



Master in Photonics – “PHOTONICS BCN” Master ERASMUS Mundus “EuroPhotonics”

MASTER THESIS PROPOSAL

Full time from April 2026 (it can start part time from February 2026)
Presentation date to be chosen: end of July or beginning of September 2026

Note: The main Master Thesis supervisor has to be a professor of the Master in Photonics program. One co-supervisor (internal or external) can be defined. Main Supervisor is responsible for the subject of the proposal and has to give continuous support to the student (research development, Report writing and presentation preparation). For external proposals a co-supervisor from the Master program and a collaboration agreement with UPC are needed. You can find all information about the Master Thesis process in [our webpage](#).

Laboratory: Single Molecule Biophotonics (SMB)

Institution: Institut de Ciències Fotòniques (ICFO)

City, Country: Barcelona, Spain

Title of the master thesis: Optical manipulation of biological membranes' properties and lateral organization

Name and affiliation of the master thesis supervisor: Prof. Maria Garcia-Parajo (ICFO)

Name and affiliation of the co-supervisor (if any): Dr. Joaquim Torra (ICFO)

(for external proposals a co-supervisor chose among the Master Program professors and a collaboration agreement with UPC is needed)

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Keywords: photo-manipulation, biological membranes, photo-active molecules, fluorescence microscopy

1. Summary of the subject (maximum 1 page):

The plasma membrane of cells is mainly composed of lipids and proteins that separate the interior of the cell from its external environment. Interactions between specific lipids and proteins drive the lateral organization of the membrane, dynamically forming microscopic regions with different properties. These regions play a crucial role in essential cellular functions such signal transduction, trafficking, adhesion, motility, and many other cellular functions. In recent years, there has been increasing interest in developing innovative methods and tools to visualize and characterize these elusive membrane domains.



In our laboratory, we harness the power of light to explore and also manipulate biological lipid membranes. Light is an extraordinary tool, offering unparalleled flexibility, specificity and precision. Its effects are instantaneous, allowing us to trigger or halt processes with a simple flick of a switch. This provides us with exceptional control and spatiotemporal resolution, enabling precise stimulation and interrogation of complex biological systems. Very recently, we demonstrated the ability to modulate the properties and microscopic organization of lipid membranes using blue light and a photo-active molecule called Flipper (Torra *et al*, *J. Am. Chem. Soc.*, 2024). Building on this, we are now advancing into the controlled photo-manipulation of lipid membranes within mammalian cells. This exciting project holds great potential to reveal the mechanisms governing membrane organization and could ultimately allow us to fine-tune the biological functions of key membrane receptors, opening new avenues for understanding cellular behaviour and signalling.

The Single Molecule Biophotonics research group at ICFO, led by Prof. Dr. Maria Garcia-Parajo, is looking for a highly motivated graduate student who wish to enhance his/her scientific career in a friendly, international and stimulating environment within the glowing fields of Fluorescence Microscopy and Photo-MechanoBiology.

2. Objectives (maximum 1 page):

This project seeks to explore innovative approaches for the photo-manipulation of biological membranes, with two key objectives:

(1) Investigating the potential of Flipper to perturb membrane properties and organization under controlled illumination.

We will focus on the ability of Flipper, a photoactive molecule characterized in our previous study, to generate reactive oxygen species (ROS) under blue light. ROS interact with unsaturated lipids (those containing double bonds in their acyl tails), potentially altering the biophysical properties and the lateral organization of the plasma membrane in mammalian cells. The selected candidate will evaluate these effects, aiming to uncover how light-driven manipulation can modulate membrane dynamics.

(2) Expanding the palette of optical tools with new photo-active compounds.

Beyond Flipper, we will explore alternative photo-active fluorophores and smart compounds that respond to light in diverse ways. The goal is to create a versatile toolkit for membrane studies, leveraging various light-based mechanisms to extend the range of controllable factors in biological systems. This will allow deeper exploration into how these compounds influence membrane structure and function, potentially offering new insights into cell signalling and behaviour.

The selected Master student will engage in hands-on research using a wide range of fluorescent sensors and lipids with different properties. He/she will combine photophysical methods and advanced fluorescence microscopy techniques, including fluorescence lifetime imaging microscopy (FLIM) and super-resolution microscopy, to probe the effects of these compounds at unprecedented spatiotemporal resolution.



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Additional information (if needed):

* Required skills: Students with a background in physics/chemistry/biology are encouraged to apply. The Master student will work in an interdisciplinary group and will acquire wet lab skills, hands-on experience in fluorescent tools, spectroscopic and fluorescence microscopy techniques, photophysics of light-activatable molecules, preparation and study of lipid membranes and experience in writing and presenting the research results to a multidisciplinary audience.

* Miscellaneous: