SYLLABUS
Master Biomolecular Sciences: Mechanisms & Therapeutic Targets (BSM2T)
All lectures and exams will be provided in English language.

UE	Technological workshops	9 ECTS	1st semester
	TD: 120h		

TEACHING UNIT TITLE: Technological workshops

FACULTY IN CHARGE OF THE TEACHING UNIT: Manuelle Ducoux (manuelle.ducoux@ipbs.fr)

LEARNING GOALS: This teaching will aim to give the keys to students to understand and implement the different stages of an experimental protocol in Biochemistry, Structural Biology and Biophysics, Molecular Biology & Imaging, Proteomics, and Metabolomics.

COURSE DESCRIPTION: Students will be offered theoretical and technical training in most of the cutting-edge techniques in structural and functional biochemistry. Most of the work will be based on the study and understanding of scientific publications, under the supervision of faculty members specialized in this field. Part of the courses will be organized as an interactive format, through reverse pedagogy, so that the students may acquire the fundamental concepts.
Students will be asked to select 3 courses among the 4 following items, in order to tailor their study program to suit their academic and career goals:
- **Molecular biology & imaging:** cloning, mutagenesis, gene expression and regulation, gene expression and function inhibition, recombinant protein production, protein/protein and protein/nucleic acids interactions, cutting-edge microscopy (fluorescence and super-resolution microscopy. There will be two principal aims in this course. The first will be to reinforce or to update your knowledge of the basic principles and methods used in molecular biology and imaging. Secondly, this course will show you how to read, understand and analyze published articles concerning molecular biology topics. As it is a technical workshop, you will be asked to raise concerns regarding the experiments, to propose alternative techniques and to discuss the results presented in several publications.
- **Integrative Structural biology of macromolecules:** Structural biology is a scientific discipline aiming at understanding at atomic or near atomic resolution the structure and dynamics of macromolecules and macromolecular complexes, and thus to explain the in vivo functions and interactions. It is a field in constant evolution, largely based on the use of advanced methodologies such as electron microscopy, X-ray crystallography, small angle X-ray scattering and nuclear magnetic resonance. It also requires a permanent use of computational biology, both for the direct data analysis and for the development of realistic three dimensional models. Finally, a detailed understanding of the molecular mechanisms involved at the molecular level also requires the characterisation of interactions between molecules by biophysical methods such as ITC, microscale thermophoresis, SPR or DSF.
This course will provide you the conceptual and practical basis required to understand the current literature and will introduce you to the latest developments in this field.

- **Proteomics:** To acquire knowledge on mass spectrometry (MS)-based approaches for global characterization of proteomes and interactomes, as well as structural exploration of proteins: principle of MS (ionization sources, analyzers, scanning modes, and bioinformatics analysis), basics of modern mass spectrometers (geometry, scanning modes, and performances like resolution, sensitivity, scanning speed…), and presentation of the main workflows used in modern proteomic analysis (Bottom-up, top-down/middle-down, interactomics, post-translational modifications, including sample preparation workflows). Courses have been organized as workshop sessions. Each course will last one or two sessions. For each course, all students will have to read a common publication and/or work on questions in groups. These questions will help understand the publication, acquire knowledge on mass spectrometry (sample preparation, workflows, quantification, MS/MS spectra interpretation, bioinformatics) and illustrate how mass spectrometry has helped answer the biological question (on various biological topics). Students will be evaluated on their ability to understand and justify a proteomic workflow and to interpret proteomic data from a scientific publication.

- **Metabolomics:** This course is aimed at acquiring in-depth understanding of the approaches (metabolomics, fluxomics) allowing the investigation of metabolism at the system level (from cells to whole organisms). It includes both conceptual knowledge on metabolic systems (metabolic networks, their reconstruction and analysis) and experimental strategies and techniques for detailed characterization of metabolomes and fluxomes. Workflows for targeted / untargeted metabolomics and fluxomics. NMR-based approaches. MS-based approaches. Isotopes and their application to metabolic studies. Data processing and interpretation. Introduction to the main metabolic databases and their exploitation. The course includes lectures, exercises, and workshops on specific topics as well as illustrative examples of the application of metabolomics and fluxomics to address current challenges in Human health and in other major research fields.

PREREQUISITES: Structure and physico-chemical properties of biological molecules. Metabolic biochemistry. Basic knowledge on structural and analytical techniques for the analysis of biological molecules and macromolecules (proteins, oligonucleotides, polysaccharides, metabolites): nuclear magnetic resonance, mass spectrometry, fluorescence microscopy. Molecular biology methodologies.

KEY WORDS: molecular biology, imaging, structural biology, metabolomics, proteomics, biophysics, biological macromolecules.

UE	Scientific analysis and communication	6 ECTS	1st semester
	TD: 60h		

TEACHING UNIT TITLE: Scientific analysis and communication

FACULTY IN CHARGE OF TEACHING UNIT: Laurence Nieto (laurence.nieto@inserm.fr)

LEARNING GOALS: This interdisciplinary course will allow students to strengthen their ability to critically analyze scientific articles and develop their knowledge for written and oral scientific communication. They will also develop skills in argumentation, listening and constructive dialogue, and confidence in contributing in discussions.

COURSE DESCRIPTION: The course will be based on recent publications concerning 3 major scientific topics like, for instance, Cancer, Aging or infectious diseases. Each student will have to study proposed scientific articles and to critically analyze their contents through two different and important means of communication in sciences, one for a written restitution (highlight of an article) and one for an oral presentation (poster session). They will work by groups, but with an individual evaluation.
The ability of students to argue, inform, explain, convince, will be particularly important.

PREREQUISITE(S): Traditional use of software for oral and written presentation.

KEY WORDS: Critical analysis, scientific communication, defend one's point of view

UE	International, bioethics, professional insertion	3 ECTS	1st semester
	CM: 6h, seminars: 6h, TD: 12h, TP: 4h		

TEACHING UNIT TITLE: Openings: international, bioethics, professional insertion

FACULTY IN CHARGE OF TEACHING UNIT: Rémy Poupot

LEARNING GOALS: The objectives of this course are, on the one hand, to open the minds of future graduates to notions besides their disciplinary core and, on the other hand, to develop the transversal skills necessary for their successful professional integration.

COURSE DESCRIPTION: The following concepts will be covered both as traditional teachings and seminars, including international lecturers:

- bio-ethics (in particular our rights and duties towards living organisms, including the simplest ones, the relationship of the scientist to the public);
- artificial intelligence: power and limits (in particular regarding ethics);
- the most recent advances in the field of nanobiotechnology: concepts, basics, applications.

Finally, with a view to their professional integration, round tables will be organized with the Master's former graduates, recruited in the academic world or in the private sector: job search, application strategies, integration, networking. Students will be challenged both through self-questioning on their professional goals, and fictive job interviews.

PREREQUISITE: 1st year of Master in Biotechnology or equivalent

KEY WORDS: bioethics, artificial intelligence, nanobiotechnology, professional insertion

UE	Thematic workshop	12 ECTS	1st semester
	TD: 80h		

TEACHING UNIT TITLE: Thematic workshop

FACULTY IN CHARGE OF TEACHING UNIT: Marie-Pierre Bousquet (marie-pierre.bousquet@ipbs.fr)

LEARNING GOALS: This teaching unit will be adapted to the professional project of each student: i) For students aiming at pursuing their studies by a PhD degree, the objectives will be to train towards optimized critical reading of scientific articles, to gain autonomy of thinking and learn to elaborate, write and defend a scientific project. ii) For students whose project is to apply for a job as an engineer in a technological facility (proteomic or metabolomic) or in industry, the objectives will be to acquire technical expertise and autonomy on state-of-the-art equipment and also to broaden knowledge on modern workflows dedicated to structural and functional biology.

COURSE DESCRIPTION: - For students aiming at pursuing their studies with a PhD degree, students will have to create a thesis project starting from 3 to 4 published papers on a specific theme. These themes will be related to the main topics of the Master's degree and will change every year. Each student will have to create a thesis project under the supervision of faculty and researchers specialized in the domain. - For students whose project is to apply for a job as an engineer in a technological facility (proteomic or metabolomic) or in industry, the content will focus on practical courses covering the complete metabolomic or proteomic workflow thanks to the access to modern equipment at Toulouse facilities. Students will have to produce reports on these practical works. Students will also have to prepare literature-based reviews on specific topics selected from their internship projects and to attend seminars on metabolomics or proteomics.

PREREQUISITE: Structure and physico-chemical properties of biological molecules.
Basic knowledge on structural and analytical techniques for the analysis of biological molecules and macromolecules (proteins, oligonucleotides, polysaccharides, metabolites): nuclear magnetic resonance, mass spectrometry, fluorescence microscopy.

REFERENCES: Available on ScholarVox (http://univ-toulouse.scholarvox.com) : - Proteomic and Metabolomic Approaches to Biomarker Editor: Elsevier Science, 2013 - Low-Abundance Proteome Discovery : State of the Art and Protocols. Author: Boschetti, Egisto,Righetti, Pier Giorgio Editor: Elsevier Science, 2013
- Peptidomics of Cancer-Derived Enzyme Products Author: Hu, Tony Y. Editor: Elsevier Science, 2017
- Metabolic Phenotyping in Personalized and Public Healthcare. Author: Nicholson, Jeremy Editor: Elsevier Science, 2016
- Metabolomics and Microbiomics: Personalized Medicine from the Fetus to the Adult. Author: Fanos, Vassilios. Editor: Elsevier Science, 2016

- Plant Metabolites and Regulation under Environmental Stress. Author: Ahmad, Parvaiz. Editor: Elsevier Science, 2018

KEY-WORDS: critical reading, project elaboration and writing, understand modern proteomic or metabololomic workflows and practical work (biochemical preparation, instrumentation, bioinformatics).

UE	Internship	30 ECTS	2nd semester
	5 to 6 months		

TEACHING UNIT TITLE: Internship
FACULTY IN CHARGE OF TEACHING UNIT: Cécile ALBENNE (cecile.albenne@univ-tlse3.fr)

LEARNING GOALS: Half of the year of Master 2 BSM2T will be dedicated to an internship in order to broaden the practical scope of the training in a professional context. The internship could be performed either in a public lab or in an industry, in France or abroad. In all cases, the objective is to participate in a scientific project, either by taking part in a research program or by contributing to a technological development using innovative instruments dedicated to structural biochemistry. A set of internship projects with partner laboratories will be offered but students can also look for new opportunities either in academic research labs, public technological platforms or in industry, as long as the content of the project fits the objectives of the Master 2's degree.

COURSE DESCRIPTION: Students will participate in a scientific project, by taking part in a research program or by contributing to a technological development using innovative instruments devoted to structural biochemistry or biochemical -omic approaches (metabolomics or proteomics). The internship could take place either in a public lab or in a company, in France or abroad. Before the beginning of the internship, a bibliographic research will be conducted and presented to understand the scientific and technological contexts of the projects as well as the strategies. At the end of the training, students will have to present their projects and their results through a written report and an oral presentation.

PREREQUISITE Students should have attended the courses of the first semester to provide the required level to conduct the internship project.

KEY-WORDS Laboratory, Academy, Technological Platform, Industry, Scientific project