France

University Lyon 1
Sciences - Technology
Health Sciences

Degree Programs Taught in English

Université Claude Bernard Lyon 1
WELCOME TO LYON 1!
The Claude Bernard University Lyon 1 is a multidisciplinary institution that is involved in basic research and its applications.
Lyon 1 offers more than 300 degree-granting programs in Health, Sciences, Technology. Almost 80% of students are enrolled on courses leading to professional qualifications. It currently has 69 research laboratories whose work focuses in particular on the areas of Health, Environment and Material Sciences.
BACHELOR’S PROGRAM IN GEOSCIENCES

Program coordinator: Prof. Fabrice Cordey fabrice.cordey@univ-lyon1.fr

- Teaching Unit: Geosciences in English I
  Description: This course is part of «UE Transversale TR3». It is an introductory course about Earth Sciences (historical and physical geology), equivalent to EASC 101/102 of North American or Canadian universities.
  Key words: Introductory Earth sciences, physical geology, historical geology
  ECTS: 2
  Hours: 20
  September - December

- Teaching Unit: Geosciences in English II
  Description: This course is part of «UE Transversale TR3». It is the second part of the introductory course on Earth Sciences, with focus on the Environment.
  Key words: Introductory Earth sciences, Environmental issues
  ECTS: 3
  Hours: 30
  January - June

MASTER’S PROGRAM IN GENETICS, CELL BIOLOGY, PATHOLOGIES

Program coordinator: Prof. Marc LEMAIRE marc.lemaire.bio@univ-lyon1.fr
Administrative coordinator: Ms Carmen MENA carmen.mena@univ-lyon1.fr

- Teaching Unit: Genome to function
  Description: The main goals of these courses are to stimulate exchanges and thinking among students interested by the latest breakthroughs in genetics and functional genomics and to bring them to formulate research questions and projects. Based on scientific conferences held by scientists from research centers around Lyon, the topics can cover several themes: From genotype to phenotype; the small non coding RNA world; epigenetic inheritance.
  Key words: genetics and functional genomics, epigenetic inheritance, genotype to phenotype
  ECTS: 3
  Hours: 30
  January - June

- Teaching Unit: Immunology and Cancer
  Description: This UE is based on the basic immunology knowledge of students to develop basic concepts research in immunology that have applications in clinical and pharmaceutical research in the field of oncology. The themes will be: the anti-tumor immune response, the cancers of the immune system, protection of immunosuppressed patients.
  Key words: anti-tumoral cancer response, immune system cancers
  ECTS: 3
  Hours: 30
  January - June

- Teaching Unit: Cellular aging and cell death
  Description: The goal of this UE is to provide an overview and recent advances on cell death and cellular aging fields. During this teaching program the emphasis will be put on how both fields are critical to understand the aging process. The following topics will be addressed: Biology of cell death; Cellular senescence; Cellular aging and damage to the molecules; Cellular aging and metabolism; Physiopathology of aging.
  Key words: Cell death, cell aging, protein aggregation, neurodegenerative diseases
  ECTS: 3
  Hours: 30
  January - June

- Teaching Unit: Molecular mechanisms of cell signaling
  Description: The goal of this UE is to give a detailed overview on the biological role and on the molecular mechanisms of signal transduction from prokaryotes to high eukaryotes cells. The main aspects of cell signaling will be covered: The machinery of cell signaling: from signals to targets; Regulatory functions of cell signaling; Cell signaling through evolution; Cell signaling and diseases.
  Key words: signal transduction pathway, cell signaling
  ECTS: 3
  Hours: 30
  January - June

- Teaching Unit: Oncology
  Description: The goal of this UE is to complement the UE+ tumor cell in its environment+ of the 1st year of the Master, as well as to provide an interest in recent and innovative cancer research. The following topics will be addressed: epidemiology of cancer; metabolic deregulation during tumorigenesis, global approaches in cancer research, news anti-cancer therapies and cancer markers.
  Key words: Cancer biology, epidemiology of cancer, global approaches (omics) in cancer research
  ECTS: 3
  Hours: 30
  January - June

- Teaching Unit: Scientific English
  Description: This unit is designed to prepare Master’s degree students for their future as part of the international scientific community. The goal is to teach them to make clear and concise oral communications in English. The program has been designed to give students the confidence to present their work to an English speaking scientific audience, either in an international congress, a seminar or an interview.
  Key words: Oral communication, comprehension tests, bibliographic report
  ECTS: 3
  Hours: 30
  September - December
Teaching Unit: Virus and immunity
Description: Organized in the form of a conference with introductory lectures and research talks by international leading scientists in the field. The course provides the means to understand the latest discoveries in virology and immunology. Topics covered include: biochemistry and structural biology of viruses, genetic variability, anti-viral treatments and drug resistance; the interaction between viruses and the immune system; the generation of immune memory, the modulation of immune response, immunosuppression, and viral persistence; viral pathogenesis anti-viral vaccination; viral vectors for gene therapy.
Key words: virology, immune system, infectiology, structural biology, vaccination, gene therapy

Teaching Unit: Comparative genomics
Description: Organised in the form of a conference with introductory lectures and research talks by international leading scientists in the field. The course introduces comparative genomics and how it enables a global approach to the mechanisms involved in the diversity of genomes, of phenotypes, or of populations. Topics covered include: transposable elements and gene appearance, gene and genome duplication, sexual chromosomes, phylogenomics, phylogeny and evolution of bacteria; evolutionary genomics of human origin, evolutionary dynamics of non-coding DNA, genomics of speciation, genome architecture.
Key words: evolution, phylogeny, genome dynamics, population genomics

Teaching Unit: Integrative Cell Biology and Immunology
Description: Organized in the form of a conference with introductory lectures and research talks by international leading scientists in the field. The course provides an integrated and multidisciplinary understanding of how multicellular systems maintain their homeostasis, with a focus on the immune system function in health and disease. Topics covered include: homeostatic roles of cell survival, cell migration, communication, or sensing the environment; animal models of immune disease, autoimmune diseases, immunodeficiency, hypersensitivity, tumour immunology, genetics and development of the immune system.
Key words: cell biology, immune system, homeostasis, pathology, development

Teaching Unit: Tissue engineering
Description: Organised in the form of a conference with introductory lectures and research talks by international leading scientists in the field. Following a general survey of the extra-cellular matrix, the course covers tissue engineering at both fundamental and medical levels. Specific topics include: three-dimensional matrices, biomaterials, stem cells; skin, bone, cartilage, and neural tissues; applications in grafting, transplantation or regeneration; ethical issues. A practical introduction to applications is provided by visits to biotechnological companies based in Lyon.
Key words: biotechnology, bioengineering, extra-cellular matrix, stem cells, grafting

Teaching Unit: Mechanisms of development in plants and animals
Description: Organized in a conference with introductory lectures and research talks by international leading scientists in the field. This course explores the mechanisms of development conceptually renewed thanks to new methods of cell biology, imaging, molecular genetics, modelling, and model organisms. Topics covered include: fertilization, embryogenesis and axis determination; cellular dynamics and morphogenesis; regulation of developmental genes; biophysical regulation; modelling; stem cells and cell-fate; sex determination; epigenetics and developmental plasticity; evolution and development.
Key words: embryogenesis, differentiation, morphogenesis, biophysics and modelling, developmental plasticity, evo-devo

Teaching Unit: Biological resources and biodiversity
Description: Organized in the form of a conference with introductory lectures and research talks by international leading scientists in the field. A course across disciplinary boundaries: ecology, evolution, economy, legal aspects, social sciences and natural resources security. This course provides a state-of-the-art knowledge on the conceptual and methodological advances in the field of bio-resources, at molecular, organisational, population and ecosystem levels. Topics covered include: conservation strategies, agriculture and domestication, breeding in the context of new planetary needs, sustainable management, biocapacity, ecosystem services.
Key words: ecology, evolution, economy, conservation, sustainable management, ecosystem services

Teaching Unit: Central & Peripheral Control of Glucose & Energy
Description: Organized in the form of a conference with introductory lectures and research talks by international leading scientists in the field. The objectives of this course are to describe at molecular, cellular and integrated levels how signals originating from the periphery of the body converge to and are integrated by the central nervous system in order to maintain energy homeostasis. Topics covered include: coordination of gut, endocrine pancreas, adipose tissue and nervous system; hormonal, nervous, and nutrient-based signals; neurotransmitters and neuronal plasticity; pathologies such as obesity and diabetes.
Key words: homeostasis, physiology, hormones, nutrients, neural system, pathology

Teaching Unit: Neural basis of cognition: from genes to mental states
Description: Organized in the form of a conference with introductory lectures and research talks by international leading scientists in the field. The course tackles one of the greatest challenges in biology – understanding how the brain works. It offers a multidisciplinary introduction to cognitive neuroscience, addressing questions such as: How and why are different cognitive functions represented in the brain? How similar or different is our cognitive apparatus from that of other species? How did the brain evolve? How does it develop?
Key words: brain, cognition, neurosciences, neurodevelopment, evolution

Teaching Unit: Paleontology
Description: Organized in the form of a conference with introductory lectures and research talks by international leading scientists in the field. This course presents the new trends underlying the recent renewal of paleontology. Indeed, new technologies such as modern molecular genetics, isotope geochemistry or X-ray microtomography enable a better access to paleo-DNA, element concentration and non-invasive imaging in the fossil. The course will focus on major steps of life history, such as the metazoan explosion, the mass extinction events, the evolution of hominids, and the changes of the climate through time.
Key words: palaeontology, evolution, extinction, radiation, fossil record

Teaching Unit: Microbial evolution and molecular epidemiology
Description: Organized in the form of a conference with introductory lectures and research talks by international leading scientists in the field. This course aims at approaching microorganisms' evolution, epidemiology, population dynamics, evolutionary history, and the main features of pathogenic bacteria (mutations, recombination, dispersion). Topics range from basic science to medical applications and include: non-coding RNAs, host susceptibility to infections, molecular subversion, CRISPRs in antiviral immunity, modelling the propagation of pathogens, host-microbe interactions.
Key words: bacterial evolution, epidemiology, infectiology, pathology, modelling
**MASTER’S PROGRAM IN NEUROSCIENCES**

**RESEARCH 2nd year**

- **Teaching Unit**: Scientific communication
  - Description: Prepare the internship: interact with the research team, work on the bibliographic field, make a presentation of the scientific context, protocols and methods that will be implemented during the future internship.
  - ECTS: 3
  - Period: September - December

- **Teaching Unit**: Neuroconference
  - Description: Series of conferences given by national and international speakers, selected for the quality of their research and pedagogic abilities. Conferences cover current neuroscientific issues, from molecular and cellular neuroscience to cognition, including synaptic plasticity, perception and memory, sleep and chronobiological rhythms, Action-Decision-Reward...
  - ECTS: 18
  - Period: September - December

- **Teaching Unit**: Statistics and scientific bibliography
  - Description: Tool box providing basic statistics for neuroscientists and tutoring for bibliography data basis use and for scientific reading and writing. Comprises lectures and practical classes.
  - ECTS: 6
  - Period: September - December

- **Teaching Unit**: Training
  - Description: Research internship in neurosciences. Oral defense and internship report required for validation.
  - ECTS: 30
  - Period: January - May

**MASTER’S PROGRAM IN SYNTHESIS, CATALYSIS AND SUSTAINABLE CHEMISTRY**

- **Teaching Unit**: NMR and Mass Spectroscopy for structural determination
  - Description: The program is intended to introduce Nuclear Magnetic Resonance, Mass Spectrometry, and other spectroscopic methods for the structural identification of organic, organometallic, inorganic compounds, as well as potentially polymers. A short section will be devoted to the theory of NMR and Mass Spectrometry, but the bulk of the course will consist of case studies using proton, carbon, and heteronuclear 1-D and 2-D NMR, in conjunction with Mass spectrometry and IR spectroscopy for the identification of organic compounds and inorganic complexes.
  - ECTS: 3
  - Period: September - December

- **Teaching Unit**: Methodology in organic synthesis
  - Description: This course will describe the functionalization of complex molecules by the means of useful and modern methods. A large importance will be given to the mechanisms and the stereocontrol of these reactions. The different processes will be illustrated by recent examples reported in the literature. Among the large number of synthetic transformations considered, the following processes will be examined in more detail: selective formation of C=C bonds, metathesis, stereocontrolled formation of 1,3-diols, radical cyclizations (Baldwin’s rules), tandem and multi-component reactions.
  - ECTS: 3
  - Period: September - December

- **Teaching Unit**: Total synthesis of natural products
  - Description: Contents: - Concepts of multi-step synthesis, retrosynthetic analysis - Synthesis of acrylic systems - Synthesis of cyclic and polycyclic systems - New approaches in total synthesis
  - Acquired skills: retrosynthetic analysis of complex molecules, construction of key bonds and structural motifs using classical reactions and reaction sequences, control of stereogenic elements.
  - ECTS: 3
  - Period: September - December

- **Teaching Unit**: Organometallic chemistry
  - Description: In the first part of this class, we will study the elemental steps taking place during an organometallic transformation. After setting the bases, we will go into more detail in studying the most common organometallic transformations leading to the formation of C-C, C-N, etc. bonds. These reactions have opened new, widely used strategies in modern organic synthesis. Selected industrial applications of organometallic chemistry will also be presented and discussed.
  - Acquired skills: basics of organometallic chemistry, new retrosynthetic approaches using organometallic chemistry, new chemical transformations using non-toxic metals.
  - ECTS: 3
  - Period: September - December

- **Teaching Unit**: Asymmetric synthesis
  - Description: The course is devoted to the synthesis of chiral compounds using enantio- and diastereoselective processes. Recent trends toward the selective formation of C-C bonds are discussed, especially those involving catalytic procedures, or those with the lowest impact on the environment like organocatalysis and the use of non-toxic solvents (ionic liquids, water). Particular attention is given to the synthesis of amino acids and nucleosides.
  - ECTS: 3
  - Period: September - December

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**Program coordinator**: Prof. Peter GOEKJIAN peter.goekjian@univ-lyon1.fr

**Administrative coordinator**: Ms Carmen MENA carmen.mena@univ-lyon1.fr
This course is problem-based and consists of two main parts: Flow regimes, Stokes flows around particles, and effective conductivity of a mixture of spheres. Einstein viscosity. Averaged equations for the flow of suspensions, shear-induced diffusion. Drift-flux models. Kinematic waves and shocks. In the third part of the course, we analyze the linear instability of separated flow and Rayleigh–Taylor instability and the Rayleigh–Taylor instability of a liquid thread. The course is concluded with a brief review of CFD methods for multiphase flows (MCFD).

Key words: Flow regimes, Stokes flows around particles, effective properties of suspensions, continuum models of suspensions, drift-flux models, kinematic waves, separated flows, stability analysis

Teaching Unit: Advanced fluid mechanics
Description: This course is problem-based and consists of two main parts: potential-flow based airfoil theory, and boundary layers. Complex potential, especially for potential flow past a cylinder with circulation. Joukowsky’s transformation. Flow past a flat plate under an angle of attack without circulation; introduction of circulation; Joukowsky airfoil. Other airfoils are also considered. 3D airfoil theory, downwash. In the second part of the course we completely work out the boundary layer analysis in various problems, including the Blasius boundary layer, Falkner-Skan, the laminar planar jet, and introduce the von Karman – Pohlhausen method for more general boundary layers.

Key words: Complex potential, transformations, 3D airfoil theory, advanced boundary-layer analysis

Teaching Unit: Revision of fluid mechanics
Description: In this short, intense revision course, we derive the Navier-Stokes equations, and solve these for various unidirectional flows. Potential flow analysis: flow past a cylinder. The course has a strong problem-based component.

Key words: finite-difference methods; convergence, consistency and stability of numerical schemes; discretization; Lax’s theorem

Teaching Unit: Molecular approach to catalysis
Description: Understand the metal-mediated catalytic phenomenon of some of industrial processes and enzymatic bio routes through the concepts and basis of molecular organometallic chemistry. This course will use the concepts and tools of organometallic chemistry to present and rationalize the mechanisms of several industrially relevant catalytic cycles or enzymatic pathways. Examples from homogeneous, supported heterogeneous of biological systems will be discussed. The link with sustainability (use of renewable feedstock, energy and life cycle assessment, novel solvents and alternative routes) will be made where relevant.

Teaching Unit: Inorganic nanomaterials chemistry
Description: This course will focus on advances developed on nanoparticle liquid phase’s syntheses by coprecipitation, sol-gel processing, microemulsions, hydrothermal/solvothermal methods. When appropriate, considerable background material is presented to provide the uninstructed student with sufficient understanding of the underlying principles and theories of the synthetic methodologies.

Teaching Unit: Advanced chemical kinetics
Description: The mastering of the kinetic parameters controlling a reaction with and without a catalyst. Content:
- The interpretation of the rate of a non-catalytic chemical reaction using the Kinetic Theory of Gases.
- The analysis of experimental data on the rate of a non-catalytic reaction considering formal and detailed kinetic approaches.
- The analysis of experimental data on the rate of a catalytic reaction considering formal and detailed kinetic approaches.

Teaching Unit: Sustainable and green chemistry
Description: The course will first describe the concepts and principles of sustainable chemistry, including “Atom Economy” proposed by Trost and Sheldon in the beginning of the nineties, the principles of “Green Chemistry” and of “Green Chemical Engineering” proposed by Anastas, the new regulation for the use of chemicals (REACH...), the Life Cycle Assessment, and some notions of evaluation of the toxicity and of the ecotoxicity of chemicals.
- The course will continue by describing the tools already available or still in development in order to reach the requirement for cleaner and safer production of chemicals: 1° catalysis (heterogeneous catalysis, phase transfer catalysis, homogeneous, biocatalysis, organocatalysis...), 2° new solvents (water-soluble catalysts and reagents, ionic liquids, supercritical CO2, fluorinated solvents ...), 3° New methods of activation (Microwaves, Ultra sounds, High Pressure and Photochemical activations...).
- Finally the course will finish with the description of chemistry using renewable materials (including the concept of Biorefinery).
- All the classes will consist of seminars and practical examples discussed with the participation of the students.

Teaching Unit: Heterocyclic chemistry
Description: Contents:
- Drugs; Definition; From hits to lead compounds; Examples
- Synthesis and reactivity of heterocycles used in organic or medicinal chemistry.
- Furan; Pyridine – quinoline – isoquinoline; Pyrrole; Indole; Thiophene – benzo-thiophene
- Applications: synthesis of natural products or drugs
MASTER’S DEGREE IN EARTH SCIENCES

MASTER’S PROGRAM IN EARTH SCIENCES

1st Year

◊ Program coordinator: Prof. Fabrice Cordey fabrice.cordey@univ-lyon1.fr

- Teaching Unit: Earth and Planetary Geology
  Description: History of the system Earth, structures of continents + oceans and their tectonic evolution, ancient paleogeographies and climates.
  Key words: Earth history, global geology and plate tectonics, geological map of the world
  6 ECTS 80 hours
  January - June

MASTER’S DEGREE IN EARTH SCIENCES

2nd Year

◊ Program coordinator: Prof. Fabrice Cordey fabrice.cordey@univ-lyon1.fr

- Teaching Unit: Reading Group: Physics, Chemistry, Earth, Planets
  Description: Students undertake bibliographical researches and oral presentations on selected articles dealing with recent scientific results or news.
  Key words: Bibliographical research, scientific issues, oral presentations and debates
  3 ECTS 30 hours
  September - December

- Teaching Unit: Reading Group: Paleontology, Sedimentology, paleoenvironment
  Description: Students undertake bibliographical researches and oral presentations on selected articles dealing with recent scientific results or news.
  Key words: Bibliographical research, scientific issues, oral presentations and debates
  3 ECTS 30 hours
  September - December

MASTER’S DEGREE IN NANOSCALE ENGINEERING

This program is offered by a joint-venture of top engineering institutions and universities in Lyon: École Centrale de Lyon (ECL), Institut des Sciences Appliquées de Lyon (INSA de Lyon), Université Claude Bernard Lyon1 (UCBL1), which are part of the “Université de Lyon”. The Nanoscale Engineering program is resolutely multidisciplinary. It provides both a theoretical base and a practical expertise in the fields of elaboration, characterization and design of nanoscale structures and systems. It offers the scientific and technological knowledge required to tackle a rewarding career in the innovative and growing field. This Master aims to prepare students to continue towards a PhD level, but also to provide nanotechnology industries with professionals able to adapt to the new challenges of this domain.

MASTER’S PROGRAM IN NANOSCALE ENGINEERING

1st Year

◊ Program coordinator: Prof. Catherine JOURNET-GAUTIER catherine.journet-gautier@univ-lyon1.fr

- Teaching Unit: Introduction to Nanoscale Engineering
  Description: This introductory course has three main objectives:
  -To provide an overview of laboratories and companies working in the nanotechnology domain in the region;
  -To improve capabilities in information research, synthesis and communication.
  Representatives of local laboratories and of companies that are working in nanoscience will present their activities to the students, who will in turn be asked to prepare a presentation of a laboratory or company.
  2 ECTS Lectures: 8 hours
  September - December

- Teaching Unit: Micro- and Nanofabrication, part 1
  Description: Introduction:
  -Emergence of nanotechnology
  -Nanostuctures in zero, one, two and three dimensions
  -“bottom-up” and “top-down” approaches
  Zero-dimensional nanostructures: nanoparticles
  One-dimensional nanostructures: Nanowires and nanorods
  Two-dimensional nanostructures: layers
  Other nanostructures :
  -Fullerenes and carbon nanotubes
  -Core-shell systems
  -Porous structures and hybrids
  Nanostructuring by physical processes:
  Lab practicals in the NanoLyon cleanroom
  2 ECTS Lectures: 30 hours Practical: 24 hours
  September - December

- Teaching Unit: Characterization Tools for Nanostructures
  Description: These courses present the main methods of nanoscale-observation of surfaces and interfaces, and the main methods of local characterization for structures of low dimensionality (e.g., morphological, optical, and spectroscopic characterization). The discussed techniques will be illustrated by specific applications in various fields of nanoscience, nanotechnology and biology.
  5 ECTS Lectures: 30 hours Practical: 12 hours
  September - December

- Teaching Unit: Quantum Engineering
  Description: This course deals with the aspects of quantum mechanics that have implications for nanotechnology. The first part of the course discusses formalism of quantum mechanics with attention to practical nanotechnology. The rest of the course is dedicated to engineering applications of quantum mechanics: nanodevices and quantum information processing.
  5 ECTS Lectures: 30 hours Practical: 8 hours
  September - December

- Teaching Unit: Quantum Engineering
  Description: This course deals with the aspects of quantum mechanics that have implications for nanotechnology. The first part of the course discusses formalism of quantum mechanics with attention to practical nanotechnology. The rest of the course is dedicated to engineering applications of quantum mechanics: nanodevices and quantum information processing.
  5 ECTS Lectures: 30 hours Practical: 8 hours
  September - December
Teaching Unit: Basics of Physics
Description: This course provides a basic knowledge of physics and is compulsory for all students who do not have a physics bachelor, to ensure that they will be able to follow the other courses of the Master of Nanoscale Engineering.

Teaching Unit: Solid State Physics
Description:
- Cohesive energy in solids
- Crystal structures
- The free electron gas model
- Energy bands in solids: nearly free electron gas model and tight binding methods
- Vibrations in crystals and thermal properties

Teaching Unit: Continuum Mechanics
Description:
- Continuum limit, conserved quantities and continuity relation
- Diffusive processes: macroscopic laws and microscopic models
- Stress tensor and the general equation of motion
- Elasticity theory: strain tensor, elastic energy, Hooke’s law, isotropic solids, full solution of a few static deformation problems, elastic wave propagation
- Fluid kinematics: Lagrangian and Eulerian motion, deformation of fluids, mass conservation
- Fluid dynamics: Newtonian viscous stress tensor, Navier-Stokes equation, boundary conditions, Reynolds number, other conservation laws, unidirectional and incompressible flows, perfect fluids, potential flows, vorticity

Teaching Unit: Physics of Semiconductors, part 1
Description: The course introduces the fundamental concepts of semiconductor solid state physics and shows how the electronic and optical properties can be finely tuned in these materials. It further highlights the prominent role played by semiconductor materials in the design of common electronic and opto-electronic devices (transistors, LEDs ...). Synthesis techniques and elaboration routes are presented as well.

Teaching Unit: Physical Chemistry and Molecular Interactions
Description: With decreasing size of systems, the influence of surface effects starts to dominate over volume effects. This course presents the intermolecular forces and the surface forces which govern the interactions in matter on the submicro scale and thus determine the mechanical and fluidic properties of micro-systems, such as adhesion, friction, and functionalization.

Teaching Unit: Biomolecules, Cells, and Biomimetic Systems
Description: This course provides a basic knowledge of biology for students with a physics, chemistry or engineering background.

Teaching Unit: Seminars
Description: These seminars provide students with the opportunity to get to know partners from industry and academia, who give presentations on their activities. This allows students to appreciate the role of nanotechnology in the socioeconomic world. Ethical and legal aspects of the increasing utilization of nanotechnology will also be covered.

Teaching Unit: Nanomechanics
Description: The mechanical properties of nanomaterials give rise to numerous industrial applications: ultra-hard composites for tools, reinforcement materials, protection layers, food preservation, etc. The extraordinary ratio between surface and volume in nanomaterials and its consequences are at the heart of the excellence of nanomaterials in these activity sectors. The lectures will impart the knowledge that is necessary to understand – at a state-of-the-art level - the mechanical properties of nanomaterials with examples of current applications and perspectives for future developments.

Teaching Unit: MEMS and NEMS
Description: Introduction to MEMS/NEMS
Materials for MEMS and NEMS properties of silicon
Principles of operation and examples
Modelling of MEMS/NEMS

Teaching Unit: Introduction to System Design
Description: The combination of nanoscale elements to form complex functional systems on microscopic and macroscopic length scales is the natural domain of application for nanotechnology. This principle already finds wide application in several economic areas, for example microelectronics, transportation and healthcare.

Teaching Unit: Drug-Delivery Systems
Description:
- Biomedical Imaging
- Magnetic resonance imaging (MRI) and magnetic nanoparticles
- Nuclear imaging and nanometric tracers
- Optical imaging, intravital microscopy and fluorescent markers
- Vectorization and targeted delivery of drugs
- Principles and challenges
- Biochemical vectorization
- Magnetic vectorization
- Therapy
- Environmentally-sensitive nanostructures (pH, temperature)
- Magnetically-induced hyperthermia
- Photodynamic therapy
- Emergent therapies: IR hyperthermia, neutron therapy

Teaching Unit: Project Management Workshop
Description: The project of the first year consists of exploring a nanotechnology-related topic in a small group, for example by compiling a report on the state of the art in some domain of nanotechnology and its implications for society, by designing a prototype of a device or by developing a new concept for a practical course. The independent group work is supported by courses on bibliographical research, project management, presentation and communication.

Teaching Unit: Research Internship
Description: The Master of Nanoscale Engineering places great emphasis on immersing the students in research laboratories so that they can see the practical application of the subjects covered in the courses and thus acquire a deeper and broader understanding. The research internship is divided into two separate periods of two months and 10 ECTS points each. It allows students to work on two different topics under the guidance of their supervisor.
## MASTER’S DEGREE PROGRAM IN NANOSCALE ENGINEERING 2nd Year

<table>
<thead>
<tr>
<th>Teaching Unit</th>
<th>Description</th>
<th>ECTS</th>
<th>Lectures:</th>
<th>Practics:</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Nanooptics and Biophotonics</strong></td>
<td>The main topic of this course is the control of light at microscopic and nanoscopic scales. The interaction between photons and different media is considered, including semiconductors, dielectrics, metals and biologic media. Different kinds of applications are introduced, ranging from information transfer and data processing to biosensing.</td>
<td>5</td>
<td>30 hours</td>
<td>6 hours</td>
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<tr>
<td><strong>Surface-Analysis Techniques</strong></td>
<td>This course introduces the main aspects of industrial conception of biochips and their fabrication, to the interpretation of the resulting data, in order to achieve an analytical performance that is best adapted to the issue under investigation. We will discuss examples from the domain of academic research as well as commercialized systems, for applications related to health and environment.</td>
<td>5</td>
<td>30 hours</td>
<td>8 hours</td>
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<tr>
<td><strong>Physics of Semiconductors, part 2</strong></td>
<td>The objective of this course is to familiarize students with the physical principles of quantum conversion and of the design of solar cells, from the material to the component, taking into account economic and environmental constraints. These basics will then permit students to discuss new concepts and nanotechnological applications for third generation solar cells.</td>
<td>2</td>
<td>20 hours</td>
<td>10 hours</td>
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<tr>
<td><strong>Micro- and Nanofluidics</strong></td>
<td>The aim of this course is to convey adequate knowledge of magnetism in solids so that magnetic nanostructures can be understood. The specific properties of such nanostructures arise from their large surface-to-volume ratio: increase of the magnetic moment, increase and modification of the anisotropy, reversal of non-conventional magnetic moments, etc. An understanding of these phenomena requires the introduction of new magnetic states and novel models. We will furthermore discuss dedicated analysis techniques for the variety of nanomagnetic materials that can be fabricated, which have to deal with the small size and quantity of the material, and the possible applications of magnetic nanostructures.</td>
<td>2</td>
<td>20 hours</td>
<td></td>
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<tr>
<td><strong>Micro- and Nanofabrication, part 2</strong></td>
<td>This course explores life on the nanometer scale. The two aspects of nanotechnology in life sciences are discussed.</td>
<td>2</td>
<td>17 hours</td>
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<tr>
<td><strong>Biosensors and Biochips</strong></td>
<td>The course introduces the main concepts related to the design, the fabrication and the utilization of microsystems for molecular analysis in complex environments, liquid or gaseous. Such systems include sensors and biosensors, i.e., systems for the detection of certain chemical species, as well as biochips, which are devices for simultaneous multifactor analysis.</td>
<td>1</td>
<td>17 hours</td>
<td></td>
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<tr>
<td><strong>Computer Modeling of Nanoscale Systems</strong></td>
<td>This course introduces the principles underlying common methods of numerical simulations used in the nanosciences, going from the atomic scale to the continuum. It discusses the appropriateness of atomic scale and continuum modeling. One of the goals is to understand the principles of the models and algorithms used in standard codes.</td>
<td>5</td>
<td>20 hours</td>
<td>10 hours</td>
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<tr>
<td><strong>Multi-Domain System Integration</strong></td>
<td>This course introduces the principles underlying common methods of numerical simulations used in the nanosciences, going from the atomic scale to the continuum. It discusses the appropriateness of atomic scale and continuum modeling. One of the goals is to understand the principles of the models and algorithms used in standard codes.</td>
<td>2</td>
<td>20 hours</td>
<td>4 hours</td>
</tr>
<tr>
<td><strong>Solar Cells and Photovoltaics</strong></td>
<td>The objective of this course is to familiarize students with the physical principles of quantum conversion and of the design of solar cells, from the material to the component, taking into account economic and environmental constraints. These basics will then permit students to discuss new concepts and nanotechnological applications for third generation solar cells.</td>
<td>2</td>
<td>20 hours</td>
<td>4 hours</td>
</tr>
<tr>
<td><strong>Nanoelectronics</strong></td>
<td>This course deals with nanoelectronic devices whose design goes beyond the CMOS (complementary metal-oxide-semiconductor) technology. It discusses different technological approaches and the architectures that are adequate to complement or replace those that are presently used in microelectronics.</td>
<td>2</td>
<td>20 hours</td>
<td></td>
</tr>
<tr>
<td><strong>Tissue and Cell Engineering</strong></td>
<td>This course explores life on the nanometer scale. The two aspects of nanotechnology in life sciences are discussed.</td>
<td>2</td>
<td>17 hours</td>
<td></td>
</tr>
<tr>
<td><strong>Seminars</strong></td>
<td>The project of the second year is reserved for a literature survey, allowing our students to prepare for their Master thesis projects.</td>
<td>1</td>
<td>17 hours</td>
<td></td>
</tr>
<tr>
<td><strong>Bibliography project</strong></td>
<td>The course introduces the principles underlying common methods of numerical simulations used in the nanosciences, going from the atomic scale to the continuum. It discusses the appropriateness of atomic scale and continuum modeling. One of the goals is to understand the principles of the models and algorithms used in standard codes.</td>
<td>2</td>
<td>20 hours</td>
<td></td>
</tr>
<tr>
<td><strong>Intellectual Property</strong></td>
<td>The course introduces the principles underlying common methods of numerical simulations used in the nanosciences, going from the atomic scale to the continuum. It discusses the appropriateness of atomic scale and continuum modeling. One of the goals is to understand the principles of the models and algorithms used in standard codes.</td>
<td>2</td>
<td>20 hours</td>
<td></td>
</tr>
<tr>
<td><strong>Master Thesis Research Project</strong></td>
<td>The final Master thesis project with duration of five to six months can be conducted in an academic research group or in an industrial laboratory, anywhere in France or abroad.</td>
<td>30</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>


**MASTER'S PROGRAM IN SKIN DELIVERY**

2nd Year

- **Teaching Unit :** Industrial Property, Trademarks, Patents, Infringement actions, Scientific documentation
  - **Description :** The Teaching Unit is proposed for Master's degree students who would like to discover and improve their knowledge on IP (Industrial Property). Experts from National Industrial Property Institute (INPI France) are involved in some key lectures. A tutorial project is prepared by the students using tools learned during the TU. An oral presentation in English allows all participants to discuss on different innovative topics.

- **Teaching Unit :** Mathematics and Statistics
  - **Description :** Mathematical models in pharmacokinetics: Applied mathematics to multi-compartmental systems. Applied statistics in experimental field: Experimental design, Parametric and non-parametric statistics, Statistical multivariate analysis, Experimental results exploitation.

- **Teaching Unit :** Cutaneous absorption and formulation
  - **Description :** Skin permeation methodology (in vitro, ex vivo) - Skin absorption modulation (enhancers-retarders) - Iontophoresis-Patch for skin: local and systemic effects - Modelling skin absorption - Pharmacokinetic predictive approach - Topical delivery systems (emulsion, nanoparticles, liposomes), transdermal delivery systems.

- **Teaching Unit :** Skin Physiology and bioavailability
  - **Description :** Normal and pathological functions of the skin barrier - Skin microflora-Skin immune system - Physical properties of the skin - Cutaneous metabolism - Effect of aging on the skin - Skin cancers - Local and systemic bioavailability - Reconstructed skin models

- **Teaching Unit :** Efficacy of skin products
  - **Description :** Safety and efficacy evaluation of products in vivo in man - Probiotics for skin - Antiseptic formulation and microbiology activity-Tanning products - Blanching products - UV transmittance through stratum corneum in different ethnic skins - Skin hydration and transdermal water loss - Transdermal delivery systems: Formulation, skin absorption with Franz diffusion cell.

- **Teaching Unit :** Drug devices development and characterization
  - **Description :** Formulation and characterization of Drug devices - Ternary diagram (oil, water, surfactant) - Green surfactants - Cyclodextrins - Nanoparticles - Liposomes - New drugs from plants - Size and Zeta potential particles determinations - Rheological properties - Biopharmaceutics for oral route, for lung - Innovation and development in drug packaging.

- **Teaching Unit :** Laboratory training
  - **Description :** Laboratory training in a research unit (University, Public laboratory, Industry) with international mobility. Individual research project with report and presentation.

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**UNIVERSITY DEGREE PROGRAM IN MARKETING & MANAGEMENT IN AN INTERNATIONAL CONTEXT**

- **Teaching Unit :** Entrepreneurship
  - **Description :** Entrepreneurship - Negotiations (internal / external)

- **Teaching Unit :** Environment I
  - **Description :** Territories, networks & global. Quantitative tools for marketing

- **Teaching Unit :** Finance I
  - **Description :** Financial management - International tax law

- **Teaching Unit :** French language for foreign students I

- **Teaching Unit :** Management
  - **Description :** Intercultural management and Geopolitics.

- **Teaching Unit :** Operational management
  - **Description :** International logistics - International risk management

- **Teaching Unit :** Marketing
  - **Description :** International sales - International Purchases
The objectives of the program are to:
- Favor learning process in English which is the key language in computer sciences-related positions.
- Attract foreign students in order to propose ERASMUS agreements and increase international exchanges.
- Improve the training's attractiveness with a teaching developing international aspects.

- Teaching Unit : Human Resources
  - Description : Human Resources in SMEs - Leadership - Business Ethics
  - ECTS : 5
  - Duration : January - June
  - Hours : 26

- Teaching Unit : Environment II
  - Description : European Union
  - ECTS : 5
  - Duration : January - June
  - Hours : 36

- Teaching Unit : Finance II
  - Description : MBA - Budgeting - ERPs
  - ECTS : 5
  - Duration : January - June
  - Hours : 36

- Teaching Unit : Strategy
  - Description : Strategic intelligence - International strategies of SMEs
  - ECTS : 5
  - Duration : January - June
  - Hours : 36

- Teaching Unit : French language for foreign students II
  - ECTS : 5
  - Duration : January - June
  - Hours : 36

- Teaching Unit : Economics
  - Description : International economics - Globalisation
  - ECTS : 5
  - Duration : January - June
  - Hours : 36

- Teaching Unit : Marketing
  - Description : International marketing of SMEs
  - ECTS : 5
  - Duration : January - June
  - Hours : 36

- Teaching Unit : Legal aspects of business
  - Description : International business law relating to goods & services, indiv. mobility
  - ECTS : 5
  - Duration : January - June
  - Hours : 36

- Teaching Unit : Professional Training
  - Description : Internship or project
  - ECTS : 5
  - Duration : January - June
  - Hours : 36
MECHANICAL ENGINEERING 3rd YEAR

- **Teaching Unit**: Basic Concepts in Fluid Mechanics (UnderGrad)
  - **Objectives**: Introduction to the fundamental principles of dynamics and energy conservation for fluid mechanics and application to a set of practical problems.
  - **Program Description**:
    - Hydrostatics
    - Dimensional Analysis
    - 1D Incompressible Flows: Bernoulli equation, theory of propeller, pumps and turbines, pressure losses
    - 1D Compressible Flows: isentropic flow, shock, Fanno flow

- **Teaching Unit**: Fluid Mechanics (UnderGrad)
  - **Objectives**: In-depth study of the basic principles of fluid mechanics
  - **Program Description**:
    - Kinematics
    - Navier-Stokes equation
    - Stokes flow
    - High-Reynolds flow – boundary layers
    - Introduction to rotating flow
    - Introduction to turbulence

MECHANICAL ENGINEERING 4th YEAR

- **Teaching Unit**: Advanced Fluid Mechanics (Grad)
  - **Program Description**:
    - Kinematics
    - Potential Flows
    - Vortex Dynamics
    - Gravity Waves
    - Theory of airfoils

MECHANICAL ENGINEERING 5th YEAR

- **Teaching Unit**: Biofluid Mechanics (Grad)
  - **Program Description**:
    - Fluid mechanics of large blood vessels: Blood pulse propagation, flow in curved tubes, entree flow into the aorta
    - Fluid mechanics of the microcirculation: Fahraeus-Lindqvist effect, squeezing of red blood cells through capillaries lined with glyocalyx layer
    - Peristaltic transport
    - Fluid mechanics of cilia: flagellar hydrodynamics, primary cilia and development, mucus transport by cilia
    - Introduction to numerical techniques for fluid-structure interaction problems

- **Teaching Unit**: Biofluid Mechanics (Grad)
  - **Program Description**:
    - Fluid mechanics of large blood vessels: Blood pulse propagation, flow in curved tubes, entree flow into the aorta
    - Fluid mechanics of the microcirculation: Fahraeus-Lindqvist effect, squeezing of red blood cells through capillaries lined with glyocalyx layer
    - Peristaltic transport
    - Fluid mechanics of cilia: flagellar hydrodynamics, primary cilia and development, mucus transport by cilia
    - Introduction to numerical techniques for fluid-structure interaction problems
Lyon is a city in east-central France in the Rhône-Alpes region.

The city is known for its historical and architectural landmarks and is a UNESCO World Heritage Site.

Lyon was historically known as an important area for the production and weaving of silk and in modern times has developed a reputation as the capital of gastronomy in France.

The city is also known for its famous light festival « Fête des Lumières » which occurs every 8 December and lasts for four days, earning Lyon the title of Capital of Lights.

Economically, Lyon is a major centre for banking as well as for chemical, pharmaceutical, and biotech industries.

Lyon is a must see tourist destination. A capital where it is pleasant to live and study.

Paris is 2 hours away by TGV, the Mediterranean coast just an hour and a half.

Within easy reach of a wide variety of areas of outstanding beauty: mountains (Mont Blanc), vineyards, gentle valleys, the largest lakes in France (Lake Geneva, Lake Bourget and Lake Annecy).

DYNAMIC STUDENT LIFE
Cultural activities, sports and physical activities, involvement of students in university life- Lyon 1 university offers an active and rewarding life student experience. The quality of life for students at the Claude Bernard University Lyon 1 is also closely linked to the activities of more than fifty clubs spread over the different campuses.

INTERNATIONAL OUTREACH
Lyon 1 is highly active internationally. The institution seeks to develop partnerships both in developed and developing countries.
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