



# UNIVERSITÀ DI PARMA

*Department of Food and Drug*

*Degree Course in Pharmaceutical Chemistry and Technology*



# Research Areas

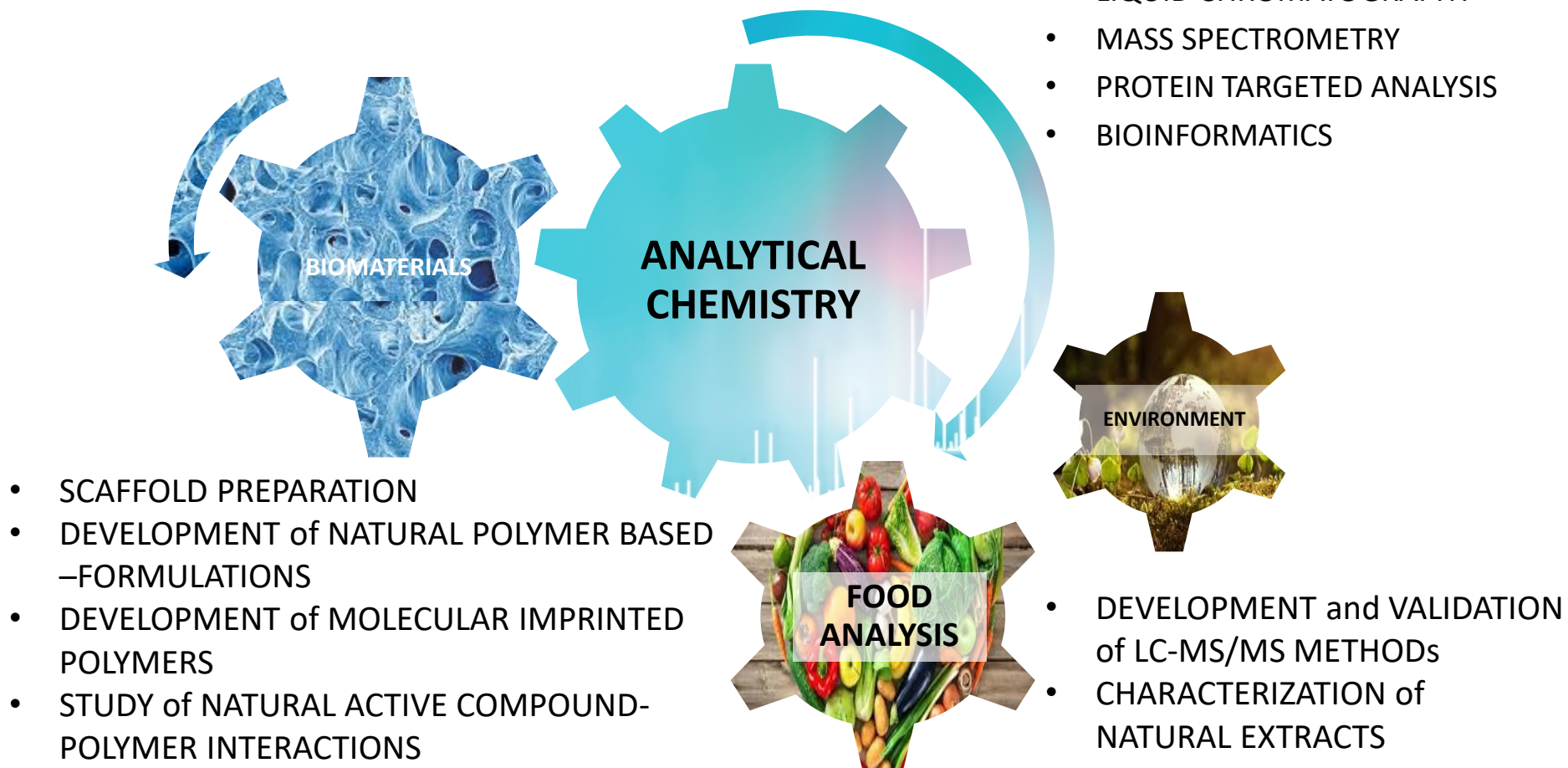
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- Analytical chemistry
- Biochemistry, Biological Physical chemistry, Biophysics
- Bio-organic Synthesis
- Drug Delivery & Pharmaceutical Technology
- Drug Design & Medicinal Chemistry
- Experimental Pharmacology
- Microbiology & Virology
- Molecular oncology
- Pharmaceutical Analysis
- Pharmaceutical Botany & Food Chemistry



# Analytical Chemistry Research Activities

**Principal Investigator:** Prof. PhD Lisa Elviri



# Biochemistry

**Bruno Stefano (Associate Professor)**  
**Campanini Barbara (Associate Professor)**  
**Faggiano Serena (Associate Professor)**  
**Raboni Samanta (Assistant Professor)**

## PROTEINS FROM ANTARCTIC ORGANISMS

- ✓ Poly-unsaturated fatty acids biosynthesis
- ✓ Globins

## SERINE METABOLISM IN HUMAN BRAIN

- ✓ Serine racemase
- ✓ Enzymes of the phosphorylated pathway

## DEVELOPMENT OF PROTEIN THERAPEUTICS

- ✓ Hemoglobin-based oxygen carriers
- ✓  $\alpha_1$ -antitrypsin
- ✓ Methionine  $\gamma$ -lyase
- ✓ Protein pegylation
- ✓ Photodynamic therapy

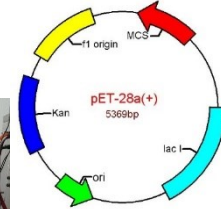
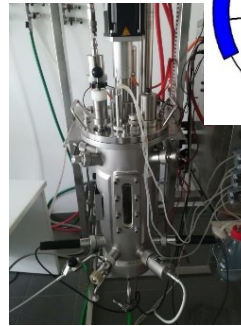
## TARGETS IN THE DEVELOPMENT OF NEW ANTIBIOTICS AND CHEMOTHERAPEUTICS

- ✓ Enzymes of cysteine biosynthesis in bacteria
- ✓ Proteins for iron acquisition in *S. aureus*
- ✓ Enzymes of metabolism as targets for anticancer drugs

# Skills

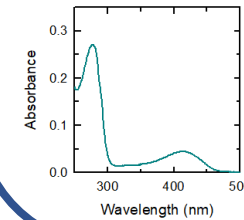
## PROTEIN EXPRESSION AND PURIFICATION

- ✓ Recombinant protein expression in *E. coli*
- ✓ Site-directed mutagenesis
- ✓ Protein purification by chromatography
- ✓ Chemical modification of proteins



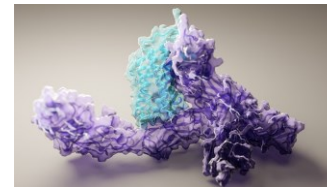
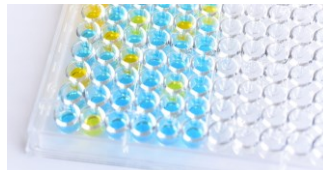
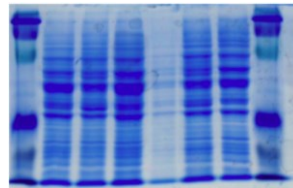
## PROTEIN SPECTROSCOPY

- ✓ UV-visible absorption spectroscopy
- ✓ Spectrofluorimetry
- ✓ Circular dichroism
- ✓ NMR
- ✓ Rapid-scanning stopped-flow
- ✓ Microspectrophotometry



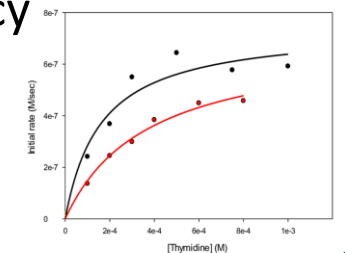
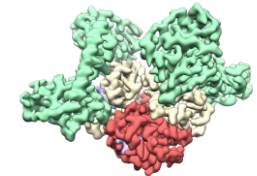
## ELECTROPHORETIC/IMMUNOCHEMICAL METHODS

- ✓ Nucleic acids electrophoresis
- ✓ SDS-PAGE
- ✓ Western blot
- ✓ ELISA



## ENZYME AND BINDING ASSAYS

- ✓ Enzyme kinetics
- ✓ Determination of inhibitors potency
- ✓ Allosteric regulation of enzymes
- ✓ Protein-protein interactions
- ✓ Oxygen binding to globins



# Biological Physical Chemistry

Prof. Carlotta Compari (Associate Professor)

## GEMINI SURFACTANTS FOR GENE DELIVERY:

molecular and functional study of the interaction between new biologically active molecules and DNA as potential use as non-viral vectors for gene delivery.

## THERMODYNAMICS OF AGGREGATE SYSTEMS:

study of newly synthesized surfactant compounds, with biological activity.

## SOLUTION EQUILIBRIA:

study of metal-ligand and macromolecule-ligand interactions of bioactive molecules of pharmaceutical interest.

## THERMODYNAMIC STUDY OF HYDROPHOBIC HYDRATION PROCESSES:

definition of new physical-mathematical models, based on statistical thermodynamics for the interpretation of receptor-ligand interaction and the hydrophobic effect.

# LAB SKILLS

## ITC

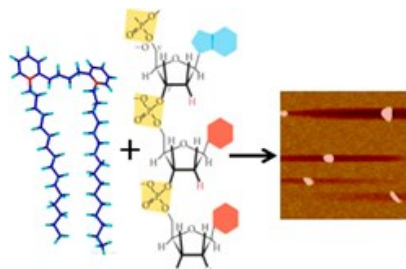
Isothermal Titration Calorimeter



MicroCal allows the determination of binding constants ( $K_d$ ), reaction stoichiometry ( $n$ ), enthalpy ( $\Delta H$ ) and entropy ( $\Delta S$ ) and can elucidate the mechanisms of molecular interactions.

## AFM

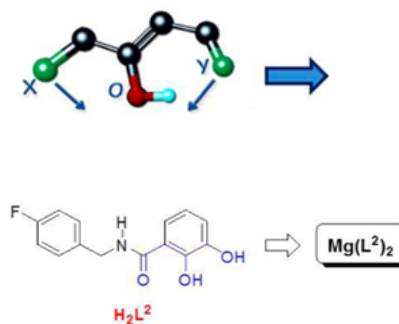
Atomic Force Microscopy



Study of the surface morphology of biological macromolecules.

## Potentiometric Titration

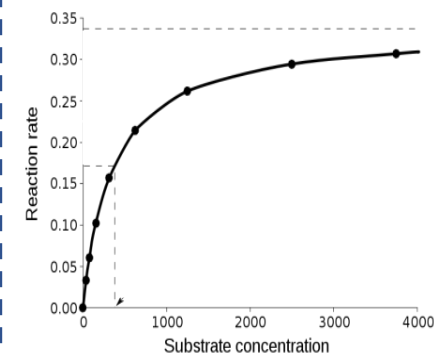
It allows the study of the solution equilibria and the determination of the binding constants.



## UV-visible

Absorption Spectroscopy

for the study of the enzyme kinetic



# Biophysics group

Cristiano Viappiani (full professor)

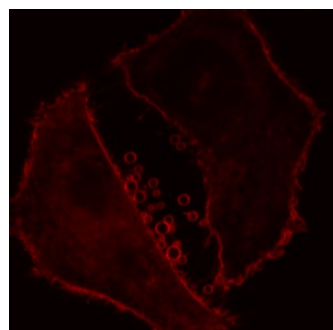
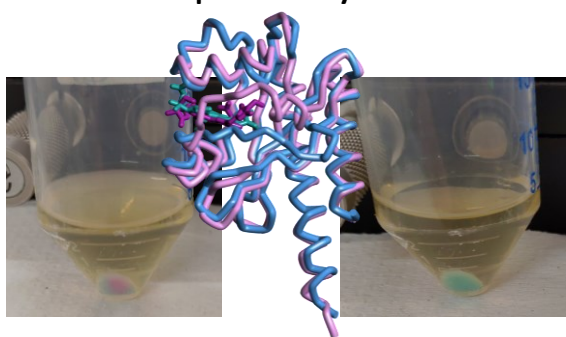
Stefania Abbruzzetti (associate professor)

Pietro Delcanale (assistant professor)

## Topics

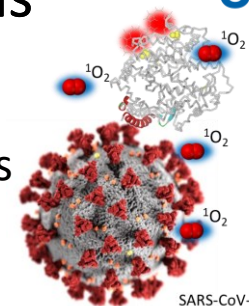
### Photomedicine

- Photoactive (fluorescent, photosensitizing, signalling) proteins
- Photoactive supramolecular compounds with targeting and fluorescence imaging properties
- Antimicrobial photodynamic inactivation
- Cancer photodynamic therapy

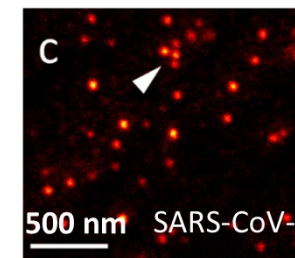


## Molecular interactions

- Protein-ligand interactions
- Protein-protein interactions
- Ligand binding kinetics
- Protein dynamics
- Photoinduced reactive oxygen species



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DI PARMA



## Methods

### Steady state and time-resolved Spectroscopy

Absorption and fluorescence emission (polarized detection)

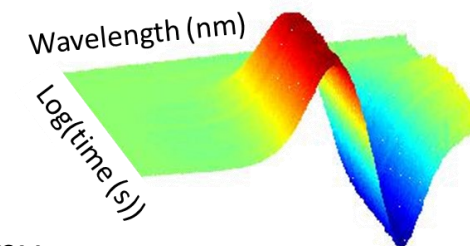
Time resolved absorption

Time resolved fluorescence

Time resolved photoacoustics

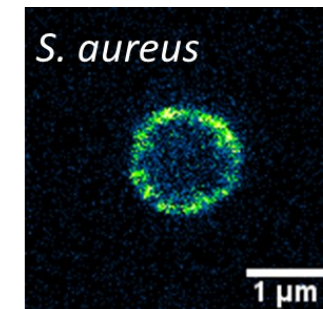
Microspectrometry

Fluorescence Correlation Spectroscopy



### Super-resolution fluorescence imaging

Identification of binding sites for delivery systems



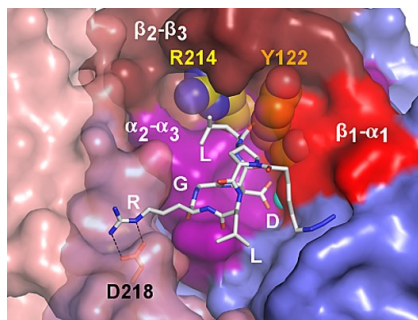


# Bio-Organic Synthesis group

<https://sites.google.com/view/bossgroupunipr/home>

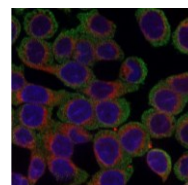
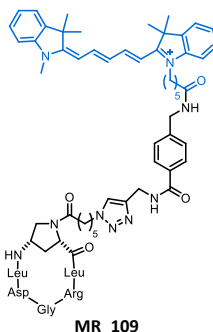
## Peptidomimetics, Covalent Conjugates & Nanomaterials Serving Bio-medicine

<https://sites.google.com/view/bossgroupunipr/research-projects/small-molecules-nanomaterials-serving-bio-medicine>



## Discovery and Application of New Imaging-Active Tools for Non-Invasive Early Diagnosis of Malignancies

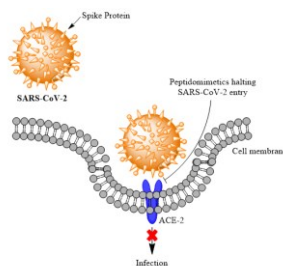
<https://sites.google.com/view/bossgroupunipr/research-projects/discovery-and-application-of-new-radioactive-diagnostic-tools>



Fluorescent probe in cell assays

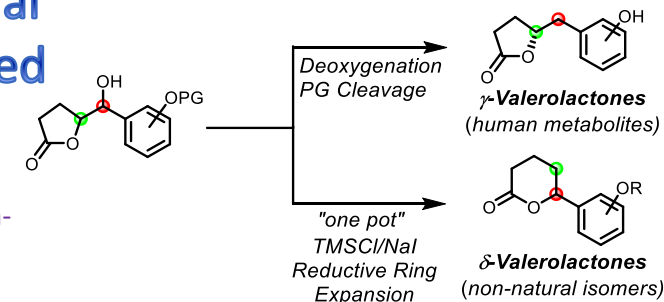
## Fighting SARS-CoV-2 using Bioinspired Peptidomimetics and/or Small Molecules

<https://sites.google.com/view/bossgroupunipr/research-projects/blocking-the-doors-to-sars-cov-2-using-bioinspired-peptidomimetics>



## Stereoselective Synthesis of Chiral Flavonoid Metabolites and Related Phase II Conjugates

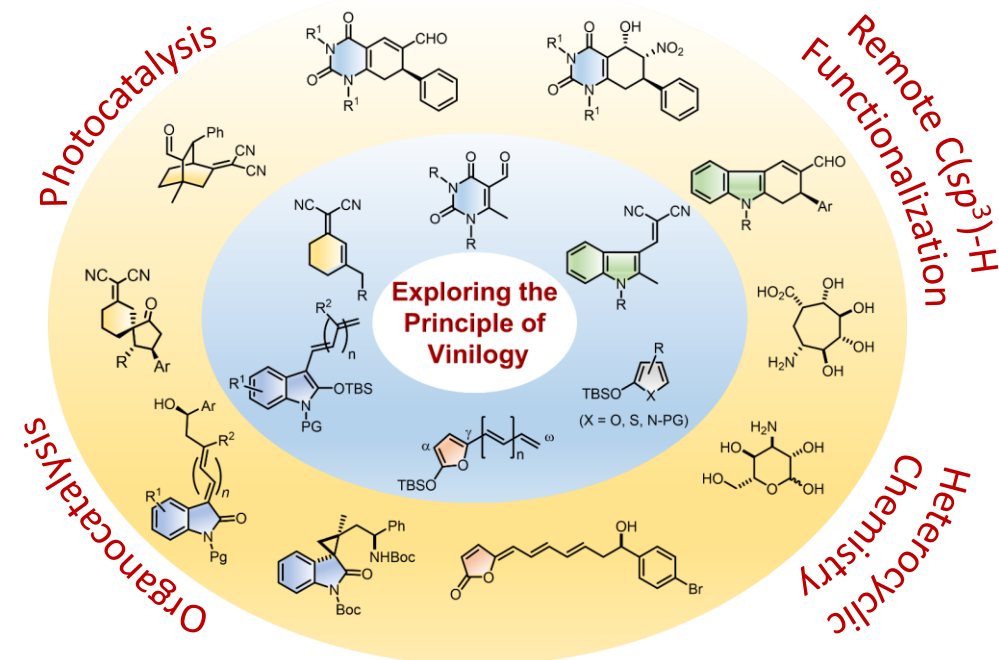
<https://sites.google.com/view/bossgroupunipr/research-projects/stereoselective-synthesis-of-chiral-flavonoid-metabolites-and-related-ph>



# Main Active Projects

## New Methodologies in Asymmetric Synthesis Pursuing Selectivity and Molecular Diversity

<https://sites.google.com/view/bossgroupunipr/research-projects/new-methodologies-in-asymmetric-synthesis-merging-selectivity-and-molecular>



# Bio-Organic Synthesis group

<https://sites.google.com/view/bossgroupunipr/home>

## Lab Skills



- Franca Zanardi (Professor)
- Lucia Battistini (Associate Professor)
- Claudio Curti (Associate Professor)
- Andrea Sartori (Associate Professor)

- Lab-scale asymmetric synthesis of chiral organic molecules
- Lab-scale equipment for photocatalytic reactions
- Purification and analysis of enantiopure compounds
- In-solution and solid-phase synthesis of small peptides, cyclopeptides and peptidomimetics
- Synthesis of covalent conjugates (peptide-small molecule drug ,peptide-lipide, peptide-fluorescent agent, peptide-chelating unit)
- Purification by chromatographic techniques (automated flash, HPLC)
- Spectroscopic characterization (1D and 2D-NMR, IR, CD, mass spectrometry)

## Research area: Bioinorganic chemistry



Prof. Mauro Carcelli



Prof.ssa Dominga Rogolino

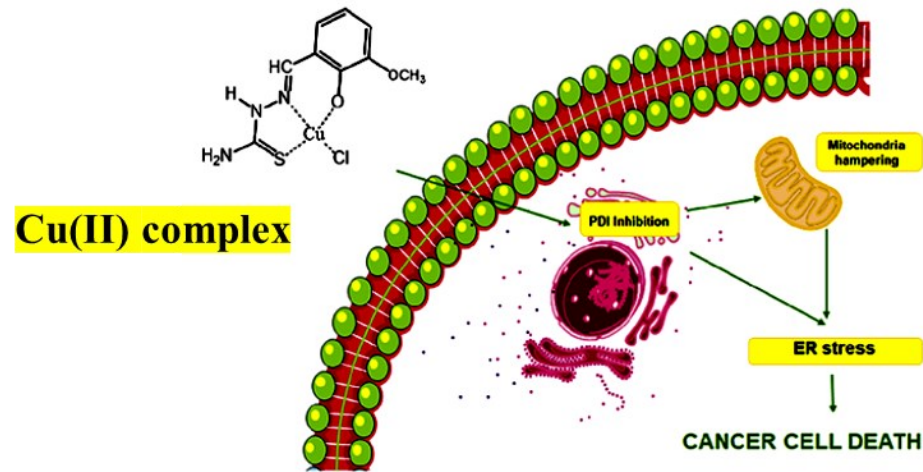
**In the lab: synthesis of new ligands and of the corresponding metal complexes**



*In network*



## Metal complexes with antitumor activity

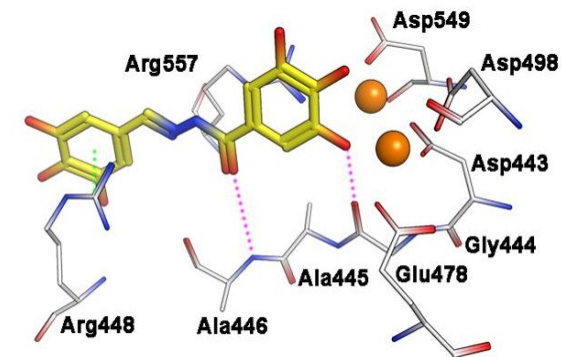
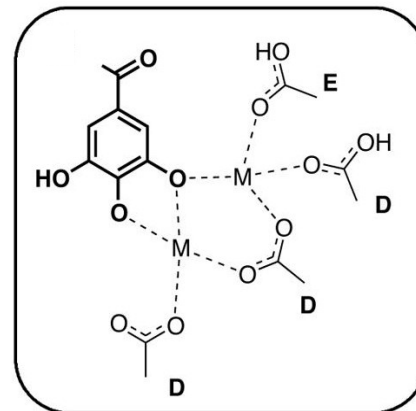


- ✓ Synthesis of the organic ligands and of the corresponding metal complexes
- ✓ Characterization of the new species in solution and solid state (FT-IR,  $^1\text{H}$  and  $^{13}\text{C}$  NMR, X-ray diffraction, UV-vis, potentiometry, calorimetry)

## Chelation of the metal ions in the active site of viral enzymes → antiviral activity

Metalloenzymes:

HIV Integrase and RNase H,  
Influenza Virus Endonuclease



- Ruggero Bettini, Professor
- Fabio Sonvico, Associate Professor
- Francesca Buttini, Associate Professor
- Alessandra Rossi, Associate Professor
- Annalisa Bianchera, Assistant Professor
- Eride Quarta, Assistant Professor

## Areas of interest

- Nasal and pulmonary drug delivery and vaccination
- Nose to brain delivery
- Nanomedicines
- Oral controlled drug delivery
- Solid-state manipulation
- Process technologies

# Research Projects

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## Inhalation drug delivery

- Powders for vaccine and adjuvants delivery to the lung
- Lung and nasal administration of cyclosporin for viral infection control
- Therapeutic protein lung delivery
- Nose to brain delivery of peptides
- Probiotic powders for microbiota modulation in the lung
- Novel therapeutic approaches for treatment of rare, chronic and degenerative lung diseases

## Oral dosage forms

- Nanomedicines for improving oral bioavailability of poorly absorbed drugs
- Innovative oral drug delivery platforms for reducing the environmental impact of drugs
- Technologies and formulation platforms for personalized medicine

# *Drug Delivery and Pharmaceutical Technology: ADDResLab*

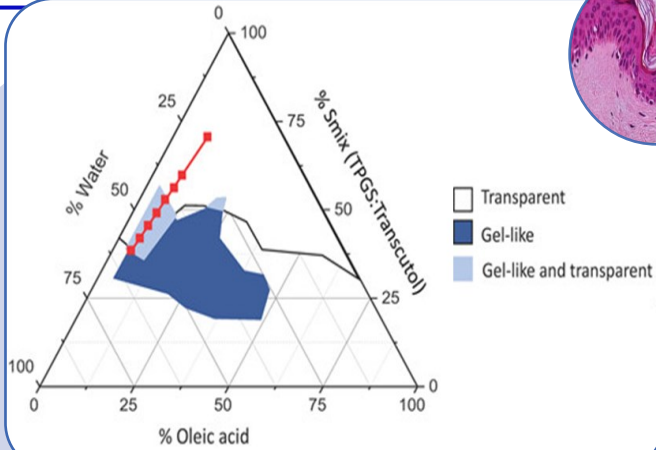
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- Patrizia Santi, Professor
- Sara Nicoli, Professor
- Cristina Padula, Associate Professor
- Silvia Pescina, Assistant Professor

## Areas of interest

- Skin delivery
- Buccal delivery
- Ocular delivery

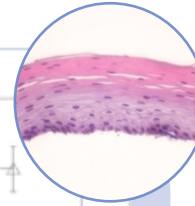
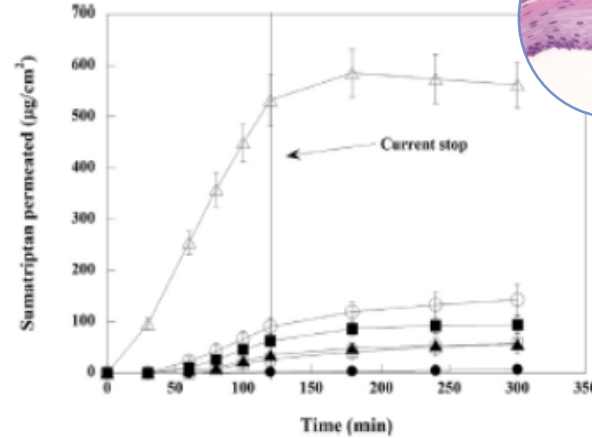
# Research Projects



## Dermal and Transdermal Delivery

Main model: Porcine ear skin

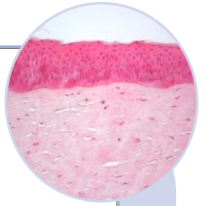
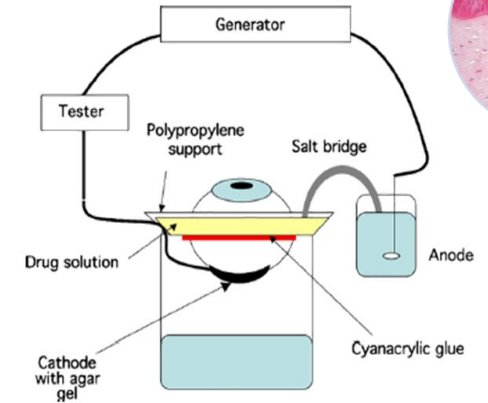
- microemulsions
- bioadhesive patch
- microneedles
- transdermal iontophoresis



## Buccal Delivery

Main model: Porcine esophageal epithelium

- microemulsions
- microneedles
- buccal iontophoresis
- enhancing strategies



Ocular Delivery  
for anterior and posterior segment  
Main model: Porcine eye

- polymeric micelles
- hydrogel
- polymeric films
- transcleral iontophoresis



## • *Members*

- Marco Mor (Professor)
- Silvia Rivara (Professor)
- Alessio Lodola (Professor)
- Federica Vacondio (Associate Professor)
- Riccardo Castelli (Associate Professor)
- Laura Scalvini (Assistant Professor)



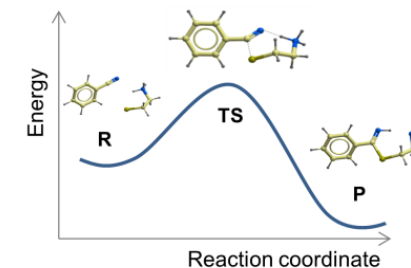
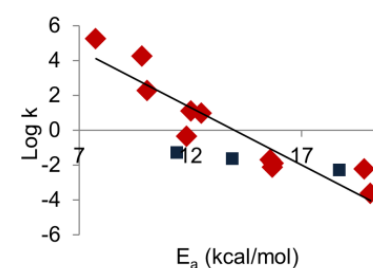
## • *Research Areas*

- Drug Design
- Synthetic Chemistry
- Pharmaceutical Analysis

# Drug Design & Discovery Group - Areas of interest

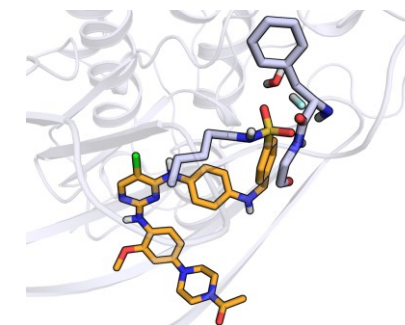
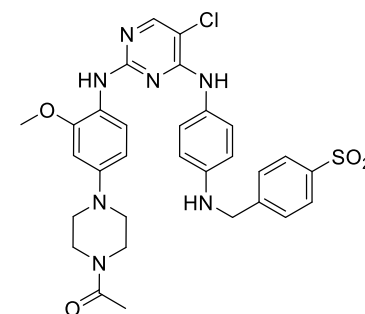
## Drug Design

- Covalent inhibition of drug targets
- Binding kinetics of drugs



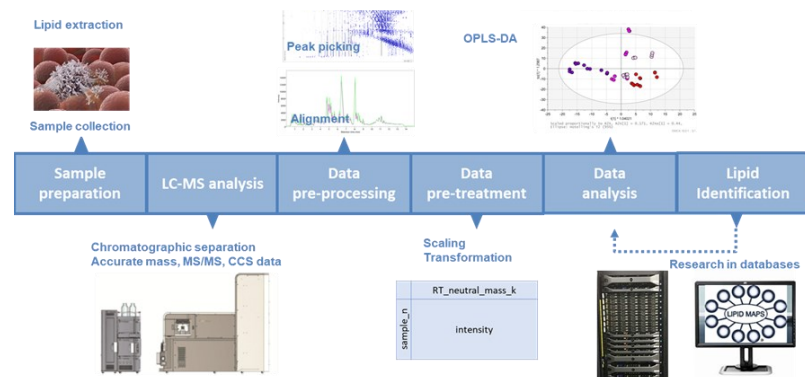
## Synthetic Chemistry

- Synthesis of chemical probes
- Conformational analysis of small molecules



## Pharmaceutical Analysis

- Compound profiling and metabolism
- Lipidome analysis by mass-spectrometry and cheminformatics



# Drug Design & Discovery Group - Research Projects

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## Modulators of the Endocannabinoid System and Related Signals

- Design and synthesis of MGL inhibitors targeting allosteric cysteines
- Design and synthesis of inhibitors and substrates of NAAA

## GPCR ligands

- Design of MT<sub>1</sub> and MT<sub>2</sub> melatonin receptor ligands

## Kinase inhibitors

- Design and synthesis of covalent inhibitors targeting cysteine or lysine

## Protein-Protein Interaction Inhibitors

- Design and synthesis of small molecules acting as FGF traps
- Design and synthesis of Eph-ephrin antagonists
- Design of modulators of YAP-TEAD interactions

## Medicinal Chemistry and Drug Discovery Group

**Gabriele Costantino (Professor)**

Marco Pieroni (Associate Professor)

Giannamaria Annunziato (Assistant Professor)



**Marco Radi (Associate Professor)**



*Involved in developing novel small-molecule probes for a wide range of therapeutic targets by combining molecular modeling and combinatorial chemistry approaches*

### **Main therapeutic areas:**

*Anti-infective agents*

*Anti tubercular agents*

*Antiviral agents*

*Pharmacological Chaperones*

*Cystic fibrosis*

*Nutraceuticals*

# RESEARCH PROJECTS:



## Anti-infective Agents

- Design and synthesis of O-acetyl serine sulfhydrylase
- Design and synthesis of Serine-acetyl transferase
- Design and synthesis of Carbonic Anhydrase inhibitors
- Design and synthesis of peptidomimetics with anti-microbial properties

## Pharmacological Chaperones

- Design and synthesis of alanine: glyoxylate aminotransferase ligands for the treatment of Hyperoxaluria type I

## Antitubercular Agents

- Design and synthesis of Thiazole derivatives for the treatment of resistant tuberculosis
- Synthesis of inhibitors of mycobacterial efflux pumps
- Synthesis of Proton Motive Force inhibitors

## Nutraceuticals

- Deep characterization of plant extracts for well-being purpose



## Antiviral agents

- Lipid Kinase inhibitors as broad-spectrum antiviral agents (BSAAs).
- Non-natural nucleobase and nucleosides as BSAAs
- Helicase inhibitors (host & viral) as BSAAs

## Multi-target inhibitors

- Antiviral/CFTR correctors for cystic fibrosis
- Antibacterial/ CFTR correctors for cystic fibrosis

## Agents for chronic diseases

- CCR6 antagonists for IBD and other diseases
- PCSK9 inhibitors for cholesterol-related diseases

## Sustainable MedChem

- Microwave-assisted synthesis
- Electrochemistry

## *MVMChem Lab (Research Group)*

**Valentina Zuliani (Associate Professor)**

**Claudia Silva (Associate Professor)**

**Mirko Rivara (Assistant Professor)**

**Matteo Incerti (Assistant Professor)**

Our main goal is the synthesis of new small molecules potentially effective in the treatment of various diseases.

We reach our objectives through a careful evaluation and optimisation of synthetic routes choosing, when possible, a **GREEN** path (e.g. click chemistry, MAOS, water based reactions).

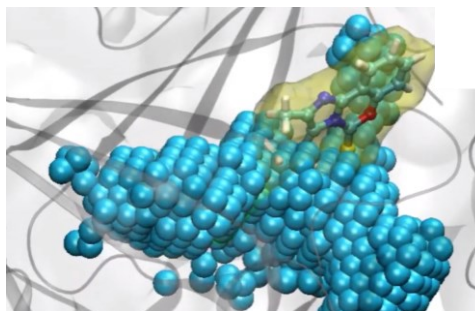
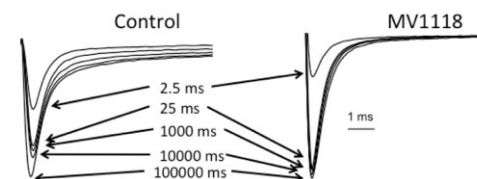
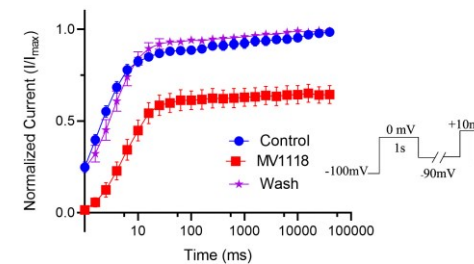
MVMChem Lab research focuses on:

- *Drugs for the treatment of glioblastoma.*
- *Sodium channel blockers as antiepileptic drugs.*
- *Sodium channel modulators for ALS zebrafish models.*

# MVMChem Lab Research Projects

- **Drugs for the treatment of glioblastoma:**

- Synthesis of ALKBH family inhibitors
- Optimization of Temozolomide activity enhancers



- **Sodium channel blockers as antiepileptic drugs:**

- Synthesis of diaryl-imidazole derivatives
- Synthesis of subtype selective compounds ( $Na_v$  1.6)

**Elisabetta Barocelli (Professor)**

Vigilio Ballabeni (Associate Professor)

Massimiliano Tognolini (Professor)

Simona Bertoni (Associate Professor)

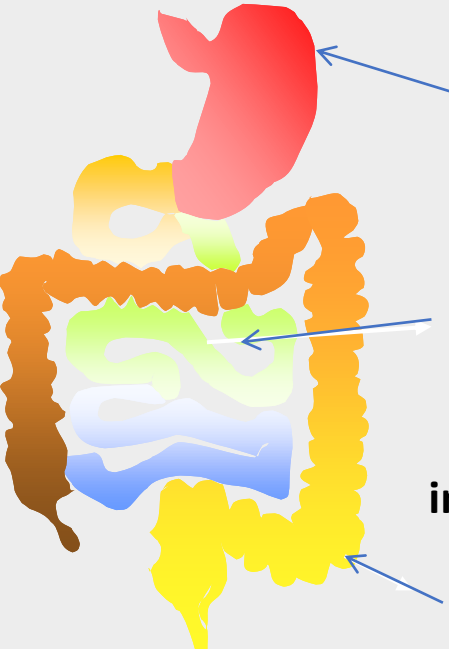
Carmine Giorgio (Assistant Professor)

## **Research Topics**

- Pharmacological characterization of drugs for the treatment of intestinal inflammation and GI secreto-motor disorders
- Discovery and development of new protein-protein inhibitors (Eph-ephrin interaction)
- Study of the local and systemic effects of drugs delivered by pulmonary inhalation
- Pharmacokinetics and safety pharmacology studies of new potential drugs and formulations
- Study of drug absorption through intestinal organoids (COLOTAN project n. 956851 H2020-MSCA-ITN-2020)



# Main researches



**Gastric secreto-motor disorders**

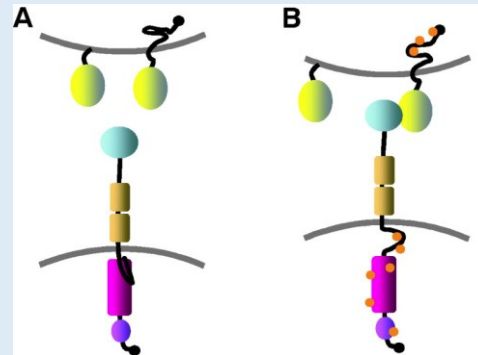
**Intestinal motor disorders  
IBS**

**Intestinal and extra-intestinal inflammatory disorders  
IBD**

*in vitro* and *in vivo* studies on GI effects of new potential drugs, natural products and probiotics

Evaluation of gut-brain axis

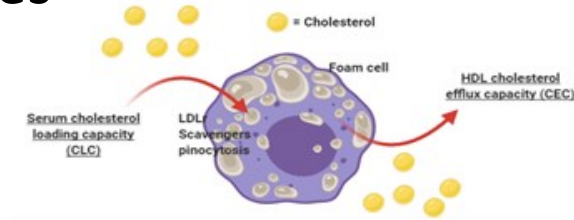
Discovery and development of new protein-protein Inhibitors of Eph-ephrin interaction



- ✓ Binding assay
- ✓ In vitro studies on cell cycle, signal transduction, cell proliferation and migration, angiogenesis
- ✓ In vivo studies in models of cancer, diabetes, pain, blood clotting disorders

## Lipid metabolism as a pharmacological/nutraceutical target for the treatment of cardiovascular, autoimmune, and neurodegenerative diseases

- Pleiotropic effects of PCSK9
- Association of lipoprotein functionality with atherosclerosis, autoimmune and neurodegenerative diseases
- Pharmacological/Nutraceutical modulation of cholesterol metabolism



### **In vitro studies (cell cultures)**

- Intracellular cholesterol metabolism and trafficking
- Expression of lipid transporters
- Cellular pro-inflammatory responses

### **In vivo studies (rodents)**

- Pharmacokinetics
- Lipid trafficking
- Lipidemia and inflammatory markers

### **Clinical studies**

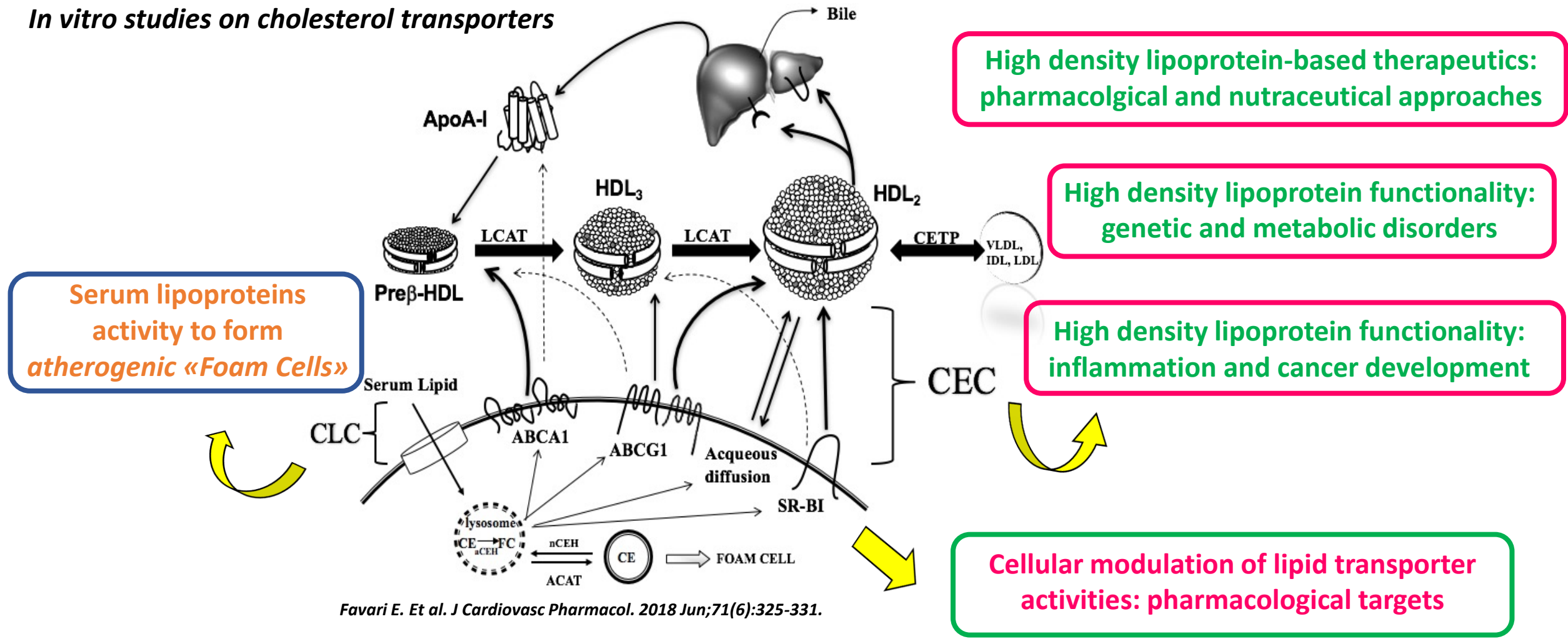
- HDL cholesterol efflux capacity
- Serum cholesterol loading capacity

# Cardiovascular Pharmacology Lab

(Elda Favari Ph.D., Associate Professor of Pharmacology)

## RESEARCH TOPICS:

- Clinical studies on human/animal models HDL functionality (CEC)
- Clinical studies on human/animal models sera pro-atherogenic activity (CLC)
- In vitro studies on cholesterol transporters



Favari E. Et al. J Cardiovasc Pharmacol. 2018 Jun;71(6):325-331.

# Experimental Oncology Unit

## Department of Medicine and Surgery

### Members

- **Pier Giorgio Petronini** (Full Professor)
- **Roberta Alfieri** (Associate Professor)
- **Andrea Cavazzoni** (Associate Professor)

### Research topics

The scientific interest is focused on Basic and Translational Research in soli tumors (lung cancer, mesothelioma, hepatocellular and renal carcinoma, CUP)

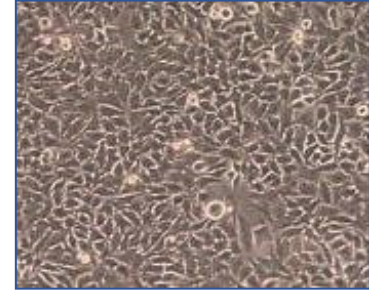
- Efficacy of targeted therapy
- Mechanisms involved in drug-resistance development
- Strategies to prevent-overcome drug-resistance



Murine Xenograft models

### IN VIVO STUDY

### Cellular biology



#### In vitro research:

- ✓ Human and murine cancer cell lines and primary cancer cells from patients
- ✓ Cell proliferation in 2D and 3D systems, cell viability, cell migration, cell metabolism
- ✓ Co-culture of cancer and stromal cells

### Molecular Biology



#### Gene editing

- ✓ gene over-expression
- ✓ Gene silencing

#### Signal transduction pathways

- ✓ evaluation of the intracellular signaling
- ✓ kinase array
- ✓ Elisa assay

#### Gene expression

- ✓ RNAseq,
- ✓ real-time PCR

# Pharmaceutical Botany

Renato Bruni, Associate Professor  
Marco Biagi, Assistant Professor  
Enrico Rolli, Assistant Professor



## ***Plants and health***

**food, food supplements and herbal drugs**

- Study of species of ethnobotanical interest and medicinal plants in different health contexts
- Extraction methods, phytochemical analysis, quality control also according to official Pharmacopoeias, EFSA or national authority requirements
- Phytochemical characterization of complex plant matrices
- Safety of botanicals and herbal formulations
- *In vitro* and *in silico* investigation on phytochemical interactions for the biological activity of phytocomplexes
- Micropropagation and *in vitro* culture of officinal species

# Microbiology and Virology Laboratory

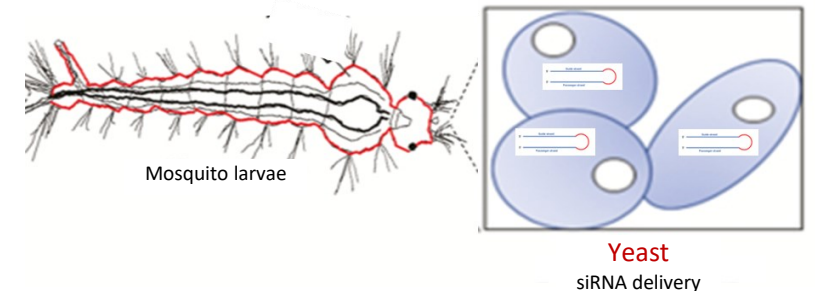
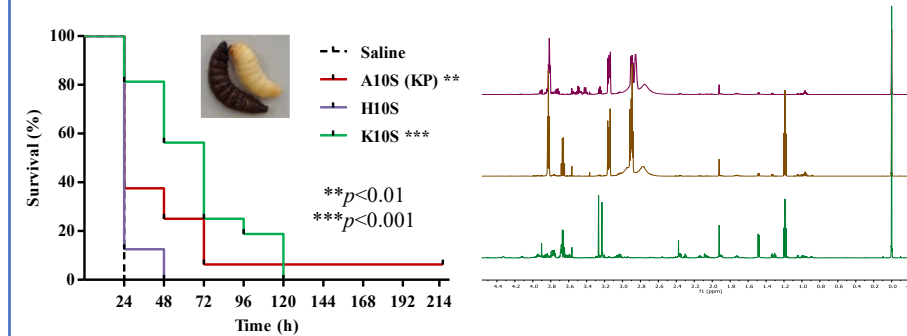
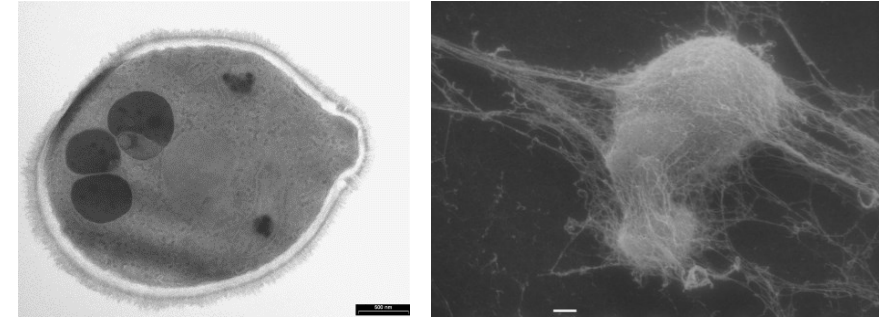
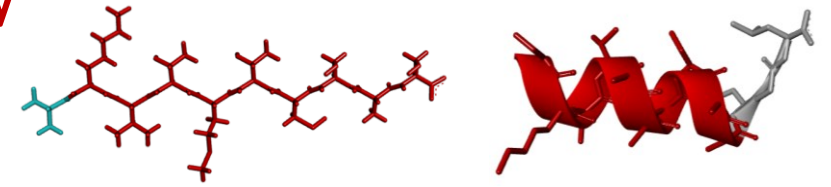
## Department of Medicine and Surgery

### Members

- **Stefania Conti** (Full Professor)
- **Tecla Ciociola** (Associate Professor)
- **Laura Giovati** (Associate Professor)

### Research topics

- Antimicrobial, antiviral and immunomodulatory activity *in vitro*, *ex vivo* and/or *in vivo* of synthetic peptides derived from physiological proteins. Studies on structure-function relationships of peptides and their derivatives for the design of new and more effective potential drugs
- Metabolomic analysis of fungal pathogens by Nuclear Magnetic Resonance Spectroscopy
- Development of new integrated biological control strategies and new drugs for vector-borne diseases based on yeast killer toxins
- Production of bioinsecticides based on yeast as siRNA expression and delivery systems
- Evaluation of the activity of antimicrobial peptides against oral microbial (fungal and bacterial) biofilms for treatment of endodontic infections



Maria Alessandra Umilta' (Associate Professor)  
Giovanni Sogari (Researcher )

## *Research Topic*

- Investigate whether the habit to consume organic products modulates the execution of reaching, grasping and swallowing movements. The top-down cognitive propensity and the movement execution measurements are correlated with eating behavioural and attitudinal traits, including consumers' attitudes towards organic foods, environment, healthiness, and the multi-dimensional assessment of empathy. Movement parameters are recorded by means of Electromyography and 3D Cinematics.