IBEC

Institute for Bioengineering of Catalonia

IBEC PhD FPI fellowships

MINISTERIO DE CIENCIA E INNOVACIÓN

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AGENCIA ESTATAL DE INVESTIGACIÓN

IBEC PhD FPI fellowships associated with the MCIN funded projects "Generación del Conocimiento" (IBEC PhD FPI fellowships)

1. PRESENTATION

The Institute for Bioengineering of Catalonia (IBEC) is one of the top research institutions named as a Severo Ochoa Research Centre by Ministry of Science and Innovation, which recognizes excellence at the highest international level in terms of research, training, human resources, outreach and technology transfer.
IBEC was established in 2005 by the Ministries of Innovation, Universities and Enterprises and Health of the Generalitat de Catalunya (Autonomous Government of Catalonia), the University of Barcelona (UB) and the Technical University of Catalonia (UPC). Today, IBEC's relationship with the UB and UPC researchers continues to operate under a framework agreement signed in 2008.
With the aim to train the next generation of experts in bioengineering, IBEC offers in this call 5 PhD fellowships associated to the research projects *Generación de Conocimiento*, funded by the Spanish Ministry of Science and Innovation.

2. LABOUR CONDITIONS

The PhD fellowships offer a 4-year predoctoral contract with the following gross annual salary:

- 19.500 € for the 1st year and 2nd year
- 22.500 € for the 3rd year
- 24.500€ for the 4th year

Moreover, 6.860€ are also offered for mobility and training, including the university enrolment fees, during the 4-year period. Indemnities will be paid at the end of the labour contract.
Predoctoral researchers will have to enrol in a university of their choice (mainly University of Barcelona-UB; Polytechnic University of Catalonia-UPC and University Pompeu Fabra-UPF). **IBEC doesn't grant the doctorate degree, instead, it provides the experimental experience you need to complete your PhD.** The awarding body of your PhD will be the University at which you are enrolled as a doctoral student.
University enrolment fees will be covered by the fellowship. PhDs will provide an annual report from the Doctoral School confirming the positive scientific progress related to the PhD thesis carried out during the year. PhDs who finish and defend their PhD thesis before the end of the 4-year period of the fellowship will be able to sign a up to 1-year postdoctoral contract (POP). The aim of this contract is to provide an orientation period to consolidate the knowledge acquired during the PhD thesis and start looking for postdoctoral opportunities, including those through other competitive fellowships. The total duration of the PhD and postdoc contract cannot exceed 4 years under no circumstance.
The expected initial date is between December 1st 2023 and January 1st 2024 contract (to be confirmed, depending on the publication date of the final resolution of the call *Proyectos de Generación de Conocimiento 2022*), when a predoctoral contract will be issued , once they have been admitted on a Doctoral Programme.

Other general conditions:
Gross salaries provide full social security coverage, which includes health and accident insurance, pension and unemployment benefits. Working conditions at IBEC also include:

- Yearly 23 working days of paid holidays
- 9 leave days for personal matters
- Measures to reconcile work and family life, such as:
  - Parental leave (16 weeks)
  - Leave for breastfeeding
  - Shorter hours for guardianship or leave to care for children and relatives
- Flexible schedule working hours
- Induction programme to facilitate incorporation at IBEC
- Additional support is provided for foreigners to obtain Visa-working permit and to install in Barcelona

IBEC provides Training and PhD discussions specially devoted for PhDs to prepare the thesis and presentation skills. IBEC also provides Seminars with top names in bioengineering and nanomedicine from all over the world in order to offer the opportunity to discuss and network the developments. IBEC also offers different courses to give the opportunity to learn new skills related to leadership, communication, time management, project management, wellbeing and language skills, among others. The institute also holds an annual symposium on a different scientific theme, as well as hosting and organizing several other project-based or general scientific meetings and workshops throughout the year.
As part of the PhD fellowship, PhD's are encouraged to take up research placements in other centers. Thanks to these stay, young researchers benefit from transnational and multidisciplinary mobility and have the added value of enabling PhDs to obtain an international PhD, a recognized distinction which significantly improves their chances of a successful career.
All PhDs should commit themselves to participate in outreach and education activities.
In order to enhance and acknowledge the excellence of the training program developed for IBEC's PhD fellows, we issue a Doctoral Certificate of Excellence funded by the Spanish Ministry of Science and Innovation through the Centro de Excelencia Severo Ochoa award. This certificate is awarded to those fellows who meet the quality requirements of the institute. Additionally, all candidates that received a Doctoral Certificate of Excellence will be eligible for a Doctoral Award. The awardees will receive a prize in an award ceremony at the IBEC Symposium.
IBEC is committed to awareness of diversity and gender equality in science and society. This follows our mission to carry out interdisciplinary research at the highest international quality level which, by creating knowledge, help to improve health and quality of live, and generate wealth.

3. REQUIREMENTS

Highly qualified researchers of all nationalities willing to join a stimulating, interdisciplinary research and high-quality scientific environment are welcome to apply.
The following **requirements** are common to the fellowships available:

- Candidates should be ready to enter an official doctoral programme on December 2023 (under Spanish Law). By this time, they must have obtained a university degree and a master's degree; or must hold an official university qualification from a country of the European Higher Education Area with a minimum of 300 ECTS of official university studies, of which at least 60 are at master's level. Candidates who expect to be awarded with such degrees by October 2023 are eligible to apply.
- Candidates must have a strong commitment to scientific research and an excellent academic record.
- Candidates must have good working knowledge of English.
- Candidates must not yet have been awarded a doctoral degree.
- Candidates must not have held a PhD contract exceeding twelve months by the beginning of the fellowship (December 2023 to January 2024).

4. PhD RESEARCH PROJECTS

The following research projects offered in this call are:

- **Group**: NANOSCALE BIOELECTRICAL CHARACTERIZATION.
  PI: Gabriel Gomila

Project: High-throughput autonomous multiparametric Scanning Force Microscope for applications in life sciences and medicine

Abstract: The passive electrical and mechanical properties of eukaryotic cells such as the surface electrical charge, electrical conductivity or polarization, Young's modulus, or resistance to deformation play a fundamental role in numerous physiological processes such as cell communication, adhesion to surfaces, the internalization of nutrients, or cell and embryonic growth. These same properties, but, of drug carriers like liposomes affect their interaction with cells and their efficiency. Due to these facts, over the years numerous techniques have been developed to measure electrical and mechanical properties in biological systems. However, in most cases these techniques are only sensitive to one of the types of properties, and when they are sensitive to both, they only provide micrometer spatial resolution, leaving out of access the nanoscale properties that are essential in most physiological processes. Among the techniques that could overcome these limitations one finds functional multiparametric scanning force microscopy. Through it, in addition to topography, images of electrical and mechanical properties could be obtained with a nanometric spatial resolution. However, up to now this microscopy has shown great limitations when attempts have been made to

simultaneously measure electrical and mechanical properties in living eukaryotic cells or in nanosystems such as liposomes in physiological media. The challenges it faces include the need to handle and process huge amounts of data and to require advanced biophysical and technical knowledge.
Moreover, they show a very low throughput and an use restricted to highly specialized personnel. The objective of the present project is precisely to develop a multiparametric functional scanning force microscope (topography, electrical and mechanical properties) applicable to living cells and nanosystems of biological interest that allows, for the first time, the simultaneous measurement of electrical and mechanical properties at the nanoscale and that incorporates automation routines guided by artificial intelligence, to achieve high throughput and its operation by non-specialized personnel. This system is expected to be able to obtain high-resolution electrical and mechanical multiparameter images (sub-50 and sub-75, respectively) in living cells or in systems of biological interest such as liposomes under physiological conditions and in times of less than a few minutes (including data processing). This capacity, together with its autonomous capabilities, will allow the measurement of hundreds of cells per day and tens of thousands of liposomes, which would place it beyond the state of the art in functional nanometric techniques for life sciences and medicine. The potential of the proposed microscope will be demonstrated in the physical multiparametric phenotyping of cancer cells and their use in the diagnosis, monitoring, and drug screening, and in the high throughput multiparametric characterization of single liposomes and polymeric nanoparticles for use as drug carriers. The results of the project are expected to produce a significant impact in the field of Scanning Probe Microscopies, Cell Biology and Nanomedicine.

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- **Group**: NANOPROBES AND NANOSWITCHES.
  PI: Pau Gorostiza.

Project: Development of inhibitory photoswitchable drugs and noninvasive illumination methods for neuromodulation and studies of neural circuits
Abstract: The EPILLUM project aims to develop disruptive chemical, optical, and materials technologies to treat epilepsy with noninvasive illumination methods and photoswitchable drugs. It addresses the unmet need to inhibit neuronal activity on demand and locally in deep brain regions. The proposal is based on the fact that red and infrared (IR) light can penetrate in tissue and explores diverse illumination methods to use those wavelengths to control the pharmacological action of photoswitchable small molecules, from direct absorption of red light by suitable compounds to multiphoton excitation using pulsed IR lasers. These methods offer complementary advantages in spatiotemporal resolution and simplicity to photoswitch drugs. They can be combined with

techniques of patterned illumination to achieve spatiotemporal control of drug action. We will deploy these illumination methods and combine them with newly developed photoswitchable neuroinhibitory drugs to apply dynamic patterns of neuronal inhibition in tissue and in vivo. A therapeutic proof-of-concept of localized, on demand seizure inhibition will be pursued using animal models of epilepsy. These results may demonstrate a novel treatment modality against seizures that raises scientific, clinical, and socioeconomic interest.

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- Group: CELLULAR AND MOLECULAR MECHANOBIOLOGY. **PI:** Pere Roca-Cusachs

Project: Understanding the regulatory role of ECM-nucleus force transmission in mechanotransduction

Abstract: Cells sense and respond to mechanical forces, and this process is important in homeostasis and disease scenarios such as cancer of fibrosis. Specifically, the cell nucleus is directly submitted to forces transmitted from the extracellular matrix (ECM), through integrinmediated adhesions and the actin cytoskeleton. In response, the nucleus acts as a mechanosensor, regulating transcription, contractility, DNA damage, or chromatin compaction. From this evidence, the control of ECM-nucleus force transmission emerges as an important potential regulator of cell function. Such control could tune mechanosensing to adapt it to specific circumstances, for instance by preventing it when it should not be triggered (mechanical buffering), or by maintaining it for long times (mechanical memory). Our preliminary data suggest that such mechanisms could be in place, but they are otherwise largely unexplored. Thus, our general objective is to understand the regulatory role of ECM-nucleus force transmission in mechanotransduction. To carry it out, we will work with a model system of fibroblasts due to their robust mechanical responses, and their involvement in pathologies such as cancer or fibrosis, with well-established mechanically-dependent functions (such as matrix remodelling). The project will be organized in three specific aims. In aim 1, we will establish a toolset for probing ECM-nucleus mechanical coupling. We will develop mechanical techniques able to apply forces, and to measure both nuclear and cytoskeletal mechanical properties (stiffness), and the degree to which forces can be transmitted from the ECM to the nucleus. We will also develop molecular techniques to specifically interfere with the mechanical coupling between the nucleus and the ECM, involving the nuclear lamina, the LINC complex, and the actin, intermediate filament, and microtubule cytoskeletons. In aim 2, we will unveil how ECM-nucleus mechanical coupling regulates mechanotransduction. We will study mechanical buffering mechanisms by evaluating if the response of the nucleus to force applied through the different techniques (measured

through nuclear deformation and mechanics) is lost or impaired. We will study mechanical memory mechanisms by applying force through the different techniques, ceasing force application, and measuring if nucleus response ceases or is maintained (and for how long). We will also carry out mechanical mathematical modelling to rationalize the mechanisms involved. In aim 3, we will assess the functional consequences of ECM-nucleus mechanical coupling. We will focus on events known to be triggered by mechanical force application to the nucleus. This includes nuclear translocation of transcription factors, activation of calcium signalling, changes in chromatin methylation, and DNA damage. Functional outputs downstream of these signals will be analyzed. We will also focus on specific functions related to fibroblasts and mesenchymal cells. These will include matrix remodelling, cell migration, and the epithelial to mesenchymal transition. Once completed, our project will provide a novel framework to understand the regulation of mechanotransduction, with potential implications in tissue function, and its de-regulation in contexts like cancer or fibrosis.

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- **Group**: BIOINSPIRED INTERACTIVE MATERIALS AND PROTOCELLULAR SYSTEMS.

PI: César Rodríguez-Emmenegger
Project: Predatory Synthetic Cells: a quasi-living therapeutic technology to fight antibiotic-resistant bacteria
Abstract: The mission of PredaSynCell is to devise and demonstrate a trailblazing therapeutic and prophylactic technology that can be applied to biological interfaces (airways, wounds, implants, contact lenses, etc.) to kill antibiotic-resistant bacteria, thereby preventing, or curtailing the infection severity. In this way, PredaSynCell will provide a feasible road to tackle antimicrobial resistance (AMR) infections, one of the most daunting and urgent unmet clinical need of our time. Our concept is based on Phagocytic Synthetic Cells (PSCs), a new type of synthetic vesicle decorated with stickers and antimicrobial components. The stickers bind specifically to epitopes on the surface of a bacterium causing it to be engulfed into an endosome where the antimicrobial components tear the bacterium's membrane, killing it. This dual mode of action is inspired by phagocytosis.
In order to achieve this aim, we will pursue four research objectives. 1) We will fabricate stealth, ultra-flexible, stable vesicles with high flexibility as needed for engulfment. The aim is to fabricate cytocompatible vesicles, with homogeneous size, stable in biological milieu that are as or even more flexible than state-of-the-art liposomes and polymersomes. 2) We will introduce superselectivity by using stickers that exert ultra-weak, specific binding and give rise to multivalency. 3) We will develop a mechanism in which engulfment destabilizes and kill bacteria based on the translocation

of ionically-linked comb polymers from the PSC membrane into the one of the engulfed bacterium. This mechanism is inspired by the action of antimicrobial peptides but is more efficient as it can target antibiotic-resistant bacteria and is not susceptible to evolution. 4) We will validate the antimicrobial activity and will assess biosafety of the PSCs at all level and select those that are neither cytotoxic nor inflammatory.
PredaSynCell will be a safe, facile, drugless enabling technology that will change how we protect from and combat antibiotic resistant infections, one of the biggest global threats for which the world is not yet prepared.

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- **Group**: MOLECULAR BIONICS. **PI:** Lorena Ruiz Pérez

Project: Fast superstructural imaging of misfolded proteins dynamic in liquid water

Abstract: Dementia ranked the 7th leading cause of death globally and the 2nd in high-income countries in 2020. The conditions causing dementia remain largely incurable, so finding disease-modifying treatments to prevent or delay their onset or slow down, reverse or stop their progression is one of the most pressing challenges for our society in this century. There is now considerable evidence suggesting that diseases causing dementia are typically triggered by proteins' misfolding and subsequent aggregates' formation. A thorough understanding of misfolded protein, particularly its most neurotoxic morphology, the oligomers, is needed to understand the molecular origins of the disease. Misfolded protein oligomers can then be used as disease biomarkers to diagnose and measure disease progression and as target biomarkers to monitor drug response. The presence and level of oligomer species in the brains affected by Parkinsons disease PD and Alzheimers disease AD dictates the severity of cognitive decline and other clinical manifestations of the diseases. Oligomer quantification becomes imperative to screen for the disease, follow the progression and assess the efficacy of drugs. Accurate detection does indeed affect current and future therapeutic and diagnostic efforts. However, precise quantification comes with challenges due to oligomers highly dynamic and heterogeneous nature. FaSIMProD will apply advanced TEM imaging in liquid phase to provide unprecedented access to the dynamics of aggregation of misfolded proteins, oligomer quantification and structural evolution over time. We will investigate the proteins amyloid-b; and tau and a-synuclein involved in AD and PD, respectively. We propose the combination of all-atom simulations with imaging via LPTEM to complement protein structural studies with dynamic investigations. The project's second stage will involve in-situ visualization of antibodies and other relevant aggregation inhibitor agents and their effects on protein structure in liquid media. Low-density lipoprotein receptorrelated protein 1 LRP1, apolipoprotein E APOE3/4, and liposomes will be used as inhibitor agents. The final goal is to design multivalent drugs using biocompatible and biodegradable block-copolymers assemblies with

phenotypic targeting properties and monitor the effect on protein structure. Most importantly, liquid TEM will allow gathering critical information on the resulting drug/protein complex. Our new approach will impact drug design, bridging cutting-edge imaging science, physics, molecular engineering, and computational science with medicinal chemistry and neurology. We expect that liquid phase TEM will be critical to shed light on the molecular interactions between misfolded proteins and associated drugs and, indeed, guide the path for designing novel drugs.

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5. HOW TO APPLY

From September 14th to October 15th 2023 an online application form will be available through the IBEC dedicated site www.ibecbarcelona.eu/phd

You will be required to provide the following information in your application:

- Personal data
- A scan of your degree and Certified Academic Record, showing grades obtained (degree and masters). It should include the grades obtained and the date of obtention for each individual subject. If these are not in Catalan, Spanish or English, applicants should attach a translation in one of these languages.[1]
- Education, training and research experience.
- Explanatory document certifying that the candidate is eligible to apply for a doctoral programme when the number of ECTS does not appear in the Certified Academic Record. This explanatory document may be an official description of the country’s educational system issued by the University or published on its website, or the admissions requirements to the University’s doctoral programme.
- Research outputs, including publications, Presentations in conferences, Awards/fellowships
- Scientific and technical skills acquired during your academic and research track
- Cover letter, including motivation for applying and adequacy to the group and IBEC

[1] For the future enrolment in the Doctoral program, Official University only accepts an official translation of educational certificates. The verification of an equivalent level of studies will be made by the university when the admission to the PhD Programme procedure starts. Should this verification not be successful, the fellowship would be withdrawn.

- Up to 2 contacts from lecturers or researchers with whom you have studied or worked and who can judge your potential as a PhD student.

Only those applications submitted before the deadline at IBEC's online application form and provided with all the required information and documents will be evaluated.
Once the application is submitted, candidate will automatically receive an acknowledgment of receipt.

6. SELECTION PROCEDURE

IBEC holds the HR Excellence in Research Award in recognition of our ongoing commitment. The recognition by the European Commission has been renewed several times, last one in February 2022.
Our Recruitment and Selection Policy is based on the OTM Strategy (Open, Transparent and Merit-based recruitment) http://www.ibecbarcelona.eu/jobs/ and accept applications without distinction on any grounds. Candidates with disabilities are strongly encouraged to apply. Our commitment to OTM-R principles can also be found in our Gender and Diversity plan. In line with the principles defined in the OTM-R procedure, selection processes are governed by the following principles:

- Transparency throughout the whole process
- Equal opportunities in the selection and hiring of personnel
- Non-discrimination on grounds of sex, age, ethnic, national or social origin, religion, sexual orientation, language, disability, political opinions or social and economic condition
- Merit based evaluation
- Confidentiality as the cornerstone of the selection process
- Principle of public dissemination of the selection processes, which must also be internationally comparable

Applications will be reviewed by a selection committee led by the corresponding IBEC Principal Investigator of the Research Group.

Candidates will be evaluated according to the following criteria, set by the Spanish Ministry of Science and Innovation:

Criteria	Score
1. Academic and professional career of the candidate	0-50
a) Scientific and technological contributions	0-45
b) Mobility and internationalization	0-5
2. Adequacy of the candidate to the research activities to develop	0-50
TOTAL SCORE	100

7. CALENDAR AND USEFUL DATES

- September 14th, 2023: Launch of the call.
- October 15th, 2023: Deadline for submission of applications.
- October 16th - November 13th, 2023: Evaluation of the candidates: CVs and online interviews.
- November 16th, 2023: Communication of the results: the acceptance letters will be sent to the shortlisted candidates. Applicants who have not been successful but have received a positive evaluation will be put on a waiting list for future positions in case a final candidate withdraw the offer.
- As of December 1st, 2023: Start of the predoctoral contract (to be confirmed, based on the resolution of the call *Proyectos de Generación de Conocimiento 2022* by the Spanish Ministry of Science and Innovation).

8. CONTACT

If you have any further questions about PhD fellowships, or if there are particular issues you'd like to discuss regarding your application, please contact phd@ibecbarcelona.eu

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