Course directory 2023.2024

school of biology (FBM-BIO) master

> Master of Science (MSc) in Molecular Life Sciences

> Specialisation Bioinformatics

> Specialisation Microbiology

UNIL | Université de Lausanne

SUMMARY

NOTICE

This course catalogue was produced using data from the *SylviaAcad* information system of the University of Lausanne. Its database contains all information about courses proposed by the different faculties and their times. This data can also be consulted online at the address :
https://applicationspub.unil.ch/interpub/noauth/php/Ud/index.php.

Web site of the faculty : **http://www.unil.ch/ecoledebiologie/**

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LEGEND

NAME OF THE COURSE

Teacher

Type of course	Status	Hours per week	Teaching language	Hours per year
Semester	Credits			

N: Levels

P: Programme requirements

O: Objective

C: Content

B: Bibliography

I: Additional information

ABBREVIATIONS

TYPE OF COURSE

Attest.	Attestation
C	Course
C/S	Course - seminar
Cp	Camp
E	Exercises
Exc	Excursion
Lg	Guided lecture
S	Seminar
T	Fieldwork
TP	Practical work

STATUS

Fac	Facultative
Obl	Compulsory
Opt	Optional
Fac/Comp/Opt	Facultative, compulsory or optional (according to the study programme)

SEMESTER

Sp	Spring
A	Autumn

UNIL | Université de Lausanne
Ecole de biologie

Master of Science in Molecular Life Sciences
2023-2024

The Master program has a normal duration of 4 semesters and comprises 120 ECTS :

Module 1 : 15 ECTS : Compulsory Courses
Module 2 : 25 ECTS : Practical Project
Module 3 : 30 ECTS : Optional Courses
Module 4 : 50 ECTS : Personal Research Project

Training objectives are available in its programme regulations.

Specific training objectives: At the end of the course the students will be able to:

Specialisation in Bioinformatics :
• Design experiments to analyse and understand genetic and genomic data.
• Mobilise in-depth knowledge of statistics and bioinformatics applied to biology.
• Use computer programming techniques.

Specialisation in Microbiology :
• Mobilise in-depth knowledge in microbiology, genetics and genomics covering aspects of environmental microbiology, microbial ecology, biotechnology, cell microbiology, virology, microbial pathogenesis, bacteriology, fungal biology, yeast models, epidemiology or synthetic biology.
• Propose research approaches in fundamental, medical or applied microbiology.

For specialisation Bioinformatics, the student must :
- Obtain **30 ECTS** in the specialisation:
  - Module 1 : 8 ECTS with Compulsory Courses in the field of Bioinformatics (marked in blue)
  - Module 3 : 17 ECTS with Optional Courses in the field of Bioinformatics (marked in blue)
  - Module 4 : 5 ECTS with "Write a Fellowship" Compulsory Course
- Carry out the Master Research Project (Module 4) in the field of Bioinformatics

For specialisation Microbiology, the student must :
- Obtain **30 ECTS** in the specialisation:
  - Module 1 : 5 ECTS with Compulsory Course in the field of Microbiology (marked in yellow)
  - Module 3 : 20 ECTS with Optional Courses in the field of Microbiology (marked in yellow)
  - Module 4 : 5 ECTS with "Write a Fellowship" Compulsory Course
- Carry out the Master Research Project (Module 4) in the field of Microbiology

MODULE 1

Compulsory Courses / *Enseignements obligatoires*	Hours per semester C	E	S	PW	Teaching Staff	ECTS	Limited nb of students
Semester 1 (Autumn) / *Semestre 1 (automne)*							
Retreat MSc MLS *Retraite MSc MLS*	-	-	-	-	**Benton R., …**	-	
Data Analysis *Analyses de données*	8	8	-	-	**Bergmann S.**	3	
Sequence a Genome I *Séquençage d'un génome I*	12	24	-	-	**Engel P.,** tutors	2.5	
Sequence a Genome II *Séquençage d'un génome II*	24	48	-	-	**Engel P.,** tutors	5	
Write a Review *Rédaction d'une revue*	15	-	-	42	**Benton R.,** tutors	4.5	
Critical Readings of Scientific Literature *Lectures critiques de la littérature scientifique*	-	-	-	56		-	
Introduction to R (optional support) *Introduction à R (mise à niveau optionnelle)*	-	-	-	-	**Schütz F.**	-	
Total	**59**	**80**	**0**	**98**		**15**	

MODULE 2

Practical Project / *Travail pratique*							
Semester 2 (Spring) / *Semestre 2 (printemps)*							
First Step Research Project *Travail d'initiation à la recherche*	-	-	-	250	**Benton R.**	25	
Total						**25**	

Abbreviations
C = Course
E = Exercise
S = Seminar
PW = Practical Work

The pandemic has shown us that circumstances beyond our control may require us to make the following adjustments / adaptations to study plans during the semester:

• possibility to switch from one mode of teaching to another (face-to-face <-> distance, synchronous <-> asynchronous, switch to co-modal teaching where it was not initially planned).
• change / modification of evaluation modalities, without inducing derogations from the Study Regulations (oral <-> written, exam <-> validation, individual work <-> group work, practical work <-> theoretical work, face-to-face evaluation <-> online evaluation, etc.)
• alternative or time-shifted modalities for teachings, internships, practical work, fieldworks and camps that could not take place or teachings that could no longer take place in the form initially planned.

Students are invited to consult this document regularly (Study Plan & Evaluation Procedure)

RETREAT MSC MLS

Richard Benton

CP	Obl		English	18
A				

N: Master

O: The goal of the MLS Master Retreat is to inform students about courses, labs in which they can perform their experiments and other practical aspects related to the programme. Each year we also invite a speaker from the non-academic research world (e.g. Nestlé, Novartis). We also initiate the "Write-a-Review" course during the retreat.

C: MLS retreat: 1 and a half days in the mountains for conferences, courses and discussions.

DATA ANALYSIS

Sven Bergmann

C	Obl/Opt	English	8
A	2/3		

E	Obl/Opt	English	8
A			

N: Master

P: We assume nothing more than the mathematics you would have obtained in your studies when you were 18.

O: In this course the goal is to be able to formulate hypotheses properly, design experiments, whether in the laboratory, in a clinic, or in the filed, that have sufficient power to test these hypotheses, conduct appropriate statistical tests of the data generated, generate clear figures, and interpret the results obtained.

C: We will cover:
1. Distributions and random variables
2. Variance, covariance and measures of association
3. Constructing statistical tests using distributions
4. Regression
5. Non-linear regression

SEQUENCE A GENOME I

Philipp Engel

C	Obl	English	12
A	2.5/3		

E	Obl	English	24
A			

N: Master

O: The goals of this class are to understand and practice the road map of sequencing, assembly and annotating a (bacterial) genome.

C: The class is a combination of both practical aspects, theory, bioinformatics and presentation of genome analysis. We will work in small student groups.
The class starts with a short introduction on the biology of the microorganisms to be sequenced, introductions to high-throughput sequence technology and assembly.
After that a number of sessions in bioinformatics follow, first to learn to communicate in Unix, then to run assemblies on the sequence data sets produced by LGF.
We will teach and practice annotation and subsystems analysis.
In the second (8th) semester, the class is followed with another practical part, annotation of the major important functions in the genome and presentation of results.

I: http://www.unil.ch/sequenceagenome/

SEQUENCE A GENOME II

Philipp Engel

C	Obl	English	24
A	3/5		

E	Obl	English	48
A			

N: Master

P: Sequence a genome I

O: The goals of the second part of this class are to learn how to carry out a comparative genome analysis. Groups of three students will work on different analysis project. At the end of the course the students will present their results to the other groups, try to integrate the different results and relate it to the biology of the organisms in question.

C: Following up on the first semester, students will carry out a comparative genome analsyis covering various aspects such as:
- Comparison of genome structures
- Inferring genome-wide phylogenetic trees
- Identifying clade-specific gene families
- Assessing gene family evolution
- Identifying mobile genetic elements
- Inferring gene functions by homology and literature search
- Working in a team and integrating results with other groups
- Writing and presenting the results

I: http://www.unil.ch/sequenceagenome/

WRITE A REVIEW

Richard Benton

C	Obl	English	15
A	4/4.5		

TP	Obl	English	42
A			

N: Master

O: Establish the current state of the art in a chosen research field.
Formulate the current knowledge in the form of a review article.
Learn basic aspects of scientific writing.
Learn how to work as a team.

C: Students form groups of 2-3 and work under the guidance of an expert of the field (the tutor) to write a review article. Students have to follow precise guidelines regarding the review format.
Further information will be provided at the MLS Retreat and via the MLS Moodle.

FIRST STEP PROJECT

Richard Benton, Marie-Christine Broillet, Antoine Guisan, Tadeusz Kawecki, Laurent Lehmann, Sanjiv Luther

TP	Obl	English	224
A	15		

TP	Obl	English	280
A	15		

TP	Obl	English	250
S	14/25		

TP	Obl	English	224
A	15		

TP	Obl	English	224
A	15		

TP	Obl	English	224
A	15		

N: Master

P: Practicals performed during the bachelor (molecular biology, genetics, biochemistry, bioinformatics)

O: - An initiation to the work of a scientist
- Conduct experimental work in research lab (wet bench or in silico)
- Interpretation of research results
- Implement basic principles in experimental design (e.g. include the appropriate controls, statistical significance of the results etc...)
- Present your experimental work in a written report which will be organized like a typical research article (intruduction, results, discussion, materials and methods)
- present your work orally (seminar style)

C: Perform laboratory work for about 12 weeks during the time when the student does not follow theoretical classes. This research project will typically be performed under the guidance of a PhD student or a post-doc from the host laboratory.

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MODULE 3

Optional Courses / *Enseignements optionnels* (1)	Hours per semester C	E	S	PW	Teaching Staff	ECTS	Limited nb of students
Semesters 1 and 3 (Autumn) / *Semestres 1 et 3 (automne)*							
Biotechnology *Biotechnologie*	18	-	-	-	**Poirier Y.**, Resch G., Veening W., van der Meer J.	2	
Chromosome Organisation and Dynamics *Organisation et dynamique des chromosomes*	6	3	-	8	**Gruber S.**	2	8
CRISPR-Cas9 Genome Editing *Edition du génome par CRISPR-Cas9*	4	4	-	8	**van Leeuwen J.**	2	12
Development of the Nervous System *Développement du système nerveux*	14	-	-	-	**Braissant O.**	2	
Genomics, Proteomics and Quantitative Genetics *Génomique, protéomique et génétique quantitative*	21	3	-	-	**Franken P.**, Quadroni M., Marquis J., Gambetta M.C.	3	
Modeling of Plant Growth *Modélisation de la croissance des plantes*	12	12	-	-	**Majda M.**	3	
Molecular Mechanisms of Evolution *Mécanismes moléculaires de l'évolution*	3	12	-	-	**Benton R.**, Geldner N.	2	
Plant and Animal Domestication : from History to Molecular Mechanisms *Domestication des animaux et des plantes : de l'histoire aux mécanismes moléculaires*	12	12	-	-	**Soyk S.**	3	
Plant Functional Genetics *Génétique fonctionnelle des plantes*	14	-	-	-	**Poirier Y.**	2	
Proteins : from Structural Determination to Molecular Dynamic Simulations *Protéines : de la détermination de la structure aux simulations de dynamique moléculaire*	12	12	-	-	**Santiago Cuellar J.**, Zoete V., Roehrig U., Cuendet M.	2	
Scientific Research in all its Forms (for Biology) (Sciences2 - in French only) *La recherche dans tous ses états (pour biologie) (Sciences2)*	16	-	-	-	**Preissmann D.**	2	
Advanced Data Analysis *Analyses de données : niveau avancé*	8	8	-	-	**Ciriello G.**	3	
Advanced Python Programming *Programmation avancée en Python*	10	18	-	-	**Salamin N.**	3	
Theory and Practice in Gene Expression Analyses *Théorie et pratique dans l'analyse d'expression des gènes*	4	32	-	-	**Gfeller D.**, Carmona S.	3	
Advanced Microbial Genetics *Génétique avancée des microbes*	16	-	-	-	**Collier J., Pelet S.**	2	
Bacterial Genomes and Genome Evolution *Génomes bactériens et évolution du génome*	6	10	-	-	**van der Meer J.**	2	12
Bacterial Virulence and Pathogenesis *Virulence bactérienne et pathogenèse*	14	2	-	-	**Greub G.**, Hauser P., Jacquier N., Jacot D.	3	
Fungal Virulence and Pathogenicity *Pathogénicité et virulence fongique*	10	4	-	-	**Lamoth F.**, Coste A., Hauser P.	2	16
Immunology and Infectious Diseases *Immunologie et maladies infectieuses*	16	-	-	-	**Roger T.**, Perreau M., Di Domizio J.	2	
Mechanisms and Principles of Yeast Cell Biology *Mécanismes et principes de la biologie cellulaire de la levure*	14	-	-	-	**Vjestica, A., Gasser S.**	2	15
Microbes as Tools in Experimental Biology *Les microbes comme outils de biologie expérimentale*	8	8	-	-	**Coste A.**, Ciuffi A.	2	16
Plant Interactions with Microbes and Insects *Interactions des plantes avec les microbes et les insectes*	14	-	-	-	**Keel C.**, Reymond P.	2	
Viral Pathogenesis and Emerging Viruses *Pathogenèse virale et virus émergents*	8	8	-	-	**Ciuffi A.**, Gouttenoire J., Cagno V.	2	
Virus-Host Interactions *Interactions virus-hôtes*	16	-	-	-	**Gouttenoire J.**	2	

(1) Students can choose some courses of the Master of Science (MSc) in Behaviour, Evolution and Conservation (max 3 ECTS)

(2) Student limit includes UNIL BSc students; this course is *only* available in Semester 3 (after students have taken "Design and Build a Synthetic Biological System I" and "Design and Build a Synthetic Biological System - Practical Project")

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MODULE 3

Optional Courses / *Enseignements optionnels* (1)	Hours per semester C	E	S	PW	Teaching Staff	ECTS	Limited nb of students
Semesters 2 and 4 (Spring) / *Semestres 2 et 4 (printemps)*							
Epigenetics and Cell Differentiation *Epigénétique et différenciation cellulaire*	8	6	-	-	**Gasser S.**	2	15
Epitranscriptomics and RNA Dynamics *L'épitranscriptomique et la dynamique de l'ARN*	6	-	-	8	**Roignant J.-Y.**	2	8
Metabolic Signaling Pathways in Health and Disease *Les voies de signalisation métabolique dans des conditions normales et pathologiques*	6	8	-	-	**Fajas L**, Ziegler D., Geller S.	2	
Scientific Communication - Scientific Hands-on Workshop Module (in French only, MSc BEC) *Médiation scientifique - module atelier scientifique (MSc BEC)*	14	14	-	-	**Kaufmann A., Reymond P.,** Ducoulombier D., Trouilloud S., Ythier M.	4	8
Training in Animal Experimentation (RESAL Module 1) (2) *Expérimentation animale (RESAL module 1) (2)*	20	-	-	20	**Broillet M.-C.,** Cadilhac C.	2	
Advanced Population Genetics *Génétique des populations avancée*	14	6	-	-	**Malaspinas A.-S.**	3	20
Bioinformatic Algorithms *Algorithmes de bioinformatique*	19	20	-	-	**Dessimoz C.,** Gfeller D.	4	
Industrial Bioinformatics *Bioinformatique industrielle*	14	-	-	-	**Xenarios I.**	2	15
Phylogeny and Comparative Methods (MSc BEC) *Phylogénie et méthodes comparatives (MSc BEC)*	14	14	-	-	**Salamin N.**	4	
Anti-Infective Agents *Agents anti-infectieux*	14	-	-	-	**Lamoth F.** Hauser P., Meylan S., Ciuffi A., Jacot D.	2	
Design and Build a Synthetic Biological System I (MSc) (3) *Concevoir et construire un système biologique synthétique I (MSc) (3)*	8	16	-	-	**Schaerli Y.**	2	15
Design and Build a Synthetic Biological System - Practical Project (3) *Concevoir et construire un système biologique synthétique - projet pratique (3)*	-	-	-	90	**Schaerli Y.**	3	15
Epidemiology of Human Pathogens *Epidémiologie de pathogènes humains*	14	-	-	-	**Blanc D.**, Manuel O., Lamoth F., Senn L., Opota O.	2	16
Microbiome Analysis *Analyse du microbiome*	8	16	-	-	**van der Meer J.,** Bertelli Lombardo C.	2	
Microbiomes *Microbiomes*	14	-	-	-	**van der Meer J.**	2	10
Systems Microbiology: Genome-Wide (Chemical) Genetics in Bacteria *Microbiologie systémique : Génétique (chimique) à l'échelle du génome chez les bactéries*	6	10	-	30	**Veening J.-W.**	4	12
Total						**30**	

(1)	Students can choose some courses of the Master of Science (MSc) in Behaviour, Evolution and Conservation (max 3 ECTS)
(2)	Only students assigned a master project involving animal experimentation may and must take this course
(3)	Student limit includes UNIL BSc students; MLS students would have to commit to taking this as well as Design and Build a Synthetic Biological System - Practical Project in the summer between Semesters 2 and 3 and Design and Build a Synthetic Biological System II in semester 3

MODULE 4

Personal Research Project / *Projet de recherche personnel*	Hours per semester C	E	S	PW		ECTS	
Semesters 3 and 4 (Autumn and Spring) / *Semestres 3 et 4 (automne et printemps)*							
Write a Fellowship *Rédaction d'une demande de bourse*	1	-	-	42	**Benton R.,** tutors	5	
Master Research Project Travail de Master					**Director of the Master Research Project**	45	
Total						**50**	

BIOTECHNOLOGY

Yves Poirier

C	Opt	English	18
A	1.5/2		

N: Master

P: None

O: Get exposure to some themes in animal, plant and microbial biotechnologies as well as to aspects relating to patenting and the biotechnology business.

C:

This course is based on presentations on various topics in green (plant), white (microbiology) and red (medicine) biotechnology.

Some of the topics covered are:

Vaccine development, including mRNA vaccines

Use of CRISPR molecular scissors in medicine

Bacterial fermentation and protein production

Transgenesis in agriculture

Plant biotechnology for the production of vitamins and other molecules

Phagotherapy

Various external experts with direct experience of the biotech industry will be invited to discuss specific aspects, such as patents and intellectual property protection, biotech start-up development, the positioning of multinationals in biotech, and so on.

CHROMOSOME ORGANISATION AND DYNAMICS

Stephan Gruber

E	Opt	English	3
A			

C	Opt	English	6
A	2		

TP	Opt	English	8
A			

N: Master

P: None

O: 1) Getting to know a new technology for chromosome and genome biology: «chromosome conformation capture» 2) Familiarize with main «chromosome architecture proteins» in theory and practice (TP)

C: 1) Basis of chromosome conformation capture and applications (Hi-C) a) From single bacterial chromosomes to complex genomes b) Gene regulation, genome evolution & human disease 2) From proteins and DNA towards folded chromosomes a) SMC protein complexes: Architecture, action, function b) Advanced protein purification on ÄKTA systems (hands-on) Research on chromosome dynamics has made excellent progress in recent years driven by a technological revolution ('conformation capture' or 3C or Hi-C) with implications for our understanding of fundamental processes as well as disease-related mechanisms. This module aims to provide an overview of these recent advances. 6 hr lectures (on Zoom) 3 hr paper discussion (on Zoom) 8 hr TP (protein purification on äkta purifier) (in real life - in small groups of max. 3 students to get hand-on experience)

I: see my.unil.ch/cours

CRISPR-CAS9 GENOME EDITING

Jolanda van Leeuwen

E	Opt	English	4
A			

C	Opt	English	4
A	1.5/2		

TP	Opt	English	8
A			

N: Master

P: Practical work performed during the bachelor (molecular biology, genetics, biochemistry, bioinformatics)

O: This course teaches both the practical as well as the theoretical aspects of CRISPR-based genome editing in cultured human cells

C: The course is a combination of theory, practical work in the lab, and practical work behind the computer. More specifically, topics covered in this course are:
- Theory: introduction to CRISPR-Cas9 genome editing, different types of CRISPR genome editing systems, CRISPR-fusion enzymes (CRISPRi, CRISPRa, base editing, methylation, precision editing, etc), and CRISPR screening
- Wet lab work: assembling CRISPR-Cas9 guide RNA particles, transfection into cultured human cells, monitoring the outcome of gene editing using fluorescence microscopy
- Dry lab work: guide RNA design, design of homologous recombination templates, predicting gene editing outcomes

DEVELOPMENT OF THE NERVOUS SYSTEM

Olivier Braissant

C	Opt	English	14
A	1.5/2		

N: Master

O: Molecular and cellular mechanisms of brain development in vertebrates, including the main pathologies affecting CNS development. Important accent on the various experimental models used to analyze vertebrate CNS development, both in vivo and in vitro.

C: The course is teached on 14 hours (3x 4h lecture, 1x 2h article presentations by students). the course is subdivided in 8 sub-chapters :
1 : CNS cell types & brain metabolism.
2 : Experimental models for the developing brain.
3 : Early development of vertebrate CNS.
4 : Neural crests and peripheral nervous system.
5 : Fundamental principles of CNS development.
6 : Molecular aspects of CNS development.
7 : Isolation and contacts between CNS and periphery.
8 : Pathologies of CNS development
Students have also to prepare and present recent articles on these thematics.

GENOMICS, PROTEOMICS AND QUANTITATIVE GENETICS

Paul Franken

C	Opt	English	21
A	3		

E	Opt	English	3
A			

N: Master

O: Get acquainted with the various experimental approaches and technologies to address fundamental principles of gene and genome function

C: This course consists of four main components. Together these components introduce and give an overview of functional genomics from gene transcription to protein, and, finally, the phenotype. Besides providing a background, the techniques applied in the various approaches will be emphasized.

1. ***Current sequencing technologies and their applications****:*

- Short-read sequencing technologies: Principle, raw data processing, limitations, and latest developments.

- Long-read sequencing technologies: Advantages over short reads sequencing, principle.

- Applications: Main types of sequencing libraries for DNA and RNA, and single cell genomics

2. ***Epigenetics and chromatin structure***:

- Currently used methods to study histone modifications, transcription factor occupancy, 3D genome folding, and nascent RNA transcription - in bulk and in single cells.

- Pros and cons of each technique, and their suitability to answer specific biological questions.

3. ***Proteomics***:

- Introduction to expression proteomics (analysis of protein expression levels and their changes) and functional proteomics (functional relationships between proteins).

- Introduction to separation techniques (liquid chromatography, 2D electrophoresis, mass spectrometry), typical workflows in which these techniques can be applied, and bioinformatics analysis.

- Discussion of the potential and limitations of the proteomics approach to study complex biological systems.

- Exercises to apply the introduced concepts: analysis of mass spectrometry data.

4. ***Analysis of Quantitative Traits****:*

- Introduction into quantitative genetics and statistical issues related to mapping of Quantitative Trait Loci (QTL).

- Mapping strategies in humans and in model and non-model organisms.

- Introduction to Systems Genetics.

- Introduction to the use of a QTL mapping tool (WebQTL).

- Discussion of a relevant publication.

MODELING OF PLANT GROWTH

Mateusz Majda

C	Opt	French	12
A	3		

E	Opt	French	12
A			

N: Master

MOLECULAR MECHANISMS OF EVOLUTION

Richard Benton

C	Opt	English	3
A	1.5/2		

E	Opt	English	12
A			

N: Master

P: Students should have a solid background in molecular genetics and developmental/cell biology.

O: To explore our current understanding of the molecular mechanisms underlying phenotypic differences between species, using examples from animals and plants.
What are the specific genetic loci underlying divergence of traits?
- how do you identify these loci and prove they are responsible?
What are the functional changes in these loci?
- what kinds of changes are possible?
What is the origin of the functional variation in natural populations?
- how do the properties of populations influence evolution?
Are there common principles in how evolution works across species and across traits?
- if so, why? If not, why not?

C: Four primary research articles (which will be made available on MyUNIL) will be read in advance by the students and discussed in detail during the course, spanning the larger scientific context and the experimental approaches used.

PLANT AND ANIMAL DOMESTICATION : FROM HISTORY TO MOLECULAR MECHANISMS

Sebastian Soyk

E	Opt	English	12
A			

C	Opt	English	12
A	3		

N: Master

P: Bachelor-level knowledge in genetics, genomics, molecular biology, and/or development is recommended. Having passed one or more bachelor level lectures in genetics, genomics, or developmental biology is of advantage.

O: The course "Plant and animal domestication: From history to molecular mechanisms" aims at delivering a profound knowledge of the history and key traits of plant and animal domestication, as well as an in-depth understanding of the genetic architecture and molecular mechanisms that were modified by human selection.
In addition, the course will enable you to improve your presentation skills (by orally presenting a scientific publication about this topic) and communication skills (by efficiently discussing scientific questions with your fellow students).

C: The content of the course will be delivered through (1) lectures, (2) group work, and (3) student presentations. Sessions will start with ~45 min lectures followed by Q&As. Afterwards, students will discuss original research articles that are related to the lecture content for ~45 min in subgroups. Finally, the students will present the main findings of the research articles and discuss the content in the group. Grading will be based on contribution to the discussions and the presentations.

The content of the course includes:

- a brief history of agriculture and domestication

- genetic basis underlying the diversity in species

- methods in genetics, genomics, and molecular biology to identify major domestication traits

- genetic and molecular basis of domestication traits in plants (e.g. fruit flavor in tomato, latitude adaptation in soybean, etc.), animals (e.g. tameness in rabbits and altitude adaptation in yak, etc.), and microbes (e.g. loss of toxicity in molds and metabolic adapations in yeasts, etc.)

- approaches in genome editing and biotechnology for de-novo domestication and improvement of plants and animals

PLANT FUNCTIONAL GENETICS

Yves Poirier

C	Opt	English	14
A	1.5/2		

N: Master

P: Good understanding of molecular biology

O: Get an overview of the spectrum of genetic and genomic tools used to isolate and decipher the role of genes involved in various aspects of plant biology

C: A Gene expression and transgenesis
Agrobacterium and biolistic
Transient vs. stable transformation
Inducible promoters
Viral vectors
Transformation of plastids
B Tools used in forward and reverse genetics
Mutagenesis and gene mapping
T-DNA and transposon tagging
RNAi
Homologous recombination
Genome editing

PROTEINS : FROM STRUCTURAL DETERMINATION TO MOLECULAR DYNAMIC SIMULATIONS

Julia Santiago Cuellar

C	Opt	English	12
A	1.5/2		

E	Opt	English	12
A			

N: Master

SCIENTIFIC RESEARCH IN ALL ITS FORMS

Delphine Preissmann

C	Opt	2	French	16
A	1.5/2			

N: Master

P: * Bachelor degree
* Passive knowledge of French

O: - Integrate technics & scientific methods from different academic fields
- Synthesize information from different disciplines
- Transpose knowledge & results from one academic field to another

C: This course offers a multidisciplinary perspective on decision making. While addressing this topic, speakers from different faculties will shed light on their own way of practicing research.

I: http://www.unil.ch/sciencesaucarre/page86487.html

ADVANCED DATA ANALYSIS

Giovanni Ciriello

C	Obl/Opt	English	8
A	2.5/3		

E	Obl/Opt	English	8
A			

N: Master

P: You must have attended the first data analysis course, or convince me that you are competent at basic statistical analyses.

O: This course follow-up on the Data Analysis course to introduce advanced statistical and algorithmic approaches tailored to the analysis of high-dimensional data.

C: In this course we will cover:
1. Penalized regression models
2. Clustering analyses
3. Dimensionality reduction techniques
4. Introduction to deep learning

ADVANCED PYTHON PROGRAMMING

Nicolas Salamin

C	Obl/Opt	English	10
A	2/3		

E	Obl/Opt	English	18
A			

N: Master

P: There are not prerequisites for this course.
The students are however expected to be familiar with computers. They should have a good understanding of the functioning of a computer (hardware components, operating system/file system). A basic knowledge of UNIX/LINUX would be good, although it is not essential.
It will be necessary to install the following software on your own laptop:
- python3 with the modules numpy and biopython
- a text editor with syntax highlighting (simple one or IDE)
- for windows user: a terminal environment (e.g. cygwin or MinGW)

C: We will cover the following aspects of programing in Python:
1) basic syntax
2) data types in Python

THEORY AND PRACTICE IN GENE EXPRESSION ANALYSES

David Gfeller

C	Opt	English	4
A	2.5/3		

E	Opt	English	32
A			

N: Master

P: Basic programming skills (R or python).

O: Provide students with the analytical and computational tools for gene expression data analysis in many fields of biological sciences. A special focus will be on methodological/algorithmic aspects and their implementation. The students will have the opportunity to develop their analytical and computational skills, and will become familiar with standard tools for gene expression data analysis in different contexts.

C: Processing of RNA-Seq data / Visualization, Clustering, Differential expression / Single-cell genomics. The course will feature short theoretical introductions of important concepts, followed by practical implementations of methods in the form of R/python scripts. The practical parts will be organized as problem-solving tasks to be implemented in programming languages.

ADVANCED MICROBIAL GENETICS

Justine Collier Close, Serge Pelet

C	Opt	English	16
A	1.5/2		

N: Master

P: - Bachelor course "Génétique Moléculaire des Bactéries" - Bachelor course "Génétique des modèles eukaryotes"

O: - Think logically about experimental approaches.
- Illustrate how cleverly designed genetic experiments can provide answers to fundamental problems.
- Learn about new technology developments in genome-wide screens.
- Read the scientific literature critically.

C: - Lecture on prokaryotic genetics and epigenetics (JC)
- Lecture on eukaryotic genetics (SP)
- Assisted and critical reading of publications

BACTERIA GENOMES AND GENOME EVOLUTION

Jan Roelof van der Meer

C	Opt	English	6
A	1.5/2		

E	Opt	English	10
A			

N: Master

O: Discover bacterial genome evolution at the example of life in the ocean, in particular that of the 'Prochlorococcus federation' of phototrophic bacteria.
Learn how to interpret genomic data and bacterial metabolism with the help of online databases.

C: The class is a mix of subjects that are introduced by the teacher, classical reading and self-working in class, notably by interrogating metabolic databases
1) Overview of utilities for interpretation of bacterial genomes (databases, online programs) - Self-learning and practise using specific examples
2) History of discoveries in bacterial genome evolution at the example of the Prochlorococcus federation of species in the oceans
3) Understanding bacterial genome evolution (literature reading)

B: Ad hoc research articles.

BACTERIAL VIRULENCE AND PATHOGENESIS

Gilbert Greub

C	Opt	English	14
A	3		

E	Opt	English	2
A			

N: Master

FUNGAL VIRULENCE AND PATHOGENICITY

Frédéric Michel Lamoth

C	Opt	English	10
A	1.5/2		

E	Opt	English	4
A			

N: Master

O: The lecture will illustrate the importance of different human fungal pathogens and give their principal characteristics. General principles of fungal pathogenesis will be given with illlustrative examples

IMMUNOLOGY AND INFECTIOUS DISEASES

Thierry Roger

C	Opt	English	16
A	1.5/2		

N: Master

B: Day 1-3:
- Janeway's Immunobiology 9th Edition, Kindle Edition. Chapters 1, 2 and 3. Disponible at UNIL athttps://renouvaud.hosted.exlibrisgroup.com/permalink/f/gt86ri/41BCU_ALMA71113136200002851
- The Third International Consensus Definitions for Sepsis and Septic Shock (Sepsis-3). Singer M, Deutschman CS, Seymour CW, Shankar-Hari M, Annane D, Bauer M, Bellomo R, Bernard GR, Chiche JD, Coopersmith CM, Hotchkiss RS, Levy MM, Marshall JC, Martin GS, Opal SM, Rubenfeld GD, van der Poll T, Vincent JL, Angus DC. JAMA. 2016 Feb 23;315(8):801-10. PMID: 26903338
- Global, regional, and national sepsis incidence and mortality, 1990-2017: analysis for the Global Burden of Disease Study. Rudd KE et al. Lancet 2020;395:200-211.
- The immunology of sepsis. van der Poll T, Shankar-Hari M, Wiersinga WJ. Immunity 2021;54:2450-2464.
Day 4, lecture 1:
- Wherry et al., Molecular and cellular insights into T cell exhaustion, Nature Reviews in Immunology 2015
- Pitman et al., Barriers and strategies to achieve a cure for HIV, The Lancet, 2018
Day 4, lecture 2:
- The NIH Human Microbiome Project http://commonfund.nih.gov/hmp/
- Gensollen T, How colonization by microbiota in early life shapes the immune system, Science. 2016 Apr 29;352(6285):539-44.

MECHANISMS AND PRINCIPLES OF YEAST CELL BIOLOGY

Aleksandar Vjestica

C	Opt	English	14
A	2		

N: Master

MICROBES AS TOOLS IN EXPERIMENTAL BIOLOGY

Alix Coste

C	Opt	English	8
A	2		

E	Opt	English	8
A			

N: Master

O: The general aim of this class is to get detailed knowledge on the use of microbial systems (including viruses, bacteria and yeast) as tools in several fields of experimental biology (microbial pathogenesis, genetic engineering applications, gene therapy).
The class is associated with reading and presentations of paper related to this topic.

C: Part Ciuffi
Description :
The aim of this class is to open up your mind and make you think out of the box, thereby making you look at viruses beyond their pathogenicity and more as potential tools that can be used for many diverse applications.
To appreciate the potential of viruses as tools in molecular biology, this class will give you a non-exhaustive list of applications in which viruses are used as tools.
Examples will include the use of viruses as pesticides, gene delivery vehicles, vaccines, tools in gene expression studies and in cellular biology studies.
Learning outcomes :
- To realize that viruses are not only pathogens.
- To realize that viruses can be used as tools in multiple applications.
- To understand that fundamental knowledge about viruses can be useful for secondary applications.
- To appreciate the diversity of viruses and their differences in replication, and thus the diversity of applications in which they can be exploited.
- To identify the viral steps that can be manipulated. To know how to manipulate these viral steps and why.
- To appreciate impact of viruses in the current society.
Part Sanglard/Coste
Description:
The aims of this class is to show the importance of genetic screens for the identification of novel biological functions related to microbial virulence and to therapeutic targets. Specifically, the aims are the following:
- To understand how genetic screens can contribute to identify virulence factors in bacteria and yeast.
- To show how genetic screens can serve the identification of genes involved in the recognition of fungal PAMP by the immune system.
- To show how genetic screens can contribute to identify novel therapeutic targets in pathogenic yeast.
Learning outcomes:
- To appreciate how methodologies can be employed in genetic screens.
- To realize how bacterial and yeast genetics can address and solve biological problems.

PLANT INTERACTIONS WITH MICROBES AND INSECTS

Christoph Keel

C	Opt	English	14
A	1.5/2		

N: Master

O: to provide students with knowledge on how intricate interactions between plants and beneficial or detrimental organisms are operating at the molecular level

C: Part C. Keel
"Molecular basis of host specificity in phytopthogenic bacteria"
The course illustrates the sophisticated molecular mechanisms by which plant pathogenic bacteria subvert plant defense mechanisms, focusing on bacterial injection devices (type III secretion systems) and virulence and avirulence proteins delivered directly into the plant host cell. The effector injection machinery of the plant pathogens is compared to that of human pathogenic bacteria to highlight the conservation of the virulence strategy.
Part P. Reymond
"Molecular study of plant-insects interactions"
The course describes the molecular mechanisms by which a plant detects the presence of an herbivore attack and responds to it by inducing hundreds of genes. It presents recent findings on the suppression of plant defense responses by insects. Finally, examples of insects that are useful for defending plants against other enemies are provided.
Exercise: Students designing research
In a final part of the course, students will design research approaches based on the topics presented during the three lecture parts and on questions provided by the lecturers. Student inputs will be discussed collectively, with the aim to highlight common and contrasting aspects occurring during interaction of microbes and insects with plants.

VIRAL PATHOGENESIS AND EMERGING VIRUSES

Angela Teresa Ciuffi

C	Opt	English	8
A	2		

E	Opt	English	8
A			

N: Master

P: Virologie BSc Course. 5th semester
Virus-Host Interactions Course, Master MLS 7th semester

O: The course will cover fundamental principles of viral pathogenesis at the molecular, systemic, and population level. Individual teaching blocks will be given by experts in the field that cover the pathogenesis of major human viral diseases, including viral hepatitis (Gouttenoire), human retroviruses (Ciuffi), and respiratory viruses (Cagno), and discussing landmark papers in the field. A last block will illustrate the power of genome screening approaches to identify host factors that confer susceptibility to viral infection and play a role in pathogenesis (Ciuffi).

C: Teaching: Angela Ciuffi, Jérôme Gouttenoire, Valeria Cagno
Respiratory viruses: Influenza, Rhinoviruses, Coronaviruses (V. Cagno)
Viral hepatitis (J. Gouttenoire)
Human retroviral infections (A. Ciuffi)
Genome screening approaches in viral infectious diseases (A. Ciuffi)
Introductory lectures will be given by the teachers.
Landmark papers will be presented by students and discussed in the group.

B: Viral Pathogenesis and Immunity. Nathanson, N. (Ed), 2nd Ed. 2007, Academic Press.

C: Plan of the module:

Lesson 1 (1 period): Fungi and fungal infections (Teacher: Frederic Lamoth)

Learning objectives

- To be able to describe the main characteristics of fungi among eukaryotes

- To know the main fungal pathogens for humans and the basic description of the most important fungal infections

- To recognize the patient populations at risk of fungal diseases

Lesson 2 (1 period): Diagnosis of fungal infections (Teacher: Frederic Lamoth)

Learning objectives

- To get familiar with the diagnostic tools used for the detection of fungal infections in clinical practice

- To recognize the challenges of the diagnostic approach of fungal infections and the research perspectives in this area.

Lesson 3 (1 period): Treatment of fungal infections (Teacher: Frederic Lamoth)

Learning objectives

- To know the mechanisms of actions of the antifungal drugs used in clinical practice

- To know the mechanisms of antifungal resistance and their clinical relevance

- To recognize the challenges of the therapeutic approach of fungal infections and the research perspectives for the development of novel antifungal agents

Lesson 4 (1 period): Host / pathogen interactions (Teacher: Alix Coste)

Learning objectives

- To recognize the importance and mechanisms of interactions between fungi and human host leading to tissue invasion and infection

- To recognize the strategies of fungi for survival in human body

Lesson 5 (1 period): Pneumocystis jirovecii and pneumocystosis (Teacher: Philippe Hauser)

Learning objectives

- To know the virulence factor of Pneumocystis jirovecii and the pathogenesis of pneumocystosis in human

Lesson 6 (1 period): Dimorphic fungi and endemic mycoses

Learning objectives

- To know the mechanisms of dimoprhism and the diseases caused by dimorphic fungi

Lesson 7 (1 period, demo): Diagnostic procedures for fungal infections (Teacher: Philippe Hauser)

Learning Objectives (practical session, demonstration)

- To get familiar with the diagnostic procedures for identification of fungal pathogens in clinical sample

- To known the methods used for antifungal susceptibility testing

Lesson 8 (2 periods): Candida and invasive candidiasis (Teacher: Alix Coste)

VIRUS-HOST INTERACTIONS

Jérôme Gouttenoire

C	Opt		English	16
A	1.5/2			

N: Master

P: Virology course 5th semester (20 h)

O: <p style="margin: 0px; font-stretch: normal; line-height: normal; font-family: Verdana;">Understanding virus-host cell interaction (advanced level)
Understand the principles of viral pathogenesis at the organismal level

Understand the basic principles of viral pathogenesis at the molecular and cellular level

Understand the molecular mechanisms of innate viral defence, including viral pathogen recognition, signalling and the interferon response

Be able to analyse data dealing with virus-host interaction and place the findings in a broader context

C: <p style="margin: 0px; font-stretch: normal; line-height: normal; font-family: Verdana;">Teacher: Jérôme Gouttenoire

Basic principles of pathogenesis

--> Viral pathogenesis at the cellular level

--> Viral pathogenesis at the organism level

Innate defence against viruses

--> Receptors and signalling in innate antiviral defence, including the interferon response

<p style="margin: 0px; font-stretch: normal; line-height: normal; font-family: Verdana;">--> Means used by viruses to counteract the cell's antiviral response

Viral infection of the nervous system

--> Viral invasion of the central nervous system

--> Antiviral defence in the nervous system

Teaching: Combination of lectures and interactive exercises based on article analysis

B: Sera donnée lors du cours

EPIGENETICS AND CELL DIFFERENTIATION

Susan Gasser

C	Opt	English	8
S	2		

E	Opt	English	6
S			

N: Master

O: Epigenetics in Development: Regulation of gene expression and of chromatin function is pivotal for the understanding of developmental programs, cellular homeostasis and many disease states. The transcription process is critically linked to the regulation of chromatin function. Epigenetic mechanisms such as histone modifications can transmit active/inactive states of a gene through cellular divisions, which are particularly relevant during early mammalian development. Epigenetic states also respond to stress and environmental factors. The study of transcription, chromatin regulation and early development received a great impetus through the availability of whole genome sequences, and novel high-throughput sequencing technologies. The integration of biochemistry, molecular biology, genomics, proteomics and cell biology now provides unprecedented insight into transcription and chromatin regulation in health and disease.

C: This course will cover the crucial concepts of regulation of gene expression by chromatin focusing on concepts derived from developmental and stress-response states. Epigenetics, chromatin and genome organization will be discussed. The themes we will discuss: genome/gene organization, chromatin remodeling and chromatin modifications, epigenetic inheritance, nuclear organization, C. elegans development and cell lineage specification. Even if you are only peripherally interested in the mechanisms of gene expression, epigenetics and development, this course is for you.

EPITRANSCRIPTOMICS AND RNA DYNAMICS

Jean-Yves Roignant

C	Opt	English	6
S	2		

TP	Opt	English	8
S			

N: Master

P: The student should already have some notions in gene regulation

O: The main goal of this module is to learn about a new player of gene regulation termed Epitranscriptomics. Epitranscriptomics is the study of RNA modifications and their role in the regulation of gene expression. Similar to modifications found on DNA and histones an extensive layer of base decorations was recently discovered in mRNAs and shown to undergo cell modulation. These modifications produce programmable fluctuations in mRNA levels, translatability and subcellular compartmentalization, affecting primary cell programs such as cell differentiation and response to stress. RNA modifications is as important as chromatin dynamics in shaping cell phenotypes and impairment of RNA modifications has been associated with numerous diseases including neurodegenerative diseases and cancers. This emerging field is hence crucial for both basic science and application to human disease. After completing this module the students will be able to detect a specific modification on the RNA and understand its implication on gene expression.

C: The content of this module includes four lectures of 90 minutes, two of which will be presented by invited international leaders in their field. In addition there will be a practical work of two afternoons where the students will learn how to detect a specific RNA modification on RNA. The techniques used include RNA extraction, primer ligation, reverse transcription and PCR.

B: https://www.sciencedirect.com/science/article/pii/B9780128236840000049

METABOLIC SIGNALING PATHWAYS IN HEALTH AND DISEASE

Lluis Fajas Coll

C	Opt	French	6
S	2		

E	Opt	French	8
S			

N: Master

SCIENTIFIC COMMUNICATION - SCIENTIFIC HANDS-ON WORKSHOP MODULE

Alain Kaufmann, Philippe Reymond

C	Opt	French	14
S	3/4		

E	Opt	French	14
S			

N: Master

TRAINING IN ANIMAL EXPERIMENTATION (RESAL MODULE 1)

Marie-Christine Broillet

C	Opt	English	20
A S	2		

TP	Opt	English	20
A S			

N: Master

O: Learning outcomes To acquire the practical and theoretical skills with laboratory animals as requested by legislation (Swiss ordinance N° 455.171.2, October 1998) to get the accreditation to perform animal experimentation delivered by the Federal Veterinary Office. This course (20h theory + 20h practical) will be recognized by the Swiss federal veterinary office to undertake animal experiments.

C: What is animal experimentation? Any interventions in which live animals are used to : - Test a scientific hypothesis in various fields (behavior, neurology, metabolism, immunology, cardiovascular...) - Verify the effects of a particular procedure on an animal - Test a substance (pharmacology, toxicology...) - Collect or examine cells, organs or body fluids - Education, training and continuing education Choosing an appropriate animal model - Before an animal model is chosen, investigators must consider alternatives to the use of live animals (3Rs) - Investigators must consider all factors when selecting the best model for research Who is concerned by this module? This training module is relevant to all students working with animals during their master project. Conditions for registration to this module: - The host laboratory must have permission to work with animals - Students must be announced to the cantonal veterinary office

ADVANCED POPULATION GENETICS

Anna Sapfo Malaspinas

C	Opt	English	14
S	3		

E	Opt	English	6
S			

N: Master

B: Textbooks and relevant articles:
Mark Stoneking, An introduction to Molecular Anthropology
John Wakeley, Coalescent theory, an introduction
Nielsen, R. et al. Tracing the peopling of the world through genomics. Nature 541, 302-310 (2017).
Novembre, J. et al. Genes mirror geography within Europe. Nature 456, 98-101 (2008).
Green, R. E. et al. A complete Neandertal mitochondrial genome sequence determined by high-throughput sequencing. Cell 134, 416-426 (2008).
Nordborg, M. On the probability of Neanderthal ancestry. Am J Hum Genet 63, 1237-1240 (1998) (theoretical paper)
Green, R. E. et al. A Draft Sequence of the Neandertal Genome. Science 328, 710-722 (2010)

BIOINFORMATIC ALGORITHMS

Christophe Dessimoz

C	Opt	English	19
S	3/4		

E	Opt	English	20
S			

N: Master

P: The course assumes familiarity with basic programming concepts (variable and function declaration, arrays, for-loops, conditional statements, etc.). Algorithms are introduced from a practical angle so the mathematical formalism is kept at a minimum.

O: The course aims at improving the student's programming skills by gaining a deep understanding of some of the key algorithms in bioinformatics, with a special emphasis on sequence and graph algorithms. Students will learn widely applicable concepts, such as asymptotic time complexity, binary search, dynamic programming, hashing. Practicals and home assignments are essential parts of the course. The language of the course is Python, though the concepts covered in the course are applicable to all computer languages.
More info, including dates, rooms, and link to Moodle page:
https://lab.dessimoz.org/teaching/bioinfalgo/

INDUSTRIAL BIOINFORMATICS

Ioannis Xenarios

C	Opt	English	14
S	2		

N: Master

PHYLOGENY AND COMPARATIVE METHODS

Nicolas Salamin

C	Opt	English	14
S	3/4		

E	Opt	English	14
S			

N: Master

P: none

O: Phylogenetic reconstruction methods and their application in evolutionary biology. To know and understand phylogenetic reconstruction methods in order to test the processes leading to genes and organisms evolution.

C: The subjects will be presented during lectures as well as practicals.
I. Reconstruction methods
- What is a phylogenetic tree and how to interpret it?
- Tree reconstruction:
a) optimisation criteria and models of evolution
b) search for the optimum tree
c) Bayesian methods
- Can we trust the inferred tree?
II. Uses for phylogenetic trees
- Detecting positive selection in a coding gene
- Testing coevolution and cospeciation
- Macroevolution:
a) dating evolutionary events
b) tempo and mode of evolution
c) testing for key innovations
- Phylogeny and conservation

B: Felsenstein, J. 2003. Inferring phylogenies. Sinauer Associates.
Page, R. 2003. Tangled trees: Phylogeny, cospeciation, and coevolution. University of Chicago Press.
Purvis, A., Gittleman, J.L. and Brooks, T. 2005. Phylogeny and conservation. Cambridge University Press.
Swofford, D.L., Olsen, G.K., Waddell, P.J. and Hillis, D.M. 1996. Phylogeny reconstruction. Pages 407-514 In Molecular Systematics (D.M. Hillis, C. Moritz, B.K. Mable, eds.). Sinauer Associates.
Yang, Z.H. 2006. Computational Molecular Evolution. Oxford University Press.

I: http://www.unil.ch/phylo/teaching/pmc.html

ANTI-INFECTIVE AGENTS

Frédéric Michel Lamoth

C	Opt	English	14
S	2		

N: Master

O: Description:
The aims of this class is to understand the mode of action and resistance to principal anti-infective agents used for the therapy of infectious diseases. Diverse classes of agents will be discussed which are used to combat bacterial, viral, fungal and parasitic infections. The molecular basis of resistance to these agents will be also illustrated by several examples.
The class is also associates with paper reading and presentations

The practical part consists of a visit of the laboratory of clinical microbiology with a demonstration of the phenotypic and genotypic testing for the the detection of antimicrobial resistance.
Learning outcomes:
- to learn about the mode of actions of anti-infective agents
- to learn about molecular resistance mechanisms developing in microbial pathogens.

C:

- Antiviral agents (4h): Prof. Angela Ciuffi

- Antibacterial agents (4h): PD Dr. Sylvain Meylan

- Antiparastic agents (2h): PD Dr. Philippe Hauser

- Antifungal agents (3h): Prof. Frédéric Lamoth

- Practical part (1h): Dr. Damien Jacot

DESIGN AND BUILD A SYNTHETIC BIOLOGICAL SYSTEM I (MSC)

Yolanda Schaerli

C	Opt	English	8
S	2		

E	Opt	English	16
S			

N: Master

P: No prior knowledge of synthetic biology is required. You need to be highly motivated and you are expected to work on the iGEM project during the summer break (practical project, 3 ECTS credits in module 3 in spring). Please be also aware that there will the 2nd part in the autumn semester (2 ECTS credits in module 3) to prepare for the Giant Jamboree.
Please note that the number of ECTS credits and the actual workload are disconnected.
Participants: minimum 4, maximum 12; students will be selected based on their application file (deadline : ...).
More information on https://www.yschaerli.com/iGEM.html

O: This course is for students who want to take part at the International Genetically Engineered Machine (iGEM) competition (www.igem.org). This is a worldwide synthetic biology competition. Synthetic Biology is an emerging interdisciplinary field combining aspects of molecular biology, systems biology, biotechnology, genetic engineering, computer science and many more to improve our understanding of biological systems and to create useful tools to solve everyday problems. The UNIL team can be composed of Bachelor and Master students in biology and other disciplines.
By the end of the course, you are expected to be able to:
- Discuss the definition of synthetic biology
- Discuss tools and approaches used for engineering biological systems
- Discuss the societal implications of synthetic biology
- Develop a project and plan on how to execute it
- Conduct independent experiments in a research (wet or dry) lab and document them
- Present and defend a research project in front of a panel of international judges
- Work in a multidisciplinary team
- Show initiative, creativity, critical thinking and leadership skills

C: During the first part of the course you will get a short introduction to synthetic biology, with a focus on microbial system. Next, you will brainstorm for project ideas from which the team will choose one. The team will then model and ultimately build the proposed genetically engineered machine in the wet-lab during the summer. In addition to carry out the project, the competition involves many elements such as fund raising, design a team logo, organise outreach activities, get into contact with stakeholders affected by your project, document your project on a dedicated homepage, prepare a poster and a presentation. You will also have the opportunity to interact with other Swiss iGEM teams and to present your project at the Giant Jamboree internationally, where you will meet other teams around the world. (Travel costs will be covered).

I: https://www.yschaerli.com/iGEM.html

DESIGN AND BUILD A SYNTHETIC BIOLOGICAL SYSTEM - PRACTICAL PROJECT (MSC)

Yolanda Schaerli

TP	Opt		English	90
S	3			

N: Master

P: To have followed the course "Design and Build a Synthetic Biological System I".
Please note that the number of ECTS credits and the actual workload are disconnected.
Participants: minimum 4, maximum 12; students will be selected based on their application file (available here: https://www.yschaerli.com/iGEM.html).

O: This course is for students who want to take part at the International Genetically Engineered Machine (iGEM) competition (www.igem.org). This is a worldwide synthetic biology competition. Synthetic Biology is an emerging interdisciplinary field combining aspects of molecular biology, systems biology, biotechnology, genetic engineering, computer science and many more to improve our understanding of biological systems and to create useful tools to solve everyday problems. The UNIL team can be composed of Bachelor and Master students in biology and other disciplines.
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- Develop a project and plan on how to execute it
- Conduct independent experiments in a research (wet or dry) lab and document them
- Present and defend a research project in front of a panel of international judges
- Work in a multidisciplinary team
- Show initiative, creativity, critical thinking and leadership skills

C: During the first part of the course you will get a short introduction to synthetic biology, with a focus on microbial system. Next, you will brainstorm for project ideas from which the team will choose one. The team will then model and ultimately build the proposed genetically engineered machine in the wet-lab during the summer. In addition to carry out the project, the competition involves many elements such as fund raising, design a team logo, organise outreach activities, get into contact with stakeholders affected by your project, document your project on a dedicated homepage, prepare a poster and a presentation. You will also have the opportunity to interact with other Swiss iGEM teams and to present your project at the Giant Jamboree internationally, where you will meet other teams around the world. (Travel costs will be covered).

I: https://www.yschaerli.com/iGEM.html

EPIDEMIOLOGY OF HUMAN PATHOGENS

Dominique Blanc

C	Opt	English	14
S	2		

N: Master

O: Acquire principles of epidemiology by the study of several examples of pathogens. Knowledge on molecular typing methods and their applications. Knowledge on bacterial population genetics.

C: General concepts. Introduction to epidemiology of infectious diseases. Molecular and genomic typing in epidemiology. Bacterial population genetics.
Epidemiology of bacteria.
Epidemiology of virus.
Epidemiology of tuberculosis.
Epidemiology of fungi.

MICROBIOME ANALYSIS

Jan Roelof van der Meer

C	Opt	French	8
S	1.5/2		

E	Opt	French	16
S			

N: Master

P: None. Practicals will involve working with R.

O: The goal of this class is to give an overview of different host-related and environmental microbiomes, of theory on microbiome development and community growth, and to explain a number of regular microbiome analysis tools. This really cool class will involve different teachers and collaborators working within the National Centre of Competence in Research on Microbiomes. It will consist both of frontal presentations, questions and discussion sessions, and practical work.
Teachers are: Senka Causevic , Maxime Batsch , Julian Garneau, Julien Luneau , Joanito Liberti , Alan Pacheco (ETHZ), Jordan Vacheron , Massimo Amicone, Jeanne Tamarelle , Claire Bertelli , Sedreh Nassirnia, Alessia Carrara, Carmen Chen, Elena Montenegro, Yangji Choi, Elindi de Coning, Jan Roelof van der Meer, Melanie Stäubli (ETHZ), Isaline Guex

C: Content is still open to last-minute changes, but will likely consist of the following lectures:
- General overview on microbiomes: what are they, how do they function?
- Diversity analysis techniques
- High-througput functional techniques
- Meta-omics techniques
- The soil microbiome
- The rhizosphere microbiome
- The plant leaf microbiome
- The human and animal gut microbiome
- Gut-brain axis

The following practicals are being prepared:
- soil microbiome diversity
- metatranscriptomic data analysis
- community modeling

B: Course material will be uploaded on Moodle shortly before the classes.

MICROBIOMES

Jan Roelof van der Meer

C	Opt	English	14
S	2		

N: Master

P: none.

O: The goal of this class is to develop a small literature project independently on a topic of choice in microbiome microbiology.
Maximum number of participants: 10

C: The topics of this class are chosen by the students individually, in discussion with the class tutor.

SYSTEMS MICROBIOLOGY: GENOME-WIDE (CHEMICAL) GENETICS IN BACTERIA

Jan-Willem Veening

C	Opt	English	6
S	4		

E	Opt	English	10
S			

TP	Opt	English	30
S			

N: Master

O: Get fascinated by the power of genetic screens in combination with modern chemical biology and systems biology approaches.

Obtain a state-of-the-art skillset, both experimentally and bioinformatically, by performing CRISPRi-seq and doing original research.

C: This course is based on several presentations (6 h in total) and exercises (10h) on various topics in chemical, synthetic and systems biology. The majority of this course (30h) consists of performing original research by doing a genome-wide CRISPRi experiment in the model bacterium *Bacillus subtilis*. *B. subtilis* is a Gram-positive, non-pathogenic sporulating bacterium that is well studied and genetically accessible as it can become genetically competent for DNA uptake. It is one of the best model organisms for bacterial cell biology, development and antibiotic resistance research and results obtained in *B. subtilis* can readily be translated to pathogenic Gram-positive bacteria such as *Staphylococcus aureus* and *Streptococcus pneumoniae*. Students will work as pairs and choose their own experiment. This can be to look for genome-wide drug-gene interactions (e.g. exposing a *B. subtilis* CRISPRi library to an antibiotic) or look for gene-gene interactions (e.g. by comparing gene fitness in a certain mutant background).

Some of the topics covered during the lectures and exercises are:

-CRISPR interference (CRISPRi)

-Chemical-genetic screens

-Synthetic gene-regulatory networks (AND gates, toggle switch, repressilator)

-Tn-seq vs CRISPRi-seq

-NGS Targeted amplicon data analysis (QC, trimming, mapping)

-NGS Statistics (DESeq2)

Examples of experiments that can be chosen (note that these are all original experiments which have never been done before):

-Identification of genes involved in cell wall biosynthesis: CRISPRi-seq + amoxicillin

-Identification of genes involved in DNA biology: CRISPRi-seq + ciprofloxacin

-Identification of genes involved in DNA replication: CRISPRi-seq in a *ccrZ* mutant background

-Identification of genes involved in chromosome segregation: CRISPRi-seq in a *parB* mutant background

WRITE A FELLOWSHIP

Richard Benton

C	Obl	English	1
A S	3/5		

TP	Obl	English	42
A S			

N: Master

O: - Construct meaningful hypotheses in the context of a particular open question in the field (typically related to the master project of the student)
- Develop an experimental strategy that tests these hypotheses
- Formulate this experimental strategy in the form of a grant application
- Present your work in a concise oral presentation
- Appreciate the granting system used to fund biological research

C: The student writes a research proposal that is typically addressing questions in the research area related to his/her master project. The research proposal has to follow precise guidelines. The student is closely supervised by his/her master supervisor who serves as the tutor for this course. The written proposal and a short oral presentation are both evaluated.