FLOW CHEMISTRY

This research area involves the design and test of fixed-bed and monolitic microreactors using organo- and bio-catalysts immobilized on silica or polystyrene as packing material. The development of continuous-flow processes by the microreactor technology allows for the synthesis of high added value molecules on the milligram-multigram scale with improved efficiency, sustainability, and lower costs compared to traditional batch processes.

GOALS

Study of the immobilization strategy of the organo- bio-catalyst - Physicochemical characterization of the (bio)material - Fabrication of fixed-bed microreactors and monolithic columns - Development of new stereoselective carboligation reactions in flow regime - Reaction modeling for process optimization

INSTRUMENTS AND METHODS

Mass (MS) and infrared (FT-IR) spectroscopy - Nuclear magnetic resonance (NMR) - Elemental analysis - Chromatographic instruments - Scanning electron microscopy (SEM).

MAIN SUBJECTS

Organic Chemistry, Biochemistry, Analytical Chemistry, Process chemistry.

RESEARCH GROUP

Prof. O. Bortolini, Prof. A. Massi, Dr. C. De Risi, Dr. P. P. Giovannini

COLLABORATIONS

Prof. A. Cavazzini (UniFe), Dr. P. Dambruoso (CNR ISOF), Prof. O. Pandoli (Pontifícia Universida de Católica do Rio de Janeiro, Brazil)

ORGANOCATALYSIS

This research area involves the development of new organocatalytic processes for the synthesis of biologically relevant molecules. Organocatalysts are low-molecular-weight-compounds whose catalytic activity resides in the molecule itself and not in the presence of metals. Organocatalysts are usually readily available, robust, inexpensive, and non-toxic. These major features provide operationally simple routes to useful compounds such as biologically active molecules without generating any wasteful by-products. From a mechanistic point of view, common ability of many organocatalysts is to mimic the catalytic activity and selectivity of metal-free enzymes. It can be envisaged that hydrogen bonding, electrostatic, and steric interactions stabilize the transition states of organocatalyzed reactions in a similar but simplified fashion if compared to enzyme catalysis, leading, however, to comparable levels of stereoselectivity.

GOALS

Study of the parallelism organo/bio catalysis in the stereoselective formation of carbon-carbon bonds - New processes promoted by *N*-heterocyclic carbenes - Development of supported organocatalysts - Mechanistic investigations.

INSTRUMENTS AND METHODS

Mass (MS) and infrared (FT-IR) spectroscopy - Nuclear magnetic resonance (NMR) - Elemental analysis - Chromatographic instruments.

MAIN SUBJECTS

Organic Chemistry, Biochemistry

RESEARCH GROUP

Prof. O. Bortolini, Prof. M. Fogagnolo, Prof. G. Fantin, Prof. A. Massi, Dr. P. P. Giovannini, Dr. C. De Risi

COLLABORATIONS

Dr. P. Dambruoso (CNR-ISOF)

ARTIFICIAL NUCLEOSIDES AND NUCLEOTIDES

This research area involves the design, synthesis, and the study of the biological activity of artificial nucleosides and nucleotides with modified properties. Such compounds have been largely used for medicinal chemistry (e.g., antiviral and anticancer agents) and chemical biology (e.g., studying of enzyme reactions) applications. Furthermore, oligonucleotides providing modified nucleotides have been employed for advanced gene therapy studies and as probes for molecular recognition interactions.

GOALS

Synthesis of nucleoside-conjugates of bile acid derivatives; synthesis of artificial glycosylnucleotide analogues; solid phase synthesis of highly modified oligonucleotides for *in vitro* and *in vivo* (animal model) applications.

INSTRUMENTS AND METHODS

Fully automated oligonucleotide synthesizer for synthesis in 1-50 µM and 150 µM - 9 mmol ranges. HPLC systems. MS, UV and Nuclear Magnetic Resonance spectroscopy.

MAIN SUBJECTS

Organic Chemistry, Pharmacology, Molecular Biology

RESEARCH GROUP

Dr. D. Perrone, Prof. M. Fogagnolo, Prof. A. Medici, Prof. G. Fantin

COLLABORATIONS

Prof. P. Merino (University of Zaragoza), Prof. A. Dalpiaz (UniFe), Dr. M. Capobianco (CNR-ISOF, Bologna), Prof. R. Gavioli (UniFe), Dr. T. Moustafa (University of Graz)

SUSTAINABLE TECHNOLOGIES FOR THE PRODUCTION OF CHEMICALS FROM BIOMASSES

The aim of this research is the study and the development of biotechnological and chemical processes for the conversion of biomass-derived molecules to fine chemicals. The starting materials of the processes can be either platform chemicals obtained from bio-refinery or wastes and by-products of agro-food industry. The strategies for the production of the new chemicals are identified and developed following the green-chemistry principles.

GOALS

The synthetic approaches are based on enzymatic or organocatalyzed reactions that, if possible and useful, are conducted under heterogeneous conditions. The use of unconventional reaction media (ionic liquid and supercritical fluids) and alternative energy sources (ultrasounds and microwaves) are additional study issues of this area.

INSTRUMENTS AND METHODS

Mass (MS) and infrared (FT-IR) spectroscopy - Nuclear magnetic resonance (NMR) - Elemental analysis - Chromatographic instruments.

MAIN SUBJECTS

Biochemistry, Molecular Biology, Organic Chemistry, Biochemistry, Process chemistry

RESEARCH GROUP

Prof. O. Bortolini, Prof. M. Fogagnolo, Prof. G. Fantin, Prof. A. Massi, Dr. P. P. Giovannini, Dr. C. De Risi

COLLABORATIONS

Prof. G. Sacchetti, Dr. G. Bernacchia (UniFe), Prof. M. Müller (University of Freiburg, Germany), Prof. D. de Oliveira (Federal University of Santa Catarina, Brazil)

SYNTHESIS OF PHARMACEUTICALLY RELEVANT COMPOUNDS

This project aims at developing different contents pertaining to the synthesis of new pharmaceutically relevant derivatives, possibly also in a stereoselective fashion. Pharmaceutically relevant compounds could find applications in the studies of several physiological and pathological processes in diverse fields, such as neurosciences and tumor diseases. Thus, their synthesis might represent the starting point to inspire the synthesis of biologically active compounds and the rational design of new drugs.

GOALS

- Synthesis of homoserin lacton derivatives as potential inhibitors of bacterial quorum sensing - Synthesis of HLA-G inducers to be used in antibiotic and transplant rejection therapies - Synthesis of modulators of mithocondrial function (e.g. inhibitors of Tim14-Tim16 complex, activators and/or inhibitors of mithocondrial proteins such as subunit c) as potential antitumor agents or modulators of Ca^{2+} afflux in the mitochondria - Enantioselective synthesis of imidazolidine and dichloroacetic acid derivatives as potential antitumor agents.

INSTRUMENTS AND METHODS

Common equipment of a synthetic organic laboratory - Mass (MS) and infrared (FT-IR) spectroscopy - Nuclear magnetic resonance (NMR) - Chromatographic instruments.

MAIN SUBJECTS

Organic Chemistry, Medicinal Chemistry, Pharmacology, Biochemistry

RESEARCH GROUP

Prof. C. Trapella, Prof. V. Zanirato, Prof. S. Benetti, Dr. P. Marchetti, Dr. A. Casolari

COLLABORATIONS

Prof. P. Pinton, Prof. P. Secchiero, Prof. G. Zauli, Prof. M. C. Zatelli, Dr. R. Rizzo (UniFe)