M1 CLS

1st year of M.Sc. degree

major Chemistry & Life Sciences

Course curriculum

M1 Chemistry & Life Sciences

Fall Semester (30 ECTS)

Mandatory Courses (12 ECTS)

- YCHI411i
Analytical Chemistry and Spectroscopies
6 ECTS
- YCHI412i
Experimental Chemistry & Bibliographic Search
6 ECTS

3 courses to choose (18 ECTS)

- YCHI413i
Organic Chemistry 1
6 ECTS
- YCHI414i
Reactivity & Transition Metals
6 ECTS
- YCHI415i - Chemistry & Physical Chem. of Polymers 1
6 ECTS
- Biology course
YBIO4112 or YBIO4115
(taught in french)
6 ECTS

Spring Semester (30 ECTS)

Mandatory Courses (12 ECTS)

- YCHITRAMi
French Language
3 ECTS
- YOPR427i
Professional Integration
3 ECTS
- YSTG428i
Research Internship - 6 ECTS
(2 months minimum in France 3 months minimum abroad)

2 or 3 courses to choose (12 or 18 ECTS)

- YCHI421i
Heterocyclic & Bioorganic Chemistry
6 ECTS
- YCHI422i
Organic Chemistry 2
6 ECTS
- YCHI423i
Bio-inorganic Chemistry
6 ECTS
- YCHI425i
Chem. Polymers 2
3 ECTS
- YCHI426i
Phys. Chem. Polymers 2
3 ECTS

0 or 1 course to choose (0 or 6 ECTS)

- YCHI424i
Micro-projects
Org. Chem.
or Biol. Chem.
or Polymers
6 ECTS

YCHI411i - Analytical Chemistry and Spectroscopies

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Teaching team 2012-2013: Catherine Bougault (Assistant Professor), Olivier Stéphan (Assistant Professor), Guy Royal (Professor), Aurélie Bouchet-Spinelli (Assistant Professor), Michel Jaquinod (CEA Researcher).
Master programs including this course: Chemistry and Life Sciences, Polymer for Advanced Technologies.
Teaching period for this course: M1 Fall semester (september-december).
Prerequisites: General chemistry (Bachelor program).
Skills at aim: Theoretical and experimental basic knowledge in spectroscopy/spectrometry and analytical chemistry.
Professional expertise for which this course is mandatory? Academic and industrial research in different chemical disciplines

Course outline:
* **Analytical Methods** (22h overall):
  - Lectures: Electrochemistry (kinetical aspects; redox titrations– 2.5h), specific ionic electrodes (1.5h), surfactants and micelles (1.5h), flame emission spectroscopy (0.5h).
  - Lab sessions (4 × 4h) : titration of $Fe^{(II)}$ by $Ce^{(IV)}$, fluoride-selective ionic electrode, surface tension, titration of calcium in mineral waters (flame emission spectroscopy).

* **NMR:** eight 1.5-hour and two 2-hour classes and one practical session of 4 hours (20h overall). During classes, students are offered formal lectures and problem solving approaches to illustrate the principles of magnetic resonance spectroscopy (NMR and EPR) and to exercise in resonance assignment and structure determination. The practical session focuses on 1D and 2D NMR signal processing in relation with signal acquisition.

➤ Introduction: Magnetic Resonance: definition; EPR and NMR: similarities and differences.

➤ Part I: Nuclear Magnetic Resonance (9 lectures) - a short history of NMR spectroscopy and current applications/potentialities of the technique.

I.1- NMR fundamentals (1 lecture)
- I.1.1- Nuclear spin and magnetic moment
- I.1.2- Spin interactions with external magnetic field: the Zeeman effect
  - a- Microscopic energetic view: Boltzmann population
  - b- Macroscopic view: magnetization
- I.1.3- The resonance phenomenon and the 1D NMR experiment
  - a- Perturbation of the system with an electromagnetic wave
  - b- The NMR signal
  - c- The intensity of the signal

I.2- NMR and relaxation (1 lecture)
- I.2.1- Excitation and system evolution back to equilibrium
- I.2.2- Relaxation parameters: an indication of systems dynamics
- I.2.3- Measurement of relaxation parameters
- I.2.4- Impact and use for chemists

I.3- Data acquisition and processing (1 lecture)
- I.3.1- Data acquisition parameters
- I.3.2- Data processing parameters
- I.3.3- Spectra analysis

I.4- Scalar coupling: a help or a burden (3 lectures)
- I.4.1- Impact of scalar couplings on ^{1}H and ^{13}C 1D spectra
- I.4.2- Homonuclear coherence transfer – use in the identification of the bonding network COSY, TOCSY
- I.4.3- Heteronuclear coherence transfer – use in the identification of the bonding network J-resolved spectroscopy, DEPT, Inadequate, HMQC, HMBC

I.5- Dipolar interactions: a key structural information (1 lecture)
- I.5.1- The NOE effect
- I.5.2- The 2D pulse sequences: NOESY, ROESY

I.5.3- Extraction of structural data
I.5.4- Implementation of NOE effects in a drug design approach

I.6- Chemical exchange and reactivity (1 lecture)
I.6.1- Slow and fast exchange
I.6.2- Extracting kinetic information
I.6.3- Chemical reactivity in the NMR tube

I.7- Practical approaches to chemical structure determination (1 lecture)
Throughout and along the course

➤ Part II: Electron Paramagnetic Resonance (1 lecture)

II.1- Electronic spin and magnetic moment
II.2- The resonance phenomenon and the continuous wave EPR experiment
II.3- The g-factor
II.4- The hyperfine coupling
II.5- Impact of anisotropy

* **Mass Spectrometry:** (9h – lectures only)
- Theory of MS (3 to 4h)
- EI/CI ionization techniques and their applications (2h)
- ESI/MALDI ionization techniques and applications (2h)
- MS/ MS^2 / MS^n / SRM techniques and applications (2h)

Format of the course:

Activities	***Hours***	***%***
Lectures	**31**	**30**
Discussion sections	_	_
Lab sessions	**20**	**20**
Estimated work load outside class	**50**	**50**
TOTAL	**100**	**100**

Format of exams:

Nature	***Mid-term in Analytical Methods***	***Final in Analytical Methods***	***Mid-term in Spectroscopy***	***Final in Spectroscopy***	***Second session***
Lab sessions' reports	**20 %**	_	**18 %**	_	_
Written exam	_	**20 %**	_	**42 %**	**20 % + 42 %**

YCHI412i – Experimental Chemistry and Bibliographic Search

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Teaching team 2012-2013: Bernard Bessières (Assistant Professor), Angéline Van der Heyden (Assistant Professor), Olivier Hamelin (Assistant Professor), Caroline Marchi-Delapierre (Assistant Professor).
Master programs including this course: Chemistry and Life Sciences, Polymer for Advanced Technologies.
Teaching period for this course: M1 Fall semester (september-december).
Prerequisites: General chemistry (Bachelor program).
Skills at aim: Theoretical and experimental basic knowledge in bibliographic and experimental techniques.
Professional expertise for which this course is mandatory? Academic and industrial research in different chemical disciplines

Course outline:
- **Lectures** (14h overall):

A) **Learning Bibliographic Techniques** (at the UJF central library – 5h overall):
Scientific and Technical Information (1h)
Using the Internet for literature search (1h)
Location of documents (1h)
Using scientific databases (SciFinder, PubMed, Medline, ... - 2h)

B) **Separative Methods** (9h overall):
I. Introduction
- I.1. General Features
- I.2. Reminders
  - I.2.1. Decantation/filtration
  - I.2.2. Separation through a change of state
  - I.2.3. Liquid/liquid extraction
  - I.2.4. Solid phase extraction

II. Chromatography
- II.1. General features and theoretical aspects
  - II.1.1. General features
  - II.1.2. Classification of chromatographic methods
  - II.1.3. The chromatogram
  - II.1.4. Physical parameters of the column
  - II.1.5. Distribution of the analyte between the mobile and the stationary phases
  - II.1.6. The concept of theoretical plates
  - II.1.7. Summary of the data obtained from the chromatogram
  - II.1.8. Optimization of the height of the theoretical plates – Van Deemter equation
  - II.1.9. Alteration of the shape of the signals
  - II.1.10. Efficiency of the separation of several analytes
  - II.1.11. Analysis optimization
  - II.1.12. Quantitative analysis by chromatography
- II.2. Gas Chromatography (GC)
  - II.2.1. General features
  - II.2.2. Carrier gas
  - II.2.3. Introduction of the sample
  - II.2.4. Sample Injector (column inlet)
  - II.2.5. Column
  - II.2.6. Stationary phase
  - II.2.7. Detector
  - II.2.8. Kovats retention index and stationary phase constants
- II.3. High Performance Liquid Chromatography (HPLC)
  - II.3.1. General features
  - II.3.2. Mobile phase
  - II.3.3. Pump
  - II.3.4. Injection

II.3.5. Columns
II.3.6. Stationary phases
II.3.7. Mobile phase adjustment
II.3.8. Detector
II.3.9. Comparison between GC and HPLC
II.4. Supercritical Fluid Chromatography (SFC)

III. Electrophoresis
III.1. General features and theoretical aspects
III.1.1. General features
III.1.2. Theory: electromigration/electro-osmosis
III.2. Gel electrophoresis
III.2.1. Gel electrophoresis, on plate
III.2.2. SDS-PAGE
III.2.3. Isoelectric focusing (IEF)
III.2.4. Immunoelectrophoresis
III.2.5. 2D Electrophoresis
III.3. Capillary electrophoresis
III.3.1. Principle
III.3.2. Capillary zone electrophoresis (CZE)
III.3.3. Micellar electrokinetic chromatography (MEKC)
III.3.4. Capillary Gel Electrophoresis (CGE)
III.3.5. Capillary Isoelectric Focusing (CIEF)
III.3.6. Equipment
III.4. Capillary electrochromatography (CEC)

- **Lab sessions** (38h overall):
  - Bibliographic techniques, using databases: 1 session (3h) for the use of SciFinder Scholar, especially in order to prepare the lab research projects.
  - Lab research projects: 4.5 days in teaching laboratories (two students per project), projects in organic chemistry, bio-organic chemistry, coordination/inorganic chemistry and polymer sciences (35h overall). A written report is requested (one per group of two students) at the end of the week in lab.

Format of the course:

Activities	***Hours***	***%***
Lectures	**14**	**14**
Discussion sections	_	_
Lab sessions	**38**	**38**
Estimated work load outside class	**48**	**48**
TOTAL	**100**	**100**

Format of exams:

Nature	***Mid-term Exam***	***Final Exam***	***Second Session***
Written exam	_	**25 %**	**25 %**
Research project's report	_	**75 %**	_

YCHI413i - Organic Chemistry 1

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Teaching team 2012-2013: Olivier Hamelin (Assistant Professor), Jean-François Poisson (CNRS researcher), Frédéric Minassian (Assistant Professor), Sébastien Carret (Assistant Professor).
Master programs including this course: Chemistry and Life Sciences, Polymer for Advanced Technologies.
Teaching period for this course: M1 Fall semester (september-december).
Prerequisites: Organic chemistry (Bachelor program).
Skills at aim: Approaches towards selectivity in organic chemistry (chemio-, regio-selectivities, protection of functional groups), redox organic chemistry, olefination methods.
Professional expertise for which this course is mandatory? Academic and industrial research in organic synthesis and in biological chemistry

Course outline:
➤ **Lectures** (30h overall):
* Chemioselectivity and orthogonal protecting groups (3.5h). Protections of functional groups (alcohols/thiols, diols, carbonyl compounds, carboxylic acids, amines, phosphorus-containing groups, non innocent PG's - 4.5h).

* Redox Organic Chemistry (17h overall):
- reminders (0.5h)
- oxidations of alcohols into carbonyl compounds ($Cr^{(VI)}$, MnO_2, TPAP, Moffatt-Swern, hypervalent iodine, Oppenauer, TEMPO) and into carboxylic derivatives (Ag(I), chlorites, Baeyer-Villiger) – (3.5h).
- *syn* et *anti*-dihydroxylations ($KMnO_4$, OsO_4, Sharpless, Woodward, Prévost) and oxidative cleavages of 1,2-diols ($KMnO_4$, OsO_4-$NaIO_4$, $Pb(OAc)_4$) – (2.5h).
- epoxidations (*via* halohydrins, peroxides/peracids, the case of allylic alcohols, ASE, Jacobsen) and subsequent transformations of epoxides – (1.5h).
- addition of oxygen (singlet and triplet) to alkenes, ozonolysis – (1h).
- oxydations of alkanes (SeO_2, dehydrogenations) and other heteroatoms (S, Se, N) – (1h).
- catalytic hydrogenation: heterogeneous (Pd, Pt, Ni, Rh-based catalysts) or homogeneous (Wilkinson, examples of asymmetric catalysis) – (2.5h).
- reductions involving hydride donors:
  - ■ general features, conformational effects, stereoselectivity models (Cram-Felkin-Anh, chelated Cram in particular) – (1.5h);
  - ■ chemioselectivities (1,2 *vs* 1,4-addition, preparation of aldehydes from carboxylic derivatives, stereoselective reductions of alkynes into alkenes, regioselective epoxide ring opening, preparation of alkanes from alcohols and alkyl halides) – (2h).
- reduction methods involving dissolved metals: Clemmensen, reductions with alkali/alkaline earth metals (including Birch) – (1h).

* Olefination methods (3.5h overall):
- reminders – (0.5h).
- olefination methods involving phosphorus ylides (Wittig and related reactions including HWE – 2h).
- olefination methods involving anions stabilised by α-effect of sulfur (Julia) or of silicon (Peterson) – (1h).

➤ **Discussion sections** (20h overall):
* Protecting groups and their removal (including a reminder/summary of the lectures): protections of alcohols as silyl ethers, alkyl ethers, esters ; amine protection as carbamates, amides – (7.5h).
* Oxidations (Cr, Mn, Ru, …-based oxidants) and their respective selectivities – (6h).
* Reductions (aluminohydrides, borohydrides, …) and their respective selectivities – (6h).

Format of the course:

Activities	***Hours***	***%***
Lectures	**30**	**30**
Discussion sections	**20**	**20**
Estimated work load outside class	**50**	**50**
TOTAL	**100**	**100**

Format of exams:

Nature	***Mid-term Exam***	***Final Exam***	***Second Session***
Written exam	**20 %**	**80 %**	**80 %**

YCHI414i - Reactivity and Transition Metals

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Teaching team 2012-2013: Damien Jouvenot (Assistant Professor), Bernard Bessières (Assistant Professor).
Master programs including this course: Chemistry and Life Sciences, Polymer for Advanced Technologies.
Teaching period for this course: M1 Fall semester (september-december).
Prerequisites: General, inorganic and organic chemistry (Bachelor program).
Skills at aim: Knowledge concerning the reactivity, the characterization of transition metal complexes as well as their applications in different areas of chemistry.
Professional expertise for which this course is mandatory? Academic and industrial research in inorganic and organometallic chemistry

Course outline:
* 1st Part: **"Coordination chemistry, inorganic reactivity and supramolecular chemistry"** (25h overall – Lectures and Discussion sections)
INTRODUCTION
Metals, ligands, complexes and their geometries
1. Nomenclature of coordination complexes
2. Types of ligands, Green formalism
3. Electron counting
4. d Atomic orbitals

INTRODUCTION to GROUP THEORY (application to molecular symmetry)

ELECTRONIC STRUCTURE OF COMPLEXES
1. Molecular orbital theory
   1.1 Reminders
   1.2 The role of symmetry
   1.3 Orbitals of ligands
   1.4 Simplified MO's diagram of ML_n-type complexes
   1.5 Ligand field theory - σ interactions
   1.6 Ligand field theory - σ and π interactions
   1.7 π–Complexes
   1.8 Jahn-Teller effect
2. Isolobal analogy

CONCEPTS OF INORGANIC REACTIVITY
1. Thermodynamic and kinetic aspects
2. Chemical reactions onto complexes
   2.1 Oxidative addition
   2.2 Reductive elimination
   2.3 Insertion
   2.4 σ–Metathesis

SUPRAMOLECULAR CHEMISTRY
1. Definitions
2. Template effect
3. Principle of maximum site occupancy
4. Self-recognition
5. Self-assembly
6. Active template
7. Molecular topology
   - Borromean rings
   - Pentafoliate node

COORDINATION PHOTOCHEMISTRY
1. Reminders

2. Electronic transitions
3. Reactivity of the excited state
4. Applications

* 2nd Part: **"Organometallic Catalysis"** (25h overall – Lectures and Discussion sections)
    - coordination complex formalism - (2h).
    - catalytic hydrogenations - (7h).
    - carbonylation reactions - (3h)
    - isomerization processes - (2h).
    - cross-coupling reactions (Heck, Sonogashira, Stille, Suzuki - 11h).

Format of the course:

Activities	***Hours***	***%***
Lectures	**36**	**36**
Discussion sections	**14**	**14**
Estimated work load outside class	**50**	**50**
TOTAL	**100**	**100**

Format of exams:

Nature	***Mid-term Exam***	***Final Exam***	***Second Session***
Written exam	**20 %**	**80 %**	**80 %**

YCHI415i – Chemistry and Physical Chemistry of Polymers 1

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Teaching team 2012-2013: Rachel Auzély (Professor), Frederic Dubreuil (Assistant Professor), Anna Szarpak-Jankowska (Assistant Professor).
Master programs including this course: Chemistry and Life Sciences, Polymer for Advanced Technologies and Chemistry and Nanosciences (Department of Physics, Engineering, Earth, Environment and Mechanics).
Teaching period for this course: M1 Fall semester (september-december).
Prerequisites: General chemistry (Bachelor program).
Skills at aim: Knowledge concerning the methods of macromolecular synthesis and the characterization of polymers (structure and average molecular mass).
Professional expertise for which this course is mandatory? Job positions dealing with the synthesis of polymer materials and/or their applications

Course outline:
The lecture part is dealing on one hand with the chemistry of polymers, and on the other hand with the study of the physical chemistry of polymers. The discussion section part includes exercises on the following topics in particular: average molecular masses, polycondensation, free-radical polymerization processes and biopolymers. These exercises allow strengthening the knowledge on these topics. Please find below the detailed program for the lecture part:

*** Part "Chemistry of Polymers" (11h Lectures – 4.5h Discussion sections):**

1. Introduction
   Definitions, brief history, economical aspects, terminology, technical/economical classification, general features of polymers, molecular structure (stereoregularity, tacticity), state domains.

2. Biopolymers
   Introduction (conformational aspects)
   Outline of the different families of biopolymers (nucleic acids, proteins and peptides, polysaccharides and other biopolymers)

3. Synthetic polymers
   Introduction - Classification of polymerization reactions
   Stepwise polymerization reactions
      General features
      Main reactions used in stepwise polymerization processes
      Kinetic aspects of stepwise polymerizations
      Chain polymerization reactions
      Reaction scheme
      Initiation and propagation
      Termination
      Kinetic aspects of chain polymerizations
      Polymerization processes
      Controlled free-radical polymerization
      Insertion polymerizations

4. Synthesis of thermosetting polymers and of elastomers

*** Part "Physical chemistry of Polymers" (11h Lectures – 7.5h Discussion sections):**

1. Analysis of the physico-chemical properties in solution:
   - Viscosimetry, osmometry (2h lectures, 2h discussion sections)
   - Light Diffusion (2h lectures, 2h discussion sections)
   - GPC, thermodynamics and chain dimensions (4h lectures, 2h discussion sections)
2. Gels:
   Polymer gels (3h lectures, 1.5h discussion sections).

*** Lab sessions (4 × 4h - 16h overall**):
Lab sessions are allowing students to complement their training in macromolecular chemistry by addressing bench problems related to polymerization processes. Lab sessions are dealing with the various methods of

polymerization, their specificities, as well as with the most well-known techniques of characterization of polymers, such as viscosity and molecular mass.

Format of the course:

Activities	***Hours***	***%***
Lectures	**22**	**22**
Discussion sections	**12**	**12**
Lab sessions	**16**	**16**
Estimated work load outside class	**50**	**50**
TOTAL	**100**	**100**

Format of exams:

Nature	***Mid-term Exam***	***Final Exam***	***Second Session***
Lab sessions' report	**15 %**	**–**	**–**
Written exam	**20 %**	**65 %**	**65 %**

YBIO4112 - Biotechnologies : Produits & Procédés
(taught in French only – could be replaced by YCHI41Xi – see below)

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Compétences pré-requises : connaissances (niveau Licence) en biologie et génétique moléculaires, biochimie, biologie cellulaire (eucaryote et procaryote), microbiologie.
Compétences visées : connaissance de l'état actuel des biotechnologies et de leurs applications industrielles et commerciales ; aptitude à envisager (proposer) d'éventuelles applications de travaux de recherche fondamentale

Programme résumé :
- Biotechnologies microbiennes : métabolismes, métabolites, protéines
- Biotechnologies végétales : OGM et leurs (multiples) applications
- Biotechnologies animales : animaux transgéniques, cellules souches, thérapie génique
- Procédés : production (du réacteur au produit fini), enzymes immobilisées, …
- Développement de nouveaux procédés ou produits : techniques de criblage, amélioration des procédés existants, invention de nouveaux produits (en particulier via l'évolution dirigée).

Structuration :
- Cours : 25 h = 1 séance introductive d'1h + 16 séances d'1h30.
- TD : 25 h = 1 séance introductive d'1h + 16 séances d'1h30 (à la suite des cours) - analyses d'articles.
- Travail personnel estimé : 70 h.

Organisation temporelle :
- S37 : cours introductif + 2 cours + TD introductif.
- Reste du semestre : deux cours + 2 TD (sauf modifications de plannings).

1. **Cours : 25 h + 20 h travail personnel**
   → apprendre son cours… (PowerPoint sur le site web !)
   → lectures complémentaires éventuelles (site web)
   → réalisation de l'étude de cas (liens sur le site web + feuille de route par binôme).

2. **TD : 25 h + 50 h travail personnel**
   → 3 ou 4 articles à lire et exposer au cours du trimestre
   → les articles exposés par les autres binômes à lire également (tous les documents sont en ligne)
   → par séance : 3 présentations = 15 min exposé (maximum !) + 15 min réponse aux questions

Nature des activités pédagogiques :

Activité	*Heures*	*%*
Cours Magistral (CM)	**25**	**21**
Travaux Dirigés (TD)	**25**	**21**
Travaux Pratiques	**–**	**–**
Travail personnel estimé	**70**	**58**
TOTAL	**100**	**100**

Modalités du contrôle des connaissances :

Nature	*Oral (CC)*	*Rapport biblio*	*Épreuve terminale (DM)*	*Épreuve de rattrapage (ER)*
	30 %	**30 %**	**40 %**	**40 %**

YBIO4115 – Chimie et Biochimie Cellulaire
(taught in French only – could be replaced by YCHI41Xi – see below)

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Equipe pédagogique 2012-2013 : Franck Fieschi (PR), Isabelle Michaud-Sorret (DR CNRS), Eve de Rosny (MCF), Hugues Lortat-Jacob (DR CNRS).
Compétences pré-requises : connaissances (niveau Licence) en biologie et génétique moléculaires, biochimie, biologie cellulaire (eucaryote et procaryote), microbiologie

Objectifs de l'UE : Chacune des parties de ce cours est censée pouvoir attirer et satisfaire une des grandes communautés de recherche grenobloise en termes d'apports de formation pour leurs futurs étudiants. L'objectif est de faire de ce module de Biochimie un pivot, (au sens d'articulation, de lien dans la formation de second cycle en Biologie), vers les différents domaines de la biologie grenobloise, mais aussi d'articuler un lien avec la communauté des chimistes d'interface. Le deuxième objectif affiché était d'apporter également un support théorique sur les aspects "stress oxydant" pour les étudiants amenés à suivre le module DEB. La partie II du cours remplira cet objectif.
- Les parties I et II sont fortement ciblées vers les labos "métaux en biologie" (chimie et biologie, laboratoires d'interfaces et laboratoires s'intéressant au stress oxydant - CEA, IBS, CHU).
- La partie III met en lumière de la biochimie végétale, intéressante pour la communauté végétale de Grenoble (surtout PCV - CEA).
- La partie IV est d'un intérêt général pour les biologistes cellulaires (IAB, GIN) et les groupes de protéines membranaires (IBS).
- La partie V porte sur la matrice extracellulaire et protéoglycane, thématique fortement orientée glycobiologie. C'est une des thématiques de l'IBS (équipe Lortat-Jacob) avec des ramifications, et des intéressements de la part du CERMAV (équipe Imberty notamment)… C'est une biochimie également en pleine explosion du point de vue des applications thérapeutiques.

Au delà de cela, de manière transversale :
- Les approches structurales seront partout dans ce module, on ira voir les choses au niveau moléculaire. La biologie structurale (et donc l'IBS mais aussi UVHCI) sera donc également fortement bénéficiaire des thématiques abordées, notamment en terme d'illustration de son pouvoir descriptif des phénomènes biochimiques et biologiques. De plus, deux thématiques IBS seront évoquées dans les divers chapitres : NADPH oxydase et les protéoglycanes.
- Les étudiants chimistes qui suivront ce module pourront trouver leur compte dans tous les aspects biocatalyse, chimie de l'oxygène, et les illustrations d'applications en agrochimie et pharmacologie issue des exemples des parties de cours.

Programme détaillé des CM (les TD (20h) consistent en des exercices venant en support des CM) :

A. Les outils de la biocatalyse : deux exemples de contexte biochimique cellulaire.

I. Vitamines, cofacteurs et coenzymes : outils des protéines. (3h CM – 1 intervenant)
- Cofacteurs et coenzymes impliqués dans des réactions redox : NADPH, flavines, hèmes, centre fer-soufre, etc…
- Cofacteurs de transfert de groupement : pyridoxal phosphate, thiamine pyrophosphate, etc…

II. Chimie et biochimie de l'oxygène – Stress oxydant et fonction cellulaire. (7.5h CM – 3 intervenants)
- Chimie de l'oxygène.
- Relation entre oxygène et métaux et place de cette relation dans l'histoire de la vie : réaction de Fenton, etc...
- Stress oxydant :
  - Toxicité des différentes espèces réactives de l'oxygène
  - Mécanismes de défense et de gestion cellulaire de ce stress :
    - Molécules anti-oxydantes
    - Systèmes enzymatiques de gestion du stress oxydant:
- Source cellulaire de ROS :
  - Source accidentelle (fuites) : chaîne respiratoire, cytochromes P450, xanthyne oxydase, etc…
  - Sources dédiées à la production de ROS : les NADPH oxydases :

- Système modèle : la NADPH oxydase des cellules phagocytaires, immunité innée.
- Nouvelles NADPH oxydases et rôles positifs des ROS :
- Pathologie associée aux ROS et aux relations Métal-Oxygène.

III. Biosynthèse des acides aminés. (6h CM – 1 intervenant)

a- Métabolisme général de la biosynthèse des acides aminés

b- Spécificités des végétaux et champignons.

Focus sur le mécanisme réactionnel de certaines enzymes de ces voies spécifiques aux plantes (illustration du rôle des cofacteurs associés dans cette biochimie):

■ Synthèse des AA dérivés de l'aspartate :

1/ Rôle de la SAM dans le contrôle allostérique de la voie :
- les aspartate kinases : inhibition par la SAM *via* un domaine régulateur de type ACT ;
- la thréonine synthase : activation par la SAM conduisant à une réorganisation du cofacteur PLP de l'enzyme.

2/ Méthionine synthase : 2 solutions pour une même réaction
- les Met synthases dépendantes de la cobalamine (vitamine B12) chez animaux et bactéries ;
- les Met synthases indépendantes de la B12 (bactéries et plantes).

c- Applications agrochimiques : voies spécifiques = enzyme cible pour herbicide et fongicide spécifiques. Intérêt de la connaissance précise du mécanisme catalytique.

■ Synthèse des AA aromatiques : applications agrochimiques

1/ EPSP synthase (cible du glyphosate) ou HPPD : aspect herbicide

2/ Arogénate dH de plante / levure / cyanobactérie : comparaison cinétique et applications pour augmenter la production de tyrosine/vitamine E.

B. Autour de la membrane plasmique : une biochimie à fort potentiel pharmacologique.

IV. La membrane plasmique : lipides et protéines. (7.5h CM – 1 intervenant)

a- Rappel sur les propriétés physicochimiques des lipides et des membranes biologiques dans les milieux aqueux.

1- Lipides et membranes. Diagramme de phase des lipides, les détergents : propriétés physicochimiques.

2- Composition et dynamique d'une membrane biologique.

1- Modèle de la mosaïque fluide.

2- Notion de raft lipidiques, propriétés et composition biochimiques.

b- Aspects théoriques sur les protéines membranaires:

1- Propriétés physicochimiques des protéines membranaires.

2- Organisation en domaines fonctionnels des membranes biologiques (plateau de signalisation, etc…).

3- Propriétés de diffusion dans la bicouche et zone de compartimentation.

4- Biosynthèse et insertion dans les membranes, règles topologiques…

c- Classification des différents types de protéines membranaires :

1- Récepteurs à Transduction de signal:

1- GPCR

2- Récepteur à activité tyrosine kinase

3- Canaux ioniques

4- Etc…

2- Transporteurs

3- Canaux

d- Protéines non trans-membranaires mais associées aux membranes

1- Protéines monotopiques

2- Protéines à ancres GPI

e- Pharmacologie des récepteurs :

1- Notion d'agonistes, antagonistes, agonistes inverses…

2- Biochimie de la transduction/dimérisation

f- Canaux ioniques.

V. Biochimie extracellulaire : la matrice extracellulaire et les protéoglycanes. (6h CM – 1 intervenant)

a- Introduction : rappels sur la composition de la matrice extracellulaire, les protéoglycanes.

b- Biosynthèse et métabolisme des protéoglycanes.

c- Fonction Biologique : biochimie des interactions protéines-oligosaccharides.

d- Aspects structuraux et méthodes d'études.
e- Un exemple de développement réussi d'une molécule thérapeutique mise sur le marché basée sur la biochimie des protéoglycanes : développements futurs.

Nature des activités pédagogiques :

Activité	*Heures*	*%*
Cours Magistral (CM)	**30**	**30**
Travaux Dirigés (TD)	**20**	**20**
Travaux Pratiques	**–**	**–**
Travail personnel estimé	**50**	**50**
TOTAL	**100**	**100**

Modalités du contrôle des connaissances :

Nature	*Contrôle continu écrit (CC)*	*Commentaire d'article*	*Épreuve terminale écrite (ET)*	*Épreuve de rattrapage écrite (ER)*
	15 %	**15 %**	**70 %**	**70 %**

YCHI41Xi – Applied Theoretical Chemistry

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Teaching team 2012-2013: Anne Milet (Professor).
Master programs including this course: Chemistry and Life Sciences, Polymer for Advanced Technologies.
Teaching period for this course: M1 Fall semester (september-december).
Prerequisites: General and physical chemistry (Bachelor program).
Skills at aim: Approaches towards quantum and MM methods.
Professional expertise for which this course is mandatory? Academic and industrial research in chemistry

Course outline:
*** Quantum Chemistry:**
- Electronic structure methods.
- Density Functional Theory.
- Basis sets.
- Applications: Molecular Properties.
- Applications: Chemical Reactivity.

*** Molecular Mechanics:**
- Force Fields Methods.
- Dynamics.
- Sampling the PES.
- Applications: Interaction Ligand/Protein

Format of the course:

Activities	***Hours***	***%***
Lectures	**25**	**25**
Discussion sections	**15**	**15**
Lab sessions	**10**	**10**
Estimated work load outside class	**50**	**50**
TOTAL	**100**	**100**

Format of exams:

Nature	***Mid-term Exam***	***Final Exam***	***Second Session***
Written exam	**20%**	**70 %**	**70 %**
Lab sessions' reports	**10 %**	**_**	**_**

YCHI421i - Chimie Hétérocyclique et Bio-organique
(taught in French only)

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Equipe pédagogique 2012-2013: Eric Defrancq (PR), Sabine Chierici (MCF).
Master intégrant cette UE : Chimie et Vivant.
UE ouverte au semestre : M1-2.
Pré-requis : Chimie organique niveau Licence parcours Chimie et Chimie-Biologie.
Compétences visées : Chimie des hétérocycles azotés. Connaissance des méthodes de base de synthèse des constituants des macromolécules biologiques tels que nucléosides, amino-acides et sucres. Connaissance de la réactivité de ces monomères ; stratégies et méthodes de synthèse sur support des oligonucléotides et peptides.
A quel type de métier, cette UE est-elle indispensable ? Métiers de la recherche à l'interface chimie-biologie.

Programme détaillé : Introduction à la chimie hétérocyclique (composés azotés tels que pyridine, pyrrole, indole, pyrimidine et purine), méthodes de synthèse des nucléosides naturels et modifiés (nucléosides à activité antivirale comme AZT, acyclovir…), méthodes de synthèse des oligosaccharides, stratégies de synthèse sur support des oligonucléotides et des oligopeptides.
25.5h CM (16 séances + CC) + 24h TD (16 séances)

➤ **Hétérocycles et ADN** (9 CM, 8 TD)
- Réactivité des pyridines, quinoléines, pyrroles, indoles (SNAr et SEAr), exemples de systèmes biologiques (cofacteurs NAD, ..)
- Synthèse et réactivité des hétérocycles poly-azotés : diazines et azoles, exemples de systèmes biologiques, rôle de l'imidazole (His) en catalyse enzymatique (ex de l'α-chymotrypsine et RNAse H).
- Synthèse et réactivité des purines.
- Synthèse et réactivité des nucléosides
- Synthèse des oligonucléotides sur support

➤ **Acides aminés et peptides** (4 CM, 4 TD)
- Rappel sur la structure des acides aminés, des peptides et protéines
- Préparation des acides aminés (précurseurs acides α–bromés ou hydroxylés puis SN par azoture, synthèse Gabriel ; Strecker)
- Méthodes de protection des acides aminés, stratégies orthogonales
- Agents de couplage pour la synthèse peptidique en solution et sur support (méthodes d'activation, problèmes de racémisation)
- Stratégies de synthèse supportée (stratégie Boc/Bzl, Fmoc/tBu) des peptides linéaires, cycliques et en particulier ceux contenant des ponts disulfures
- Introduction aux méthodes de 'ligation native'

➤ **Carbohydrates** (4 CM, 4 TD)
- Structure des principaux sucres, configurations et conformations, nomenclature, représentations (Fisher, Tollens, Haworth)
- Phénomène de mutarotation, Effet anomère
- Réactivité classique des monosaccharides : réduction, amination réductrice, oxydation, formation d'hydrazone et oximes, cyanhydrines, synthèse de Kiliani-Fischer (élongation, dégradation)
- Glycosylation de Fischer
- Protection des fonctions alcools (éthers, esters, acétals)
- Méthodes classiques de glycosylation (*via* halogénure, acétimidate, thioglycoside, …)
- Stratégie de synthèse des disaccharides
- Brève introduction aux autres méthodes de synthèse des sucres (synthèse enzymatique et supportée)

Nature des activités pédagogiques :

Activité	***Heures***	***%***
Cours Magistral (CM)	**25**	**25**
Travaux Dirigés (TD)	**25**	**25**
Travail personnel estimé	**50**	**50**
TOTAL	**100**	**100**

Modalités du contrôle des connaissances :

Nature	***Contrôle continu (CC)***	***Épreuve terminale (ET)***	***Épreuve de rattrapage (ER)***
Épreuve écrite	**30 %**	**70 %**	**70 %**

YCHI422i – Organic Chemistry 2

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Teaching team 2012-2013: Yannick Vallée (Professor), Philippe Delair (Assistant Professor), Frédéric Minassian (Assistant Professor), Sébastien Carret (Assistant Professor).
Master programs including this course: Chemistry and Life Sciences, Polymer for Advanced Technologies.
Teaching period for this course: M1 Spring semester (january-march).
Prerequisites: Organic chemistry (Bachelor program).
Skills at aim: Knowledge on the most important methods in organic chemistry leading to the formation of C-C single bonds. Physical organic chemistry.
Professional expertise for which this course is mandatory? Academic and industrial research in organic synthesis and in biological chemistry

Course outline:
Reaction mechanisms and reactivity, pericyclic reactions, C-C single bond-forming processes implying either free radical or carbanion intermediates.

➤ **General features:**

- Acids and bases in Organic Chemistry: Brönsted and Lewis concepts / HSAB theory, pK_a scales, factors influencing acidity or basicity.
- Influence of the structure on reactivity: electronic and steric effects, Hammett equation, primary and secondary isotope effects, solvent effects.
- Thermodynamics and kinetics of organic processes: characteristic values, Hammond postulate.
- Diastereoselectivity: nucleophilic addition to carbonyl compounds (Bürgi-Dunitz trajectory, Felkin-Anh models, effect of chelation, …), diastereoselective epoxidation.

➤ **Chemistry of enolates:**

- Alkylation reactions: formation of enols/enolates, alkylation of active-methylene compounds, alkylation of ketones, of esters and nitriles, formation and alkylation of enamines, formation and alkylation of silyl enol ethers.
- Aldol reactions: condensation of active methylene compounds with aldehydes and ketones, aldol reaction of aldehydes, of ketones and esters, synthesis of cyclic compounds *via* an aldol process, Mannich reaction, Henry (nitroaldol) reaction.
- Acylation at the carbon atom: Claisen condensation, Dieckmann cyclization, ketone acylation, enamine acylation, acylation under acidic conditions.
- Stereochemistry of enolates and stereoselectivity of their reactions: E *vs* Z enolates (Ireland model), diastereoselective aldol reactions (Zimmerman-Traxler model), diastereoselective alkylations (Oppolzer and Enders strategies).
- Enolates and conjugate additions: Michael addition, use of enolate equivalents (enamines, silyl enol ethers), Robinson annulation, enolates obtained after a 1,4-addition process.

➤ **Cycloadditions, electrocyclic reactions and sigmatropic rearrangements:**

- Woodward-Hoffmann rules, electrocyclic reactions.
- Diels-Alder reaction: mechanism, influence of electronic effects on both the regioselectivity and the stereoselectivity, catalysis, reactions in aqueous medium, influence of the pressure, intramolecular Diels-Alder reactions, retro-Diels-Alder reactions, inverse electron-demand Diels-Alder reactions.
- Other cycloadditions: 1,3-dipolar cycloadditions, olefin dimerization (allowed and forbidden processes), reactions of ketenes, Paterno-Büchi reaction, other cycloadditions.
- Sigmatropic rearrangements: rules for nomenclature, H-shifts (allyl system), alkyl shifts (Cope and oxy-Cope rearrangements), Claisen rearrangement.

➤ **Reaction intermediates:**

- Free radicals: definition, free-radical processes, stability of free-radicals, functionalization of C-H bonds (halogenations, Hofmann-Löffler-Freytag and Barton reactions, hydroxylations), free-radical reactions in synthesis (inter and intramolecular, tandem processes, Baldwin's rules), pinacol-type or acyloïn-type reactions, McMurry reaction, free-radical deoxygenation (Barton-Zard-McCombie).

- Carbenes and nitrenes: electronic structure and spin multiplicity, cyclopropanation reactions, formation of carbenes, insertion of carbenes into C-H bonds and rearrangements (Arndt-Eiser homologation), reactivity and rearrangements of nitrenes (Curtius, Hofmann), olefin metathesis, stable carbenes.
- Organometallic species: organolithium and Grignard reagents (formation and addition reactions), organocuprates (1,4-addition), other organometallics (Cd, Zn, Al), metallated aromatic and Heteroaromatic compounds.

Please find the outline of the discussion sections below:
- Chemistry of enolates: 7.5h.
- Pericyclic reactions: 6h.
- Free-radical reactions: 3h.
- Carbenes: 3h.

Format of the course:

Activities	***Hours***	***%***
Lectures	**30**	**30**
Discussion sections	**20**	**20**
Estimated work load outside class	**50**	**50**
TOTAL	**100**	**100**

Format of exams:

Nature	***Mid-term Exam***	***Final Exam***	***Second Session***
Written exam	**20 %**	**80 %**	**80 %**

YCHI423i – Bio-Inorganic Chemistry

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Teaching team 2012-2013: Fabrice Thomas (Professor), Vincent Artero (CEA researcher), Olivier Jarjayes (Assistant professor), Carole Duboc (CNRS researcher), Catherine Gerez (Assistant professor).
Master programs including this course: Chemistry and Life Sciences, Polymer for Advanced Technologies.
Teaching period for this course: M1 Spring semester (january-march).
Pre-requisites: General chemistry (Bachelor level), descriptive and fundamental biochemistry (terminal high school level).
Skills at aim: Knowledge in coordination chemistry and catalysis, use of metalloenzymes and biocatalysis.
Professional expertise for which this course is mandatory? Research positions at the interface between chemistry and biology

Course outline:
After reminding of the properties of complexes and the thermodynamic and kinetic aspects of the complexation processes, the role and the reactivity of metals into biological systems and chemical models will be investigated. The metal ion mediated transport, the biocatalysis in hydrolysis reactions and redox processes will also be studied. Finally, the reactivity of complexes used in therapeutic applications and the detoxification of heavy metal compounds.

➤ **Lectures (25h):**

I. Introduction to bio-inorganic chemistry (3h)
- Metals of biological interest and homeostasis
- Coordination: Chemistry and Biochemistry
- Biological ligands

II. Zinc proteins (3h)
- Introduction
- MonoZinc hydrolytic enzymes: carboxypeptidase
- Lyase: carbonic anhydrase
- Redox role: Alcohol Dehydrogenase
- Zinc finger proteins

III. Spectroscopy applied to metalloproteins (3h)
- Introduction to absorption spectroscopies
- UV-Visible spectroscopy
- Mössbauer (iron) spectroscopy
- EPR spectroscopy

IV. Dioxygen binding and transport (3h)
- Introduction
- Transport of O_2 into invertebrates: Hemerythrin
- Transport of O_2 into molluscs: Hemocyanin
- Transport of O_2 into mammals: Myoglobin and Hemoglobin

V. Copper Proteins (2.25h)
- Introduction
- Enzymes with an odd number of copper atoms (metallothionein, plastocyanin)
- A particular case: Galactose Oxidase (1 Cu)
- Polyphenol Oxydases: Catechol Oxydase and Tyrosinase (2 Cu)

VI. Iron Proteins (3.75h)
- Introduction
- Non-heminic oxygenase: Methane Monoxygenase
- Heminic oxygenase: P450
- Heminic electron transfer: Cytochromes
- Non-heminic electron transfer: iron-sulfur clusters

VII. Use of metals in medicine (7.5h)

VII.1. Pt chemistry

VII.2. Radiopharmaceutics and ^{99}Tc chemistry

VII.3. Contrast agents

VII.4. Metals and MRI

➤ **Discussion sections (15h):**

* Exercises about model of enzyme active centers in order to understand the reactivity, the spectroscopic characterization of the metallic site with a special attention brought to EPR, IR, magnetism, Mossbauer, paramagnetic NMR techniques – 9h.

* Exercises about the redox properties of complexes, as well as their physico-chemical properties (calculations of complexation constants, of exchange constants, etc…) - 6h.

➤ **Lab sessions (10h):** Extraction, purification and enzymatic activity of the yeast catalase.

Format of the course:

Activities	***Hours***	***%***
Lectures	**25**	**25**
Discussion sections	**15**	**15**
Lab sessions	**10**	**10**
Estimated work load outside class	**50**	**50**
TOTAL	**100**	**100**

Format of exams:

Nature	***Mid-term Exam***	***Final Exam***	***Second Session***
Lab sessions' reports	**20 %**	_	_
Written exam	**30 %**	**50 %**	**50 %**

YCHI424i - Micro-projects

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Teaching team 2012-2013: Bernard Bessières (Assistant Professor), Nicolas Spinelli (Assistant Professor), Olivier Renaudet (Professor), Damien Jouvenot (Assistant Professor), Sébastien Carret (Assistant Professor), Rachel Auzély (Professor), Anna Szarpak-Jankowska (Assistant Professor).
Master programs including this course: Chemistry and Life Sciences, Polymer for Advanced Technologies (professional courses in particular).
Teaching period for this course: M1 Spring semester (january-march).
Prerequisites: General, Organic, Inorganic chemistry (Bachelor level) and Polymers (Fall semester of the M1 level).
Skills at aim: Improved experimental autonomy for students.
Professional expertise for which this course is mandatory? Research positions either in Organic Chemistry, or in Polymer sciences, or at the interface between Chemistry and Biology.

Course outline:
Lab sessions as micro-projects in order to improve the students' bench autonomy (students are working alone). The micro-project will deal either with organic synthesis (for students interested in M2 SO-IPA), or in bioorganic chemistry (for students interested in M2 C-BOBI), or in Polymer sciences (for students interested in M2 PTA).

➤ **Micro-projets in bioorganic chemistry:** research themes are among the following:
- Oligosaccharide synthesis including modification at the anomeric position. The students are addressing issues such as protections, activation at the anomeric position (bromine, fluorine, trichloroacetimidate), glycosylation (Lewis acid promotor or phase transfer catalysis), deprotection and analysis (1D and 2D NMR).
- Solid-phase supported peptide synthesis.

For each student, the final evaluation is based on preparatory work before coming in the lab (bibliographic search, set-up of the timetable in lab), behaviour and technical skills in the lab, as well as on the overall quality of the lab notebook and of the oral presentation held at the end of the week.

➤ **Micro-projects in organic chemistry:**
During this week, students are placed individually in the working context of either a total synthesis, or ligand synthesis, or asymmetric catalysis … Five possible projects are proposed. Students are requested to carry out the bibliographic search, to compare the known methods if applicable, to plan the use of any necessary reactant/reagent or solvent (the students are designing their own retrosynthetic approach). The final evaluation is including:

- a 15-minute long oral presentation (5 min presentation then 10 min discussion), before the week in lab, will allow the student to explain her/his strategy and to anticipate the possible chemical issues: 5 points.
- General behaviour during the week in lab, the abilities of the student both to cope with experimental problems and to propose solutions, self-organization and finally, the results obtained will also be evaluated: 10 points.
- A lab notebook (which is different from a lab session's report) is requested at the end of the week. This point should allow the student to learn brevity in scientific description, ranking the relative weight of observations, analysis of spectra…: 5 points.

➤ **Micro-projects in polymers:**
The aim of these micro-projets is to improve the students' independence in the lab. There are several possible projects to choose and to develop (such as Polymer nanoreactor of gold nanoparticles, Self-assembly of polymer colloids and their solvatochromic-responsive properties, Drug encapsulation in pH/temperature stimuli sensitive core-shell beads, Synthesis, characterization and properties of magnetic - polysaccharide gel beads). In the course of these micro-projects, students are synthesizing and characterizing different polymers. These polymers are then used for the elaboration of appropriate systems which will be characterized using various physico-chemical techniques such as NMR, FTIR, GPC, DSC, UV-Vis, DLS and rheometry.

Working abilities such as decision making, sufficient scientific evidence for any explanation or justification, self-organization (in order to plan and prepare the week in lab) are developed. The evaluation of the project is achieved taking into account the following criteria: oral evaluation, written report, working abilities, quality of the lab notebook.

Format of the course:

Activities	***Hours***	***%***
Lectures	_	_
Discussion sections	_	_
Lab sessions	**50**	**50**
Estimated work load outside class	**50**	**50**
TOTAL	**100**	**100**

YCHI425i – Chemistry of Polymers 2
(Watch out ! This course is inseparable from the YCHI426i course)

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Teaching team 2012-2013: Rachel Auzély (Professor), Frederic Dubreuil (Assistant Professor), Anna Szarpak-Jankowska (Assistant Professor).
Program including this course: Master programs including this course: Chemistry and Life Sciences, Polymer for Advanced Technologies and Chemistry and Nanosciences (Department of Physics, Engineering, Earth, Environment and Mechanics).
Teaching period for this course: M1 Spring semester (january-march).
Prerequisites: General and physical chemistry (Bachelor program).
Skills at aim: Chemical properties of polymer materials.
Professional expertise for which this course is mandatory? Job positions dealing with the use of polymer materials

Course outline: Elaboration of polymers with controlled architecture (living polymerization, copolymer synthesis). Chemical modifications of polymers. Degradation and recycling.

19h Lectures + 6h Discussion sections

General introduction on polymers
Definitions, reminders on macromolecular syntheses

I Polymers with controlled architecture: synthesis and properties
Statistical copolymerization
Synthesis of block and graft copolymers, either by living of by controlled free-radical polymerizations
Synthesis of dendrimers
Development of 'intelligent' polymer materials

II Chemical modifications of polymers
Obtention of functional biopolymers or synthetic polymers *via* 'click-chemistry' processes

III Biosourced polymers
Different classes
Synthesis, properties and applications

IV Supramolecular polymers
Development strategies
Properties and applications

V Application of NMR spectroscopy to the characterization of polymers.

Format of the course:

Activities	***Hours***	***%***
Lectures	**19**	**38**
Discussion sections	**6**	**12**
Lab sessions	**–**	**–**
Estimated work load outside class	**25**	**50**
TOTAL	**100**	**100**

Format of exams:

Nature	***Mid-term Exam***	***Final Exam***	***Second Session***
Written exam	**30 %**	**70 %**	**70 %**

YCHI426i – Physical Chemistry of Polymers 2

(Watch out ! This course is inseparable from the YCHI425i course)

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Teaching team 2012-2013: Frédéric Dubreuil (Assistant Professor).
Master programs including this course: Chemistry and Life Sciences, Polymer for Advanced Technologies and Chemistry and Nanosciences (Department of Physics, Engineering, Earth, Environment and Mechanics).
Teaching period for this course: M1 Spring semester (january-march).
Prerequisites: General and physical chemistry (Bachelor program).
Skills at aim: Physico-chemical properties of polymer materials and characterization methods.
Professional expertise for which this course is mandatory? Jobs implying the use of polymer materials

Course outline: Configurational and conformational analysis of polymer chains, self-organization of polymers at the solid state (amorphous state and glass transition, crystalline and semi-crystalline states), general thermomechanical behaviour and methods for the elaboration of polymers and polymer-forming.

19h Lectures + 6h Discussion sections

➤ Amorphous polymers (7h)

I. Introduction to mechanical testing and reminders on the different state domains.
   - Dynamic mechanical analysis – thermomechanical behaviour
   - Viscoelastic phenomenons: Maxwell models and Voigt model

II. The glass transition
   - Highlighting the glass transition from the variation of the specific volume with temperature
   - Highlighting by DSC

III. Molecular origin of the glass transition

IV. Influence of the chemical structure of polymers on the temperature of glass transition

Discussion section 1: Mechanical models
Discussion section 2: Dynamic mechanical analysis

➤ **Semi-crystalline polymers (3h)**

I. Crystalline structures of mass polymers
   - Crystal lamella
   - Spherulites

II. Measurement of the crystallinity ratio
   - X-Ray diffraction
   - Density measurements
   - DSC

III. Melting point of crystalline domains
   Influence of the chemical structure of polymers on the melting point

IV. Crystallisation kinetics

Discussion section 3: Cristallinity measurement

➤ **Rubber elasticity (4h)**

Rubber elasticity: the phenomenon, the theory.
Discussion section 4: Measurements of Young's modulus and critical mass of a polymer

➤ **Elaboration of polymers and polymer-forming (1.5h)**

Molding, extrusion techniques…
Spinning techniques (obtention of fibers used in the textile industry and in the biomedical field (manufacturing surgical materials).

➤ **Colloids and dispersions (4.5h)**

- Applications of polymers to the stabilisation of colloidal suspensions
- What is a colloid?
- Dispersed media and their expected properties
- A bit of theory (DLVO)
- Steric repulsions

- Practical examples in Discussion sections.

- **Analysis by radiation scattering techniques (3.5h)**
  - Introduction to SAXS, WAXS and SANS analyses; link with colloids and bulk structures
  - Parameters accessible with these techniques

  Discussion section: Analysis of a scientific publication

- **Liquid crystal polymers and nano-organized layers (1.5h)**
  - Properties of thermotropic or lyotropic polymers
  - Structures of these different polymers
  - The block copolymers, the obtained bulk and thin layer structures
  - Applications of these polymers

Format of the course:

Activities	*Hours*	*%*
Lectures	**19**	**38**
Discussion sections	**6**	**12**
Lab sessions	**–**	**–**
Estimated work load out of class	**25**	**50**
TOTAL	**100**	**100**

Format of exams:

Nature	*Mid-term Exam*	*Final Exam*	*Second session*
Written exam	**30 %**	**70 %**	**70 %**

YOPR4277 - Ouverture Professionnelle
(taught in French only – could be replaced by YOPR427i – see below)

Programme de l'Unité d'Enseignement :

Phase I. Introduction (TD N°01 – 2h)

* Objectifs : l'étudiant à l'issue de cette séquence doit avoir une bonne vision du travail qui sera entrepris dans cette UE en lui donnant du sens au travers d'une recherche de stage en lien avec les formations de M2 et/ou des métiers qu'il vise à l'issue du M1.

* Séquence : présentation de UE afin que les étudiants aient une bonne vision du travail qui sera réalisé dans cette UE dans le but de donner du sens à ce travail : contextualiser le travail dans le cadre de la recherche de stage et mise en perspective des différentes phases de travail et de leur lien.

Qui a déjà fait un stage?

Comment vous-y prenez-vous pour rechercher un stage ?

- présentation du Portefeuille d'Expériences et de Compétences (PEC)
- chaque étudiant explicite son projet de formation, vers quel(s) M2 se destine-t-il ? Vers quel type de métier ?

Phase II. Métier/formation/entreprises (TD 02 à 04 – 6h)

- Objectif : l'étudiant à l'issue de cette séquence doit avoir acquis une méthodologie de travail lui permettant de connaitre les métiers en lien avec la formation de M2 visée (ou avoir identifié les formations qui débouchent au métier visé) et de connaitre un certain nombre d'entreprises dans lesquelles ce métier s'exerce dans la perspective de rechercher un stage.
- Démarche :

* savoir identifier différentes ressources web qui permettant d'obtenir des informations fiables en termes de métier/formation, métier/entreprise et entreprise/proposition de stage.

* savoir analyser ces ressources pour connaître le métier en termes de compétences, spécificités, fonction et place du métier dans l'entreprise en vue de répondre à une proposition de stage ou de poser une candidature spontanée.

Phase III. Compétences métier et mes expériences. (TD 05 à 07 – 6h)

- Objectif : l'étudiant à l'issue de cette séquence doit savoir i) identifier et formuler ses compétences développées au travers de sa formation, de ses propres activités extra-universitaires et ses activités professionnelles (jobs d'été) et ii) faire le lien avec les compétences associées au métier identifié dans la phase II.
- Démarche :

* savoir analyser une expérience en termes de compétences.

* pouvoir formuler ses compétences en termes compréhensibles par un futur recruteur.

* être capable de faire le lien entre compétences acquises par mes expériences et compétences requises pour le métier.

Phase IV. Communiquer : CV, lettre de motivation et entretien (TD 08 à 011 – 8h)

- Objectif : l'étudiant à l'issue de cette séquence doit savoir se préparer à un entretien, rédiger un CV et une lettre de motivation dans un cadre donné : répondre à une proposition de stage et poser une candidature spontanée.
- Démarche :

* Sur la base du travail effectué dans le TD N°07, savoir inscrire sa démarche de recherche de stage dans le cadre d'un projet en lien avec un métier.

* Etre capable de rédiger un CV et une lettre de motivation dans un contexte donné comme une proposition de stage.

* Savoir préparer un entretien et se comporter face à un recruteur.

Evaluation :

L'évaluation pourra se composer de deux parties pondérées à 50% chacune :

- partie 1 relative aux phases II et III sous la forme d'un dossier écrit. C'est un exercice d'identification de ressources, de synthèse des travaux menés lors des phases II & III et d'analyse de sa démarche afin de préciser dans quel cadre, quel projet va s'inscrire sa demande de stage. Ce dossier se composera d'une feuille recto-verso composée de trois parties : une première relative au projet de formation (formation envisagée et raisons, métiers associés, entreprises concernées, compétences et fonctions associées à l'un des métiers visés), une seconde sur mes compétences en lien avec mes expériences – formation, job et activités - et une troisième, une description des démarches que l'étudiant va entreprendre pour trouver un sujet de stage en argumentant ces choix (Pourquoi répondre à cette proposition de stage ou pourquoi déposer une candidature spontanée dans cette entreprise ?).
- partie 2 : rédaction d'un CV et lettre de motivation dans le cadre d'une réponse à une proposition de stage et/ou d'une candidature spontanée.

YOPR427i – Professional Integration
(taught in english)

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38041 Grenoble cedex 9 - France
Tel.: +33.476.514. 804 ; E-mail: anne.milet@ujf-grenoble.fr

Teaching team 2012-2013: Anne Milet (Professor).
Program including this course: Chemistry and Life Sciences, Polymers for Advanced Technologies.
Teaching period for this course: M1 Spring semester (january-march).
Prerequisites: Basic knowledge in chemistry.
Skills at aim: Knowledge of some european regulation procedures for the registration of chemicals (REACH, CLP).
Professional expertise for which this course is mandatory? Jobs in the chemical industry

Course outline:
This course deals mainly with the REACH regulation at the European level.
REACH is a regulation of the European Union, adopted to improve the protection of human health and the environment from the risks that can be posed by chemicals, while enhancing the competitiveness of the EU chemicals industry. It also promotes alternative methods for the hazard assessment of substances in order to reduce the number of tests on animals.
In principle, REACH applies to all chemical substances; not only those used in industrial processes but also in our day-to-day lives, for example in cleaning products, paints as well as in articles such as clothes, furniture and electrical appliances. Therefore, the regulation has an impact on most companies across the EU.
REACH places the burden of proof on companies. To comply with the regulation, companies must identify and manage the risks linked to the substances they manufacture and market in the EU. They have to demonstrate to ECHA how the substance can be safely used, and they must communicate the risk management measures to the users.
If the risks cannot be managed, authorities can restrict the use of substances in different ways. In the long run, the most hazardous substances should be substituted with less dangerous ones.
REACH stands for Registration, Evaluation, Authorisation and Restriction of Chemicals. It entered into force on June 1st, 2007.
Also, the CLP regulation ensures that the hazards presented by chemicals are clearly communicated to workers and consumers in the European Union through classification and labelling of chemicals.

Format of the course:

Activité	***Heures***	***%***
Lectures	**12**	**25**
Discussion sections	**12**	**25**
Estimated work load out of class	**25**	**50**
TOTAL	**50**	**100**

YSTG428i – Research Internship

Contact: Dr. Damien Jouvenot
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38041 Grenoble Cedex 9 - France
Tel.: 33.476.514.596 ; Email: damien.jouvenot@ujf-grenoble.fr

Teaching team 2012-2013: Damien Jouvenot (Assistant Professor), Catherine Bougault (Assistant Professor), Frédéric Minassian (Assistant Professor), Sandrine Py (CNRS researcher).
Program including this course: Chemistry and Life Sciences, Polymers for Advanced Technologies.
Teaching period for this course: M1 Spring semester (january-march).
Prerequisites: Knowledge about how to write a CV and a motivation letter (YOPR4277 course in particular).
Skills at aim:
- Being able to search (and find !) a host research team or company or institution.
- Being able to conduct a research work or an application work in the context of an assignment from a public laboratory mission or a private company.
- Perform well in a team.
- Being able to perform literature searches and cite references.
- Being able to write about scientific research and prepare a report of limited size, presenting the main results obtained during the internship.
- Being able to give an oral presentation about this work and to discuss the results.

Professional expertise for which this course is mandatory? Any kind of job in the chemical industry or academic research in chemistry

Course outline:
No preset program.
Writing of a final report.
Oral presentation.

Format of the course:

Activité	***Heures***	***%***
Lectures	–	–
Discussion sections	–	–
Lab sessions	–	–
Estimated work load out of class	**500**	**100**
TOTAL	**500**	**100**