MASTER

Chimie

SCIENCES SORBONNE UNIVERSITÉ

5CI014	**Biomimetic and Biotechnology** Mots clés : *Biomineralized materials, Natural adhesives, Silks, Spectroscopy, Biomimetic synthesis*								
Responsable,	Souhir BOUJDAY, Pr, Laboratoire de Réactivité de Surface, Sorbonne Université								
ECTS	*Cours (h)*	*TD (h)*	*TP (h)*	*Tutorat (h)*	*Ecrit (%)*	*CC (%)*	*TP (%)*	*Oral (%)*	*Eval. répartie*
6	40		10	10	40	20	40		oui/non

Descriptif de l'UE

The objective of this course is to introduce students to the growing field of bioinspired and biomimetic materials, to offer a truly inter-disciplinary course at the frontier of material science and life sciences, which will allow them to communicate efficiently in an ever-increasing multidisciplinary research environment. The professors offering the course are faculties from Nanyang Technological University (NTU) in Singapore. Therefore some of the courses will be offered during a visit in UPMC of NTU faculties and the rest will be seen in video (with a UPMC tutor in the room). The assessment will be as follows: quiz/short-questions examinations: 40% ; Essay/paper : 60% among which 40% are on the written document and 20% on the oral presentation..

Objectifs d'apprentissage

At the end of the course, students will be able to first: identify and explain the numerous strategies used by nature to solve materials problems in an efficient way, and second: describe the chemical and physical concepts by which biological materials are processed and interprete their critical structure/function relationships (case studies will involve materials relevant to the human body (collagen, elastin, bone) as well as those from model organisms (arthropods, mollusks, cephalopods)). The course will also be the opportunity to learn some of the basic concepts and techniques used in life sciences (proteomics tools, gene cloning and protein engineering, protein chemistry), which will allow students to communicate more efficiently with life scientists in their future research activities

Prérequis

This course is intended to be accessible to all the students with a Master 1 in Chemistry or Physics. The course MU4CI703 (Material, Surfaces and Interfaces) and the Material science interdisciplinary profile will be an advantage. This course is part of the Interdisciplinary International profile Material Science and Nanotechnologies at the BioInterfaces (MatNanoBio) in conjunction with NTU (Singapore) with the courses "Material Surfaces at the BioInterfaces" and "Plasmonics and nano-optics for Chemistry & BioInterfaces

Langue[1]	*Cours, TD, TP*	*Documents*	*Bibliographie*
English	English	English	English

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Fonctionnement de l'UE

Course syllabus

Introduction (3 hours, week 1)

Overview: Biological materials and technological priorities. Fundamental building blocks of biological materials (proteins, polysaccharides, biominerals).

Structural characterization of biological materials (3 hours, week 2)

Mechanical testing: from the macro- to the nano-scale, contact mechanics and nanoindentation. Single-molecule force spectroscopy techniques (AFM, optical and magnetic tweezers).

Biomineralized materials (6 hours, weeks 3 and 4)

Hierarchy and structural performance of bioceramics, mollusk shells, teeth, and bone. Silica-based materials (diatoms and sponges).

Protein prospection and characterization (6 hours, weeks 5 and 6)

Amino acid and primary structure of proteins. Sequencing and proteomic techniques (Edman, internal sequencing mass spectrometry). Secondary structure of proteins (x-Ray, NMR, CD, Raman spectroscopy techniques).

Most abundant load-bearing protein: Collagen (3 hours, week 7)

Chemical processing and assembly of collagens, structure and mechanics, deformation mechanisms.

Physical processing of silks (3 hours, week 8)

Silks sequence and structure/properties relationships, silk processing (liquid crystal, spinning).

Bioelastomers (3 hours, week 9)

Elastin, elastomeric membranes, mussel byssus (self-healing and elastic gradients), cell mechanics.

Sclerotized proteins and structures (3 hours, week 10)

Insect cuticle and chitin/protein biocomposites, metalloproteins of jaws and fangs, cephalopod beaks.

Natural adhesives (3 hours, week 11)

Mussel adhesive fibres and proteins, barnacle cement, underwater glue (complex coacervation).

Biomimetic synthesis (6 hours, weeks 12 and 13)

Genetically engineering biomaterials (elastin, silks, resilin), enzyme-directed synthesis of ceramic and semi-conductors, MEMS technology for biomimicry of surface patterning.

References

1. Vogel, S. (2003). **Comparative Biomechanics: Life's Physical World**, Princeton University Press.

2. Nelson, D. L. and M. M. Cox (2005). **Principles of Biochemistry**. New York, W.H. Freema and and Company

3. Meyers, M. A., P. Y. Chen, et al. (2008). "*Biological Materials: Structure and Mechanical Properties.*" **Progress in Materials Science 53**: 1-206.

4. Specialized papers will be distributed to students weekly before the lectures.