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Consiglio Nazionale delle Ricerche
Istituto Officina dei Materiali - Materials Foundry
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Notice: training and master thesis project at CNR-IOM, ac 2022/23

Project title: Investigating the response of red blood cells (RBCs) to mechanical forces

Abstract: The unique mechanical properties of RBCs enable an exceptional level of cellular deformability, of which reduction is present in various diseases such as metabolic disorders, sickle cell or oxidative stress. RBCs experience significant mechanical forces while traversing the circulatory system that influence their physiology, including deformability and Ca2+ influx. Recent studies reported on the expression of Piezo1 mechanosensitive non-selective cation channel (see Nobel Prize in Physiology or Medicine 2021 – Patapoutian) by RBC and the role of Piezo1 to regulate Ca2+ influx (see eLife 2015, Calahan,… and Patapoutian). Piezo1 activation in RBC has been demonstrated using the chemical activator Yoda1 and mechanical activation by micropipette aspiration.

The goal of this project is to investigate Pezo1 activation and the response of human RBC to mechanical forces in a wide range (from 10 piconewtons to 1 micronewton) using different techniques as optical tweezers (pull/push mode), micropipette (pull/push mode), comparing them with the chemical activation by Yoda1. The activation of Piezo1 will be monitored by Ca2+ fluorescence imaging and the changes in cell morphology (e.g. cell volume and shape) measured by digital holography microscopy.

The student will be trained to use nanotechnology techniques as optical tweezers force spectroscopy, fluorescence time lapse microscopy, sample preparation, image processing and data analysis in the first part, followed by an autonomous experimental activity to acquire and interpret the experimental results in the laboratory.

Where: 3M Laboratory@ CNR-IOM Trieste; **Extent:** 7-9 months starting with February 2023.

Requests: background in biotechnology, motivation, and enthusiasm for experimental activity.

Contact: Dan COJOC, cojoc@iom.cnr.it

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Project title: Investigation of mechanosensitive channels activity in mechanosensory neuron by combining mechanical and optical approaches.

Abstract: Mechanoreceptor cells of the somatosensory system provide mammals with a variety of sensory response: touch, pain, itch, and proprioception. At cellular level the mechanotrasduction response has been observed to be mediated by several cellular elements: plasma-membrane, adhesion proteins, cytoskeleton and mechanosensitive ion channels. Recently, the mechanosensitive Piezo channels have been identified as key elements in the transduction of mechanical stimuli.
Due to the relevance that force, pressure and tension have in the physiology of touch and pain, there is the need to exploit new approaches to better understand how mechanosensory neurons respond to physical cues. These instrumentations have to deliver a controllable mechanical stimulus at the level of biological forces (pN-nN). Moreover, since Piezo channels are Ca2+ permeable channels, their functionality can be measured using Ca2+ imaging assay.
In this project the student will participate at integrating Atomic Force Microscopy and FluidFM microscopy, which enable to apply a controlled localized mechanical stimulus (push or pull), with the live fluorescence microscopy, to perform calcium imaging after or during the mechanical stimulation.

The goal of the project will be the mechanical stimulation of single sensory neurons in well defined cell region (soma and dendrites) by different mechanical stimulus (positive or negative pressure) by using AFM or FluidFM while monitoring the response of Piezo mechanosenstive channels by calcium imaging.

The student will get in touch with a rich variety of methodologies and scientific environments (e.g, neurobiology, atomic force microscopy, fluorescence microscopy) and will work within a strong interdisciplinary team.

Where: 3M Laboratory@ CNR-IOM Trieste.

Extent: 7-9 months

Contact: Interested candidates should contact Laura Andolfi (andolfi@iom.cnr.it)

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Notice: training and master thesis project at CNR-IOM , ac 2022/23

Project title: Design and fabrication of advanced 2D platforms for the investigation of various cellular behavior of biomedical interest

Abstract: Standard flasks and petri-dishes, although are fundamental to enable long term maintenance of cell cultures, they do not represent the complexity of cues perceived by the cells in the microenvironment of various tissues. The topological and mechanical cues from the microenvironment play a fundamental active role in many physiologically relevant cellular behaviors such as: cell migration, mitosis, differentiation, etc.
To imitate specific topological and mechanical features of cellular microenvironment novel 2D platforms with different characteristics need to be devised.
Patterned surfaces can reproduce specific topological cues. Fabrication procedures can be used to vary the surface topography by introducing pillars, stripes, waves, grooves, air-water interface gaps, etc. Likewise, we can modulate the physical character of the culture supports, by fabricating flexible substrates or substrates with variable stiffness.
Such 2D platforms are very important not only for basic research, but they have attracted much attention in the biomedical and healthcare industries for applications in tissue engineering, medical implants, drug testing and diagnostic tool.

The aim of the project is to design and fabricate novel 2D platforms to investigate cell adhesion, migration ability, and replication.

The student will get in touch micro- and nanofabrication techniques, cell culture and fluorescence microscopy and will have the possibility to interact with an interdisciplinary team.

Where: 3M Laboratory@ CNR-IOM Trieste.

Extent: 7-9 months

Contact: Interested candidates should contact Simone Dal Zilio (dalzilio@iom.cnr.it) and Laura Andolfi (andolfi@iom.cnr.it) for further information.