

**International Master “Catalysis, Molecules and Green Chemistry”  
University of Rennes, France  
Program 2008-2012**

**Starting beginning of September 2008**

**Each module involves 36 hours.**

**First Year**

**UE Modern Molecular Synthesis and Natural Products (36h)**

**1- Advanced organic synthesis, retrosynthesis and asymmetric synthesis:**

Cycloadditions, aldol reactions, oxidations (epoxidations, dihydroxylation, aminohydroxylation), reductions, protecting groups...

Retrosynthesis analysis – applications to a few examples (prostaglandines, alcaloides, cephalosporines ...).

**2- Natural Products**

New use of aminoacids, peptides, polysaccharides, terpenes in synthesis, catalysis and polymerization.

**UE Advanced organometallics and spectroscopy (36h)**

**1- Advanced organometallics**

Organometallic complexes and molecular catalysts, molecule activation processes, influence of ligand nature on activity, stabilization of unstable moieties for catalysis, metal-carbene, -vinylidene, -carbyne and -cumulene chemistry, olefin metathesis, polymerisation, C-H, Si-H bond activation

**2- Spectroscopies**

- NMR Spectroscopy. The objective of the course is to give the student knowledge about modern spectroscopic techniques used for structure elucidation of molecular compounds.

Fundamentals of data acquisition (pulse sequences, detection), multi-dimensional techniques, study of dynamic processes and their application to the determination of structure.

- Mass spectrometry

## UE French course and History

Economical and cultural aspects of France and European Union

## UE Bibliographic and research seminars in English

### Second Year

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#### UE Catalysis for fine chemistry (36h)

##### 1- Catalysis and fine chemistry (24h) :

Transition metal catalysis: molecular catalyst design and important catalytic reactions for fine chemicals production. Catalytic methods to make C-C, C=C, C-heteroatom bonds, C-H bond activation, enantioselective catalytic oxidation and reduction.

##### 2- Asymmetric synthesis and catalysis (12 h) :

Use of chiral inductors in synthesis. Origins of the stereoselectivity (thermodynamic and kinetic controls); Catalyzed formation of C-C bonds (cross-coupling reactions, allylic substitution, aldol reactions...), Catalyzed reduction (hydroboration, hydrogenation, hydride transfer) and oxidation (epoxidations, dihydroxylation, hydroxylamination), Organocatalysis.

#### UE Polymers and dendrimers (36h)

Single site catalysts for polymerisation, olefin polymerisation Ziegler Natta, metallocene and post-metallocene catalysts.

Dendrimers: synthesis, characterization, methodologies, applications in catalysis, supramolecular engineering, electron and energy transfer, molecular recognition, medicine.

Synthetic and natural biodegradable and biocompatible polymers.

#### UE New molecular and supramolecular materials (36h)

Synthesis and structural aspects, radical reactivity, electronic and magnetic properties of molecular organic materials, pi-conjugated organic polymers, organic light emitting diodes, non linear optics, molecular switches, molecular engineering, conductive materials.

Basic knowledge on coordination chemistry (Chelate and macrocyclic effects, template effects, geometry and symmetry of coordination complexes);

Self-assembling of nanostructures promoted by transition metals (molecular polygones and polyedres); Self-assembling of double and triple helix; Engineering of supramolecular catenanes, rotaxanes, molecular knots and molecular machines.

## UE Green Chemistry, industrial chemistry and new technologies (36h)

### 1- Green chemistry and catalysis in industry

#### Concepts of green chemistry and sustainable development

- . The Fundamentals of Green Chemistry
- . The Chlorine Controversy, Replacing Toxic Chemicals, Alternative Solvents and Reaction Media
- . Selective Catalysis, Energy and the Environment
- . The Environmental Factor in Chemical Research and Development Management

#### Chemistry and catalysis in industry

- . Presentation of industry: products and market
- . Green chemistry concepts applied in industry
- . Modern way to produce C-C and C-N bonds in industry
- . Enantioselective catalysis in industry, ligands and catalysts syntheses, High screening techniques
- . Industrial oxidation processes: homolytic oxidation, catalytic oxidations, molecular oxygen activation, enantioselective oxidations
- . Green aspects of industrial processes hydrosilylation, hydrocyanation, hydroamination, use of carbon monoxide, hydroformylation, carbonylations

### 2- New technologies for synthesis and catalysis

- . Non conventional reaction media; ionic liquids: synthesis, properties, quality, chirality
- . Microwave and material interactions. Microwave applications to heterocyclic chemistry and to solid and liquid phase synthesis. Green chemistry aspects.
- . Molecular diversity: library synthesis, parallel synthesis, solid phase synthesis, split and pool
- . High throughput screening: adapted spectroscopic and analytic methods.