPECIFIC MODULES

Module title	**Modelling of Complex Systems**
Code	CO1
Degree Programme	Master of Science in Life Sciences
Group	Computation
Workload	3 ECTS (90 student working hours: 42 lessons contact = 32 h; 58 h self-study)
Module Coordinator	**Name**: Prof. Dr. Sven Hirsch **Phone**: +41 (0)58 934 54 44 **Email**: sven.hirsch@zhaw.ch **Address**: ZHAW Life Sciences und Facility Management, Schloss 1, 8820 Wädenswil
Lecturers	• Prof. Dr. Sven Hirsch, ZHAW • Dr. Simone Ulzega, ZHAW • guest lecturers
Entry requirements	• Students should have basic statistics experience at the bachelor level, including: descriptive statistics, correlation measures, probability distributions such as normal and binomial distribution, basics of probability theory. • Students should know fundamentals of ordinary differential equations as taught at the bachelor level. • Students will have to complete an entry self-test (Moodle) in advance of the module. Preparatory material is provided on the Moodle platform • Students will have to install a systems dynamics software and get acquainted with the software prior to the course (details will be provided on Moodle) • **See also information under "comments"**
Learning outcomes and competences	After completing the module students will be able to: • describe different aspects of system theory and assess where and how system theory is applied to real-world problems; • use a mathematical tool (Vensim) to model and simulate a dynamical system; • derive a system formulation from ordinary differential equations (e.g. chemical reaction); • perform parametric studies with the Monte-Carlo method and apply optimization techniques to fit model predictions to experimental findings; • model, analyze, justify and communicate a system autonomously.
Module contents	The course introduces basic mathematical tools and software used for the modelling and analysis of real-world systems in the context of life sciences. The following contents are taught in this course: • Introduction into system theory / system dynamics - What is a complex system? What is its purpose? - Overview and characterization of various systems (static/dynamical systems, discrete and continuous systems) - Introduction to mathematical models used for the modeling and analysis of systems, including differential equations. - Properties of linear, non-linear and chaotic systems - Qualitative methods for analyzing system models (graphs, feedbacks, active-passive Matrix, Vester's paper computer) • Introduction into tools and methods used for system analysis and modeling - Basic modeling using software tools (e.g. Vensim, Excel) - Control structures, Look-ups, data sampling, functions - Analysis of equilibrium and stationary states - Numerical integration methods

	- Introduction to stability analysis and convergence testing - Level of validity and detection of simulation-inherent errors • Advanced system dynamics techniques - Parameter optimization for fitting model behavior to experimental data - Monte-Carlo simulation to perform parametric sensitivity studies • Detailed case studies of systems and their modeling with examples from biomechanics, environmental sciences, biology, chemistry, industrial processes, and economics, e.g. plant dynamics, bacterial population behavior, drug reactions, or buyer/seller market dynamics • Practical communication and documentation of a model and of simulation results - argumentation and motivation of a model logic - visualization of the model structure and its behavior - formulation of hypothesis and testing by means of simulation
Teaching / learning methods	The course will be taught in short frontal sessions and by practical implementation sessions. The students will conceive and develop an own case study in a group work and will have time to work on the project in class under supervision.
Assessment of learning outcome	The students will develop an own model as a case study (practical study). The individual projects will be conceived and developed during the course (during the course two individual presentations are given by the student). The project will be finalized and documented after the module. 1. A report will be delivered one week after the end of the module (100%)
Format	7-weeks
Timing of the module	Autumn semester, CW 38-44
Venue	Blended learning format. Presence sequences take place in Olten
Bibliography	Course Book H. Bossel, Systems and Models, 2007, ISBN 978-3-8334-8121-5 Introductory material R. L. Flood, E. R. Carson, Dealing with Complexity: An Introduction to the Theory and Application of Systems Science, Springer, 1993 http://en.wikipedia.org/wiki/Systems_thinking D. Aronson, Overview of Systems Thinking, http://www.thinking.net/Systems_Thinking/OverviewSTarticle.pdf K. North, An Introduction to Systems Thinking, http://courses.umass.edu/plnt597s/KarlsArticle.pdf Important literature and lecture notes will be provided on Moodle
Language	English
Links to other modules	The concepts will handshake with the specialisation module ZHAW “Mathematical Modelling” and BECS4 “Optimisation Methods”
Comments	There is a participant limit in this module. Registrations will be considered as follows: 1. Students for whom BECS1 is a compulsory module 2. Students from the BECS-Cluster 3. Students who need the ECTS for the graduation in the semester concerned 4. The remaining places will be drawn by lot Whether participation is possible will be communicated by the end of week 37.
Last Update	18.04.2023

Module title	**Machine Learning and Pattern Recognition**
Code	CO2
Degree Programme	Master of Science in Life Sciences
Group	Computation
Workload	3 ECTS (90 student working hours: 42 lessons contact = 32 h; 58 h self-study)
Module Coordinator	**Name**: Dr. Claus Horn **Phone**: +41 (0) 58 934 51 47 **Email**: claus.horn@zhaw.ch **Address**: ZHAW Life Sciences und Facility Management, Schloss 1, 8820 Wädenswil
Lecturers	Dr. Claus Horn
Entry requirements	The module requires a solid background in mathematics at Bachelor's level. Specifically, familiarity with: • Statistics, • probability theory, and • linear algebra. Familiarity with basic programming is required (data input/output, data structures, control structures). The module and associated practical exercises will be taught using Python. Familiarity with Python is required, including basics of plotting and visualization. Students will be provided with preparatory material. It is recommended that students have studied the module "D1 Handling and Visualizing Data" beforehand.
Learning outcomes and competences	After completing the module, students will be able to: • understand the motivation and main concepts behind machine learning • apply classification and regression techniques • know the advantages and drawbacks of individual machine learning algorithms, and make informed decisions about their application • design and validate data science experiments • solve practical problems using machine learning techniques in the context of life sciences. The objective of the module is to provide the students with the knowledge of the state-of-the-art machine learning techniques and apply them to problems of computational life sciences.
Module contents	The module covers the following topics: 1. The Importance of Machine Learning 2. Theoretical Foundations 3. Handling Data for Machine Learning 4. Practical Aspects of Machine Learning Projects 5. Feature Engineering 6. Types of Machine Learning Tasks 7. Basic Machine Learning Algorithms 8. Algorithms for Supervised Learning 9. Model Development 10. Outlook: Machine Learning and Artificial Intelligence
Teaching / learning methods	The module will consist of lectures and practical exercises. In addition to lectures, students will be required to self-study selected topics and present the project results. The presentations and accompanying code will be graded.
Assessment of learning outcome	1. Entry exam on preparatory exercises (written, closed book): 10% 2. Graded exercises during the course: 40% 3. Data challenge project work (report to be handed in 3 weeks after the course): 50%

Format	7-weeks
Timing of the module	Autumn semester, CW 45-51
Venue	Blended learning format. Presence sequences take place in Olten
Bibliography	Students will be provided with a script which includes references to additional texts. A good reference book is this one: “Hands-On Machine Learning with Scikit-Learn, Keras, and TensorFlow - Concepts, Tools and Techniques to Build Intelligent Systems” by Aurélien Géron A mathematical preparation course (used for the entry exam): https://moodle0.zhaw.ch/course/view.php?id=18663 An introductory Python tutorial (used for the entry exam): https://cs231n.github.io/python-numpy-tutorial/ The script and supporting material will be provided on Moodle.
Language	English
Links to other modules	The module is coordinated with the cooperation module “D3 Modelling and Exploration of Multivariate Data” and the ZHAW specialisation module “Neural Networks and Deep Learning”
Comments	
Last Update	24.02.2023

Module title	**Compound Profiling in Pharmaceutical Drug Discovery**
Code	BP1
Degree Programme	Master of Science in Life Sciences
Group	Bio/Pharma
Workload	3 ECTS (90 student working hours: 42 lessons contact = 32 h; 58 h self-study)
Module Coordinator	**Name**: Dr. Laura Suter-Dick **Phone**: +41 (0)61 228 56 59 **Email**: laura.suterdick@fhnw.ch **Address**: Hochschule für Life Sciences FHNW, Institut für Chemie und Bioanalytik, Gründenstrasse 40, 4132 Muttenz
Lecturers	• Dr. Laura Suter-Dick, FHNW • Dr. Eric Kübler, FHNW • Dr. Johannes Mosbacker, FHNW • Guest lecturers (Industry)
Entry requirements	• Bachelor Degree in Life Sciences • Course on bioanalytics, pharmacology, drug discovery, biochemistry, molecular biology and pharmacokinetics • Self-test on Moodle
Learning outcomes and competences	The focus of the course lies on the characterization of small molecules in drug discovery, from the identification of a "drugable" target to the selection of a clinical candidate. After completing the module, students will be able to: • explain the process of identifying and characterizing a new drug target • apprehend the value of screening systems to identify bioactive compounds on the level of hits • recognize the use of in vitro and in vivo models for drug efficacy and early ADME • understand toxicological studies in view of drug safety • plan experiments clarifying pharmacological and toxicological findings • understand the concept of translational research (Bench to Bedside) • describe and explain profiling activities of a selected compound from literature
Module contents	From target identification to clinical candidate selection: Concepts and Processes • The process of identification of a target • Overview on high-throughput-systems • The concept of iterative compound optimization • Concept, relevance and implementation of ADME in drug screening • Regulatory requirements in toxicology and safety assessment • Extrapolation from animal and in vitro studies to man • Determination of a safe dose to start clinical trials • Decision making: if, when and how should clinical Phase 1 studies be performed
Teaching / learning methods	• Lectures, self-study, invited speakers from the pharmaceutical industry • Team based learning using case studies • Short group presentations
Assessment of learning outcome	1. Group work (15%) 2. Closed book exam (85%)
Format	7-weeks
Timing of the module	Autumn semester, CW 38-44
Venue	Blended learning format. Presence sequences take place in Olten

Bibliography	Current publications Drug Discovery and Development. Edited by H.P. Rang. 2006. Churchill Livingstone Real World Drug Discovery. Robert M. Rydzewski. ELSEVIER, Amsterdam 2008. Toxicology: The Basic Science of Poisons. Klaassen, C.D. (Ed), McGraw-Hill, New York 2008 FDA Guideline M3(R2) "Nonclinical Safety Studies for the Conduct of Human Clinical Trials and Marketing Authorization for Pharmaceuticals" www.fda.gov Drug Discovery and Evaluation: Pharmacological Assays, H.G. Vogel, 2008, Springer Verlag FDA Guidelines for Industry: Guidance for metabolism and drug interactions studies – study design, data analysis, and recommendations for dosing and labeling, 2012. www.fda.gov
Language	English
Links to other modules	
Comments	
Last Update	18.04.2023

Module title	**Physicochemical Principles of Pharmaceutics**
Code	M-SLS-MSc BP8
Degree program	Master of Science in Life Sciences
Workload	3 ECTS (90 student working hours: 42 lessons contact = 32 h; 58 h self-study)
Module coordinator	**Name** Oliver Germershaus **Phone** 061-228-5526 **Email** oliver.germershaus@fhnw.ch **Address** FHNW, HLS, Hofackerstrasse 30, 4132 Muttenz
Lecturers	Georgios Imanidis Martin Kuentz
Entry requirements	Bachelor level in pharma technology, pharmaceutics, and/or chemistry and physical chemistry
Learning outcomes and competences	After completing the module, students will be able to… • fundamentally understand principles underlying design of drug delivery systems • define and solve challenges related to colloidal systems for pharmaceutical application • implement interfacial phenomena, solubility theory into pharmaceutical product design • apply properties of solid and semi-solid materials to delivery system development • define types and applications of polymers in a pharmaceutical context and know key properties and characterization approaches of/for polymers
Module contents	*Interfacial phenomena, micromeritics and compaction (Georgios Imanidis,14 lessons)* • Interfacial Phenomena / Surfactants: multi-phase systems, liquid-liquid, liquid-air, liquid-solid interfaces. adsorption, Gibbs equation, Langmuir isotherm, wetting, spreading. Applications in drug formulation, and delivery • Micromeritics & Compaction: Compressibility, compatibility, manufacturability, tablettability, material properties of powders and compacts and relationship to process and product quality, manufacturing challenges of solid and semi-solid preparations *Solutions, computational modelling, rheology (Martin Kuentz, 14 lessons)* • Solutions and structured liquids including solid solutions and deep eutectics. Computational modeling & property prediction (e.g. solubility and partitioning) • Rheology: elastic/plastic behavior, viscoelasticity, thixotropy, measurement principles and systems *Pharmaceutical nanotechnology and polymers (Oliver Germershaus, 14 lessons)* • Pharmaceutical nanotechnology and colloidal systems: types of colloidal systems; optical, kinetic and electrical properties of colloids; stabilization of colloidal systems; pharmaceutical application of colloids • Pharmaceutical polymers: polymer types, polymer properties and characterization, pharmaceutical application of polymers
Teaching / learning methods	lecture, student presentations, group work, practical exercise
Format	7-weeks
Timing of the module	Autumn semester, CW 45-51

Assessment of learning outcome	• Closed book examination at the end of the semester (100 %)
Venue	Blended learning format. Presence sequences take place in Olten
Bibliography	Sinko: Martins Physical Pharmacy and Pharmaceutical Sciences Florence, Attwood: Physicochemical Principles of Pharmacy Kim: Advanced Pharmaceutics, Physicochemical Principles
Language	English
Link to other modules	
Comments	
Last update	21.04.2022

Module title	**Design of Biopharmaceutical Production Facilities**
Code	BP3
Degree Programme	Master of Science in Life Sciences
Group	Bio/Pharma
Workload	3 ECTS (90 student working hours: 42 lessons contact = 32 h; 58 h self-study)
Module Coordinator	**Name**: Dr. Dieter Eibl **Phone**: +41 (0)58 934 57 11 **Email**: dieter.eibl@zhaw.ch **Address**: ZHAW Life Sciences and Facility Management, Campus Grüental, 8820 Wädenswil
Lecturers	• Dieter Eibl, ZHAW • Stefan Seidel, ZHAW • Martin Krahe, Bideco AG • Henry Weichert, Sartorius • Georg Dorn, Cytiva • Fabrice Gachot, Cytiva • Nicole Fontourcy, Pall Life Sciences • Valentin Rüttimann, Pall Life Sciences • Olaf Stoll, S&G Gebäudetechnik AG • Pascal Wirth, Wirth+Wirth Architekten
Entry requirements	• BSc in Biotechnology, Chemistry, Mechanical Engineering or Plant Engineering • Study of provided reading material • Usage of software Visio or AutoCAD • Self-test on MSLS Community Centre • **See also information under "comments"**
Learning outcomes and competences	After completing the module, students will be able to: • Plan and design biopharmaceutical production facilities This concerns both traditional biopharmaceutical production facilities and facilities of the future. • Choose the optimal facility set-up under consideration of compliance and regulatory aspects, special features of newly constructed and rebuilt facilities, supply chain management, Industry 4.0 demands, automation concepts and project management • Use software Accelerator Vision Platform
Module contents	• Overview of modern design concepts of biopharmaceutical production facilities: From the manufacture of the drug substance to the drug product, pros and cons • Facility concepts (vertical or horizontal arrangement, conventional biopharmaceutical production facility vs. facility of the future) • Modularization of production facilities (standard personnel airlock, clean room and technical interstitial area, technical process chase and HVAC concept) • Room concept (zone concept) of the production level ("Closed systems" in "Controlled -Non-Classified Room" and "Controlled-No-Classifield (CNC) Room Concept") • Closed processing (where are the open gaps?) • Space and concepts of utilities and services (WFI, steam, ventilation, waste products, containment, storage) • Compliance and regulatory aspects • Special features of newly constructed or rebuilt facilities

<table>
<tr><td></td><td>

Supply chain management of biopharmaceutical production facilities
Industry 4.0, automation concepts of biopharmaceutical production facilities
Project management for the realization of biopharmaceutical production facilities

</td></tr>
<tr><td>Teaching / learning methods</td><td>

Lectures (company workshops included)
Literature study and case study work
Presentations of the current state of the case study work

</td></tr>
<tr><td>Assessment of learning outcome</td><td>
1. Self-test on MSLS Community Centre (30%)
2. Individual grading of the activity during the project work (30%)
3. Presentation on progress of the case study work and defense of the case study work: Every subgroup has to present and answer (separate mark for each subgroup) (10%)
4. The report of the case study work (in groups) to be handed in 3 weeks after the end of the module (30%)
</td></tr>
<tr><td>Format</td><td>Winter School</td></tr>
<tr><td>Timing of the module</td><td>
Autumn Semester, CW 4
Submission of the case study work in CW 7

<table>
<tr><th>Day of the block week</th><th><1</th><th>1</th><th>2</th><th>3</th><th>4</th><th>5</th><th>>5</th></tr>
<tr><td>Contact teaching (lessons)</td><td></td><td>8</td><td>9</td><td>9</td><td>9</td><td>7</td><td></td></tr>
<tr><td>Self-study (hours)</td><td>24</td><td></td><td></td><td></td><td>2</td><td></td><td>32</td></tr>
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</td></tr>
<tr><td>Venue</td><td>Wädenswil</td></tr>
<tr><td>Bibliography</td><td>

Eibl R., Eibl D. (2019) Single-Use Technology in Biopharmaceutical Manufacture, John Wiley & Sons; ISBN: 9781119477839
ISPE Guidance Documents
Jagschies G., Lindskog E., Lacki K., Galliher P. (2017) Biopharmaceutical Processing: Development, Design, and Implementation of Manufacturing Processes; Elsevier; ISBN: 9780081006238
Jeffery N. Odum (2013) Biopharmaceutical Facility Design and Validation; in Encyclopedia of Industrial Biotechnology; DOI: 10.1002/9780470054581.eib654

</td></tr>
<tr><td>Language</td><td>English</td></tr>
<tr><td>Links to other modules</td><td>Specialisation module ZHAW “Bioprocessing and Bioanalytics” (Production systems)</td></tr>
<tr><td>Comments</td><td>
There is a participant limit in this module. Registrations will be prioritized according to the following order:
1. Students for whom BP3 is a compulsory module
2. Students from the BP-Cluster
3. Students who need the ECTS for the graduation in the semester concerned
4. The remaining places will be drawn by lot

Whether participation is possible will be communicated by the end of week 37.
</td></tr>
<tr><td>Last Update</td><td>21.04.2023</td></tr>
</table>

Module title	**Bioanalytics in a Regulated Environment**
Code	BP7
Degree Programme	Master of Science in Life Sciences
Group	Bio / Pharma
Workload	3 ECTS (90 student working hours: 42 lessons contact; 58 h self-study)
Module Coordinator	**Name**: Franka Kalman **Phone**: +41 (0)79 528 25 29 **Email** : franka.kalman@hevs.ch **Address** : HES-SO, Valais-Wallis, Sion
Lecturers	• Franka Kalman, HES-SO/VS • Oliver Germershaus, FHNW • Sabina Gerber, ZHAW • Guest Speakers from Industry
Entry requirements	• Knows the different physico-chemical principles of liquid chromatography and electrophoresis (including capillary electrophoresis) • Knows the principles of spectroscopy & refractive index, fluorescence, mass spectroscopy • Knows the general chemical structure, 3D-structure and properties (e.g. pKa, pI, absorption, fluorescence, molecular weight) of biomolecules (peptides, proteins, glycoproteins, monoclonal antibodies, antibody-drug conjugates, complex carbohydrates (N-glycans) and nucleic acids)
Learning outcomes and competences	After completing the module, students will be able to: • Know and understand the instrumental (bio)analytical tools mostly used in current routine (bio)pharmaceutical industry • Knows main quality attributes of (bio)pharmaceuticals & biosimilars, in particular antibodies • Understand the relevance of particles and particle characterization in biologics drug products • Identify common challenges related to particles and particle formation in biologics including strategies to circumvent such problems • Describe the basic stability challenges of biologic drugs, especially physical instabilities • Be able to plan an efficient testing monograph for a biopharmaceutical e.g. bioanalytical techniques for the characterization of APIs in the modern (bio)pharmaceutical industry • Understand the concept of a “test” method in relation to an analytical method / technique • Know specific modern methods for complex N-glycan analysis, sub-visible particles, AA composition, posttranslational modifications, different digestion strategies for protein APIs, modern aggregation analysis • Know the basic health authority rules for medicinal and drug products in the regulated pharmaceutical environment • Understand the basic GMP requirements depending on the drug development phase • Know the structure of and how to design an analytical SOP / SST concept • Know ICH guidelines: validation of analytical methods and specification, stability testing
Module contents	• Concept of specification (ICH guideline), User Requirement Specification (URS) = Analytical Target Profile (ATP) and basics of statistical process control (SPC) • Concept of a test method including structure and criteria of a typical system suitability test (SST), the different development phases of a test

<table>
<tr><td></td><td>method (URS / ATP, feasibility studies, method development inclusive SOP, Validation, QC release, technical method transfer)
• A typical testing monograph for a MAB API / drug product in Pharma QC release analytics
• A typical monograph for a MAB drug put on batch stability testing
• Particle formation and particle characterization in biologic drug products
• Typical modern release analytical methods for content, identity, impurity (product related, process related) e.g. aggregate analysis, N-glycan analysis, posttranslational modifications e.g. deamination, free and bound sialic acids etc.
• Most important interaction networks / discussion groups e.g. PDA (Europe / USA), AT Europe, CaSSS
• Most important Guideline’s like ICH Method Validation, Stability Testing & Specification, European & US Pharmacopeia & Swissmedic</td></tr>
<tr><td>Teaching / learning methods</td><td>• Lectures
• Case studies
• Group work and presentation</td></tr>
<tr><td>Assessment of learning outcome</td><td>1. Written final Exam (80%)
2. Presentation of case study prepared by group work (20%)</td></tr>
<tr><td>Format</td><td>Winter school CW6</td></tr>
<tr><td>Timing of the module</td><td>Block week: structure see following table (Contact teaching: 42 lessons / self-study: 58h)

<table>
<tr><th>Day of the block week</th><th><1</th><th>1</th><th>2</th><th>3</th><th>4</th><th>5</th><th>>5</th></tr>
<tr><td>Contact teaching (lessons)</td><td></td><td>7</td><td>9</td><td>9</td><td>9</td><td>8</td><td></td></tr>
<tr><td>Self-study (hours)</td><td>20</td><td></td><td></td><td></td><td></td><td></td><td>38</td></tr>
</table></td></tr>
<tr><td>Venue</td><td>Muttenz</td></tr>
<tr><td>Bibliography</td><td>Entry level:
• D.C. Harris “Quantitative Chemical Analysis” 8th edition
Chapter 3 (Experimental Error)
Chapter 5 (Quality Assurance and Calibration Methods)
Chapter 22 (Introduction to Analytical Separations)
Chapter 24 (High-Performance Liquid Chromatography)
Chapter 25 (Chromatographic Methods and Capillary Electrophoresis)

• F. Lottspeich “Bioanalytics”
Chapter 1 (Protein Purification)
Chapter 2 (Protein determination)
Chapter 5 (Immunological Techniques)
Chapter 6 (Chemical Modification of Proteins and Protein Complexes) – for information

Chapter 11 (Electrophoretic Techniques)

Course material:
• ICH guideline (Method Validation, Stability Testing, Specification)
• European Pharmacopoeia (Ph. Eur.) 10th edition</td></tr>
<tr><td>Language</td><td>English</td></tr>
<tr><td>Links to other modules</td><td>Strong links to central Regulatory Affairs (pharma part) (BP6) and Pharmaceutical Sciences Technology (S23) but no overlap</td></tr>
<tr><td>Comments</td><td></td></tr>
<tr><td>Last Update</td><td>03.03.2023</td></tr>
</table>

Module title	**Physiology and Immunotherapies**
Code	BP5
Degree Programme	Master of Science in Life Sciences
Group	Bio/Pharma
Workload	3 ECTS (90 student working hours: 42 lessons contact = 32 h; 58 h self-study)
Module Coordinator	**Name**: Dr. Bruno Schnyder **Phone**: +41 (0)27 606 86 59 **Email**: bruno.schnyder@hevs.ch **Address**: HES-SO, Institut für Life Technologies, Rte du Rawyl 64, 1950 Sitten / Sion
Lecturers	• Dr. Bruno Schnyder, HES-SO Vs • Dr. William Pralong, EPFL • Dr. Gerrit Hagens, HES-SO Vs • Dr. Eric Kübler, FHNW-HLS
Entry requirements	Bachelor Degree in Life Sciences (Biotechnology, Bioanalytics, Pharmatechnology) including the basics described by the following keywords: • properties of the biomolecules proteins, lipids, carbohydrates (sugars), genes, vitamins, small chemical molecules • analytical methods of proteins and cells • structure and function of living cells, physiological transport of nutrition across cell membranes These basics are summarized by the indicated literature (Silverthorn 2015) provided on moodle, including a self-test.
Learning outcomes and competences	After completing the module, students will be able to: • list the key physiological aspects of organs, cell systems, and molecular systems • master cell-based therapy and gene therapy • identify obstacles in recipients of a therapy e.g. adverse immune reaction • understand the fascinating complexity of the brain, and respective therapies
Module contents	"Physiology and Immunotherapies" introduces and goes beyond the medical aspects of classical "Physiology". Physiology is the science of functioning of an organism, an organ, or a cell. Eventual dysfunctions can be repaired by newly adopted cells. Other dysfunctions are being targeted by molecular and gene therapies. The module's training includes illustrative examples thereof. The tissues, cells, molecules, and genes under *in natura* conditions will be compared with those in engineering facilities. Novel and next generation therapies (e.g. CART cell-therapy) will be based on this. <u>Key aspects of Physiology:</u> Brain science discoveries, Immune system defense (e.g. against infectious disease, including antibiotics resistances), Intestinal and Urinary tracts, whole organism models (e.g. gene-ko mice) <u>Key aspects of Immunotherapies:</u> Cell-based and antibody-based Immunotherapy, furthermore Gene-Therapy, Microbiota "our home pharmacy"
Teaching / learning methods	lectures in oral and written form • exercise trainings individually and in groups • literature study of selected research publications • self-study, both prior to and following the lectures • Overview of teaching hours (12 lectures by B.Schnyder, 12 lectures by G.Hagens, 12 lectures by W.Pralong, 6 lectures by E.Kübler)

Assessment of learning outcome	1. Final written exam, closed book (100%)
Format	7-weeks
Timing of the module	Spring semester, CW 8-14
Venue	Blended learning format. Presence sequences take place in Berne
Bibliography	pre-course work: Silverthorn D.Unglaub "Human Physiology" Edit. Benjamin Cummings, Pearson ISBN-13: 978-0-321-75000-6: Summaries and a self-test (both are available on moodle) Course material (moodle): Manuscripts and a selection of scientific papers
Language	English
Links to other modules	BP6 "Tissue Engineering for Drug Discovery"
Comments	
Last Update	20.09.2022

Module title	**Tissue Engineering for Drug Discovery**
Code	BP6
Degree Programme	Master of Science in Life Sciences
Group	Bio/Pharma
Workload	3 ECTS (90 student working hours: 42 lessons contact = 32 h; 58 h self-study)
Module Coordinator	**Name**: Dr. Michael Raghunath **Phone**: +41 (0)58 934 55 18 **Email**: ragh@zhaw.ch **Address**: ZHAW Life Sciences and Facility Management, Einsiedlerstrasse 31, 8820 Wädenswil
Lecturers	• Dr. Michael Raghunath, ZHAW • Dr. Laura Suter-Dick, FHNW • Dr. Markus Rimann, ZHAW • Guest lecturers from industry
Entry requirements	Bachelor's degree in Life Sciences (Biotechnology, Bioanalytics, Pharmatechnology, Chemistry with specialization in Cell Biology or Tissue Engineering, Biomaterials) Key words: • cell surface receptors, signal transduction, • Extracellular matrix and cell-matrix interactions • Biomaterials, assembly of (bio)polymers • Three dimensional cell culture, stem cell differentiation • Current tissue engineering strategies such as organ tissue engineering and macromolecular crowding • Tissue engineering, screening, drug development Basics are covered by the indicated literature (see below) provided on Moodle
Learning outcomes and competences	After completing the module, students will be able to: • Critically assess tissue engineering (TE) strategies including bioprinting vis-à-vis clinical viability, industrial value • Identify current bottlenecks in TE in general and for drug development in particular • explain differences between TE for regenerative medicine, academia and drug development • differentiate between 2D, ultraflat 3D and thicker 3D tissue constructs • develop concepts of industrial applications of TE depending on tissue type and question to be answered • delineate rationale for TE design to address questions in disease modelling and cosmetics • improve presentation technique and defend view points
Module contents	"Tissue Engineering for Drug Discovery" is an advanced course for graduate students to critically interrogate current approaches and methods of tissue engineering and how they can be harnessed for the generation of in vitro tissue models for drug and substance testing. In order to build a tissue its microarchitecture (histology) and its physiology must be understood. As a perfect tissue will not arise in vitro, a selection must be made as to which functional features of this particular tissue should be preserved to be testable and which are relevant for the drug or cosmetic substance to be tested. We will discuss this using skin and liver as an example. Skin is one of the oldest and most successful tissue engineering feats in both clinical and in vitro settings, yet full physiology has not been reached. Liver is a central organ relevant to pharmaco-toxicity but also fulfill a myriad of synthetic functions.

	Therefore, every tissue model needs to fulfill different needs for different purposes. The topics span stem cell as tools for tissue differentiation and as a focus for personalized medicine and the newest 3D approaches to generate living tissue models. This will set the stage for the group presentations that will tackle to build a suitable organ model and to emulate the necessary physiological functions. Selected organs and tissues are set for problem-based groups..
Teaching / learning methods	• Lectures, self-study, company presentation • Team based learning (groups to extract information from the internet) • Interactive discussions, presentation clinic • Final group presentations (problem-based learning) with detailed-feedback on form and content • Overview of teaching hours (27-30 lectures by M. Raghunath, 6 by L. Suter-Dick, 6 by M. Rimann, 0-3 by guest speakers, as available).
Assessment of learning outcome	1. One group presentation on selected topics (6-8 students) (40%) 2. Final exam, closed book (60%)
Format	7-weeks
Timing of the module	Spring semester CW 15-21
Venue	Blended learning format. Presence sequences take place in Olten or Berne
Bibliography	Pre course work "Molecular Biology of the Cell", Bruce Alberts, Alexander Johnson, Julian Lewis, David Morgan, Martin Raff, Keith Roberts, Peter Walter, 6th edition, "Garland Science, Taylor & Francis, 2014, ISBN-13: 978-0815345244; Chapters 19 (Cell junctions and the extracellular matrix), 22 (Stem Cells and Tissue Renewal) "Principles of Tissue Engineering", Lanza, Langer & Vacanti, 4th edition, 2014, Academic Press, Chapters 1-4 (Introduction to TE); Chapters 13-17 (In vitro Control of Tissue Development) Course Material (Moodle) Relevant publications will be uploaded along with lecture notes. Further Material for problem-based learning presentation groups is posted on Moodle
Language	English
Links to other modules	BP5 "Physiology and Immunotherapies"
Comments	
Last Update	14.07.2022

<table>
<tr><td>Module title</td><td>Regulatory Affairs</td></tr>
<tr><td>Code</td><td>BP4</td></tr>
<tr><td>Degree Programme</td><td>Master of Science in Life Sciences</td></tr>
<tr><td>Group</td><td>Bio/Pharma</td></tr>
<tr><td>Workload</td><td>3 ECTS (90 student working hours: 42 lessons contact = 32 h; 58 h self-study)</td></tr>
<tr><td>Module Coordinator</td><td>Name: Dr. Marc E. Pfeifer
Phone: +41 (0)58 606 86 61
Email: marc.pfeifer@hevs.ch
Address: HES-SO, Institute of Life Technologies, Rue de l’Industrie 19, 1950 Sion</td></tr>
<tr><td>Lecturers</td><td>• Dr. Marc Pfeifer, HES-SO
• Industry, authority and/or consulting firm representatives</td></tr>
<tr><td>Entry requirements</td><td>B.Sc. in Life Sciences (e.g. Chemistry or Biotechnology); Basic knowledge of Quality Management</td></tr>
<tr><td>Learning outcomes and competences</td><td>After completing the module, the student will be able to:
• understand the role and importance of regulatory affairs within regulated industries (i.e. pharmaceutical, medical device and in vitro diagnostics)
• apprehend how product development and manufacturing as well as associated processes and milestones are interlinked with documentation deliverables
• appreciate the relevance and high-level conception of clinical and performance evaluations
• give support with the preparation and compilation of quality- and regulatory-relevant documents</td></tr>
<tr><td>Module contents</td><td>• Role and responsibilities of regulatory affairs professionals within an organization in the healthcare industries
• The module will contain two major – related, yet distinct – parts: 1) a drug / biologics, and 2) a medical device / IVD regulatory pathway development (which includes identification of applicable regulations and standards as well as registration sequence for different countries in the world)
• Changes in the regulatory landscape in Europe for medical devices and in vitro diagnostics (IVD), i.e. from directives to regulations
• Integration of specific requirements in the quality management system (QMS)
• Structured communication with Regulatory Bodies and Competent Authorities
• Preparation of the technical documentation in preparation for CE mark and US FDA approval (e.g. including preparation of verification and validation activities)</td></tr>
<tr><td>Teaching / learning methods</td><td>Lectures will be given on the principles of Regulatory Affairs referencing guidelines and standards. The seminars will include reviewing real-world case examples also illustrating successful approaches as well as failures, shortcomings and other issues that have occurred in the past. This course requires active participation and individuals / groups are required to develop feasible solutions for potential industry use. The students during interactive exercises are coached by the experts.</td></tr>
<tr><td>Assessment of learning outcome</td><td>1. The report of a case study (prepared in groups) has to be handed in latest 3 weeks after the end of the module (100%)</td></tr>
<tr><td>Format</td><td>Summer school</td></tr>
<tr><td>Timing of the module</td><td>Spring semester, week 25
<table>
<tr><th>Day of the block week</th><th><1</th><th>1</th><th>2</th><th>3</th><th>4</th><th>5</th><th>>5</th></tr>
<tr><td>Contact teaching (lessons)</td><td></td><td>9</td><td>9</td><td>9</td><td>9</td><td>6</td><td></td></tr>
<tr><td>Self-study (hours)</td><td>8</td><td>2</td><td>2</td><td>2</td><td>2</td><td>2</td><td>40</td></tr>
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Venue	On-site lectures in Sion
Bibliography	Literature and regulatory guidelines will be provided during the course.
Language	English
Links to other modules	Any quality-related, analytical method developments and drug / IVD / med. device development module.
Comments	
Last Update	13.09.2022

Module title	**Materials Science**
Code	C1
Degree Programme	Master of Science in Life Sciences
Group	Chemistry
Workload	3 ECTS (90 student working hours: 42 contact lessons = 32 h; 58 h self-study)
Module Coordinator	**Name**: Dr. Michael de Wild **Phone**: +41 (0)61 228 56 49 **Email**: michael.dewild@fhnw.ch **Address**: FHNW, Hochschule für Life Sciences, Hofackerstrasse 30, 4132 Muttenz
Lecturers	• Dr. Michael de Wild, FHNW • Dr. Patrick Shahgaldian, FHNW
Entry requirements	Scientific background in chemistry, physics and analytical chemistry. The students need a Bachelor in Materials Sciences, Chemistry, Physics, Engineering, Biomedical Engineering or equivalent. Basic lectures on materials sciences, chemistry, physics and biomaterials are a prerequisite to follow this course.
Learning outcomes and competences	After completing the module, students will be able to: • give an overview of the broad spectra of metallic and ceramic materials from the perspective of materials science from the macroscopic to the nanoscopic scale; • explain different state-of-the-art technologies and methodologies for the analysis of materials; • illustrate the important approaches involved in designing and creating materials and nanostructures; • express the central concepts of nanosciences.
Module contents	• The solid state is discussed based on material scientific theories. • The crystallographic and electronic structure of solid materials, as well as optical, mechanical and magnetic properties are examined. • The influence of sterilization and irradiation on material properties is reviewed. • Shape Memory Alloys are discussed. • Metallographic preparation techniques, Fractography. • High-end oxide ceramics and their ability for phase-transformation toughening are discussed. • The macroscopic and microscopic structure and properties of metallic and ceramic materials are compared and state-of-the-art characterization methods are introduced. • Nanocrystalline materials are discussed. • Imperfections and their effects on material properties are highlighted. • Key physical characteristics of nanoscale materials (vs. bulk) are studied, including lotus and gecko effects. • Fabrication, functions and properties of nanomaterials of different types are discussed. • Top-down as well as bottom-up approaches are emphasized. • Several important classes of nanomaterials (e.g., nanoparticles, nanotubes, 2D material, metal-organic frameworks, mesoporous materials, advanced polymers) are studied • Selected applications of nanomaterials in the field of life sciences are treated. • Important aspects of the (eco)toxicity of nanomaterials are discussed.

Teaching / learning methods	Lecture and blended learning: Contact lessons • Lectures, Q&A-sessions • Group Exercises • Simulations • Demonstrations Self-study • Learning videos • Interactive simulations (https://phet.colorado.edu/en/simulations/category/new) • Individual Project Studies
Assessment of learning outcome	1. Final written exam, closed book, (100%).
Format	7-weeks
Timing of the module	Autumn semester, CW 38-44
Venue	Blended learning format. Presence sequences take place in Olten
Bibliography	Pre-reading The scripts for this module will be available on moodle timely before the module starts. Likewise, selected scientific articles and instructions for pre-work are announced on the moodle platform. Course material G. Carter, D. Paul, Materials Science and Engineering, ASM International, Materials Park, OH, 2010. ISBN 978-0-87170-399-6. E. Hornbogen, G. Eggeler, E. Werner, Werkstoffe, Aufbau und Eigenschaften von Keramik-, Metall-, Polymer- und Verbundswerkstoffen, Springer Verlag Berlin Heidelberg, 2008., ISBN 978-3-540-71857-4. W.D. Callister, D.G. Rethwisch, Materials Science and Engineering: SI Version (English), Wiley-VCH Verlag GmbH & Co KgaA, 2016. M. Köhler, W. Fritsche: Nanotechnology, 2. ed, Wiley-VCH Verlag GmbH & Co KgaA, Weinheim, 2007. ISBN 978-3-527-31871-1. J. N. Israelachvili, Intermolecular and surface forces, 3rd ed., Academic Press, San Diego, 2011. ISBN-978-0-12-391927-4. Interactive simulations (https://phet.colorado.edu/en/simulations/category/new) Selected recent scientific articles
Language	English
Links to other modules	Recommended supplementary modules: C2 “Surface Characterization” and C3 “Polymers and Applications”. Specialisation modules FHNW: “Bio-interfaces and Bio-conjugate Chemistry”, “Medical Device Development”, “Implant Design and Manufacturing”
Comments	
Last Update	21.03.2023

Module title	**Surface Characterisation**
Code	C2
Degree Programme	Master of Science in Life Sciences
Group	Chemistry
Workload	3 ECTS (90 student working hours: 42 contact lessons = 32 h; 58 h self-study)
Module Coordinator	**Name**: Dr. Michael de Wild **Phone**: +41 (0)61 228 56 49 **Email**: michael.dewild@fhnw.ch **Address**: FHNW, Hochschule für Life Sciences, Hofackerstrasse 30, 4132 Muttenz
Lecturers	• Dr. Michael de Wild, FHNW • Dr. Renzo Raso, FHNW • Dr. Patrick Shahgaldian, FHNW
Entry requirements	Scientific background in chemistry, physics and analytical chemistry. The students need a Bachelor in Materials Sciences, Chemistry, Physics, Engineering, Biomedical engineering or equivalent. Basic lectures on materials sciences, chemistry, physics and biomaterials are a prerequisite to follow this course.
Learning outcomes and competences	After completing the module, students will be able to: • explain in-depth modern microscopic and spectroscopic surface characterization techniques. • describe the importance of surface chemistry and the structural features of surfaces with regard to cell-surface interactions. • describe the principal methods of sample preparation for analytical techniques required to accurately analyze the surface. • select the right combination of surface analytical techniques to proper analyze the surface properties of various materials. • explain the most recent sensing strategies and detection principles in Life Sciences. • critically evaluate the scope and limitations of the applied methods, the range of sensitivity and the influence of disturbing factors on the results.
Module contents	• Electron microscopy (EM), incl. cryogenic EM, EDX and WDX Analysis • Scanning tunneling and atomic force microscopy techniques • Advanced confocal microscopy • White light interference microscopy, • Interpretation of microscopic and spectroscopic data • (FT) infrared and Raman spectroscopy, incl. confocal Raman microscopy, tip enhanced Raman spectroscopy • Surface ellipsometry (spectroscopic and imaging modes) and Brewster angle microscopy (BAM) • Interactions with surfaces (SPR, QCM, OWLS) • XPS and applications • Porosimetry: gravimetry, MIP, BET, µCT • Profilometry, 3D-SEM, confocal laser scanning microscope • Calometer, tribometer • Dynamic contact angle measurement • Non-destructive testing
Teaching / learning methods	Lecture and blended learning: Contact lessons • Lectures, Q&A-sessions • Group Exercises • Individual Project Studies

	• Demonstrations Self-study • Learning videos • interactive simulations (https://phet.colorado.edu/en/simulations/category/new) • Individual Project Studies
Assessment of learning outcome	1. Final written exam, closed book, (100%)
Format	7-weeks
Timing of the module	Autumn semester, CW 45-51
Venue	Blended learning format. Presence sequences take place in Olten
Bibliography	Pre-course The scripts for this module will be available on moodle timely before the module starts. Likewise, selected scientific articles and instructions for pre-work are announced on the moodle platform. Course material Oura K, Lifshits V.G., Saranin A.A., Zotov A.V., Katayama M. , Surface Science: An Introduction, ISBN 978-3-642-05606-2, Springer Verlag, Berlin Heidelberg, 2010. Buddy D. Ratner, Allan S. Hoffman, Frederick J. Schoen and Jack E. Lemons, *Biomaterials Science. An Introduction to Materials in Medicine: An Introduction to Materials in Medicine,* 2004. Interactive simulations (https://phet.colorado.edu/en/simulations/category/new) Selected recent scientific articles
Language	English
Links to other modules	Collaboration with modules C3 “Polymers and Applications” and C1 “Materials Science”. Specialisation modules FHNW: “Bio-interfaces and Bio-conjugate Chemistry”, “Medical Device Development”, “Implant Design and Manufacturing”.
Comments	
Last Update	21.03.2023

<table>
<tr><td>Module title</td><td>Polymers and Applications</td></tr>
<tr><td>Code</td><td>C3</td></tr>
<tr><td>Degree Programme</td><td>Master of Science in Life Sciences</td></tr>
<tr><td>Group</td><td>Chemistry</td></tr>
<tr><td>Workload</td><td>3 ECTS (90 student working hours: 42 lessons contact = 32 h; 58 h self-study)</td></tr>
<tr><td>Module Coordinator</td><td>Name: Dr. Pierre Brodard
Phone: +41 (0)26 429 67 19
Email: pierre.brodard@hefr.ch
Address: Haute école d'ingénierie et d'architecture Fribourg, Perolles 80, 1700 Fribourg</td></tr>
<tr><td>Lecturers</td><td>• Prof. Pierre Brodard, HEIA-FR
• Prof. Roger Marti, HEIA-FR
• Prof. Rudolf J. Koopmans, PICC Plastics Innovation Competence Center
• Prof. Hans-Ulrich Siegenthaler, HEIA-FR
• Prof. Stefan Hengsberger, iRAP Institute of Applied Plastics Research
• Prof. Dominik Brühwiler, ZHAW
• Guest lecturers & experts from industry</td></tr>
<tr><td>Entry requirements</td><td>Chemistry at Bachelor of Science level.
Knowledge required in: Organic chemistry (reactivity of carbonyl and carboxylic acid derivatives, radical reactions) & Analytical and physical chemistry (spectroscopy, thermal analysis, chromatographic methods).
Preparatory reading will be made available on Moodle.

See also information under “comments”</td></tr>
<tr><td>Learning outcomes and competences</td><td>After completing the module, students will be able to:
• design and execute typical synthetic methods for the preparation of polymers
• select appropriate analytical and physico-chemical methods to characterize polymers
• work with inorganic polymers and biopolymers and use them for applications
• explain polymer processing and industrial application of polymers</td></tr>
<tr><td>Module contents</td><td>Synthesis of polymers (Chain-growth and step-growth polymerization)
Chemical Post-Polymerization Modifications
Characterization of polymers
Biopolymers (“Bio”-Plastics & Biodegradable Polymers, Polysaccharides, Chemical synthesis of biomacromolecules)
Environmental impact of plastics
Inorganic & electronic polymers
Polymers processing
Industrial applications</td></tr>
<tr><td>Teaching / learning methods</td><td>• Basic concepts and theoretical backgrounds by lecturers
• Inputs by guest lecturers from industry and academia
• Exercises and analysis of case studies
• Lab visits with hands-on demonstration</td></tr>
<tr><td>Assessment of learning outcome</td><td>1. Written exam (closed books), final (100%)</td></tr>
<tr><td>Format</td><td>Winter school</td></tr>
<tr><td>Timing of the module</td><td>Autumn semester, CW6

<table>
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<tr><td>Self-study (hours)</td><td>20</td><td>2</td><td>2</td><td>2</td><td>2</td><td>2</td><td>30</td></tr>
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</td></tr>
<tr><td>Venue</td><td>Fribourg</td></tr>
</table>

Bibliography	Course based on: Chada & Roy: "Industrial Polymers, Specialty Polymers, and their Applications" CRC Press 2009 Carraher: "Introduction to Polymer Chemistry" CRC Press 2011 Campbell, Pethrick & White: "Polymer Characterization: physical techniques" CRC Taylor & Francis 2000 Mark, Allcock & West: "Inorganic Polymers" Oxford University Press 2005 Lectures notes (PDF) and additional material (exercises) will be delivered in addition during the module.
Language	English
Links to other modules	Coordination with modules C1 "Materials Science", C2 "Surface Characterisation", C4 "Green Chemistry" and C5 "Chemistry and Energy".
Comments	There is a participant limit in this module. Registrations will be considered as follows: 1. Students for whom C3 is a compulsory module 2. Students from the Chemistry-Cluster 3. Students who need the ECTS for the graduation in the semester concerned 4. The remaining places will be drawn by lot Whether participation is possible will be communicated by the end of week 37.
Last Update	09.03.2023

Module title	**Green Chemistry**
Code	C4
Degree Programme	Master of Science in Life Sciences
Group	Chemistry
Workload	3 ECTS (90 student working hours: 42 lessons contact = 32h; 58h self-study)
Module Coordinator	**Name**: Dr. Jürgen Stohner **Phone**: +41 (0)58 934 54 93 **Email**: juergen.stohner@zhaw.ch **Address**: ZHAW Life Sciences and Facility Management, Einsiedlerstrasse 31, 8820 Wädenswil
Lecturers	• Dr. Achim Ecker, ZHAW • Dr. Christian Frech, ZHAW • Guest Lecturer
Entry requirements	Basic knowledge in chemistry on the level of a BSc Degree in Chemistry.
Learning outcomes and competences	After completing the module, the students are able to: • evaluate the sustainability of industrial chemical and bio-chemical processes using different perspectives • explain the different steps of the supply chain (from raw materials to the products end of life) and their impact on sustainability • consider environmental, economic as well as social aspects in their assessment of industrial processes
Module contents	<u>From Sustainability to Green Chemistry Metrics</u> • History of sustainability • The chemical industry • 12 Principles of Green Chemistry • Green Chemistry Metrics • <u>Industrial Green Chemistry</u> • The fine chemical industry • Green manufacturing concepts and their ecological impact • Green supply chain • Greenness vs. cost & capital investment • <u>Solvent and Solvent systems</u> Raw materials and environmental concerns are important and discussed as follows: • Introduction to solvents and solvent systems • Sustainable raw materials: evaluation/selection of green processes • Potential chemicals derived from sustainable raw materials (including processes to get these chemicals) • Ethanol production from crops (corn, sugar cane, wheat etc.), methyl-THF, etc. • Alternative green solvents and chemicals
Teaching / learning methods	• Lectures • short seminars • presentations • case studies • exercises • demonstrations and self-study When pre-readings and pre-course works are required, the students will be informed prior to the course.
Assessment of learning outcome	1. Final examination; up to 12 students oral, from 12 or more students written exam (100%)
Format	7-weeks

Timing of the module	Spring semester, CW 8 - 14
Venue	Mix of online and on-site lectures (in Olten)
Bibliography	Will be announced at beginning of the lectures. Course material can be downloaded from the MSLS Moodle platform.
Language	English
Links to other modules	This module serves as basic course to the spring semester specialisation module “Green Chemistry – Advanced Concepts” at ZHAW.
Comments	
Last Update	23.09.2021

Module title	**Chemistry and Energy**
Code	C5
Degree Programme	Master of Science in Life Sciences
Group	Chemistry
Workload	3 ECTS (90 student working hours: 42 lessons contact = 32 h; 58 h self-study)
Module Coordinator	**Name**: Dr. Jürgen Stohner **Phone**: +41 (0)58 934 54 93 **Email**: juergen.stohner@zhaw.ch **Address**: ZHAW Life Sciences and Facility Management, Einsiedlerstrasse 31, 8820 Wädenswil
Lecturers	• Dr. Christian Adlhart, ZHAW • Dr. Thomas Pielhop, ZHAW • Dr. Dominik Brühwiler, ZHAW • Dr. Jürgen Stohner, ZHAW • Guest Lecturer
Entry requirements	Basis knowledge in chemistry on the level of a BSc Degree in Chemistry is required; this includes knowledge in thermodynamics, electrochemistry, catalysis, inorganic and organic synthesis.
Learning outcomes and competences	After completing the module, students will be able to: • understand the processes that lead from energy sources (solar, bio, chemical) to energy usage (e.g. mobility) considering - energy conversion - energy storage - energy distribution infrastructure • evaluate the various energy sources with respect to energy density based on (bio)chemical foundations
Module contents	<u>Chemical energy storage</u> Chemistry plays a crucial role in future energy storage strategies. Figures from the broad perspective of our current energy system including storage strategies (chemical, electro-chemical, mechanical and mobile) and energy storage densities will be given. These figures will be challenged in depth with the students' knowledge in thermodynamic and electrochemical concepts by selected examples including conversion and production technologies. These may include power to gas (thermochemical CO_2 activation), methanol chemistry, synthesis gas, hydrogen technology, ammonia, and mobile or static electrochemical storages systems such as redox flow batteries. <u>Bio-gas/Bio-energy</u> Biomass in its different forms (native – waste, lignocellulosic – carbohydrate – protein – lipid) represents an indispensable source of energy. This part will deal with different aspects of biomass characterization, treatment and energetic valorization such as: • methods to assess the sustainable potential of biomass of a region; • biomass composition and characterisation and the chemical value of biomass; • the role, production and characterization of traditional bioenergy carriers (biogas, biomethane, biodiesel, bioethanol) • the production and use of advanced biofuels (gasification, pyrolysis, synthetic biofuels) from renewable bioresources; • advanced concepts of bioraffination of natural resources, including technology chains and energy products of biorefineries. <u>Solar energy</u>

	This part of the lecture focuses on two major fields of solar energy utilization, namely photocatalysis and photovoltaics. The following topics are covered: • Photocatalysis: Generation of solar fuels (H_2 and products of CO_2 reduction) and environmental remediation (water purification). • Photovoltaics: Theory of operation and chemistry of photovoltaics, including classic silicon-based and thin film cells, as well as emerging cell technologies and photon management. Energy and mobility This part highlights problems associated with `mobility' when energy policy, air quality and climate issues are considered and which might be solved by the techniques discussed before. • The turnaround in energy policy will lead us into the solar age, turning away from fossil fuels and nuclear power, with the following consequences: - The greenhouse effect forces us to get rid of coal energy used for electric mobility. - The political interest of air pollution control falls off, the climate debate has priority - Biofuels and biomass combustion leads to conflicts of interests between air quality and climate when used for electric mobility • High density energy storage of renewable energy as a possibility • Power to gas as an option for high density energy storage, using existing technology for storage, transportation and filling station • Air pollutants and after-treatment of exhaust gases for the future mobility with diesel, petrol or electricity.
Teaching / learning methods	• Lectures • short seminars • presentations • case studies • exercises • demonstrations and self-study When pre-readings and pre-course works are required, the students will be informed prior to the course.
Assessment of learning outcome	1. Final written examination (100%).
Format	7-weeks
Timing of the module	Spring semester, CW 15-21
Venue	Blended learning format. Presence sequences take place in Olten
Bibliography	Will be announced at beginning of the lectures. Course material can be downloaded from the MSLS Moodle platform.
Language	English
Links to other modules	
Comments	
Last Update	20.09.2022

Module title	**Industrial Chemical Process Safety**
Code	C6
Degree Programme	Master of Science in Life Sciences
Group	Chemistry
Workload	3 ECTS (90 student working hours: 32 h contact (= 42 lessons), 58 h self-study)
Module Coordinator	**Name:** Dr. Ludovic Gremaud **Phone:** +41 26 429 68 06 **Email:** ludovic.gremaud@hefr.ch **Address:** HEIA-FR, Chemistry Department, Bd. Pérolles 80, 1700 Fribourg
Lecturers	• Dr. Ludovic Gremaud, HEIA-FR • Dr. Véronique Breguet-Mercier, HEIA-FR • Dr. Pierre Brodard, HEIA-FR • Dr. Roger Marti, HEIA-FR • Dr. Andreas Zogg, FHNW • Guest lecturers, experts from the industry
Entry requirements	Chemistry at Bachelor of science level **Knowledge requirement:** • *Physical chemistry:* thermodynamics & kinetics, thermal analysis (DSC), basic concepts of thermal safety (criticality classes) • *Industrial chemistry:* Industrial unit operation (filtration, distillation, drying…), process scale-up & safety, EHS **Way to support/encourage students to reach it:** • Preparatory reading and exercises, including a self-test for students to check their actual understanding of the topics and to give them the opportunity to have the skills and knowledge to be ready for the summer school
Learning outcomes and competences	**After completing the module, students will be able to:** • Appreciate how to give support to process development, operational excellence and manufacturing activities with DynoChem & Reaction Lab tools as well as MATLAB • Understand the role and importance of safety valves within de production industries as well as the pathway to design it • Apprehend how to develop, interpret and apply EHS concept including compilation of regulatory relevant documents • Put into practice appropriate process safety tools, master hazardous chemistry as well as assess and explain results for process review
Module contents	• Understanding of the interconnected nature of process safety and design of production unit • Evaluate the thermal safety risk of various chemical processes, based on Case Studies • Concept and approach for green process development of hazardous reactions, operational excellence and engineering activities • Role and responsibilities towards Environmental, Health & Safety legal right • Integration of specific requirements for Process R&D & Production activities in a Highly Potent API environment
Teaching / learning methods	• Basic concepts and theoretical background by lecturers • Inputs by guest lectures from industry and academia • Exercises and analysis of case studies coming from the industries and academia • KiloLab & Pilot Plan visits with hands demonstration and/or exercises • Questions & Answers session (individual and group support)

<table>
<tr><td>Assessment of learning outcome</td><td>

Entry exam prior the summer school, individual, open book (20%)
Resolve case studies, individually and in group (3-4), open book (40%)
Bibliographic report based on a scientific publication/chapter book, submission deadline 7 days after the summer school, groups of min. 2 people, open book (40%)

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<tr><td>Format</td><td>Summer school</td></tr>
<tr><td>Timing of the module</td><td>Spring semester, CW26

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</td></tr>
<tr><td>Venue</td><td>On-site lectures in Fribourg</td></tr>
<tr><td>Bibliography</td><td>

Ullmann’s Encyclopedia of Industrial Chemistry. DOI: 10.1002/14356007
Dynochem Resources. Locate to: https://www.scale-up.com/
Techniques de l’ingénieur. Locate to: https://www.techniques-ingenieur.fr/
Ignatowiz, E. (1997). Chemietechnik. Haan-Gruiten: Verlag Europa-Lehrmittel
Stoessel, F. (2008). Thermal Safety of Chemical Processes. Weinheim: WILEY-VCH
Legal texts regarding chemistry (chapter 813). Locate to: https://www.admin.ch/opc/fr/classified-compilation/81.html

Lectures notes (PDF) and additional material (exercises) will be delivered in addition before and during the module.
</td></tr>
<tr><td>Language</td><td>English</td></tr>
<tr><td>Links to other modules</td><td>Coordination with modules:

C4, Green Chemistry
C5, Chemistry and Energy

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<tr><td>Comments</td><td>-</td></tr>
<tr><td>Last Update</td><td>07.09.2022</td></tr>
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Module title	**Journal Club Environmental and Natural Resource Sciences**
Code	E1
Degree Programme	Master of Science in Life Sciences
Group	Environment
Workload	3 ECTS (90 student working hours: 42 lessons contact = 32 h; 58 h self-study)
Module Coordinator	**Name**: Dr. Lindsey Norgrove **Phone**: +41 (0)31 910 21 94 **Email**: lindsey.norgrove@bfh.ch **Address**: Berner Fachhochschule, HAFL, Länggasse 85, 3052 Zollikofen
Lecturers	• Dr. Lindsey Norgrove, BFH • Dr. François Lefort, HES-SO • Dr. Philippe Corvini, FHNW • Dr Silvia Zingg, BFH • Possibly guest lecturers
Entry requirements	Students will be asked to read the selected articles before the start of the module and select their preferred papers Preferences (1-6) should be listed in the provided excel file and emailed to the module coordinator at least two weeks before the start of the module. A self-test will be made available on Moodle similar to the morning tests, so that students can get used to the format.
Learning outcomes and competences	After completing the module, students will be able to: • Grasp main ideas of a scientific publication • Identify novelties in approach, methods and results • Describe to peers the conclusions and their relevance to the scientific community • Critically reflect on the above • Understand meta-analyses
Module contents	Lecturers from the three schools identify recent peer-reviewed papers from their specialization that are meaningful to a wider public (e.g. from Nature, Science). They provide a general matrix for analysis and questions specific to each paper. Papers are grouped into several themes (one per day) and participating lecturers take responsibility for entire themes. Students choose a paper of their interest for in-depth study and prepare a presentation, either individually or in pairs, to their classmates. Yet, all students read all the 25-30 papers as preparation for the scientific debate in class and further students act as discussants, preparing critical questions. The module is structured as follows into the seven sessions: 1. Introduction: The process of scientific publishing (incl. peer review); the idea of the journal club; tasks and responsibilities of students; allocation of papers; etiquette in scientific debates; team work contract, if applicable; presentation skills, systematic reviews and meta-analyses. 2. Reading and online coaching (students stay in their home school; the lecturers for each theme are available remotely for questions; the module coordinator is available remotely) 3.-7. Journal club in the narrow sense with the following structure (moderation by the lecturer responsible for the theme of the day) a) Morning test (20', multiple choice, on Moodle) on all papers b) Introduction by the lecturer responsible for the theme c) Presentations and debate for each paper, discussants give their individual arguments in the debate The lecturer responsible for the theme corrects for each paper any wrong concepts presented by students

	d) Wrap-up by the lecturer: What are the links and cross-cutting issues between the papers, what can we learn from the debates? e) Overall evaluation (week 7 only)
Teaching / learning methods	Inputs on general principles illustrated by examples from NRM and followed by exercises Seminar style for sessions 3-7
Assessment of learning outcome	1. 5 morning tests (written, individual, open-book). The results of all tests count (30%) 2. Presentation (50%) - form depends on the number of participants: - teams of two or more (group mark) - individual presentation 3. Performance as discussant (individual) (20%)
Format	7-weeks
Timing of the module	Autumn semester, CW 38-44
Venue	Bern and/or online
Bibliography	Pre-course material: 30 publications will be uploaded on Moodle four weeks before the start of the module. Luederitz C, Meyer M, Abson DJ, Gralla F, Lang DJ, Rau AL, von Wehrden H, 2016. Systematic student-driven literature reviews in sustainability science–an effective way to merge research and teaching. Journal of Cleaner Production, 119, 229-235.
Language	English
Links to other modules	The framework for analysis could be useful also in other modules where papers play an important role.
Comments	The module will be given by lecturers from the three schools; the lecturers from HES-SO and FHNW contribute one theme each linked to their specialisations (including identifying suitable papers and guiding through the respective day). The present proposal includes systematic reviews / meta-analyses only as a topic, which will be illustrated by examples.
Last Update	07.02.2023

Module title	**Life Cycle Assessment**
Code	E2
Degree Programme	Master of Science in Life Sciences
Group	Environment
Workload	3 ECTS (90 student working hours: 42 lessons contact = 32 h; 58 h self-study)
Module Coordinator	**Name**: Dr. Matthias Meier **Phone**: +41 (0)31 910 22 88 **Email**: matthiassamuel.meier@bfh.ch **Address**: Bern University of Applied Sciences, HAFL, Länggasse 85, 3052 Zollikofen
Lecturers	• Dr. Thomas Kägi (Carbotech) • Mischa Zschokke (Carbotech) • Dr. Matthias Meier (BFH-HAFL)
Entry requirements	To be able to successfully participate in this module, students should have: • profound knowledge of subject matter in their field of expertise; • basic knowledge of environmental challenges such as climate change, water pollution, ecosystem eutrophication, soil acidification, etc.; • experience in working with databases and analytical software (needed to be able to work with LCA software during the module). • A self-test for assessing personal competences in relation to the module contents is available on the Moodle platform.
Learning outcomes and competences	After completing the module, students will be able to: • understand the principles of life cycle assessment (LCA) and appraise the potential and limitations of the method for their personal field of expertise/work; • correctly plan and carry out an LCA using common LCA software tools and databases; • critically review and interpret LCA studies and results.
Module contents	Quantitative information on the environmental impacts of products and services is ever more important in the optimization of production processes and value chains. LCA is the most widely used method for quantifying global warming potential, energy use, eutrophication potential and other environmental impacts of products and services, from cradle to grave. • Life cycle thinking as the underlying principle of LCA. • Where did LCA evolve from and how was it developed further? Seminal examples of LCA. • How can LCA support environmental decision making? Applications of LCA in industrial and agricultural/food contexts. Use and misuse of LCA. • Overview of other methodological approaches based on life cycle thinking to assess social and economic sustainability aspects (social LCA, life cycle costing). • The four steps of LCA: 1. Goal and scope definition (defining goals, system boundaries, functional units amongst others); 2. Life cycle inventory analysis (data collection and emissions modelling); 3. Life cycle impact assessment (midpoint and endpoint impact assessment methods); 4 Interpretation of results (critical evaluation of reliability and limitations of the analysis). • Case study (group work): students carry out an LCA of a product/service from their field of expertise using LCA software tools and databases.
Teaching / learning methods	• Interactive lectures • Discussions • Group work (practical case study) • Presentations (practical case study)

Assessment of learning outcome	1. Written group report on the LCA case study (50%) 2. Oral group presentation of the LCA case study (50%)
Format	7-weeks
Timing of the module	Autumn semester, CW 45-51
Venue	Blended learning format. Presence sequences take place in Berne
Bibliography	• ISO norms 14040 and 14044 • Klöpffer W, Grahl B, 2014. Life Cycle Assessment (LCA): A Guide to Best Practice. Wiley-VCH Publishers. (Note: If you understand German, you should rather read the German version of this textbook.) • Selected, regularly updated, articles that highlight potential and limitations of LCA e.g., in the food and chemical industries. • A comprehensive script is available for download from the Moodle course of this module.
Language	English
Links to other modules	There is a link to several advanced sustainability modules (e.g., “Holistic Assessment of Production Systems” [MSLS_AF-22 AS] at BFH, “Sustainable Food Supply Chains” [MSLS F4] at ZHAW).
Comments	Students will CARRY OUT an LCA. It is important that they can choose the product (or service) to analyse; this allows them to draw on their diverse backgrounds.
Last Update	18.04.2023

Module title	**Sustainable Natural Resource Management**
Code	E3
Degree Programme	Master of Science in Life Sciences
Group	Environment
Workload	3 ECTS (90 student working hours: 42 lessons contact = 32 h; 58 h self-study)
Module Coordinator	**Name**: Dr. Dominic Blaettler **Phone**: +41 (0)31 910 22 50 **Email**: dominic.blaettler@bfh.ch **Address**: Berner Fachhochschule, HAFL, Länggasse 85, 3052 Zollikofen
Lecturers	• Dr. Dominic Blaettler, BFH-HAFL • Sandra Wilhelm, anderskompetent.ch • Guest lecturers
Entry requirements	To be able to successfully participate in this module, students should: • Have knowledge of the core concepts of natural resources management (NRM) and sustainable development, especially in their own field of expertise or study; • Have a basic understanding of concepts such as human behaviour, stakeholders, institutions and governance in NRM or environmental issues; • Take a strong interest in current issues at the human/environment interface. Documents covering these aspects will be made available on Moodle, along with key questions students should be able to answer (self-test). To prepare specifically for the module, students will have to read up literature before the start of the module in order to be well prepared for contact teaching.
Learning outcomes and competences	After completing the module, students will be able to: • Work with the core principles of sustainable NRM • carry out a stakeholder analysis, an institutional analysis and apply techniques of behaviour change • Assess conflict potential over natural resources, use conflict analysis tools and devise ways of conflict mediation and dispute settlement (link between NRM and conflict management) • Differentiate between approaches to NRM and relate them to policy interventions/governance measures • Express their own opinion, debate with others, moderate discussions and produce session proceedings
Module contents	The key focus and overarching topic of the module is sustainable natural resources management, understood less as a technical but rather as a complex and dynamic process of human-environment interaction. Conflicts are a central issue, as natural resource management is often conflict management. 'The Future is Now' (UN, 2019) serves as a starting point for the module. Where do we stand regarding natural resources and their management, what are the challenges and where do we go? How are natural resources utilized, shared, by whom and how, and what norms and values regulate access to natural resources, their use and distribution? This paves the road for an Extended Case Study (Mongolia) where a number of the pertinent practical challenges of sustainable NRM become apparent. To go deeper requires having a closer look at theoretical and methodological aspects of NRM which go together with very concrete and real-life examples involving invited guest speakers from a variety of backgrounds. Topics include: human behaviour, stakeholders, institutions, governance, policy and conflict mediation. In addition, a series of case studies will shed light on the diversity of approaches for the management of different natural resources (forest, land, water). The case studies will be selected to reflect different geographical regions, different scales of assessment, different methods of analysis and different sources of conflict and potential solutions. Invited guest speakers will

<table>
<tr><td></td><td>link theory and methodology to practice by sharing professional experience from their fields of expertise. More generally, E-3 module is also about interdisciplinary learning and Education for Sustainable Development.</td></tr>
<tr><td>Teaching / learning methods</td><td>• Thematic/methods inputs (lectures)
• Guest lectures
• Debates, and debate moderation
• Case study exercises, group work (“family tables”)
• Self-test</td></tr>
<tr><td>Assessment of learning outcome</td><td>1. Final written exam, open book (80%)
2. Assessment of group moderation & discussion summary (20%)</td></tr>
<tr><td>Format</td><td>Winter School</td></tr>
<tr><td>Timing of the module</td><td>Autumn semester, CW 4
<table>
<tr><th>Day of the block week</th><th><1</th><th>1</th><th>2</th><th>3</th><th>4</th><th>5</th><th>>5</th></tr>
<tr><td>Contact teaching (lessons)</td><td></td><td>8.5</td><td>8.5</td><td>8.5</td><td>8.5</td><td>8</td><td></td></tr>
<tr><td>Self-study (hours)</td><td>20</td><td></td><td></td><td></td><td></td><td></td><td>38</td></tr>
</table></td></tr>
<tr><td>Venue</td><td>Zollikofen</td></tr>
<tr><td>Bibliography</td><td>Core reading for the Module:
United Nations, 2019. Global Sustainable Development Report 2019: The Future is Now – Science for Achieving Sustainable Development. New York. Executive Summary.
Gardner GT, Stern PC, 2002. Environmental problems and human behavior. 2nd ed. Boston, MA: Pearson Custom Publishing.
GTZ, n.d. Conflict Analysis. GTZ: FRCS.
SDC PED, 2011. Stakeholder Analysis. Bern: SDC.
SDC, 2016. Analysing informal local governance institutions. Bern: SDC.</td></tr>
<tr><td>Language</td><td>English</td></tr>
<tr><td>Links to other modules</td><td>There is a link to several specialisation modules dealing with sustainability (e.g. ‘Holistic assessment of production systems’ of BFH or ‘Policies and institutions as drivers for development and innovation’ of BFH).</td></tr>
<tr><td>Comments</td><td></td></tr>
<tr><td>Last Update</td><td>28.02.2023</td></tr>
</table>

<table>
<tr><td>Module title</td><td>Ecological Infrastructure in Landscapes</td></tr>
<tr><td>Code</td><td>E4</td></tr>
<tr><td>Degree Programme</td><td>Master of Science in Life Sciences</td></tr>
<tr><td>Group</td><td>Environment</td></tr>
<tr><td>Workload</td><td>3 ECTS (90 student working hours: 42 lessons contact = 32 h; 58 h self-study)</td></tr>
<tr><td>Module Coordinator</td><td>Name: Dr. Claude Fischer
Phone: +41 (0)22 546 68 75
Email: claude.fischer@hesge.ch
Address: hepia, filière Gestion de la Nature, 150 route de Presinge, 1254 Jussy</td></tr>
<tr><td>Lecturers</td><td>• Dr. Claude Fischer, hepia, HES-SO
• Dr. Beat Oertli, hepia, HES-SO
• Dr. Jeremy Gauthier, Muséum Cantonal des Sciences Naturelles de Lausanne
• Member of the cantonal administration and local experts</td></tr>
<tr><td>Entry requirements</td><td>Knowledge of following concepts: Biodiversity, Ecosystem, Populations and Communities, Spatial behavior (home range, dispersion, migration), Spatio-temporal space use of populations (seasonality, activity), Theory of island biogeography, Basics in population genetics, Basic GIS
Recommended documents (to acquire the entry requirement): Campbell Biology (11th edition), chapters: 23, 53, 55.

See also information under “comments”</td></tr>
<tr><td>Learning outcomes and competences</td><td>After completing the module, students will be able to:
• Assess the ecological infrastructure in a landscape
• Identify corridors and gaps in ecological networks (with GIS tools)
• Plan and model land-use trends (e.g. development in urban, rural or mountain areas)
• Make propositions for the restoration of the landscape (functional infrastructure)</td></tr>
<tr><td>Module contents</td><td>• Landscape and Movement Ecology
• The national ecological network (from national to local implementation)
• GIS tools for assessing and representing the ecological infrastructure and the dynamics of land-use
• Genetic tools for measuring ecological connectivity (spatial genetic structure of populations)
• Decision-making support for spatial land-use planning and interconnecting areas of importance</td></tr>
<tr><td>Teaching / learning methods</td><td>The module is organized in three complementary parts: 1. Theoretical introduction, 2. A real case-study (in interaction with professionals), 3. An introduction to landscape genetics. These different aspects will be integrated in a practical project.</td></tr>
<tr><td>Assessment of learning outcome</td><td>1. An individual written report (with a joined GIS project) to be handed in 3 weeks after the end of the module (100%)</td></tr>
<tr><td>Format</td><td>Winter School</td></tr>
<tr><td>Timing of the module</td><td>Autumn semester, CW 6

<table>
<tr><th>Day of the block week</th><th><1</th><th>1</th><th>2</th><th>3</th><th>4</th><th>5</th><th>>5</th></tr>
<tr><td>Contact teaching (lessons)</td><td></td><td>10</td><td>8</td><td>8</td><td>8</td><td>8</td><td></td></tr>
<tr><td>Self-study (hours)</td><td>8</td><td></td><td></td><td></td><td></td><td></td><td>42</td></tr>
</table></td></tr>
<tr><td>Venue</td><td>Geneva (practical parts in the surroundings of Geneva)</td></tr>
<tr><td>Bibliography</td><td><u>Landscape ecology:</u></td></tr>
</table>

	J. A. Hilty J., W. Z. Lidicker Jr., and A. M. Merenlener (2006). Corridor Ecology. The science and practice of linking landscapes for biodiversity conservation. Island press M. G. Turner & R. H. Gardner (2015). Landscape Ecology in Theory and Practice. Pattern and Processes. Springer. National Ecological Network: http://www.sib.admin.ch/ Landscape genetics: N. Balkenhol, S. Cushman, A. Storfer, and L. Waits (2015) Landscape Genetics: Concepts, Methods, Applications. Wiley-Blackwell, Oxford (http://www.landscapegenetics.info/)
Language	English
Links to other modules	There will be close coordination with the CS-module E5 “Biodiversity”. Both modules are designed to be complementary. Links with E3 “Sustainable Natural Resource Management”, GIS modules at HES-SO and BFH.
Comments	There is a participant limit in this module. Registrations will be considered as follows: 1. Students for whom E4 is a compulsory module 2. Students from the Environment-Cluster 3. Students who need the ECTS for the graduation in the semester concerned 4. The remaining places will be drawn by lot Whether participation is possible will be communicated by the end of week 37.
Last Update	21.04.2023

Module title	**Biodiversity**
Code	E5
Degree Programme	Master of Science in Life Sciences
Group	Environment
Workload	3 ECTS (90 student working hours: 42 lessons contact = 32 h; 58 h self-study)
Module Coordinator	**Name**: Dr Andreas Stampfli (BFH) **Phone**: +41 (0)31 910 21 98 **Email**: andreas.stampfli@bfh.ch **Address**: Berner Fachhochschule, HAFL, Länggasse 85, 3052 Zollikofen
Lecturers	• Dr. Alessandra Giuliani, BFH • Dr. Thibault Lachat, BFH • Dr. Heidi Signer-Hasler, BFH • Dr. Silvia Zingg, BFH • Guest lecturers
Entry requirements	To be able to successfully participate in this module, students need to: • know the basic concepts related to biodiversity (diversity within and between species and of ecosystems, options for characterization of diversity, natural versus human-influenced ecosystems) • have down-to-earth experience with measures to preserve biodiversity or to make use of it in production systems • be familiar with the drivers of biodiversity loss and maintenance and identify them in a specific case Documents covering these aspects will be made available on Moodle, along with key questions that the students should be able to answer. Respective skills and knowledge will be assessed in the end-of-module exam.
Learning outcomes and competences	After completing the module, students will be able to: • relate issues of biodiversity to their specific fields of expertise • assess the impact of interventions in natural resource management on biodiversity design effective measures for maintaining and enhancing biodiversity in their specific field of expertise.
Module contents	Starting with concepts and a theoretical ecological framework related to biodiversity, the module will illustrate biodiversity maintenance and ecological applications using selected cases from both human-influenced and natural ecosystems. Students will work on specific cases in problem-solving classes and present these cases in a seminar. Introduction • Global change, species loss, rise of the concept, status and trends of biodiversity • Biodiversity and the functioning of ecosystems • Biodiversity products and ecosystems services • International conventions and policies aiming at sustainable management of biodiversity and their impact Management for biodiversity maintenance • Land use and biological conservation in the Alps • Examples for biodiversity maintenance in forest, grassland and aquatic ecosystems • Sustainable management and development of value chains to maintain biodiversity • Genetic resources for food and agriculture, their use and conservation strategies • Molecular techniques for optimizing conservation: The case of local animal breeds Ecological applications in natural resources management – agrobiodiversity • Species diversity in production: intercropping, permaculture • Enhancing productivity and resilience and mitigating climate change by agroforestry

	• Effects of interventions in habitat diversity on pest control • Linking ecological principles and sustainable resource use Seminar: cases of biodiversity maintenance and use
Teaching / learning methods	Contact teaching: • Lectures • Field excursion • Joint development of conceptual framework • Presentation and discussion of case studies • Seminar-style workshop with students presenting cases • Exercises Self-study: • Pre-course assignments • Analyzing case studies during the module • Studying documents on conceptual frameworks • Preparing for the workshop
Assessment of learning outcome	1. Presentation of a case study in class, groups of 2 (50%) 2. Final essay (50%)
Format	7-weeks
Timing of the module	Spring semester, CW 8-14
Venue	Blended learning format. Presence sequences take place in Berne
Bibliography	For preparation of entry requirements and lectures: Mittelbach GG, 2012. Biodiversity and ecosystem functioning. In: Community ecology, pp. 41-62. Sinauer, Sunderland, MA, USA. For preparation of lectures: TEEB, 2010. The Economics of Ecosystems and Biodiversity: mainstreaming the economics of nature: a synthesis of the approach, conclusions and recommendations of TEEB. During the course, more selected references and an extensive list of papers for the workshop and for further reading will be available on Moodle
Language	English
Links to other modules	There is a link to specialisation modules dealing with production systems (agro-biodiversity, diversity in forests) or with management of natural areas. There will be close coordination with the CS-module E4 “Ecological Infrastructure in Landscapes”. Both modules are designed to be complementary.
Comments	In teams of two, students choose the topic for their case study from a list of topics provided, covering the vast array of biodiversity studies. They can thus pursue their specific interests and learn from well selected scientific papers for their case.
Last Update	18.09.2022

Module title	**Water Management for Households, Industry and Agriculture**
Code	E6
Degree program	Master of Science in Life Sciences
Group	Environment
Workload	3 ECTS (90 student working hours: 42 lessons contact = 32 h; 58 h self-study)
Module coordinator	**Name**: Christoph Hugi **Phone**: +41 61 228 55 84 **Email**: christoph.hugi@fhnw.ch **Address**: FHNW Campus Muttenz, Hofackerstrasse 30, CH-4132 Muttenz
Lecturers	• Christoph Studer, BFH-HAFL • Dirk Hengevoss, FHNW-HLS • Christoph Hugi, FHNW-HLS • Maryna Peter, FHNW-HLS • Emmanuel Oertlé, FHNW-HLS
Entry requirements	Basic knowledge of environmental technologies and management. Basic knowledge about water resources and environmental quality aspects (Blanc 2014). • Documents covering these aspects will be made available on Moodle, along with key questions that the students should be able to answer before the start of the module.
Learning outcomes and competences	After completing the module, students will be able to: • explain the relationships between water quality aspects and human health as well as environmental quality. • apply basic methods to describe and assess water resources and their utilization for main sectors (household/industry/agriculture) and environmental needs. • apply methods in the different phases of managing the water cycle to enable efficient and effective utilization and conservation of water resources.
Module contents	• Characteristics of water resources: precipitation, surface water, and groundwater • Status and exploitation of water resources (quantitative and qualitative aspects) • Water abstraction, treatment, and distribution systems for the different sectors (household/industry/agriculture) • Water use/reuse/discharge and challenges in different sectors (household/industry/agriculture) • Water demand and supply management • Water distribution and water loss reduction • Monitoring and pricing of water use • Water resources protection incl. Habitat management • Water quality health and environmental impacts • Total water cycle management / integrated water resources management • Student seminar
Teaching / learning methods	The module will be a mix of project/problem-based lectures, tutorials and group work leading to a seminar presentation, and several practical exercises on the water topics covered in the course (quantity and quality).
Assessment of learning outcome	• Group writing assignment and seminar presentation during the course (40%) • Individual assignments during the course (60%)
Format	7-weeks
Timing of the module	Spring semester, CW 15-21
Venue	Mix of online and on-site lectures (in Olten)
Bibliography	• BAFU about water resources management: Water resource management (admin.ch) and High-level instruments (admin.ch) • Blanc P (2014) Water in Switzerland – an overview. Swiss Academies of Arts and Sciences

	• Holden JA (2013) Water Resources: An Integrated Approach. Taylor & Francis. ISBN-139780415602822 • United Nations World Water Assessment Reports: http://www.unesco.org/new/en/natural-sciences/environment/water/wwap • Federal Office of Public Health and Federal Office for the Environment (2010) Reporting for Switzerland under the Protocol on Water and Health
Link to other modules	Links with E3 “Sustainable Natural Resource Management”, GIS modules at HES-SO and BFH.
Comments	-
Last update	16.05.2023

Module title	**Progresses in Food Processing**
Code	F1
Degree Programme	Master of Science in Life Sciences
Group	Food
Workload	3 ECTS (90 student working hours: 42 lessons contact = 32 h; 58 h self-study)
Module Coordinator	**Name**: Prof. Dr. Michael Beyrer **Phone**: +41 (0)27 606 85 23 **Email**: michael.beyrer@hevs.ch **Address**: School of Engineering, Institute of Life Technologies, Rue de l'Industrie 19, 1950 Sion
Lecturers	• Prof. Dr Michael Beyrer, HES-SO • Guest lecturers
Entry requirements	• Basic knowledge of thermal and mechanical food processing operations • Basic understanding of heat and mass transport phenomena • Knowledge of most characteristic modifications of food ingredients caused by the processing or preparation of food • Basic knowledge in food microbiology • Basic skills in chemical, microbiological and physical food analysis • **See also information under "comments"**
Learning outcomes and competences	After completing the module, the students will be able to • explain principles and fields of application of several emerging food processing technologies, • measure, report, and discuss the influence of the different technologies on food properties.
Module contents	Theoretical input We explain principles, equipment design, and impact on food properties of emerging technologies. For illustration, we present case studies for beverages, fruits, vegetables, plant-based food, meat, and dairy products and discuss the technologies' advantages, limitations, and technical readiness. The lecture focuses on (1) non-thermal and (2) plant-based food technologies applicable at a large scale. Specifically, pulsed electric fields and high-pressure processing will be elucidated in the chapter (1) and extraction of proteins and twin-screw extrusion in chapter (2). Practical activities 1st activity: Shelf-life extension and food safety control with non-thermal technologies • Inoculation of food with relevant spoilage microorganisms • Inactivation of microorganisms by heat, pulsed electric field and high pressure at the pilot-plant scale • Detection of the inactivation effect and calculation of inactivation kinetics • Determination of variation of other characteristic product properties, such as colour, antioxidant capacity, texture, and viscosity as a function of the type of treatment and process window • Optional: Cold atmospheric plasma treatments • Reporting and discussion of results 2nd Topic: Plant-based food • Illustration of the down-stream processing of bioresources for protein extracts and powder manufacturing • Training on methods for the characterisation of techno-functionality of proteins, such as dynamic viscosity, thermal analysis, water holding capacity, and protein solubility

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Training on twin-screw extrusion for producing meat substitutes
Methods for the characterisation of extruded plant-based foods such as texture analyses and sensory evaluation
Reporting and discussion of results

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<tr><td>Teaching / learning methods</td><td>
<u>Theoretical inputs (18% - 16h):</u>

Lecturing and co-working

<u>Practicals (18% - 16h)</u>

Practical activities in the pilot plant and several laboratories

<u>Self-study (64% - 58h)</u>

Pre-reading – 24h
Report preparation: 20h
Exam preparation: 12h
Written exam: 1h

</td></tr>
<tr><td>Assessment of learning outcome</td><td>
1. Final individual written test for theoretical inputs and self-study (closed book; 60%)

2. Group report for practical's assessment, to be handed in 3 weeks after the end of the module (40%)
</td></tr>
<tr><td>Format</td><td>Winter School</td></tr>
<tr><td>Timing of the module</td><td>
Autumn semester, CW 4

<table>
<tr><td>Day of the block week</td><td><1</td><td>1</td><td>2</td><td>3</td><td>4</td><td>5</td><td>>5</td></tr>
<tr><td>Contact teaching (lessons)</td><td></td><td>8</td><td>9</td><td>9</td><td>8</td><td>8</td><td></td></tr>
<tr><td>Self-study (hours)</td><td>24</td><td>2</td><td>2</td><td>2</td><td>2</td><td>2</td><td>24</td></tr>
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</td></tr>
<tr><td>Venue</td><td>Sion / Sitten</td></tr>
<tr><td>Bibliography</td><td>
Recommended textbooks for pre-course work (information regarding relevant chapters will be provided on Moodle):
Fellows PJ, 2016. Food Processing Technology. Woodhead Publishing, 4th edition, 1152 pp.
Singh RP, Heldman D, 2013. Introduction to Food Engineering. Academic Press, 5th edition, 892 pp.
Advanced course material:
Sun DW, 2014. Emerging Technologies for Food Processing. Academic Press, 2nd edition, 666 pp.
</td></tr>
<tr><td>Language</td><td>English</td></tr>
<tr><td>Links to other modules</td><td></td></tr>
<tr><td>Comments</td><td>
There is a participant limit in this module. Registrations will be considered as follows:
1. Students for whom F1 is a compulsory module
2. Students from the Food-Cluster
3. Students who need the ECTS for the graduation in the semester concerned
4. The remaining places will be drawn by lot

Whether participation is possible will be communicated by the end of week 37.
</td></tr>
<tr><td>Last Update</td><td>18.04.2023</td></tr>
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Module title	**Nutrition and Nutrition Related Chronic Diseases**
Code	F2
Degree Programme	Master of Science in Life Sciences
Group	Food
Workload	3 ECTS (90 student working hours: 42 lessons contact = 32 h; 58 h self-study)
Module Coordinator	**Name**: Janice Sych **Phone**: +41 (0)58 934 59 90 **E-Mail:** janice.sych@zhaw.ch **Address**: ZHAW Life Sciences und Facility Management, Einsiedlerstrasse 34, 8820 Wädenswil
Lecturers	• Dr. Janice Sych, ZHAW • Dr. David Fäh, BFH • Dr. Samuel Mettler, BFH • Guest speaker(s) / Assistant(s) to be announced
Entry requirements	At least one module at bachelor level with nutrition-related contents and one with basic statistics.
Learning outcomes and competences	After completing the module, students will be able to: • Summarize main characteristics and impacts of nutrition-related chronic diseases (the 4 main NCDs). • Describe the main characteristics of healthy versus unhealthy diets; nutritional recommendations and what people actually eat; and key determinants of dietary behaviour and health. • Critically discuss the evidence linking diet (nutrition-related exposures) with increased or decreased risk of NCDs, and the different perspectives on physical activity / inactivity. • Identify and assemble in a diagram the most important factors contributing to NCDs and discuss their interactions. • Propose new approaches to tackle NCDs and promote health.
Module contents	The course aims to develop an understanding about the role of diet in maintaining health and preventing disease, considering the four major NCDs. A holistic approach will be promoted as students explore the following topics: • Healthy/unhealthy diet; dietary patterns versus food group /nutrient-focus; new approaches to dietary assessment; health effects of bioactives. • Basic theory for selected NCDs (obesity, diabetes type 2, cardiovascular diseases, specific types of cancer). • Physical activity / inactivity and health outcomes. • Selected examples also include aspects of nutrient-gene interactions, the microbiome and the food environment as related to NCDs. • Basic terminology in nutrition epidemiology (study designs; levels of evidence and causation) and public health.
Teaching / learning methods	Lecture and assignments, emphasizing critical thinking and student-centered learning • Pre-course slide casts and readings, must be completed before the course. • Individual / group activities, based on theory and readings
Assessment of learning outcome	1. Written final exam: 40 % - closed book 2. Group project: 60 %
Format	Block week
Timing of the module	Winter school CW 6

Day of the block week	**<1**	**1**	**2**	**3**	**4**	**5**	**>5**
Contact teaching (lessons)		8	9	9	8	8	
Self-study (hours)	20	2	2	2	2	0	30

Venue	Olten
Bibliography	Pre-course reading Slidecasts and other materials for course preparation will be uploaded on the Moodle course, including selected research papers and weblinks. Diet Collaborators 2019: Health effects of dietary risks in 195 countries, 1990–2017: a systematic analysis for the Global Burden of Disease Study 2017. Lancet 393:1958-72 Global Nutrition Report, 2017. Nourishing the SDGs, Bristol, UK: Development Initiatives: (summary and chapters 1-2). Bassaganya-Riera et al. 2021. Goals in Nutrition Science 2020-2025 Frontiers in Nutrition. Key et al. 2020 Diet, nutrition, and cancer risk: what do we know and what is the way forward. BMJ 2020. Lieberman 2015 Is Exercise really medicine: an evolutionary perspective. Current Sports Medicine Reports. Cade 2017 Measuring diet in the 21st century: use of new technogies. 76, 276-282. Willett W, 2012. Nutritional epidemiology (third edition), Publisher: Oxford University Press, (Chapters 1-5).
Language	English
Links to other modules	
Comments	
Last Update	01.04.2023

Module title	**Foodomics**
Code	F3
Degree Programme	Master of Science in Life Sciences
Group	Food
Workload	3 ECTS (90 student working hours: 42 lessons contact = 32 h; 58 h self-study)
Module Coordinator	**Name**: Dr. Wolfram Brück (HES-SO, Sion) – Representing FNH (BFH) **Phone**: +41 (0)27 606 86 64 **Email**: wolfram.bruck@hevs.ch **Address**: HES-SO Valais//Wallis, Institute of Life Technologies, Route du Rawyl 64 1950 Sion
Lecturers	• Dr. Wolfram Brück • Guest lecturers
Entry requirements	Preparatory reading list given before course begins and unmarked online pre-test on reading material Preparatory work for terminology and online pre-test
Learning outcomes and competences	After completing the module, students will be able to: • Explain digestive tract anatomy & function; • Explain a nutrient's absorption, metabolism, elimination or biological effects; • Evaluate current nutrigenomic, microbiome and metabolome methods (16S sequencing and metagenome sequencing (NGS-based), NMR, HPLC-MS, GC-MS); • Develop strategies to evaluate and analyse large data sets (data mining); • Formulate their own ideas on the impact of dietary regulation of gene function on human disease; • Explain the basics of systems biology.
Module contents	• Digestive tract anatomy & function • Nutrient absorption, metabolism, biological effect and elimination • Nutrition and the human microbiome in health and disease - I: Overview - II: Gut-Brain Axis and autoimmune diseases • How the Microbiome Influences Host Diet Metabolism • How Diet Impacts the Microbiome • Pre- and Probiotics • Microbiota-Targeted Therapies: An Ecological Perspective • Tools and Models for Assessment of the Microbiome and Metabolome • Dietary regulation of gene function • Metabolic disorders • Working with large data sets: Strategies, Programs, Formatting • Functional Foods and personalised nutrition • Regulatory Framework & Challenges • Systems biology
Teaching / learning methods	Self-study, group work, student and instructor presentations, instructor lead discussions, case studies
Assessment of learning outcome	3. Presentation of group work (50%) 1. Written final examination, closed book (50%)
Format	7-weeks
Timing of the module	Spring semester, CW 8-14
Venue	Blended learning format. Presence sequences take place in Berne
Bibliography	Pre-course reading: • Pray L, Pillsbury L, Tomayko E, 2013. The Human Microbiome, Diet, and Health. The National Academic Press, Washington D.C., USA (doi.org/10.17226/13522.) – **Free pdf download**

	Selected reading (suggested): • Foodomics: Omic Strategies and Applications in Food Science Editor: Jorge Barros-Velázquez, Print ISBN-10: 1788018842 • Foodomics: Advanced Mass Spectrometry in Modern Food Science and Nutrition, Editor: Alejandro Cifuentes, Print ISBN: 9781118169452 • Bioinformatics for High Throughput Sequencing Editors: Naiara Rodríguez-Ezpeleta, Michael Hackenberg, Ana M. Aransay, Print ISBN: 978-1-4614-0781-2 • The Gut Microbiome in Health and Disease Editors: Dirk Haller, Print ISBN: 978-3-319-90544-0 • Metabonomics and Gut Microbiota in Nutrition and Disease Editors: Sunil Kochhar, Francois-Pierre Martin, Print ISBN : 978-1-4471-6538-5
Language	English
Links to other modules	The present module complements specialisation modules of BFH FNH-4 “Food for Specific Target Groups“ and FNH-5 “Food Ingredients“, where more specific subjects are addressed
Comments	
Last Update	12.07.2022

Module title	**Sustainable Food Supply Chains**
Code	F4
Degree Programme	Master of Science in Life Sciences
Group	Food
Workload	3 ECTS (workload: 90 hours comprising 32 contact hours (= 42 lessons) plus 58 h self-study)
Module Coordinator	**Name**: Dr. Claudia Müller **Phone**: +41 (0)58 934 54 53 **Email**: claudia.mueller@zhaw.ch **Address**: ZHAW Life Sciences und Facility Management, Einsiedlerstrasse 34, 8820 Wädenswil
Lecturers	• Dr. Claudia Müller, ZHAW • Dr. Kirsten Hillebrand, BFH • Regula Keller, ZHAW • Dr. Evelyn Markoni, BFH • Dr. Matthias Meier, BFH • Further guest lecturers
Entry requirements	Knowledge of food technology and / or of agriculture, as well as basic knowledge of the principles of sustainability is highly recommended. Compulsory online module and corresponding pre-course test.
Learning outcomes and competences	After completing the module, students will be able to: • explain sustainability in all three dimensions; • illustrate how sustainability relates to the current food system; and • develop a sustainable food system model (= concept of a sustainable supply chain) for the future – one which is economically viable, environmentally friendly and socially acceptable – using the example of a selected food product.
Module contents	The main objective of the module is to understand the concept for the sustainability-driven production of healthy food using selected food products as examples. Therefore, the course will cover a holistic evaluation of the food value chain and its sustainability-performance with regard to social, economic, environmental and health aspects and will include: • principles of process analysis; • economic basis of a sustainable business; • sustainable agriculture (conventional versus organic); • environmental assessment (Life Cycle Analysis); • social aspects and sourcing; • process optimization; and • principles of a sustainable and healthy diet.
Teaching / learning methods	Students work in groups, assessing and optimizing the supply chain of a selected food product to make it more sustainable. Experts provide inputs on the different sustainability dimensions and stages of the supply chain during the course. They address the corresponding challenges with respect to sustainability.
Assessment of learning outcome	4. Online pre-course test (20%) 5. Two short online tests during the course (20%) 2. Group work (60%)
Format	7 weeks
Timing of the module	Spring semester, CW 15-21
Venue	Blended learning format. Presence sequences take place in Olten
Bibliography	Smith, 2008. Developing sustainable food supply chains; Philosophical Transaction of the Royal Society; 363: 849-861; https://doi.org/10.1098/rstb.2007.2187 FAO, 2018. Sustainable Food Systems – Concept and framework; http://www.fao.org/3/ca2079en/CA2079EN.pdf

Language	English
Links to other modules	Potential similarities and links to E2 ‘Life Cycle Assessment’
Comments	There will be compulsory attendance on 3 days of the module (estimated: week 1, week 6 and week 7).
Last Update	12.07.2022

Module title	**Advanced Sensory Techniques**
Code	F5
Degree Programme	Master of Science in Life Sciences
Group	Food
Workload	3 ECTS (90 student working hours: 42 contact lessons = 32 h; self-study = 58 h)
Module Coordinator	**Name**: Pascale Deneulin **Phone**: +41 22 363 40 55 **Email**: pascale.deneulin@changins.ch **Address**: CHANGINS, Route de Duillier 50, 1260 NYON
Lecturers	• Pascale Deneulin, HES-SO, CHANGINS • Charlotte Bourcet, BFH • Annette Bongartz, ZHAW • Guest lecturers
Entry requirements	Bachelor of Science in Life Sciences, basic sensory and statistical competences Sensory competences: the student should be familiar with basic sensory techniques (Discriminative analysis such as triangular test and two-out-of-five, Quantitative Descriptive Analysis, consumer acceptance and preference test) and basic physiology of human perception. Statistical competences: the student should be able to manage data e.g. with R software for descriptive analysis (Analysis of Variance, Chi-square test, Regression) and have basic knowledge of multivariate analysis (such as Principal Component Analysis and Clustering). It is recommended to attend the CC courses D1 (“Handling and Visualising Data”). As preparation for the block week, students are required to read papers available on Moodle 4 weeks before the beginning of the course. **See also information under “comments”**
Learning outcomes and competences	After completing the module, students will be able to: • Conduct a sensory case study from the initial question to the conclusion • Manage a sensory tasting session (give instructions to panellists, train panellists and validate performance, explain the sensory procedure, manage sample presentation), • Select the appropriate sensory technique from a wide range of tests depending on the objective of the study, • Apply common and advanced sensory techniques to beverages and others food products, • Manage statistical tools to process sensory data, • Illustrate the results with appropriate graphic representations, • Interpret the results and conclude, • Consider consumer expectations in terms of external information (e.g. packaging, medal) and marketing design, • Provide concrete recommendations based on sensory results in an industrial view.
Module contents	The module focusses on sensory aspects of food with two mains thematic: consumer acceptance/preference and descriptive analysis included new sensory methods. The aim is to give an advanced level to food science master students to manage sensory tests in connection with research and marketing questions taking the needs of the industry into account. **Sensory analysis in industrial context** • Industry example: Use of consumer & sensory methods along the development process **Neuroscience of tasting** • How the brain makes sense of food sensory dimensions **Consumer perception**

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Hedonic testing: application of qualitative and quantitative test methods in order to collect consumer acceptance data and consumer insights, taking the adequate number of consumers as well as target groups into account.
Correlation of data: identification of relevant analytical attributes (from sensory analysis and instrumental evaluations) in the context of consumer preference. What are the sensory cues and drivers of liking? Segmentation of consumers based on their sensory preference or consumer insights.
Internal and external preference mapping

Improvement of panel performance

Manage sensory panel: recruitment, training for Quantitative Descriptive Analysis and evaluation of panel performance
Validate panel performance

Innovative sensory evaluation techniques

History and origin of developing new and faster sensory methods
For each new method: principle and sensory test, application, statistical analysis, pros and cons

Verbal-based methods: Flash profile and Check-All-That-Apply
Similarity-based methods: Free sorting and Napping / Projective mapping
Reference-based methods: Polarized Sensory Positioning and Pivot profile

Statistical data management

Statistical methods to analyze sensory / consumer data
Statistical methods to correlate sensory / consumer data with marketing or instrumental data (chemistry, production parameters or other)

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<tr><td>Teaching / learning methods</td><td>

Previous self-study is mandatory – reading referenced papers
Lectures with practical examples
Sensory exercises (as panellist and as “panel leader”)
Practical data analysis
Final case-study
Active participation in the module is requested

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<tr><td>Assessment of learning outcome</td><td>
1. Case study (40%): the grade of case study included the practical part, data analysis, interpretation and oral presentation on Friday.
2. Written exam on Moodle, individual, open-book, final (60%)
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<tr><td>Format</td><td>Summer School</td></tr>
<tr><td>Timing of the module</td><td>
Spring semester, week 25
<table>
<tr><th>Day of the block week</th><th><1</th><th>1</th><th>2</th><th>3</th><th>4</th><th>5</th><th>>5</th></tr>
<tr><td>Contact teaching (lessons)</td><td></td><td>8</td><td>9</td><td>9</td><td>8</td><td>8</td><td></td></tr>
<tr><td>Self-study (hours)</td><td>11</td><td>2</td><td>2</td><td>2</td><td>2</td><td>2</td><td>37</td></tr>
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</td></tr>
<tr><td>Venue</td><td>Changins, haute école de viticulture et œnologie, 1260 NYON</td></tr>
<tr><td>Bibliography</td><td>
Final bibliography will be available on Moodle 4 weeks before the beginning of the module.
Delarue, J., Lawlor, B, Rogeaux, M. (2014). Rapid Sensory Profiling Techniques. Application sin new product development and consumer research. Ed. Woodhead Publishing, 584p.
Dehlholm, C., Brockhoff, P. B., Meinert, L., Aaslyng, M. D., & Bredie, W. L. P. (2012). Rapid descriptive sensory methods - Comparison of Free Multiple Sorting, Partial Napping, Napping, Flash Profiling and conventional profiling. Food Quality and Preference, 26(2), 267–277. https://doi.org/10.1016/j.foodqual.2012.02.012
Faye, P., Brémaud, D., Teillet, E., Courcoux, P., Giboreau, A., & Nicod, H. (2006). An alternative to external preference mapping based on consumer perceptive mapping. Food Quality and Preference, 17(7–8), 604–614. https://doi.org/10.1016/j.foodqual.2006.05.006
Lattey, K. A., Bramley, B. R., & Francis, I. L. (2010). Consumer acceptability, sensory properties and expert quality judgements of Australian Cabernet Sauvignon and Shiraz wines.
</td></tr>
</table>

	Australian Journal of Grape and Wine Research, *16*(1), 189–202. Valentin, D., Chollet, S., Lelièvre, M., & Abdi, H. (2012). Quick and dirty but still pretty good: a review of new descriptive methods in food science. *International Journal of Food Science & Technology*, *47*(8), 1563–1578. https://doi.org/10.1111/j.1365-2621.2012.03022.x
Language	English
Links to other modules	There is a participant limit in this module. Registrations will be considered as follows: 1. Students for whom F5 is a compulsory module 2. Students from the Food-Cluster 3. Students who need the ECTS for the graduation in the semester concerned 4. The remaining places will be drawn by lot Whether participation is possible will be communicated by the end of week 07.
Comments	
Last Update	14.07.2022

Module title	**Journal Club "Food and Nutrition Sciences"**
Code	F6
Degree Programme	Master of Science in Life Sciences (MSLS)
Workload	3 ECTS Credits (90 h: 32 h contact (= 42 lessons), 58 h self-study)
Module Coordinator	**Name** Dr Franziska Götze **Phone** +41 (0)31 910 29 43 **Email** franziska.goetze@bfh.ch **Address** Bern University of Applied Sciences BFH, School of Agricultural, Forest, and Food Sciences HAFL, Länggasse 85, 3052 Zollikofen, Switzerland
Lecturers	Specialization Food, Nutrition and Health • BFH-HAFL: coordinated by Dr Franziska Götze (Consumer Behaviour), Dr Evelyn Markoni (Sustainable Food Consumption), Dr Lindsey Norgrove (Introduction), Dr Lisamaria Bracher & Dr Stephanie Jeske (Bioconversion and Protective Cultures) • HES-SO Sion: coordinated by Dr Wilfried Andlauer and Dr Wolfram Brück (Bioactive compounds) • BFH-Health: coordinated by Dr Franziska Pfister and Dr Leonie Bogl (Public Health Nutrition) Specialization Food and Beverage Innovation • ZHAW: coordinated by Dr Claudio Beretta (Sustainability and Foodwaste) Specialization Viticulture and Enology • HES-SO Changins: coordinated by Dr Liming Zeng
Entry Requirements	Students will be asked to read the selected 30 papers (uploaded on Moodle) before the start of the module and decide on which of them they would like to conduct an in-depth study and prepare a presentation or discussion. Preferences (1-6) should be listed in the provided excel file and emailed to the module coordinator at least two weeks before the start of the module. A self-test will be made available on Moodle similar to the morning tests, so that students can get used to the format.
Learning Outcomes and Competences	After completing the module, students will be able to: • Grasp the main ideas of a scientific publication • Identify novelties in approach, methods and results • Describe to peers the conclusions and their relevance to the scientific community • Critically reflect on the above • Understand meta-analyses
Module Content	Lecturers from three Universities of Applied Sciences (BFH, HES-SO, ZHAW) select recent peer-reviewed papers from their fields of specialization that are meaningful to a wider public. Papers are grouped into several themes (one per day) and participating lecturers take over responsibility for entire themes. Students choose a paper of their interest for in-depth study and prepare a presentation. Yet, all students read all 30 papers as preparation for the scientific debate in class and further students act as discussants, preparing critical questions.

	The module is structured as follows into seven sessions: 1 Introduction: The idea of the journal club, the process of scientific publishing (incl. peer review), etiquette in scientific debates, presentation skills, systematic reviews and meta-analyses (*this part of the module will be held together with the participants of module E1)*; tasks and responsibilities of students, allocation of papers. 2 Reading and online coaching (students stay in their home school; the lecturers for each theme are available remotely during 30 minutes per student for questions; the module coordinator is available remotely). 3-7 Journal club in the narrow sense with the following structure (moderation by the lecturer(s) responsible for the theme of the day) a) Quiz (20', multiple choice) on the papers of the day (min. 5 papers). b) Introduction by the lecturer(s) responsible for the theme. c) Presentations and discussions for each paper, discussants give their individual arguments in the debate. The lecturer(s) correct(s) for each paper any wrong concepts presented by the students. Detailed feedback will be sent to the students after the module. d) Exercises and group work (depending on the number of students). e) Wrap-up by the lecturer(s): What are the links and cross-cutting issues between the papers? What can we learn from the debates? f) Overall wrap-up and evaluation (week 7 only).
Teaching / Learning Methods	• Self-study • Lectures, expert inputs and group work exercises • Seminar style for sessions in week 3-7
Assessment of Learning Outcome	1. 5 quizzes (individual, open-book). The results of all quizzes count. (30%) 2. Presentation (50%) 3. Performance as discussant (20%)
Format	7-weeks
Timing	Autumn semester, CW 38-44
Venue	Blended learning format. Presence sequences take place in Bern.
Bibliography	Pre-course material: • 30 publications will be uploaded on Moodle four weeks before the start of the module. • Luederitz C, Meyer M, Abson DJ, Gralla F, Lang DJ, Rau AL, von Wehrden H, 2016. Systematic student driven literature reviews in sustainability science–an effective way to merge research and teaching. Journal of Cleaner Production, 119, 229-235**.**
Language	English
Last Update	18.04.2023

Lectures of the University of Basel, Department of Pharmacy which can be credited (Specialisation: Bioanalytics, Applied Cell Biology or Pharmatechnology)

Autumn semester

Lecture	Code	ECTS	first half of semester	second half of semester
Lecture: Cancer: Basics, Cause and Therapy	28934	2		
Lecture: Molecular and Pathologic Basis of Disease	28939	3		
Lecture: Computer Modeling of Adverse Effects	28935	1		
Lecture: Development of Therapeutic Antibodies	14429	1		
Lecture: Target Validation and Identification of Modulators	448141	1		
Lecture: Early Safety Assessment and Alternatives to Animal Testing, 3Rs	28937	1		
Lecture: Clinical Toxicology	29950	1		
+ Lecture: Natural Toxins and Toxin Producing Organisms	14431	1		

Spring semester

Lecture	Code	ECTS	first half of semester	second half of semester
Lecture: Food Toxicology and Risk Assessment	29954	1		
Lecture: Immunosafety	29955	1		
Lecture: Modern Cancer Therapy	35975	1		
Lecture: Chemical Risk Assessment	46374	1		
Lecture: From Novel Targets to Novel Therapeutic Modalities	46375	2		
Lecture: Regulatory Aspects for Approval of Therapeutics	46376	1		

Please consult additionally the information provided by the department:

https://www.unibas.ch/de/Studium/Studienangebot/Studiengaenge-faecher/Drug-Sciences.html

https://www.unibas.ch/de/Studium/Mobilitaet/Mobilitaet-Region/Belegen-FHNW-Studierende.html

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