UCLouvain

lbbmc2105

2022

Protein engineering and directed evolution

5.00 credits	36.0 h + 18.0 h	Q2

Teacher(s)	Chaumont François (compensates Soumillion Patrice) ;Claeys Bouuaert Corentin (compensates Soumillion Patrice) ;Hachez Charles (compensates Soumillion Patrice) ;Morsomme Pierre ;Soumillion Patrice ;
Language :	English
Place of the course	Louvain-la-Neuve
Main themes	The main topics of the course will be : 1. Protein science 1.1. Protein stability, folding and dynamics : - thermodynamics of protein stability and folding (theory and methods of investigation) - reversible and irreversible denaturation - in vivo protein folding (folding pathways, disulfide bonds formation, proline isomerisation, protein chaperones, conformationnal diseases) - spectroscopic methods (FRET, BRET, single molecule spectroscopy) 1.2. Enzymology- practical aspects of enzymology (assays, enzyme inactivation, experimental design) - estimation of rate constants (experimental and analytical problems) - mathematical simulation and optimisation (derivation of rate equations, numerical integration, analysis of experimental data) - multi-substrate reactions and multi-enzyme systems - isotope exchange and isotope effects - fast reactions (pre-steady-state kinetics, active site titration, burst kinetics, experimental techniques) 2. Protein engineering - techniques for mutagenesis and combination of mutations (directed mutagenesis, error prone PCR, incorporation of degenerated oligonucleotides, DNA shuffling) - screening libraries (characteristics of screening assays, high throughput screening, examples) - in vivo selection (principle, examples) - in vitro selection (phage display and similar technologies, compartmentalisation) - engineering new protein - ligand interactions - enzyme engineering (specificity, regulation, catalysis) - chemical modification of proteins in vitro and in vivo- protein engineering in silico.
Learning outcomes	**At the end of this learning unit, the student is able to :** 1 The objective of the course is to deepen the understanding of the properties of natural proteins and to introduce the student to the field of protein engineering that allows artificial evolution towards new properties. The student will learn some of the advanced investigation methods in enzymology and protein science as well as the theoretical and practical notions that are related to protein stability and folding. Then, he will get to know the different engineering strategies currently used as well as the associated biotechnologies. With the help of recent case studies describing directed, random, combinatorial and in silico approaches, the student will understand the actual limitations and difficulties of protein engineering but also its possibilities and future challenges. He/she will also study the properties obtained by engineering and compare them with the natural properties of proteins. The notion of directed evolution will be introduced and the description of some examples will aim at acquiring a vision of the artificial mechanisms of evolution in comparison with our knowledge of natural mechanisms.
Evaluation methods	This teaching unit (LBBMC2105) is organized as a flipped class, with continuous evaluation of student work. Therefore, no other evaluation is organized during the examination sessions; the mark obtained is deemed to be attached to each of the sessions of the academic year. Students will make three oral presentations during the quad term.
Teaching methods	Flipped classroom, coaching
Content	The course will begin with a short reminder of protein biochemistry. With the help of examples chosen in recent scientific literature, about 30 hours will then be devoted to three main themes : 1. Modern methods for creating protein variants: - site directed and random mutagenesis, recombinogenesis (DNA shuffling), synthetic oligonucleotides incorporation, non natural amino acids incorporation, synthetic or semi-synthetic peptidic ligation (use of inteins), genetic fusions with or without susbequent chemical modifications in vitro or in vivo. 2. Screenings and Selections : - colorimetric, fluorimetric, microbiologic and analytic assays, high throughput screenings, in vivo selection, in vitro selection (phage display and compartmentalisation).

	3. New fields of applications of engineered proteins : - fine structure-function relationships studies, new tools for molecular and cellular biology, biocatalysis, biomedicine, biotechnology. After the lectures, students will work individually on research articles. During one month, weekly meetings of questions and answers will be organized for discussing different aspects of the articles (state of the art, strategic choices, experimental methodology, rigour in data treatment and interpretation). Each student will finally present his article to the rest of the group by giving a 30 min lecture.
Inline resources	Moodle
Other infos	Precursory courses: - Protein biochemistry (e.g. BBMC2101 Structural and Functional Biochemistry) - Basics in molecular biology (e.g. BBMC2102 Integrated Molecular and Cellular Biology) Evaluation: Presentation of research articles Support: PowerPoint slides
Faculty or entity in charge	BIOL

Programmes containing this learning unit (UE)				
Program title	Acronym	Credits	Prerequisite	Learning outcomes
Master [120] in Biochemistry and Molecular and Cell Biology	BBMC2M	5		
Master [60] in Biology	BIOL2M1	5		
Master [120] in Chemistry and Bioindustries	BIRC2M	5		