UCLouvain

lbrna2202

2023

Nano-biotechnologies

3.00 credits	30.0 h	Q2

Teacher(s)	Dufrêne Yves ;
Language :	French
Place of the course	Louvain-la-Neuve
Main themes	At the meeting point between nanosciences and biology, nanobiotechnology aims at creating, characterizing and exploiting biosystems on the nanometer scale. In view of its numerous applications, this fast-moving area is attracting more and more attention both in basic research and in industry. The course aims at providing a survey of the concepts, methods and challenges of nanobiotechnology. Following a general introduction on nanosciences, the course describes the main nanocharacterization and nanofabrication methods. In particular, we show how the tools of nanotechnology (scanning probe microscopies, lithography) can be used to explore and transform biosytems at the level of single atoms and molecules, on the one hand, and how the basic principles of biology (self-assembly) can be used to elaborate new materials and devices, on the other hand. Finally, the applications and perspectives are discussed (biosensors, microfluidics, bioMEMS, quantum dots, nanoparticles, biomolecular machines), together with the main limitations and technological challenges remaining to be addressed.
Learning outcomes	**At the end of this learning unit, the student is able to :** a. Contribution of the activity to the AA (AA of the programme) 1.1, 1.2, 1.4, 1.5 3.1, 3.4, 3.6 à 3.9 6.1, 6.2., 6.4 à 6.7 b. Specific formulation for this activity to the AA of the programme (**maximum 10**) At the end of this learning activity, the student will be able to: - Explain, with an integrated and transversal vision, the main challenges of nanotechnology and nanosciences in the broad sense (nanoelectronic, nanomaterials, nanobiotechnology), - Explain the principles of the different nanofabrication methods (top-down vs bottom-up), and evaluate their throughput. - Compare the physical principles of nanocharacterization methods (scanning probes, fluorescence), and define their advantages and limitations, as well as their complementarity. - Interpret the data obtained via these different techniques. Justify with examples. - Propose an integrated vision of the main applications of nanobiotechnology (BioMEMS,Nanoparticles, Biomolecular Machines), while speculating on their long term feasibility (science vs science fiction). - Formulate a critical synthesis of scientific articles which represent major breakthrough in nanobiotechnology. - In groups of 2 or 3 students, criticize an article in written (written report of 5 pages) and oral (talk of 15 min) forms. Estimate the strengths and weaknesses of the article. Criticize the methodology, the results (originality, quality, reproducibility and statistics) and their interpretation (is the discussion founded or not). Speculate on the perspectives (basic or applied research) offered by the study.
Evaluation methods	Written examination and practical work (written + oral)
Teaching methods	The theoretical lessons are completed by a critical analysis and presentation of an article, as well as by seminars given by invited speakers, aiming at illustrating the different applications of nanobiotechnology.
Content	**I. Nanotechnology: introduction** Definition, history, budgets / Expected applications / From micro- to nanotechnologies / Three main fields : nanoelectronics, nanomaterials, nanobiotechnology **II. Nanofabrication methods** II.1. Top-down: lithographies Photolithography / Electronic lithography / Soft lithography / Dip-pen nanolithography II.2. Bottom-up: self-assembly and supramolecular chemistry Self-assembled monolayers (SAMs) / Supramolecular chemistry / Nanostructured polymer systems / Q dots / Colloidal lithography / DNA assembly / 2D protein arrays (S-layers) / Lipid films / Layers of adsorbed proteins **III. Nanocharacterization methods** Scanning tunnelling microscopy (STM) / Atomic force microscopy (AFM) / Scanning near-field optical microscopy (SNOM) / other microscopies at the single molecule level **IV. Applications and perspectives**

	IV.1. Biosensors, microfluidics, BioMEMS (detection: mechanical, electrical, optical) IV.2. Nanoparticles Quantum dots for bio-imaging / Detection of proteins based on nanoparticles IV.3. Biomolecular machines F1-ATPase / Actin motors / Kinesin motors / DNA nanoactuators
Inline resources	Moodle
Bibliography	Notes et articles fournis par le professeur et mis à disposition sur Moodle
Other infos	This course can be given in English.
Faculty or entity in charge	AGRO

Programmes containing this learning unit (UE)

Program title	Acronym	Credits	Prerequisite	Learning outcomes
Master [120] in Biochemistry and Molecular and Cell Biology	BBMC2M	3		
Master [120] in Biomedical Engineering	GBIO2M	3		
Master [120] in Chemistry and Bioindustries	BIRC2M	3		
Advanced Master in Nanotechnologies	NANO2MC	3		