

UNIVERSITÀ DEGLI STUDI DI MILANO-BICOCCA
DOTTORATO DI RICERCA IN Tecnologie Convergenti per i Sistemi
Biomolecolari – XLII CICLO

Research Topic ID: XLII – 1.9

Project Tutor: Barbara La Ferla

Project Supervisor/s: Elena Regonesi

Project Title: Synthesis and Characterization of innovative nanodevices as theragnostic tools in the biomedical field.

Scientific background & Objectives

One of the main challenges of pharmacological research is to develop or optimize targeted delivery systems to make systemic drug administration safer and more effective. In this field nanocarriers are "multitasking," enclosing targeting moieties, contrast agents or other compounds able to control drug release depending on specific environmental conditions (*e.g.*, pH, redox state, ionic composition).ⁱ Moreover, slight modifications of physicochemical characteristics of nanoparticles, such as size, shape, surface charge, and surface activation, can be exploited to modulate their interaction with the host. In this context we have been focussing on three different types of nanocarriers: cellulose nanocrystals (CNC)^{4,6-9}, carbon quantum dots (CQD)^{1-3,5}, and tannin nano capsulesⁱⁱ. Objectives of the present PhD project is to develop new specific drug/contrast agents loaded systems and to study their activity *in vitro* cellular models, zebrafish and nematode models of neurodegenerative and cancer diseases.

i) Farokhzad OC, et al. ACS Nano 3(1), 16–20 (2009)

ii) a) L. Zongo, et al. ACS Omega 2021, 6, 13192–13203; b) E. D. Bartzoka et al. ChemSusChem 2018, 11, 3975 – 3991; c) E. Alfonsi et al. Industrial Crops & Products 192 (2023) 116105

Project's Networks, Sustainability & Mobility

a) the coherence of the suggested project with competences/tools of the hosting lab

b) intradepartmental or external collaborations

c) at least one pertinent research article published by the proposer/s

d) 1 (or more) putative foreign institutions for achieving the required ordinary mobility (6 months)

a) We have experience in the synthesis, manipulation and characterization of the nano systems object of the research (see point c), and well established collaborations for the *in vitro* evaluation.

b) We will activate inter department and interdisciplinary co-tutoring.

c) 1) L. Andria, G. Capitani, **B. La Ferla**, H. Lange, M. Saibene, L. Zoia, B. Vercelli "Carbon Quantum Dots Interactions with Pyrogallol, Benzoic Acid, and Gallic Acid: A Study on Their Non-Covalent Nature" *Nanomaterials* (2025) 15, 1457. <https://doi.org/10.3390/nano15181457>

2) Vercelli B., De Micheli E., Donnini R., Losurdo M., Lange H., **La Ferla B.**, Pavan A., Saibene M., Capitani G., Ghezzi F., Montenegro Martos J.M., del Carmen Ruiz Delgado M., Ponce Ortiz R., "Hydrothermal Approach for the Preparation of Blue-Emitting Carbon Quantum Dots: An

insight into the Influence of the Reaction Parameters”. *Small Structures* (2024), 6(3), 2400481. <https://doi.org/10.1002/sstr.202400481>.

3) **B. La Ferla**, B. Vercelli “Red-emitting Carbon Quantum Dots for Biomedical Applications: Synthesis and Purification Issues of the Hydrothermal Approach. *Nanomaterials* (2023), 13, 1635. <https://doi.org/10.3390/nano13101635>

4) E. Panio, A.C. Ionescu, **B. La Ferla**, L. Zoia, P. Savadori, G. M. Tartaglia, Cellulose nanocrystals show anti-adherent and anti-biofilm properties against oral microorganisms. *Bioengineering* (2024), 11(4), 355. <https://doi.org/10.3390/bioengineering11040355>

5) F. Ghezzi, R. Donnini, A. Sansonetti, U. Giovanella, **B. La Ferla**, B. Vercelli Nitrogen-doped Carbon Quantum Dots for Biosensing applications: The Effect of The Thermal Treatments on Electrochemical and Optical Properties. *Molecules* (2023), 28, 72. <https://doi.org/10.3390/molecules28010072>

6) L. Zoia, A. Binda, L. Cipolla, I. Rivolta, **B. La Ferla**. Binary biocompatible CNCs-Gelatine hydrogel as 3D scaffolds suitable for cell culture adhesion and growth. *Applied Nano* (2021) 2, 118–127. DOI: <https://doi.org/10.3390/applnano2020010>.

7) L. Zoia, A. Morelli, L. Talamini, M. B. Violatto, A. B. Lovati, S. Lopa, C. Recordati, C. Toffanin, A. Salanti, L. Russo, L. Colombo, M. Moretti, M. Salmona, **B. La Ferla**, P. Bigini. Cellulose Nanocrystals: a multimodal tool to enhance the targeted drug delivery against bone disorders. *Nanomedicine* (2020) 15(23) 2271-2285. DOI: 10.2217/nmm-2020-0139

8) G. D’Orazio, L. Munizza, J. Zampolli, M. Forcella, L. Zoia, P. Fusi, P. Di Gennaro, **B. La Ferla**. Cellulose Nano Crystals as Effective Inhibitors of host cell bacteria adhesion. *J. Mater. Chem. B.* (2017) 5, 7018-7020. DOI: 10.1039/c7tb01923h.

9) L. Colombo, L. Zoia, M. B. Violatto, S. Previdi, L. Talamini, L. Sitia, F. Nicotra, M. Orlandi, M. Salmona, P. Bigini, **B. La Ferla**. Organ Distribution and Bone Tropism of Cellulose Nanocrystals in Living Mice. *Biomacromolecules* (2015) 16, 2862-2871. DOI: 10.1021/acs.biomac.5b00805.

d) University of Patras, University of Graz.