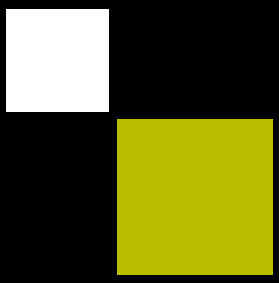
IBEC ANNUAL REPORT 09

Institute for bioengineering of Catalonia

Centres de recerca de Catalunya



IBEC ANNUAL REPORT 09

"This Annual Report is the evidence of the work and effort to consolidate the position of IBEC as an international centre of reference"

INTRODUCTION LETTER

It is with great satisfaction that I am presenting our 2009 Annual Report, a concise review of the work of the Institute over the last twelve months that bears witness to the consistent effort and solid achievements of all those who are working to further improve and develop this institution. This systematic review of our activities will, in time, serve as a record of the history of the IBEC, but we also want it to be a communicative tool that will inform those who read it about our scientific competence, our technological expertise, the talent we foster, and the excellent return we provide for the investment that finances our organisation.

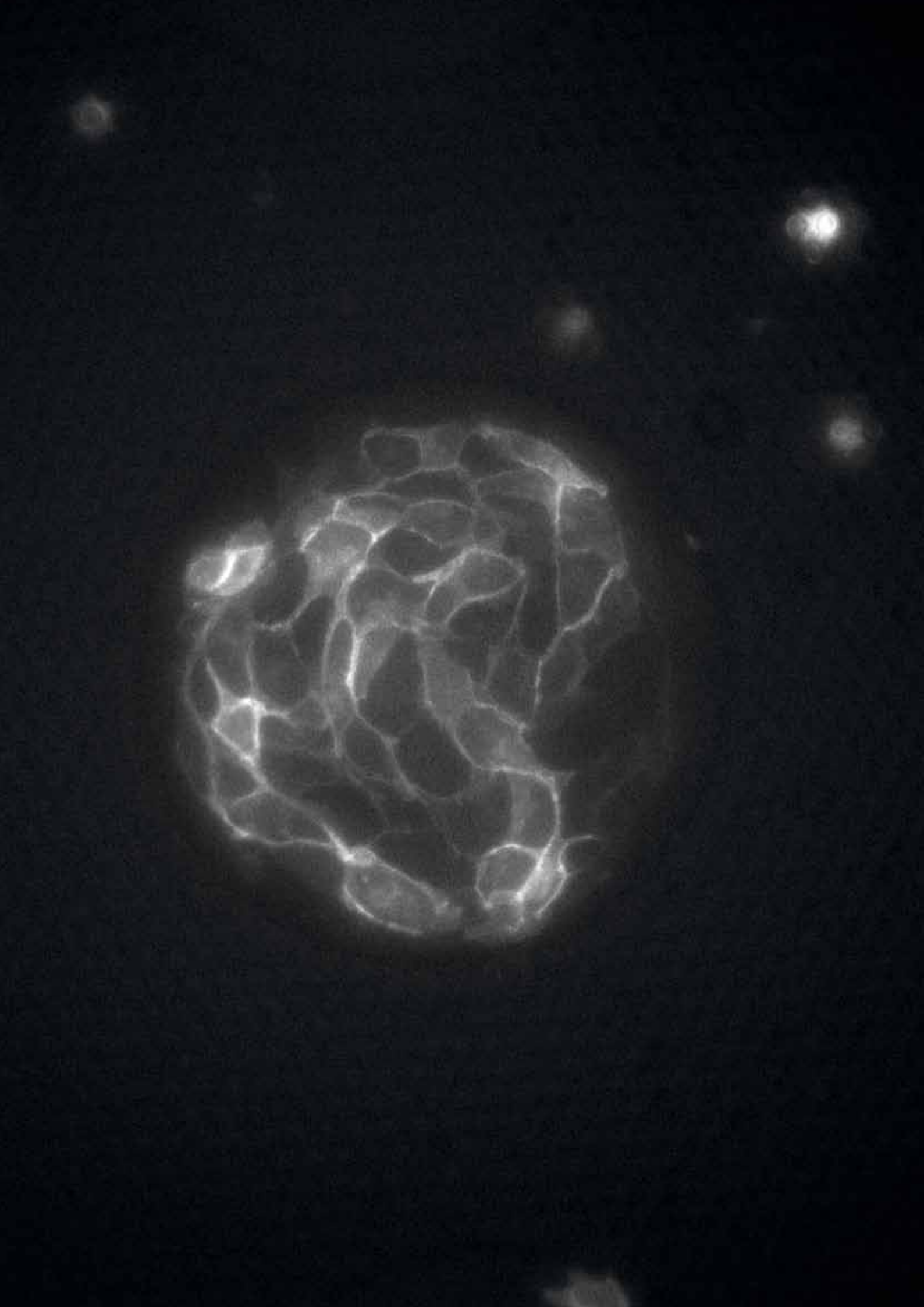
In terms of the research output in the last year, we have seen no increase in the number of scientific articles published, but there has been a marked increase in terms of impact of our publications, a good sign aligned with the objective to improve the quality/quantity balance. At the same time, we continue to attract talent from both our close surroundings and from abroad. In terms of competitive funding, the number of projects applied for and the funds received have both increased significantly, another good sign with respect to the quality/quantity balance we are looking for, since the responsibility for coordinating both National and European projects has also increased. In 2010, we will have the opportunity to increase and improve both the applicability and the transfer of our research.

The consolidation of our Molecular and Cellular Neurobiotechnology research line and the incorporation of a new line of research, Control of Stem Cell Potency, represent significant progress in terms of IBEC's interdisciplinary scientific ambitions. This expansion in the number of research groups has produced an increase in the number of researchers and the need for more space. In 2009, we have managed to bring all the teams together and to provide each research group with its own space. We can congratulate ourselves that all the research groups have now working space within the IBEC facilities.

I would like to conclude by saying that our ambition to consolidate the position of IBEC as an international centre of reference in bioengineering and nanomedicine is alive and I hope that this Annual Report is the evidence of the work and effort that all of us, as IBEC members, are investing in achieving that goal. The relocation of the research groups in good laboratories, their proximity to one another, the interdisciplinary nature of our research teams, and the quality of our administration and support services will allow us to keep improving and making further progress not only towards the achievement of our own objectives but also towards the fulfillment of our social function of contributing to a better quality of life for everyone through advances in bioengineering and nanomedical research.

Thank you!

Josep A. Planell



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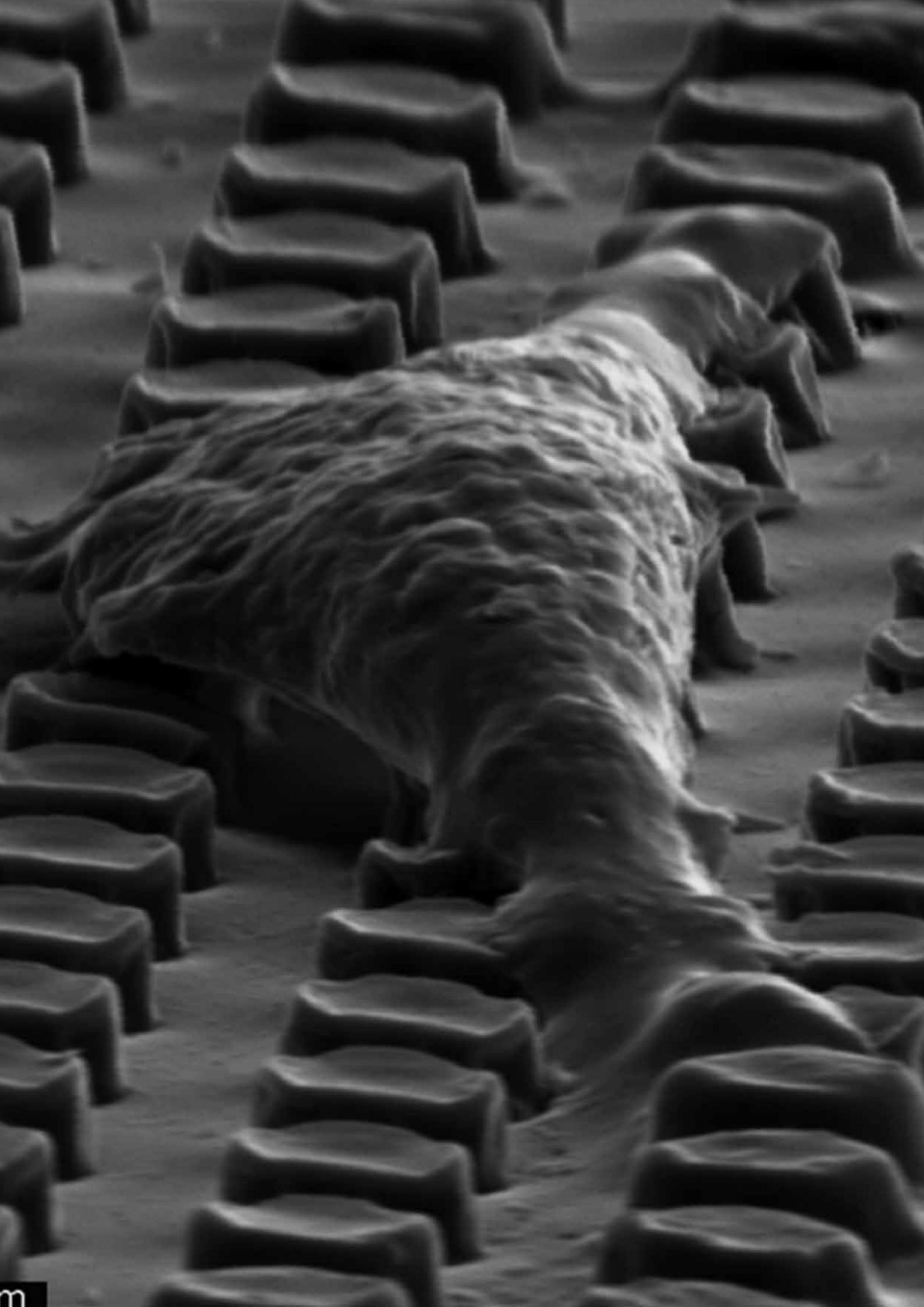


HIGHLIGHTS

HIGHLIGHTS

IBEC Expands its Research Program with a New Line of Stem Cell Investigation

Control of Stem Cell Potency is a research line recently initiated under the leadership of Ángel Raya, a research professor at the Catalan Institute for Research and Advanced Studies (ICREA). This is within IBEC's Cellular Biotechnology research programme.

The focus of this new line of research is the regeneration of complex structures, the biotechnology of cell reprogramming, and stem cell differentiation. The team uses the paradigm of heart (re)generation to address the basic question of how a discrete and defined degree of developmental potency can be imposed on somatic cells, enabling them to regain the capacity to regenerate a functional structure or tissue. With this addition, the IBEC foundation now has 15 research lines and is further consolidating the growth of its programmes of investigation.

2nd IBEC Symposium on Bioengineering and Nanomedicine Held in Barcelona

Some 300 scientists gathered at the World Trade Center in Barcelona on 14th and 15th April for the 2nd IBEC Annual Symposium. The participants presented details of their most recent research in the areas of bioengineering and nanomedicine. Keynote speakers from Europe and the United States were internationally renowned scientists including Dr. Martin Bennink of the University of Twente in the Netherlands, Professor Alan Gelperin of the Monell Chemical Senses Center in Philadelphia, Professor Frederick Grinnell of the Southwestern Medical Center at the University of Texas, Professor Michael Sheetz of Columbia University, Professor Keita Ito of Eindhoven University in the Netherlands, Professor Nongjian Tao of Arizona State University, and Angel Raya of the Center of Regenerative Medicine in Barcelona.

Collaboration Agreements

In the context of the Biopol'H project, IBEC and the Bellvitge Institute for Biomedical Research (IDIBELL) have signed a collaboration agreement covering the exchange of human resources, the organization of joint activities, shared use of facilities and equipment, and participation in joint projects. The two institutes will collaborate in the following areas: transplantation; bioengineering; implants; tissue engineering and biocompatibility; new medical imaging technologies; new technologies for molecular and genetic diagnosis; biomedical and bioelectronic engineering; and the neurosciences.

IBEC has signed a memorandum of understanding (MOU) with the National Institute for Materials Science (NIMS) in Japan on the "Design of Biomaterial Surfaces and Biosensors for Cell Function Manipulation and Analysis". Under this agreement, NIMS and IBEC will promote the exchange of researchers and information, cooperate in research and development projects, and publish the results of such research jointly.

IBEC also signed a research agreement with the Interstaatliche Hochschule für Technick Buchs in Switzerland for cooperation on the "Development and fabrication of advanced polymeric 3D microfluidic structures". The two research centres will contribute their knowledge and expertise to this project and collaborate on the implementation of the results of the research in future applications.

2nd Annual Conference of the Spanish Technology Platforms on Biomedical Research, Innovative Medicine, and Nanomedicine

The second annual conference of the Spanish Technology Platform on Nanomedicine (Nanomed Spain) and the Spanish Technological Platform for Innovative Medicines took place in Madrid on 27 and 28 January. This event is a meeting place for companies and institutions working in these areas. The two Spanish technology platforms working in the field of biomedicine presented their current projects. In particular, Nanomed Spain chose this conference to officially present its international innovation unit, Nanomed-UII. Another item of particular interest was the presentation describing the development of the roadmap for nanomedicine drawn up by the European Technology Platform on Nanomedicine, of which both IBEC and Nanomed Spain are members.



Opening of NANOMED-UII, the International Innovation Unit of the Spanish Platform on Nanomedicine

Nanomed-UII was created in January 2009 as a result of a contract between the Spanish Platform on Nanomedicine (Nanomed Spain) and the Centre for the Development of Industrial Technology (CDTI). The mission of this international innovation unit is to improve the participation of Spanish companies in projects financed by the European Union's seventh framework programme, in particular with respect to the application of nanotechnology to healthcare. Nanomed-UII is now integrated into the existing structure of Nanomed Spain, a body established in 2005 which is coordinated by IBEC.

The aim of this technology platform, which affiliates over 100 companies, hospitals and publically-funded research centres, in addition to representatives of official bodies, is to bring together the public and private sectors and develop joint strategies aimed at advancing the field of nanomedicine in Spain.

UK-Iberia Nanomedicine Workshop

The Foreign and Commonwealth Office Science and Innovation Network and the Spanish Technology Platform on Nanomedicine (Nanomed Spain) organized the UK-Iberia Nanomedicine Workshop hosted at the British Embassy in Madrid on 10 and 11 December 2009.

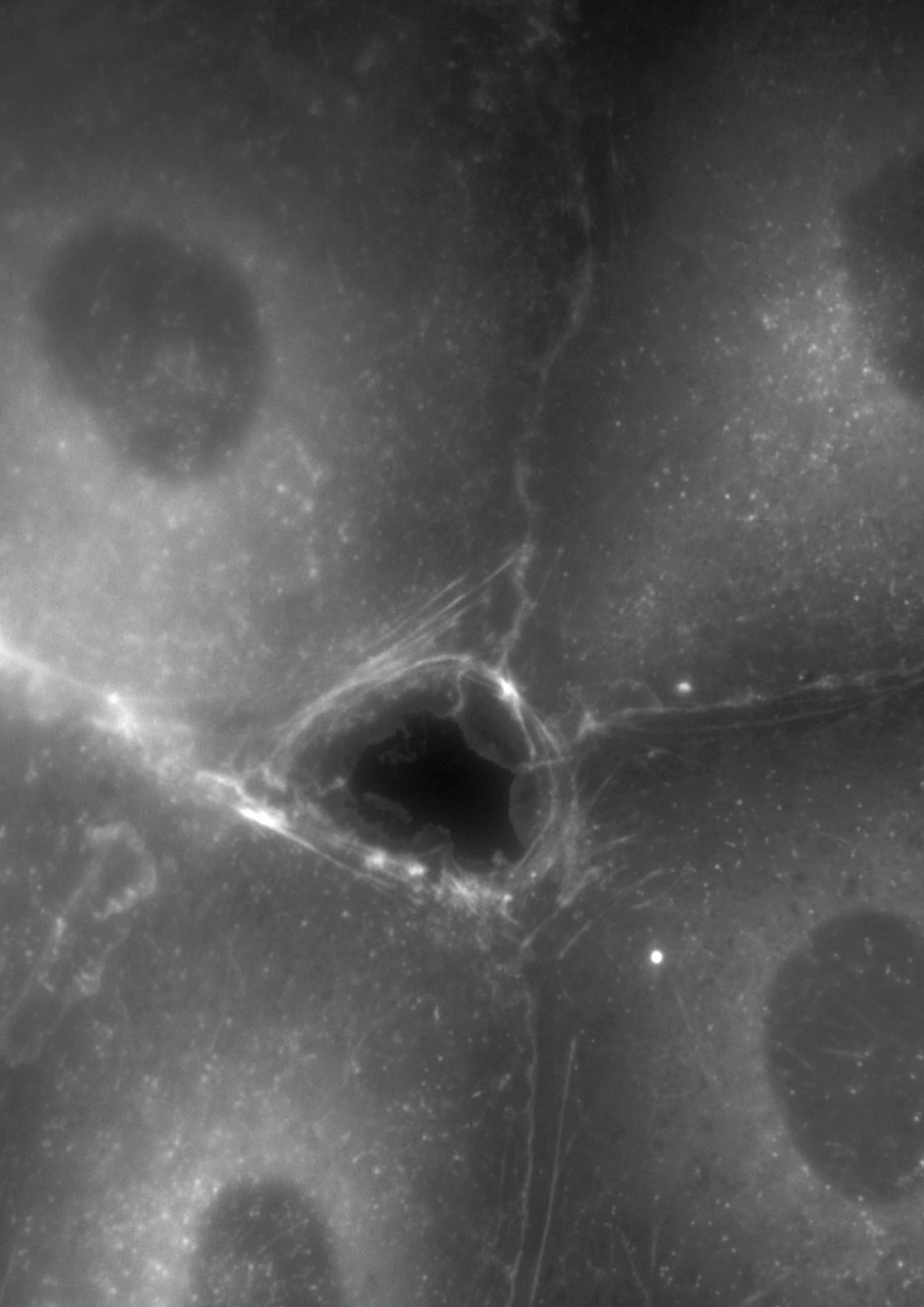
The event provided an opportunity for experts from the United Kingdom and Spain to share knowledge on recent initiatives and developments in nanomedicine. It also offered research centres and industry stakeholders the chance to identify new opportunities for cooperation and collaboration. Some of the latest developments in the field of nanomedicine were presented, including the remarkable example of collaboration between Spain and Portugal at the International Nanotechnology Laboratory (INL) in Braga, Portugal.

IBEC Hosts the 2nd China-Europe Symposium on Biomaterials in Regenerative Medicine

The 2nd China-Europe Symposium on Biomaterials in Regenerative Medicine took place in Barcelona from 16 to 20 November. This event brought together over 150 participants and the top specialists in biomaterials from China and Europe. The symposium, organised by IBEC, was a joint initiative of the European Society for Biomaterials and the Chinese Committee for Biomaterials. The goal was to showcase the latest research, to provide a forum for the discussion of recent advances, to build relationships between European and Chinese researchers, and to promote collaboration in future research projects.

IBEC at Japan´s Nano Tech 2009

IBEC attended the International Nanotechnology Exhibition and Conference, one of the world's largest nanotechnology exhibitions, which took place in Tokyo from 18 to 20 February, 2009. IBEC shared space with other exhibitors and displayed a specially-designed pop-up stand and other corporate materials to promote its research activities. The event was attended by over 600 companies and organizations from 21 countries and regions.



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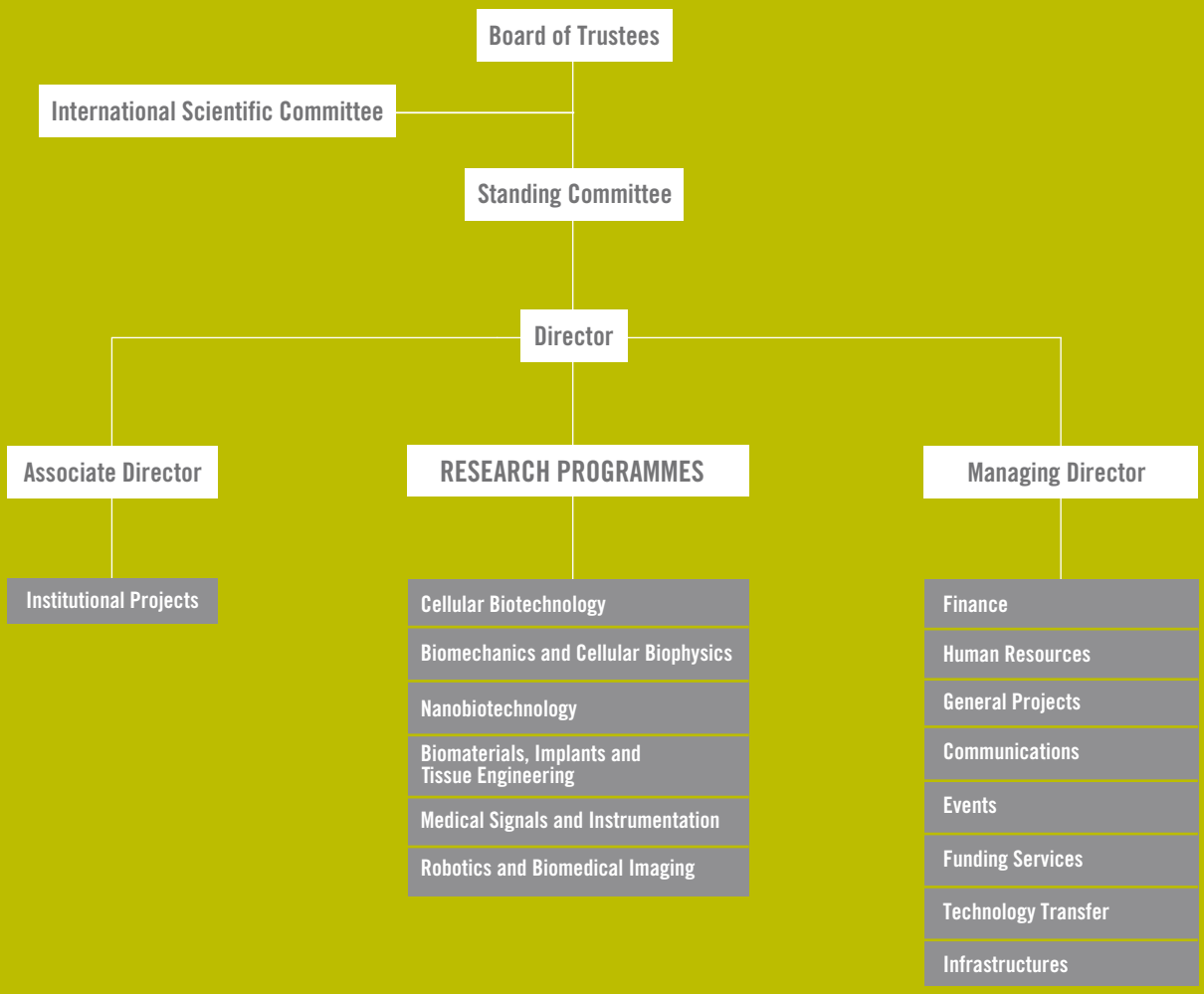
ORGANISATIONAL CHART



ORGANISATIONAL STRUCTURE

IBEC has a staff of 203 researchers and expert technicians. Of these, some work on an in-house basis, some come from the University of Barcelona (UB) or the Technical University of Catalonia (UPC), and some are funded through programs that support the recruitment of research staff, such as the Bosch i Gimpera Foundation, ICREA, and the Ramón y Cajal Program (MEC). IBEC also employs a staff of 23 people to carry out support activities.

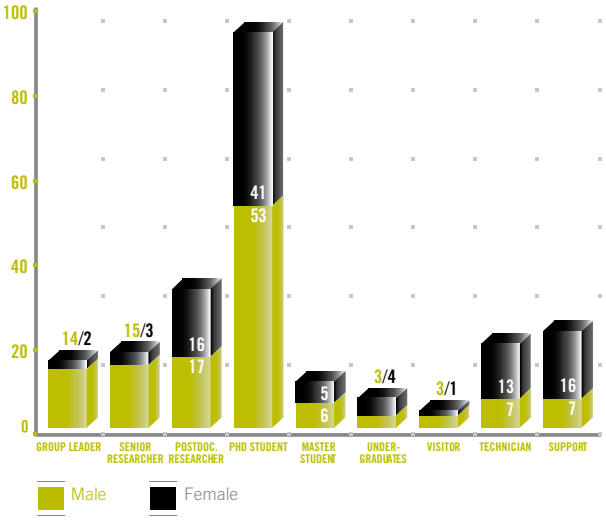


Figure 1. IBEC researchers, technicians and support services staff by gender and category

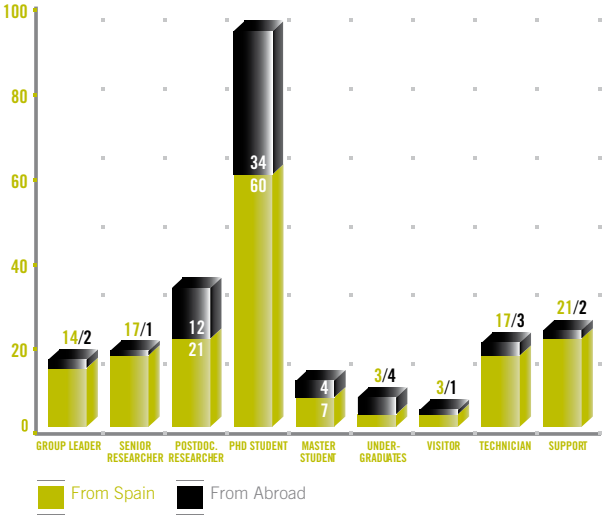


Figure 2. IBEC researchers, technicians and support services staff by nationality and category

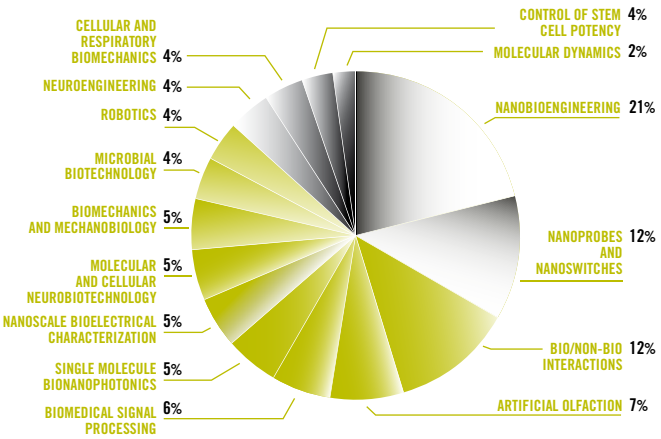


Figure 3. IBEC researchers and technicians by group

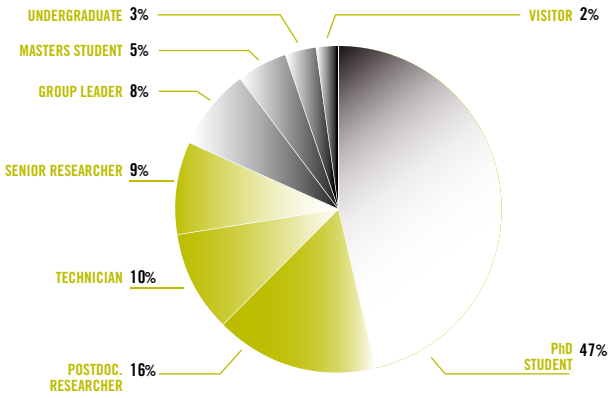


Figure 4. IBEC researchers and technicians by category

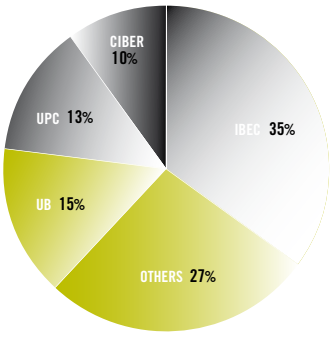


Figure 5. IBEC researchers and technicians by associated or contracting institution

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MANAGING DIRECTOR **Abel Riera**
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EVENTS
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FUNDING SERVICES
FUNDING SERVICES MANAGER **Esther Gallardo**

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Austria 1
Bulgaria 3
Chile 2
Colombia 3
Cuba 3
Ecuador 1
France 6
Germany 5
India 1
Italy 10
Mexico 9
Netherlands 1
Portugal 5
Spain 142
Sweden 3
Switzerland 1
Turkey 2
United Kingdom 1
USA 1
Venezuela 1

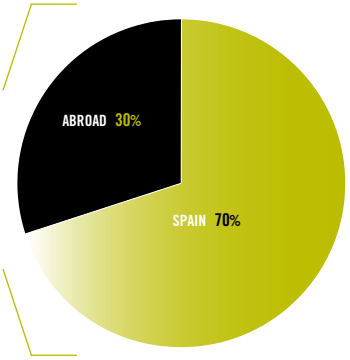


Figure 6. IBEC researchers and technicians by nationality

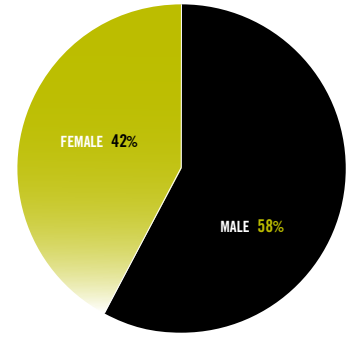


Figure 7. IBEC researchers and technicians by gender

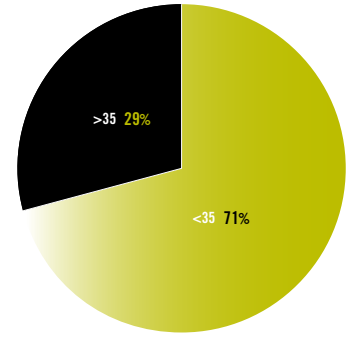
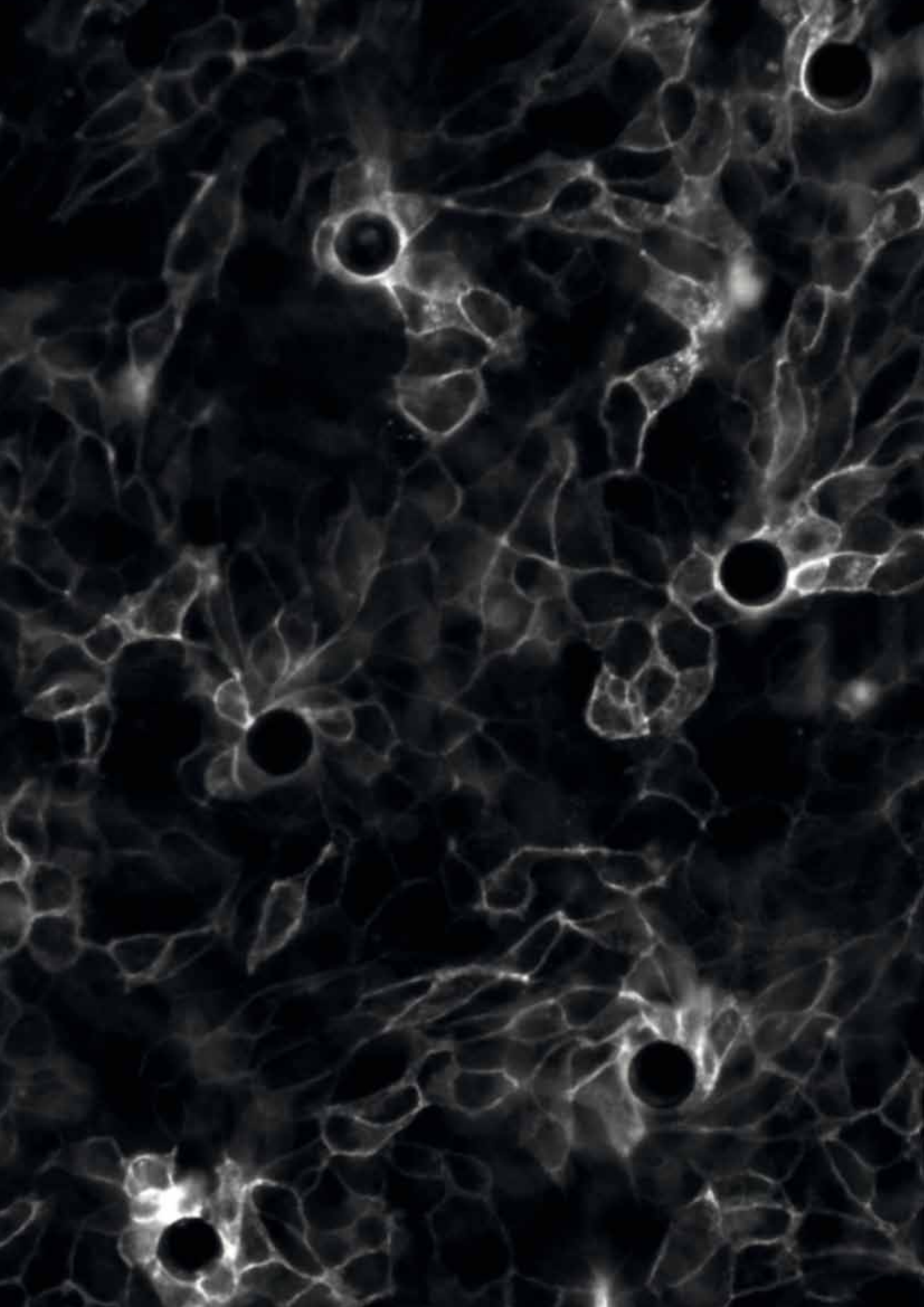


Figure 8. IBEC researchers and technicians by age

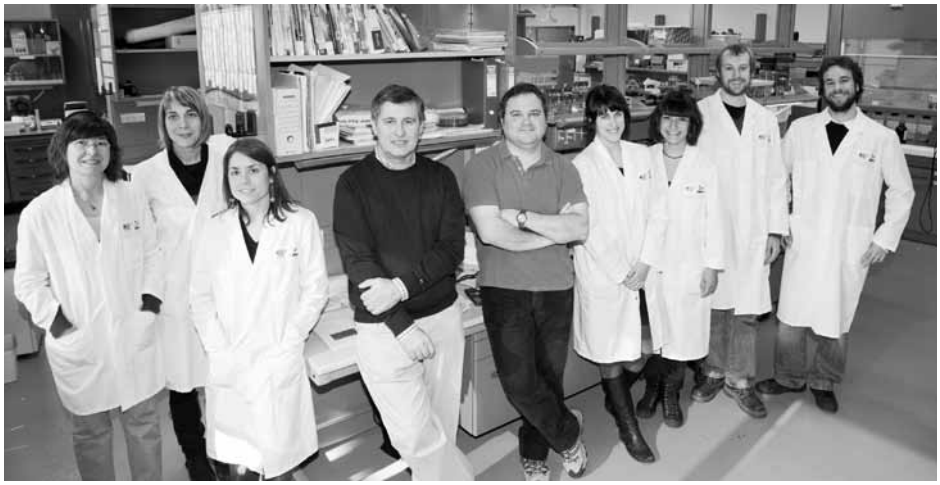


RESEARCH

RESEARCH LINES

Cellular Biotechnology Programme

Microbial Biotechnology and Host-Pathogen Interaction



Research staff:
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Dr. Eduard Torrents Senior researcher
Dr. Rosa Carmen Baños Postdoctoral researcher
Dr. Martin Edwards Postdoctoral researcher
Mª Carmen Jaramillo Technician
Nahia Barberia PhD student
Maria del Mar Cendra PhD student
Daniel Esteban Ferrer PhD student
Laura Pedró PhD student

1. Structure and function of bacterial proteins that modulate virulence expression. Protein-protein and protein-DNA interactions play key roles in the ability of virulent bacteria to adapt to the host environment and cause disease. Two groups of proteins are currently the focus of our research: nucleoid-associated proteins (NAPs) that contribute to DNA architecture and modulate gene expression, and ribonucleotide reductases (RNRs), which are key enzymes in all living organisms providing the nucleotide precursors for DNA replication and repair. In the former group, we are interested in unravelling the role played by two of these proteins—Hha and H-NS— in the regulation of virulence. In the case of latter group, our current research objectives are to analyze the importance of bacterial RNRs in pathogenesis and the molecular mechanisms of gene expression and to identify new specific RNR inhibitors. Owing to their essential function, these enzymes offer excellent potential for combating bacterial infection.

2. Application of nanotools to bacterial biotechnology.

2.1. Dielectrophoresis. We previously showed that dielectrophoresis can be a valuable tool for bacterial cell sorting and characterization. We are currently using different chip designs (2D and 3D carbon electrodes) with three different objectives: a) to study the effect of electric fields on bacterial cell physiology; b) to evaluate the ability of chip designs to capture and release bacterial cells, and c) to concentrate bacterial pathogens and facilitate their detection.

2.2. Atomic force microscopy (AFM). Conventional AFM approaches have been shown to be powerful techniques for characterizing both biomaterials and biomolecules. In a joint project with the Nanoscale Bioelectrical Characterization Group, we intend to use electrical-AFM to characterize the bacterial cell envelope. We also plan to use this approach to further analyze the location of bacterial proteins of unknown function predicted to be present on bacterial cell envelope.

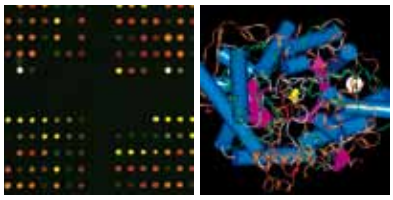

Fig.1 (left) Representative portion of a Salmonella typhimurium microarray.

Fig.2 (right) Structural superposition of NrdA (class I) and NrdD (class III) subunits of ribonucleotide reductase.

Molecular and Cellular Neurobiotechnology

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Dr. Franc Llorens Postdoctoral researcher
Isabel Jiménez Research assistant
Patricia Carulla PhD student
Vanessa Gil PhD student
Sara Nocentini PhD student
Alejandra Rangel PhD student
Oscar Seira PhD student
Anna Ramos Masters student

During the year, we established that cellular prion protein is a crucial susceptibility factor in epilepsy because it modulates the expression of the inhibitory neurotransmitter gamma-Aminobutyric acid type A (GABAA) and glutamate receptors in the CNS. Correct gene dosage and protein levels are essential for correct neuronal homeostasis. Secondly, we established that OMgp, a myelin-derived protein with unknown functions during development, plays a critical role in the development of sensory connections in the cerebral cortex. Its absence leads to profound deficits in thalamo-cortical connections in developing CNS. Thirdly, we characterized an immortalized cell line of olfactory ensheathing cells (OECs) for use in regenerative studies in combination with appropriate biomaterial scaffolds and functional environments. We also determined that the intracellular kinase GSK-3 is involved in the absence of regeneration after cortical lesions in the adult CNS. Using 2D and 3D organotypic slices and molecular techniques (microarray gene expression data and analysis), we developed pharmacological treatments that can block the activity of GSK-3 in order to enhance axon regeneration after injury. Lastly, we determined that the disabled-1 (Dab1) intracellular adaptor is a link between prion disease and Alzheimer disease. We found direct correlations between Met/Met polymorphism at codon 129 of the Prnp gene, the pathogenic PrP found in CJD patients, the presence of amyloid plaques in the brain, and the presence of Dab1. These factors also correlate with the diagnosis and evolution over the time of the illness in CJD patients. Finally, we have collaborated with scientists from the Consejo Superior de Investigaciones Científicas (CSIC) and the Institute for Research in Biomedicine (IRB-Barcelona) in the development of a peptide that will block secreted semaphorins by reactive cells at the glial scar to enhance axon regeneration in lesioned CNS.

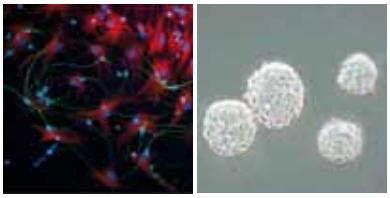
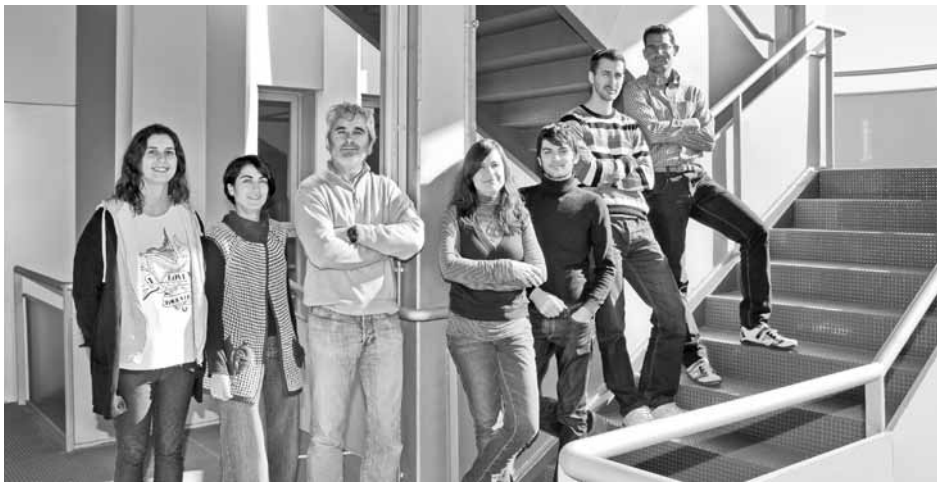


Fig. 1 (left) Differentiation on neural stem cells in neurons (green) and astrocytes (red), *in vitro* after 7 days in culture.

Fig. 2 (right) OPC neurosferes obtained from the adult cerebral cortex of mouse brain after 12 months in culture.

Control of Stem Cell Potency



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Dr. Senda Jiménez Research assistant
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Yvonne Richaud-Patin Research assistant
Eduard Sleep PhD student
Mario Barilani Visiting student
Marta Lorente Visiting student

During embryo development, the potency of the zygote is deployed through coordinated and stereotypical changes in cell behaviours and tissue patterning processes, ultimately resulting in the formation of an entire, highly complex organism in a relatively short period of time. With two remarkable exceptions, this process is irreversible, that is, the progressive increase in the complexity of the system is coupled to a decrease in the overall potency of its constituents. One such exception is regeneration, a phenomenon by which the cells of certain organisms re-acquire potency and the capacity to rebuild lost parts or structures. Developmental potency can also be regained experimentally through a process called reprogramming, either by nuclear transfer, cell fusion with pluripotent cells, or, more recently, induced reprogramming by defined factors.

Using a multipronged approach, our laboratory takes advantage of recent conceptual and technical developments to address the basic question of how a discrete and defined degree of developmental potency can be imposed on a somatic cell thereby enabling it to regain the capacity to regenerate a functional tissue or structure.

For this purpose, we mainly use the paradigm of heart (re)generation. Overall, our research is based on the following working hypotheses: 1) careful investigation of the mechanisms that control zebrafish heart regeneration will uncover the critical transcriptional and epigenetic features that underlie the re-acquisition of developmental potency; 2) by using a combination of specific factors and appropriate selection procedures we will be able to partially reprogram somatic cells to create multipotent cardiogenic progenitors; and 3) providing adequate extracellular cues to suitable pluripotent or multipotent progenitors will guide their intrinsic potential to generate functional myocardial tissue.

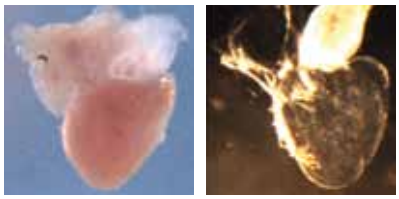
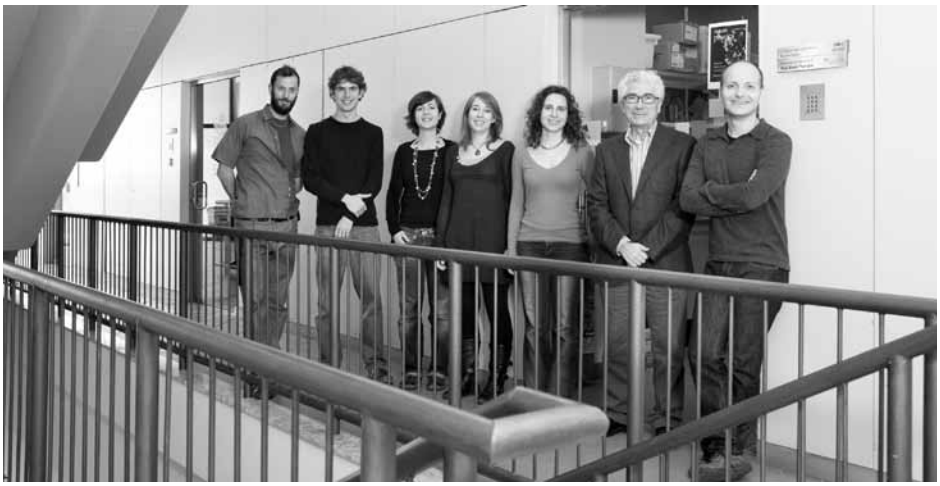


Figure: Brightfield images of a zebrafish heart before (left image) and after (right image) decellularization. Decellularized hearts provide useful matrices to investigate extracellular cues underlying regeneration.

Biomechanics and Cellular Biophysics Programme

Cellular and Respiratory Biomechanics



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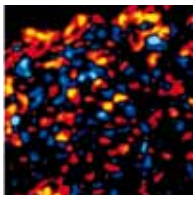
Dr. Xavier Trepat Senior researcher
Dr. Pere Roca-Cusachs Postdoctoral researcher
Irene Acerbi PhD student
Ester Añón PhD student
Simón García PhD student
Xavier Serra PhD student
Laura Casares Masters student

Our research goal in this field is to gain a better understanding of cellular and respiratory biomechanics in order to improve the diagnosis and treatment of respiratory disease. Our work is organized into two interrelated areas, focussing on respiratory mechanics at both the systemic and the cellular level. We use basic and translational approaches in a multidisciplinary framework involving cooperation with clinical research groups working in the field of respiratory medicine.

At the systemic level, we study the mechanical properties of the airway and lung tissues and the changes that occur in the context of the mechanical dysfunction associated with respiratory diseases. The research is mainly focused on the mechanics of the upper airway in sleep apnea syndrome and on mechanical ventilation in acute and chronic respiratory failure.

At the cellular level, we develop and apply cutting edge nanotechnology and advanced biophysical techniques to probe the mechanical behaviour of the cells and their mechanical interactions with the microenvironment. We study the mechanical properties of the cell and its response to inflammation and mechanical stresses. We develop new approaches to differentiate stem cells using mechanical stimuli. Our research also focusses on the study of the biophysical mechanisms regulating the adhesion and vascular transmigration of leukocytes. We also investigate the mechanical determinants of carcinogenesis. Finally, we measure and model the physical forces that drive collective cell migration.



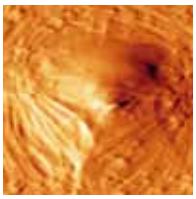
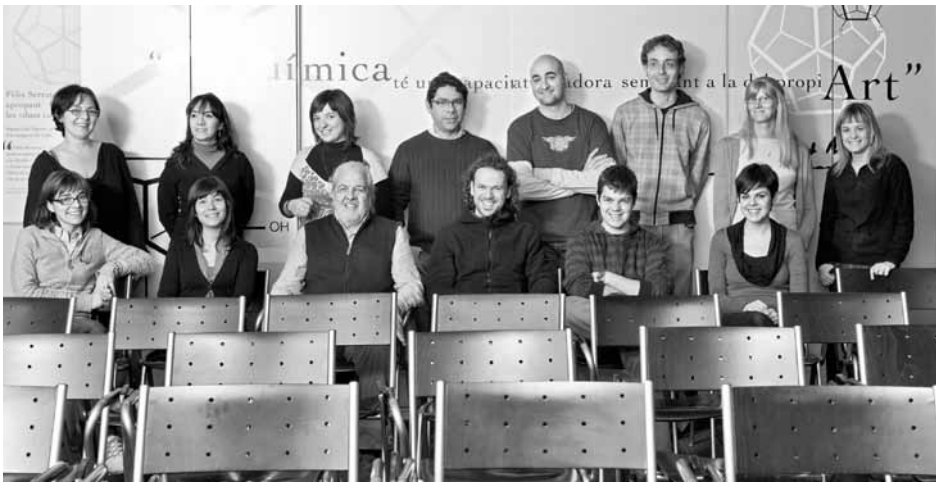


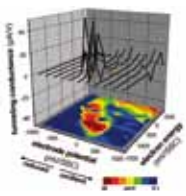
Fig. 1 (left) Map of the physical forces exerted by a migrating cell monolayer measured by traction miscoscopy.

Fig. 2 (right) Control of cell shape by surface micro-patterning.

Nanoprobes and Nanoswitches



The group's research focuses on developing nanoscale tools to study biological systems. These tools include instrumentation based on proximity probes, such as electrochemical tunnelling microscopy and spectroscopy that is being applied to the study of metal oxides and redox proteins. Another set of nanotools that we are developing is based on molecular actuators that can be switched with light, such as azobenzene, which can be chemically attached to biomolecules in order to optically control their activity.



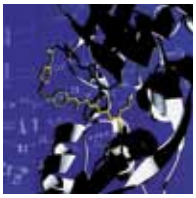


Fig.1 (left) Conductance map of an iron polycrystal in borate buffer solution, obtained by electrochemical tunnelling spectroscopy. Credit: I. Díez-Pérez, F. Sanz and P. Gorostiza (2007). Curr. Op. Sol. St. Mat. Sci. 10:144-152.

Fig. 2 (right) Light-activated glutamate receptor based on the photoisomerizable tethered ligand MAG (in yellow). Credit: P. Gorostiza and E. Y. Isacoff (2007). Mol. Biosyst. 3:686-704.

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Nanobiotechnology Programme

Nanobioengineering

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The engineering of micro-nanosystems is a new interdisciplinary applied field of research that combines materials, technologies, structures, devices and algorithms to obtain new smart subsystems. The assembly of these subsystems allows the high-density functionality needed in small devices and/or instruments such as lab on chips, microrobots or biochips. It is then expected that microsystem engineering will contribute to improving sustainability and manufacturing processes and, thus improve the quality of life.

Biomedical applications increasingly require the miniaturization of sensors, actuators and systems. Biomedical systems that combine accurate and stable sensors, efficient actuators, low-power and wireless integrated circuits and hermetic and biocompatible packages are now needed in applications ranging from *in vivo* implantable bio-systems for diagnostics and prostheses to *in vitro* portable devices for blood and DNA analysis. In these applications, reducing the size of their components is a key to improving system functionality and reliability and, at the same time, to making savings in reagent consumption and analysis time.

The introduction of complex biological entities such as eukaryotic or bacterial cells and viruses into micro-nanosystems, however, requires an advanced methodology for particle handling and manipulation combining materials, devices and fluidics. In the appropriate methodological context, data from chip-based experiments can provide significant quantitative information about major cellular pathways and processes. The main challenges in biology and the medical sciences could be addressed by the development of complete lab-on-a-chip and point-of-care systems.

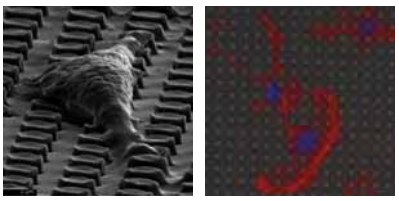

Fig.1 (left) Scanning electron microscopy image of a NRK fibroblast cultured onto PMMA posts of 4 μm^2.

Fig.2 (right) 3T3 fibroblast treated with 100 nM phorbol 12-myristate 13-acetate (PMA) and cultured on PMMA posts of 25 μm^2.

Single Molecule Bionanophotonics

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The work of the bionanophotonics group is focused on the development and application of modern optical techniques for the study of biological processes at the single-molecule level in living cells. Multimolecular interactions occur commonly at the nanoscale, a size regime not accessible optically because of the limits imposed by diffraction. The aim of our group is to develop optical tools capable of nanometric probing and manipulation of the biological function of single molecules in the living cell, their native environment. In conjunction with the increased spatial optical resolution afforded by near-field scanning optical microscopy (NSOM), we also use other methods, including fluorescence correlation spectroscopy (FCS) and Epi/Total internal reflection fluorescence microscopy (Epi/TIRF) for single molecule tracking.

In 2009, we have focused on mechanisms that regulate receptor clustering on cell membranes and in particular we used NSOM to investigate lipid rafts as local organizers of the cell membrane and their functional role in integrin-mediated cell adhesion (PNAS, 106 18557, 2009). Using nanoantenna concepts we succeeded for the first time in imaging receptors on intact cell membranes in physiological conditions at an unprecedented optical resolution of 30nm (Small, doi: 10.1002/smll.200901204, 2009). Using our Epi/TIRF set-up in combination with microcontact printing we fabricated ligand pattern surfaces to reveal distinct dynamic reorganization of the integrin adhesion receptors involved in the immune system (Small, 5 1258, 2009). We are fascinated and challenged by the complexity of cell membranes and will continue to explore their spatio-temporal compartmentalization and their role in processes such as cell adhesion, pathogen recognition, virus binding, and internalization.

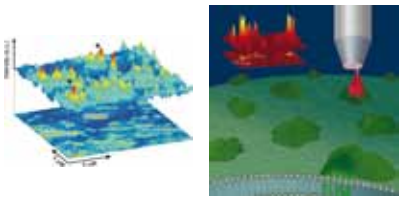
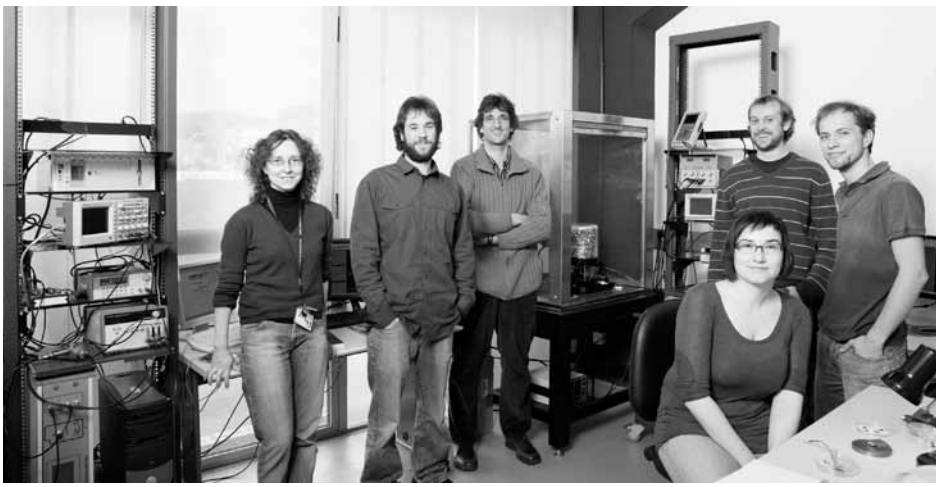


Fig. 1 (left) Nanometre scale hot spots regions of GPI anchored proteins on the membrane of immune cells imaged with NSOM.

Fig. 2 (right) Artist impression on how a optical nanoantenna carved on a NSOM probe images individual proteins on the cell membrane with an optical resolution of 30nm. The inset shows a real superresolution image of adhesion receptors on monocytes.

Nanoscale Bioelectrical Characterization



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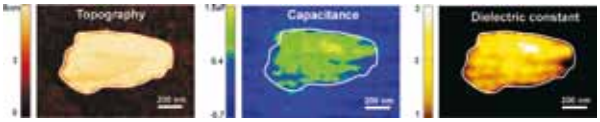
The main goal of our nanoscale research line is to develop experimental setups based on atomic force microscopy and theoretical frameworks that will enable us to measure and understand the electrical properties of biological samples at the nanoscale (for example, biomembranes, single biomolecules and single cells). The broader objective is to contribute to the development of new label-free biological characterization methods and electronic biosensors. In the area of instrumentation, we have developed a state-of-the-art nanoscale electrical impedance atomic force microscope with unprecedented sensitivity. We have also recently set up an electrostatic force microscope for electrostatic and surface potential measurements. In theoretical modelling, we have implemented finite element numerical simulation algorithms to quantitatively interpret nanoscale electrical measurements using atomic force microscopy. Over the past year, we have been able, using these instruments and theoretical methods, to quantify for the first time the nanoscale dielectric constant of a solid supported biomembrane. Ongoing work includes the analysis of the nanoscale electrical properties of single bacterial cells and the study of ligand-binding processes in olfactory receptors for use in biosensor applications.



Nanoscale dielectric imaging of a single layer of purple membrane on graphite:

Fig.1 (left) Measured topography,
Fig.2 (center) Measured local capacitance, and
Fig.3 (right) Dielectric constant image calculated from fig.1 and fig.2.

Biomaterials, Implants and Tissue Engineering

Bio/Non-Bio Interactions for Regenerative Medicine

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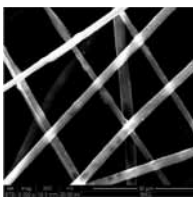
The Bio/Non-Bio Interactions for Regenerative Medicine research line is focused on the development of new third-generation bioactive and biodegradable materials for the treatment of diseased or altered tissues. The strategy used is known as tissue engineering and it involves isolating and cultivating progenitor cells and developing three-dimensional structures or matrices that these cells can use as scaffolds to regenerate the specific tissue. These scaffolds materials are aimed not only to provide support for the cells, but also to provide them with physical, chemical and biological signals appropriate to control and guide their activity in order to trigger the body self regeneration of the specific tissue. The specific objective of the research line is to design and develop new material surfaces by means of strategies such as their functionalisation using bioactive peptides or molecules able to mimic the extracellular matrix and promoting adhesion, migration and differentiation of specific cells for every type of tissue. The nano and microstructure of the surface is also an important signal in terms of cell behaviour and consequently the topographic modification of surfaces may promote desired cell activities, such as preferential adhesion, migration, or even differentiation into cells of a more progenitor lineage. A number of technologies have been developed in order to produce the three-dimensional matrices to be colonised by cells; these include robotic methods of rapid prototyping, electro-spinning, and solvent casting.

These advances have allowed in these recent years, to investigate processes associated with angiogenesis and to develop a new nanostructured material that promotes the formation of new vessels from endothelial progenitor cells. Different processes allow to manufacture appropriate matrices to be used in different applications, such as blood vessel or bone regeneration. In the field of neurosciences, substrates have been developed that allow the orientation of nerve cells without altering their more progenitor properties, and thereby promoting a permissive environment for regeneration. Finally, the functionalisation of biodegradable polymers with collagen and different peptides makes it possible to grow successfully different cell types, especially the epithelial cells of the cornea and fibroblasts, for the regeneration of specific tissues.



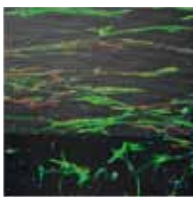


Fig. 1 (left) Electrospun nanofibers of polylactic acid containing nanoparticles of biodegradable calcium phosphate glass.

Fig. 2 (right) Rat glial cells: the cells are aligned following the direction of the grooves on the surface (2 micrometers wide); but on a smooth surface, they are not aligned and their morphology is that of astrocytes.

Molecular Dynamics at Cell-Biomaterial Interface

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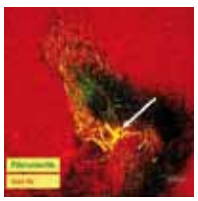
The interaction of cells with foreign materials is fundamental for biology and medicine and the key to understanding the phenomena of biocompatibility. Cell adhesion and the generation of a proper cellular response are prerequisites for the successful incorporation of implants, the colonization of scaffolds and, possibly, all tissue engineering applications. Our recent studies have shown that tissue compatibility of materials is highly dependent on cells being able to remodel the surface-associated proteins and to form a provisional matrix. How the underlying surface properties affect this process is of substantial scientific interest. To address this, we focus our research on the cellular interaction with biomaterial surfaces that represent intrinsic nanotopography or distinct molecular organization. We want to learn how they affect the organization of the ECM (extracellular matrix) and subsequent tissue integration. Thus, our research is related to the current needs of IBEC in that it monitors the biological response of newly designed biomaterials.

Another of our research lines highlights the dynamic behaviour of integrins, the cellular adhesive mechanism that controls adhesion strength and matrix assembly. We wish to discover how the cells “imprint” their specific biological information at the biomaterials interface and how this reflects the organization of the surrounding ECM. We wish to determine whether clues can be introduced that guide cellular behaviour and if nanofibres, designed from natural or synthetic polymers, might provide such an instrument. In conjunction with our observation that integrin dynamics is strongly altered on low compatible surfaces, we anticipate that the biocompatibility of materials requires that they adsorb matrix proteins loosely, i.e. in such a way that the integrins can be organized in a matrix-like structure. Thus, our research has the potential to shed direct light on the specific area of nano-tissue engineering with major implications for regenerative medicine and biohybrid organ strategies.



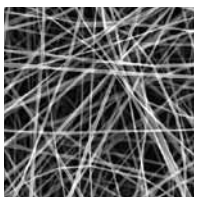


Fig.1 (left) Fibroblast arrangement of substratum associated collagen IV along with fibronectin fibrils.

Fig.2 (right) Nanofibres from native fibrinogen, SEM.

Biomechanics and Mechanobiology

The focus of the Biomechanics and Mechanobiology research line is the study of the effect of mechanical stimuli on biological response. It is clear that among the physical and chemical cues that influence tissue response and adaptation, mechanical loading plays an important role throughout life. We use numerical methods based on the finite element method to model implants at the organ level and implant-cell interactions at the cellular level. The numerical concepts developed are then tested against *in vivo* and *in vitro* models to validate the numerical models, and particular attention is paid to the study of load transfer from the organ level to the cell level.

In 2009, it has been shown that mechanical stimuli in a scaffold cultured in an *in vitro* bioreactor could be of several orders of magnitude different depending on whether a discretized or a continuum numerical approach is used, and for the first time angiogenesis could be simulated over time (Olivares *et al*, Milan *et al*). These results are particularly relevant to the design of tissue engineering scaffolds and to the understanding of mechanical in cell differentiation. Another important result has been the development of a factorial statistical analysis method that was applied to the intervertebral disc of the lumbar spine to identify which parameters are the most critical in the development of finite element models or for use in patient specific studies (Malandrino *et al*). Current projects include the design of rapid-prototyping scaffolds, the simulation of fluid transport in intervertebral discs, and the understanding of mechanical stimuli at the single cell level using microfluidic chambers and numerical models.

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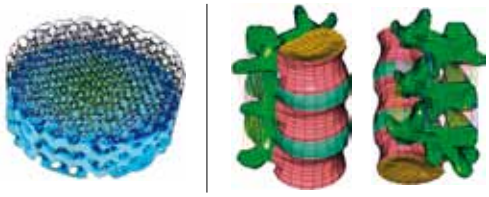

Fig. 1 (left) Computational fluid dynamics analysis of a scaffold with a radial gradient of pore size distribution in a bioreactor under perfusion.

Fig. 2 (right) Finite element model of the lumbar spine.

Medical Signals and Instrumentation Programme

Biomedical Signal Processing and Interpretation

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The research line is oriented to new methods and techniques for multi-channel and multimodal acquisition, processing, modelling and interpretation of clinically relevant information from biomedical signals. The main objective is to improve the diagnosis capability through the characterization of physiological phenomena, and to the enhance early detection of major diseases. The group's research addresses the design and development of advanced signal processing techniques and the interpretation of biomedical signals to improve monitoring, diagnosis, disease prevention and pathology treatment.

Recent studies have shown that there is a close relationship between sleep, respiratory and cardiac signals in different pathologies. In some cases, obstructive respiration during the night, such as obstructive sleep apnoea syndrome (OSAS), gives rise to sleep disorders and the subsequent cardiovascular effects. In other cases, cardiac pathologies result in significant changes to respiratory patterns. This biological interaction suggests that a multimodal-multichannel approach will improve the identification and study of major cardiac and respiratory diseases that are highly prevalent in the world population. Simultaneous analyses and the processing of bioelectrical, mechanical, sound and blood signals will enhance our understanding of physiology and our diagnostic capabilities.

This line proposes relevant applications in the field of sleep disorders related to breathing, respiratory and cardiac pathologies.

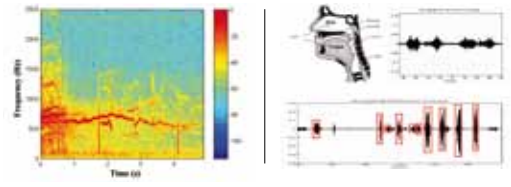

Fig. 1 (left) Analysis and interpretation of time-frequency respiratory sounds for monitoring and diagnosing asthma and obstructive lung diseases.

Fig. 2 (right) Diagnosis of the obstructive sleep apnoea syndrome, through the detection and interpretation of snoring episodes.

Artificial Olfaction

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Artificial olfaction (AO) systems are intelligent chemical instruments for the detection of volatile compounds and smells. These systems usually combine a matrix of nonspecific chemical sensors with a pattern recognition system.

The emphasis is not on the identification and quantification of the individual components—as is the case with analytical instruments—but rather on the overall evaluation of the odour. Moreover, AO systems tend to favour miniaturised devices capable of analyzing an odour in seconds. The focus of our research in this field is the development of signal and data processing systems inspired by the neuronal processing of the biological olfactory pathway.

Our research in 2009 included the following:

- Within the framework of the European NEUROCHEM project for the development of biologically-inspired computational solutions, we have developed detailed neuronal models of insect mushroom bodies and integrated more abstract complete models inspired by the olfactory system of vertebrates in a neural simulator. The next step will be to explore whether these computational models can resolve scenarios of biological behaviour associated with olfaction behaviours.
- In the context of the LOTUS project, we have developed blind source separation methods for temporal sequences of ion mobility spectra and have begun developing algorithms based on Bayesian sequential inference for the localisation of odour sources.
- In the context of BREATH, a project focussed on the analysis of exhaled breath in the diagnosis of COPD and lung cancer using ion mobility spectrometry, we have developed a methodology for sampling the exhaled breath of patients.

Other developments during the last year have been related to methods for reducing drift in chemical sensors, blind source separation in temperature-modulated sensors, and a proposal for figures of merit in clustering algorithms.

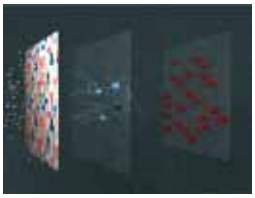

Fig. 1 (left) Intelligent sensor system for the analysis of multicomponent mixtures based on thermoelectric sensors.

Fig. 2 (right) Data processing model in the NEUROCHEM artificial olfactory system.

Neuroengineering

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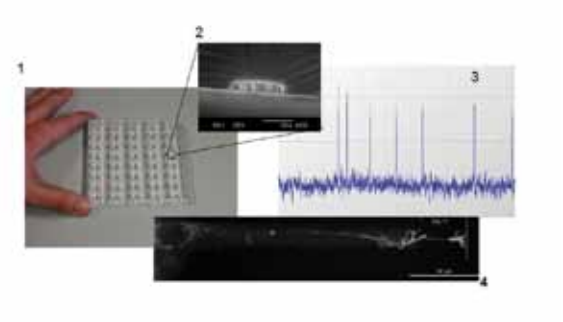
The neuroengineering group focuses on technology to monitor and control neuronal activity with the aim of empowering basic research, drug discovery and therapeutic action against neuropathologies.

We have developed the PoM (Polymer-on-Multielectrode) array technology, which combines planar arrays of substrate-embedded electrodes and 3D polymeric structures to monitor and stimulate neuronal activity *in vitro*. Using the PoMs, it has been possible to culture individual neurons within microstructures and to obtain multisite recordings of single-unit activity along individual neurites. This tool renders possible a whole new set of experiments in which the anatomy and function of individual neurons can be correlated *in vitro*.

The group has also achieved a novel family of consumable, all-polymeric cell culture dishes with embedded microchannels and culture chambers. These enable low-complexity, low-cost electrophysiological measurements, including drug screening, with convenient manufacturability. A spin-off, Aleria Biodevices SL, has been created to market this approach to *in vitro* electrophysiology.

The production of neurochips using conventional technologies is costly and technically complex. In order to help address this issue, we have developed a laser-write lithography system that supports rapid-prototyping of the PoM and all-polymeric devices.

In parallel with work on lab-on-a-chip electrophysiology, we are pursuing research on novel optical techniques to monitor neuronal activity. We are particularly interested in photobleaching-free techniques capable of supporting long-term studies on learning both *in vitro* and *in vivo*. Along these lines we are focusing on plasmon-resonance as measured on functionalized nanoparticles bound to electroactive membranes.



Multiwell polymeric chip (1) for integrated electrophysiology on a large scale (see scanning electron microscopy — SEM — of an integrated microchannel (2). Figures 3 and 4 show neuronal activity measured using our devices and an axon growing inside the microchannels.

Robotics and Biomedical Imaging Programme

Robotics

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Research on robotics in medicine deals with the close interaction between people and robots. The robotics research group designs and develops intelligent robotics systems to assist people with disabilities and medical personnel. This involves acquiring detailed knowledge about the behaviour and intentions of users in order to develop an interface adapted to both their needs and the requirements of the tasks and to facilitate fine tuning of the level of cooperation between the person and the machine taking into account the user's abilities.

Our main project in this field is the development of a robot-assisted kitchen with an interface featuring highly intuitive means of communication that allows users with limited mobility to control the robot and other elements. The kitchen is equipped with a range of different control options that allow users to interact easily and intuitively with the system and with a perception system that can visualize space and locate objects.The research in this project includes 3D perception, task coordination, knowledge of the user's intentions, interactive monitoring, and object manipulation control.

In surgical robotics our research is focussed on the design of assisted teleoperation strategies with the goal of reducing the stress on surgeons who perform operations requiring highly delicate actions and great precision. Some surgical procedures can be carried out safely and more effectively with robotic assistance and this technique also improves reliability. The research of the group in this area deals with physical (based on touch-force) and remote (based on vision) interaction to provide a safe and user-friendly programming and control environment.

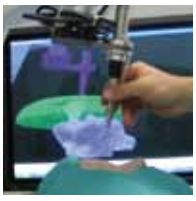

Fig. 1 (left) Experimental kitchen for the disabled.

Fig. 2 (right) Co-manipulation in robot assisted surgery.

RESEARCH PROJECTS

IBEC, which aims to be an international reference point in the field of bioengineering research, took part in various international projects and consortiums in 2009. In addition, the Institute established the foundations for future collaborations with clinical institutions, hospitals and other university and research centres.

IBEC Projects with European Funding

- CELL TRANS. *Integrated Molecular and Cellular Mechanotransduction Mediated by Protein* (2008-2011).
Fellow: **Pere Roca-Cusachs**
PI: **Daniel Navajas**
International Outgoing Fellowships (IOF)
Marie Curie Action within the framework of the EU–FP7.

- OPTICALBULLET. *Neurosecretion by Remote Control of Exocytosis and Endocytosis with Light* (2008-2013).
PI: **Pau Gorostiza**
European Research Council - Starting Grant.

- Photosyn-STM. *Single-Molecule Studies of Photoconductance on Photosynthetic Molecular Systems by SPM Break-Junction Measurements* (2008-2011).
Fellow: **Ismael Díez**
PI: **Fausto Sanz**
International Outgoing Fellowships (IOF)
Marie Curie Action within the framework of the EU–FP7.

- EURONANOBIO. *European Scale Infrasctructure in Nanobiotechnology* (2009).
PI: **Josep Samitier**
Project within the framework of the EU–FP7.

- BIO-LIGHT-TOUCH. *Advanced Near-Field Optical Tools with Biochemical Functional Recognition at the Single Molecule Level* (2007-2010).
PI: **Maria Garcia-Parajo**
NEST Project coordinated by IBEC within the framework of the EU–FP6.

- IMMUNANOMAP. *Unraveling the Nano-Landscape of Receptors Controlling Molecular Processes of the Immune System* (2007-2011).
PI: **Maria Garcia-Parajo**
Marie Curie Research Training

- PHOTONICS4LIFE (2009-2012).
PI: **Maria Garcia-Parajo**
Cluster partner of the European Network of Excellence for Biophotonics EU-FP7

- ANGIOSCAFF. *Highly Porous Bioactive Scaffolds Controlling Angiogenesis for Tissue Engineering* (2008-2012).
PI: **Josep A. Planell**
Collaborative project within the framework of the EU–FP7.

- DISC REGENERATION. *Novel Biofunctional High Porous Polymer Scaffolds and Techniques Controlling Angiogenesis for the Regeneration and Repair of the Degenerated Intervertebral Disc* (2008-2012).
PI: **Josep A. Planell**
Collaborative project within the framework of the EU–FP7.

- SERVIOM. *Mechanistic and Evolutive Development of Spine Biomechanical Modelling* (2009-2011).
Fellow: **Jérôme Noailly**
PI: **Damien Lacroix**
Marie Curie Action (ERG) within the framework of the EU-FP7.

- *Virtual Physiological Human Network of Excellence* (2008-2011).
PI: **Damien Lacroix**
Cluster partner of this European Network of Excellence EU-FP7.

- NANO2MARKET. *Best Practices for IPR and Technology Transfer in Nanotechnology Developments* (2009-2010).
PI: **Arantxa Sanz**
Collaborative project within the framework of the EU–FP7.

Projects with European Funding Managed by the PCB or UB

- PRIORITY. *Protecting the Food Chain from Prions: Shaping European Priorities through Basic and Applied Research* (2009-2013).
PI: **José Antonio Del Río** (participation of two teams form UB)
Large scale integrated collaborative project within the framework of the EU-FP7.

- *Physical Forces Driving Collective Cell Migration: From Genes to Mechanism* (2009-2014).
PI: **Xavier Trepat**
IDEAS Starting Grants. European Research Council.

- BOND. *Bioelectronic Olfactory Neuron Device* (2009-2013).
PI: **Josep Samitier** (Coordinator)
Technical Manager: **Gabriel Gomila**
Collaborative Project coordinated by UB within the framework of the EU-FP7.

- ARAKNES. *Array of Robots Augmenting the KiNematics of Endoluminal Surgery* (2008-2012).
PI: **Josep Samitier**
Large-scale project within the framework of the EU-FP7.

- THERAEDGE. *An Integrated Platform Enabling Theranostic Applications at the Point of Primary Care* (2008-2011).
PI: **Josep Samitier**
Large-scale project within the framework of the EU-FP7.

- DVT-IMP. *Deep Vein Thrombosis - Impedimetric Microanalysis System* (2006-2009).
PI: **Josep Samitier**
Nanobiotechnology project within the framework of the EU-FP6 - STREP.

- VECTOR. *Versatile Endoscopic Capsule for Gastrointestinal Tumor Recognition and Therapy* (2006-2009).
PI: **Josep Samitier**
Nanobiotechnology project within the framework of the EU-FP6.

- ARES. *Assembling Reconfigurable Endoluminal Surgical System* (2006-2009).
PI: **Josep Samitier**
NEST project within the framework of the EU–FP6.

- MAPTECH. *Training for Micro-Analytical Platform Technology* (2005-2010).
PI: **Josep Samitier**
Marie Curie RTN within the framework of the EU-FP6.

- NEUROCHEM: *Biologically Inspired Computation for Chemical Sensing* (2008-2010).
PI: **Santiago Marco** (Coordinator)
Convergence projects coordinated by UB within the framework of the EU-FP7-STREP.

- LOTUS. *Localisation of Threat Substances in Urban Society* (2009 - 2011).
PI: **Santiago Marco**
Collaborative project within the framework of the EU FP7.

Projects with European Funding Managed by the UPC

- STEPS-*Systems Approach to Tissue Engineering Processes and Products* (2005-2009).
PI: **Josep A. Planell**
Tissue engineering project within the framework of the EU-FP6.

- VSN. *Voltage Sensitive-Resonant Nanoparticles / Novel Nanotransducers of Neuronal Activity* (2006-2009).
PI Coordinator: **Enric Claverol-Tinturé**
Project in nanobiotechnologies within the framework of the EU-FP6.

- *A Novel Strategy for Development of Multielectrode Devices and Integration of Microfluidics for Recording of Neuronal Activity.*
PI: **Enric Claverol-Tinturé**
FlashPoMs - Inter-Reg European Project.

National Projects Managed by IBEC

- *Función de las ribonucleotidil reductasas bacterianas en patogenia: bases moleculares de la expresión génica y cribaje de inhibidores específicos* (2009-2011).
PI: **Eduard Torrents**
Instituto de Salud Carlos III. MSC – FIS programme.

- PATHOGENOMICS. *Identification of Hot Spots of Divergence and Rapidly Changing Genes within Shiga Toxin-Producing Escherichia Coli* (2009-2012).
PI: **Eduard Torrents**
MICINN, Acciones Complementarias.

- *Ajuts de suport als grups de recerca* (2009-2014).
PI: **Antonio Juárez**
AGAUR - SGR.

- DEVREG. *Caracterización funcional de genes regulados durante la ontogenia del SNC en el desarrollo cortical y la regeneración axonal* (2009-2012).
PI: **José Antonio Del Río**
MICINN, Investigación fundamental no orientada.

- *Ajuts de suport als grups de recerca* (2009-2014).
PI: **José Antonio Del Río**
AGAUR - SGR.

- CELLSCAFF-CARTILAGE. *In Situ Tissue Engineering Using Stem Cells and Functional Biomaterials to Repair Articular Cartilage: An "in Vivo Model"* (2009-2012).
PI: **Ángel Raya**
MICINN, ACI-E Medicina Regenerativa.

- CIBER-BBN. CIBER *en Bioingeniería, Biomateriales y Nanomedicina* (2006-2010).
PI: **Ángel Raya**
Instituto de Salud Carlos III.

- OPTICAL SWITCH. *Development of Photoswitchable Peptides with Biological Implications* (2008-2011).
PI: **Pau Gorostiza**
MICINN, Investigación fundamental no orientada.

- *Ajuts de suport als grups de recerca* (2009-2014).
PI: **Fausto Sanz**
AGAUR - SGR.

- ONCONANOTARGET. *Advancing the Field of Drgug Delivery - Combined Targeted Treatment against Human Breast Cancer and Human Leukemia* (2009 – 2011).
PI: **Josep Samitier**
MICINN, I+D+i Euroinvestigación.

▪ CARDIO-STEM *Terapias regenerativas con células madre para el fallo cardíaco* (2009-2012).
PI: **Josep Samitier**
MICINN, ACI-E Medicina Regenerativa.

▪ *Plataforma Española de Nanomedicina* (2009-2011).
PI: **Josep Samitier**
MICINN, Redes Tecnológicas.

▪ CIBER-BBN. CIBER *en Bioingeniería, Biomateriales y Nanomedicina* (2006-2010).
PI: **Josep Samitier**
Instituto de Salud Carlos III.

▪ *Ajuts de suport als grups de recerca* (2009-2014).
PI: **Josep Samitier**
AGAUR - SGR.

▪ NANOMEDIAG *Nanobioanalytical Platforms for Improved Medical Diagnosis of Infections Caused by Pathogen Microorganisms* (2009 – 2011).
IP: **Elena Martínez**
Project coordinated by IBEC. MICINN, Euroinvestigación.

▪ NANOMALARIA. *Desarrollo de nanovectores para la liberación dirigida de antimaláricos* (2009 - 2011).
IP: **Xavier Fernández-Busquets**
MICINN, Investigación fundamental no orientada.

▪ MICROTIME *Microscopio óptico de barrido de campo cercano con reconocimiento bioquímico a escala molecular* (2007 – 2010).
PI: **Maria Garcia-Parajo**
MEC, Acciones Complementarias.

▪ HYBRID-NANO-CELL. *Novel Hybrid Nanotechnologies to Explore Molecular Interactions at Bio-Nonbio-Interfaces* (2007-2010).
PI: **Maria Garcia-Parajo**
MEC, Proyectos I+D.

▪ CIBER-BBN. CIBER *en Bioingeniería, Biomateriales y Nanomedicina* (2006-2010).
PI: **Maria Garcia-Parajo**
Instituto de Salud Carlos III.

▪ *Ajuts de suport als grups de recerca* (2009-2014).
PI: **Maria Garcia-Parajo**
AGAUR - SGR.

▪ BIOFUSS. *Materiales biofuncionalizados para reparación y regeneración de tejidos* (2009 - 2011).
PI: **Josep A. Planell**
Project coordinated by IBEC. MICINN, Investigación fundamental no orientada.

▪ ANGIOSCAFF. *Preparación de propuesta del proyecto del 7PM-ANGIOSCAFF* (2009).
PI: **Josep A. Planell**
MICINN, Acciones complementarias.

▪ DISC REGENERATION. *Novel Biofunctional Polymer Scaffolds and Techniques for the Regeneration and Repair of Degenerate Intervertebral Disc* (2008-2009).
PI: **Josep A. Planell**
MICINN, Acciones complementarias.

▪ *Ajuts de suport als grups de recerca* (2009-2014).
PI: **Josep A. Planell**
AGAUR - SGR.

▪ EUCHINABIOMAT. *Congreso China-Europa de Biomateriales en Medicina Regenerativa* (2009).
PI: **Josep A. Planell**
MICINN, Acciones Complementarias.

▪ CIBER-BBN. CIBER *en Bioingeniería, Biomateriales y Nanomedicina* (2006-2010).
PI: **Josep A. Planell**
Instituto de Salud Carlos III.

▪ *Evaluación biológica de materiales bioactivos, biomiméticos y multifuncionales para la regeneración ósea* (2009-2012).
PI: **Elisabeth Engel**
MICINN, Investigación fundamental no orientada.

▪ MATIX DYNAMICS. *Dinámica de las proteínas de la matriz en la interfase célula-material* (2009-2012).
PI: **George Altankov**
MICINN, Investigación fundamental no orientada.

▪ NANOFIBROGEL. *Gel de nanofibras biomimetizador para la terapia celular en enfermedades degenerativas del tejido esquelético* (2009).

PI: **George Altankov**
MICINN, Acciones Complementarias.

▪ *Estudio micromecánico por elementos finitos de la columna lumbar* (2009).
PI: **Daniel Lacroix**
MICINN, Acciones Integradas.

▪ *Prototipatge d'instrument de mesura de consum energètic -gas natural-* (2009 - 2011).
PI: **Santiago Marco**
CIDEM.

▪ BREATH. *Biomarcadores inflamatorios, de estrés oxidativo y metabonómicos en el aire exhalado en la enfermedad pulmonar obstructiva crónica y el cáncer de pulmón* (2009 - 2011).
PI: **Santiago Marco**
Instituto de Salud Carlos III.

▪ CIBER-BBN. CIBER *en Bioingeniería, Biomateriales y Nanomedicina* (2008-2010).
PI: **Raimon Jané**
Instituto de Salud Carlos III.

- *Hybrid NeuroProsthetic and NeuroRobotic Devices for Functional Compensation and Rehabilitation of Motor Disorders* (2009 – 2014).
PI: **Alícia Casals**
MICINN, Consolider.

- UII. *Creación de la Unidad de Innovación Internacional de la Plataforma Española de Nanomedicina* (2009).
PI: **Arantxa Sanz**
CDTI.

National Projects Managed by PCB or UB

- *Interactivity of Plasmid Modules and The Genomes of Bacterial Pathogens* (2008-2013).
PI: **Antonio Juárez**
MICINN, Consolider (CSD2008-00013).

- *Regulación de operones de virulencia: un modelo para el estudio de redes reguladoras conservadas en enterobacterias* (2008-2010).
PI: **Antonio Juárez**
NBME – Programa Nacional de Biomedicina.

- *Funciones de nuevos genes candidatos y proteínas asociadas a mielina durante el desarrollo y regeneración de las conexiones corticales* (2007-2010).
PI: **José Antonio Del Río**
MEC (BFU2006-13651).

- *Intracellular Signalling in Prion Diseases* (2007-2009).
PI: **José Antonio Del Río**
MEC, Exploratory Grants with Foreign Groups (BFU-2004-365-E).

- CIBER-NED. CIBER *en Enfermedades Neurodegenerativas* (2006-2010).
PI: **José Antonio Del Río**
Instituto de Salud Carlos III – MSC.

- *Support on Excellence Research Groups of Catalonia* (2005-2009).
PI: **José Antonio Del Río**
Catalonian Science Agency (SGR2005-0328).

- *Infrastructure Grant* (2007-2009)
PI: **José Antonio Del Río**
AGAUR.

- *Dotación de equipos y acondicionamiento de un servicio de criogenia en la Facultad de Biología* (2006-2009).
PI: **José Antonio Del Río**
MEC (UNBA05-35-015).

- *Alteración de la Nanomecánica de los neutrófilos en la lesión pulmonar inducida por el ventilador.*
PI: **Daniel Navajas**
Ministerio de Sanidad y Consumo (PI081908).

- CIBER-RES. CIBER *de Enfermedades Respiratorias.*
PI: **Daniel Navajas**
Instituto de Salud Carlos III – MSC.

- CIBER-BBN. CIBER *de Bioingeniería, Biomateriales y Nanomedicina.*
PI: **Daniel Navajas**
Instituto de Salud Carlos III – MSC.

- *Mechanisms of Stretch-Induced Disruption of the Alveolar Epithelial Barrier* (2008-2012).
PI: **Xavier Trepat**
MICINN.

- *Study of the Physical Forces Driving Collective Cell Migration During Lung Epithelial Repair* (2009-2012).
PI: **Xavier Trepat**
MICINN.

- DIACROPOL. *Early Diagnostics of Prostate Cancer by Nanobiosensors Based on Olfactory Receptors* (2007-2010).
PI: **Josep Samitier** (Coordinator).
MICINN.

- ONCNOSIS. *Research and Development of Diagnosticprognostic Technologies and Products and Therapeutic Applications in Neoplastic Disease* (2006-2009).
PI: **Josep Samitier**
CDTI. CENIT Project.

- VACMON. *Generación de biosensores electroquímicos basados en híbridos biomolécula-nanopartícula para la evaluación de la respuesta inmune funcional* (2009-2011).
PI: **Josep Samitier**
MICINN.

- MINAHE3. *Bio-Functionalization of Micronanotools to Study, Tag and Actuate Inside Living Cells* (2009-2011).
PI: **Christian Sporer**
MICINN.

- NANOBIOMED. *Nanotecnologías en biomedicina* (2006-2010).
PI: **Xavier Fernández-Busquets**
MEC, CONSOLIDER Programme (CSD2006-00012).

- HYBRID-NANOCELL. *Novel Hybrid Nanotechnologies to Explore Molecular Interactions at Bio-Non/Bio-Interfaces* (2007-2010).
PI: **Gabriel Gomila**
MEC, Proyectos I+D.

- *Ayuda para la intensificación de la actividad de la investigación* (2008-2010).
PI: **Gabriel Gomila**
Programa 13, MEC-Generalitat de Catalunya.

- *Systems for the Detection of Explosives in Centers and Public Infrastructures* (2008-2011).
PI: **Santiago Marco**
Project CENIT, MITC.

National Projects Managed by UPC

▪ *Desarrollo de nuevos biomateriales para regeneración ósea.*
PI: **Josep A. Planell**
MICINN. Acción Complementaria Internacional con Corea.

▪ *Angiogenesis en ingeniería de tejidos* (2008-2010).
PI: **Elisabeth Engel**
Project co-financed by the UPC and MEC.

▪ MUBISIPRO. *Multimodal Multichannel Biomedical Signal Processing* (2007-2010).
PI: **Raimon Jané**
CICYT (TEC2007-68076-C02-00).

▪ M3PBIO. *Multichannel Monitoring and Multimodal Processing of Biomedical Signals in Sleep-Disordered Breathing, Respiratory Diseases and Cardiac Pathologies* (2007-2010).
PI: **Raimon Jané**
MEC.

▪ *Robotic Multielectrode System for Microcircuit Electrophysiology* (2007-2010).
PI: **Enric Claverol-Tinturé**
CICYT (TEC2007-60436).

▪ *Real time analyzer of respiratory sounds for detection and evaluation of snoring and apnoea* (2009-2010).
PI: **Raimon Jané**
Industrial project with SIBEL, S.A.

▪ *Estudio y desarrollo de estrategias de cooperación multirobot con arquitecturas redundantes* (2009-2010).
PI: **Alícia Casals**
CICYT.

Research Projects with Companies

▪ ONCOLOGICA. *Nuevas estrategias basadas en biomarcadores para la detección del cáncer, su pronóstico, la predicción de respuesta y el desarrollo de nuevos tratamientos* (2009-2012).
PI: **Josep Samitier**
CDTI – CENIT Project. Industrial project with Genómica, S.A.U. Coordinated by PharmaMar.

▪ NANOFARMA. *Sistemas de liberación dirigida de fármacos* (2006-2009).
PI: **Maria Garcia-Parajo** (Coordinació: FAES FARMA i PharmaMar)
CDTI, CENIT Programme.

▪ SOMNO-ALERT® P-10. *Detección de Somnolencia* (2009 - 2011).

PI: **Santiago Marco**
Industrial project with FICOMIRRORS, S.A.

PUBLICATIONS

Microbial Biotechnology and Host-Pathogen Interaction

- Baños, R. C., Vivero, A., Aznar, S., Garcia, J., Pons, M., Madrid, C. and Juarez, A. *Differential regulation of horizontally acquired and core genome genes by the bacterial modulator H-NS.* PLoS Genetics, 5 (6): 8 (2009).
- Lundin, D., Torrents, E., Poole, A. and Sjoberg, B.-M. *RNRdb, a curated database of the universal enzyme family ribonucleotide reductase, reveals a high level of misannotation in sequences deposited to Genbank.* BMC Genomics, 10 (1): 589 (2009).
- Garcia, J., Madrid, C., Cendra, M., Juarez, A. and Pons, M. *N9L and L9N mutations toggle Hha binding and hemolysin regulation by Escherichia coli and Vibrio cholerae H-NS.* FEBS Letters, 583 (17): 2911-2916 (2009).

Molecular and Cellular Neurobiotechnology

- Aguado, F., Diaz-Ruiz, C., Parlato, R., Martinez, A., Carmona, M. A., Bleckmann, S., Urena, J. M., Burgaya, F., Del Rio, J. A., Schutz, G. and Soriano, E. *The CREB/CREM transcription factors negatively regulate early synaptogenesis and spontaneous network activity.* Journal of Neuroscience, 29 (2): 328-333 (2009).
- Nicolas, O., Gavin, R. and Del Rio, J. A. *New insights into cellular prion protein (PrPc) functions: The "ying and yang" of a relevant protein.* Brain Research Reviews, 61 (2): 170-184 (2009).
- Montolio, M., Messeguer, J., Masip, I., Guijarro, P., Gavin, R., Del Rio, J. A., Messeguer, A. and Soriano, E. *A semaphorin 3A inhibitor blocks axonal chemorepulsion and enhances axon regeneration.* Chemistry & Biology, 16 (7): 691-701 (2009).
- Rangel, A., Madroñal, N., Gruart i Masso, A., Gavin, R., Llorens, F., Sumoy, L., Torres, J. M., Delgado-Garcia, J. M. and Del Rio, J. A. *Regulation of GABA(A) and glutamate receptor expression, synaptic facilitation and long-term potentiation in the hippocampus of prion mutant mice.* PLoS ONE, 4 (10): e7592 (1-14) (2009).

Cellular and Respiratory Biomechanics

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- Farre, R. and Navajas, D. *Quality control: A necessary, but sometimes overlooked, tool for improving respiratory medicine.* European Respiratory Journal, 33 (4): 722-723 (2009).
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Nanoprobes and Nanoswitches

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▪ Nussio, M. R., Oncins, G., Ridelis, I., Szili, E., Shapter, J. G., Sanz, F. and Voelcker, N. H. *Nanomechanical characterization of phospholipid bilayer islands on flat and porous substrates: A force spectroscopy study.* Journal of Physical Chemistry B, 113 (30): 10339-10347 (2009).

▪ Gomez, M. L., Hoppe, C. E., Zucchi, I. A., Williams, R. J., Giannotti, M. I. and Lopez-Quintela, M. A. *Hierarchical assemblies of gold nanoparticles at the surface of a film formed by a bridged silsesquioxane containing pendant dodecyl chains.* Langmuir, 25 (2): 1210-1217 (2009).

▪ Caballero-Briones, F., Artes, J. M., Diez-Perez, I., Gorostiza, P. and Sanz, F. *Direct observation of the valence band edge by in situ ECSTM-ECTS in p-type Cu2O layers prepared by copper anodization.* Journal of Physical Chemistry C, 113 (3): 1028-1036 (2009).

Nanobioengineering

▪ Guix, F. X., Ill-Raga, G., Bravo, R., Nakaya, T., de Fabritiis, G., Coma, M., Miscione, G. P., Villa-Freixa, J., Suzuki, T., Fernandez-Busquets, X., Valverde, M. A., de Strooper, B. and Munoz, F. J. *Amyloid-dependent triosephosphate isomerase nitrotyrosination induces glycation and tau fibrillation.* Brain, 132 (5): 1335-1345 (2009).

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Dr. Lourdes Arce Dept. Química Analítica, Universidad de Córdoba (Spain).
Prof. Enrique Ruspini European Center for Softcomputing, Mieres, Asturias (Spain).
Prof. María Pilar Marco Applied Molecular Receptor group (AMRg), Insitute of Advanced Chemistry of Catalonia, Spanish Council for Scientific Research (IQAC-CSIC), Barcelona (Spain).

Neuroengineering

Technical University of Eindhoven (Netherlands).
Ludwig-Maximilians-Universität Munic (Germany).
University of Nottingham (United Kingdom).
Vrije Universiteit Amsterdam (Netherlands).
DiverDrugs, S.L. (Spain).
Multi Channel Systems GmbH (Germany).
Hebrew University of Jerusalem (Israel).
University of Milano (Italy).

Robotics

Dr. Josep M. Tormos Fundació Institut Guttmann, Barcelona (Spain).
Dr. Enric Laporte Corporació Sanitària Parc Taulí, Sabadell (Spain).
Dr. Joan Antoni Hueto Hospital de la Vall d'Hebrón, Barcelona (Spain).
Dr. Carlos Torrens Hospital del Mar, Barcelona (Spain).
Javier Magriñá Mayo Clinic, Scottsdale, Arizona (USA).
Salvador Riera Centre per a la Vida Independent, Barcelona (Spain).

Scientific Equipment and Techniques

Microbial Biotechnology and Host-Pathogen Interpretation

- Microbial culture facilities
- Protein expression and purification systems
- Biomolecule production process
- Protein and DNA electrophoresis apparatus
- Thermocycler (PCR)

Molecular and Cellular Neurobiotechnology

- Gradient thermocyclers (PCR) and molecular biology equipment
- Neural Cell culture (2D and 3D)
- Neural stem cell culture
- Microscopy facility (Olympus BX61 and OPTIKA XDS2 with LCi culture system)
- Protein expression and purification systems

Control of Stem Cell Potency

- Molecular biology facilities
- Cell culture facilities
- Stereomicroscope for picking hES colonies
- Neon transfection system
- Zebrafish transgenesis

Cellular and Respiratory Biomechanics

- Atomic force microscope
- Magnetic tweezers
- Optical tweezers
- Live cell fluorescence microscopy
- Cell stretching
- Traction microscopy
- Micro/nano patterning of surfaces
- Cell culture
- Confocal microscopy
- Fluorescence resonance energy transfer (FRET) microscopy

Nanoprobes and Nanoswitches

- Electrochemical scanning tunnelling microscope (STM) for molecular imaging
- Three-patch clamp setup
- Autolab potentiostat
- Molecular force probe
- Asylum research molecular force probe
- iMic molecular imaging system

Nanobioengineering

- Chemical functionalisation
- Soft lithography
- Electrochemical sensor characterization equipment
- Surface plasmon resonance
- Imaging surface plasmon resonance
- Quartz crystal microbalance
- Atomic force microscope
- Nanoplotter equipment
- Microfluidics laboratory
- Automatized microcontact printing system (custom-made)
- Optical waveguide lightmode spectroscopy (OWLS System)
- Microplate Manager (Bio-Rad)
- Biological safety cabinet (Class II)

Single Molecule Bionanophotonics

- Aperture type near-field optical microscopy (NSOM) for working under aqueous conditions
- Single-molecule-detection-sensitive scanning confocal microscopy: imaging, polarization, and wavelength sensitive
- Dual-colour total internal reflection fluorescence microscopy (TIRF): polarization and wavelength sensitive
- Dual-colour wide-field fluorescence microscopy equipped with intensified charge coupled device (CCD) camera
- Multi-parametric single-molecule confocal / epi-fluorescence microscopy (Microtime 200)
- Lasers: helium-neon (He-Ne) and argon/krypton (Ar/Kr+)

Nanoscale Bioelectrical Characterization

- Two Atomic Force Microscopes (Nanotec Electronica S.L.) fully customized for DC and AC electric current and electrostatic force detection
- Sub-Femtoamp Remote SourceMeter (Keithley 6430)
- Optical Microscope
- Atomic Force Microscope (Nanosurf easyScan 2) for imaging and DC electrostatic force detection

Bio/Non-Bio Interactions for Regenerative Medicine

- Surface characterization equipment (contact angle, Z potential, quartz crystal microbalance, nanoindenter)
- Cell culture facilities
- Molecular Biology equipment: protein and DNA electrophoresis
- Thermocycler (PCR)
- Biotool (Rapid prototyping)
- Peptide synthetiser
- Combustion furnace
- Electrospinning device
- Spin-coater
- Vibrational viscosimeter
- Ion selective electrodes for Ca2+, Na+, K+, and pH

Molecular Dynamics at Cell Biomaterial Interface

- Flow chamber for measuring the strength of cell adhesion
- Experimental electrospinning device designed for the production of nanofibres from natural and synthetic polymers
- Equipment for advanced cell culturing

Biomechanics and Mechanobiology

- Finite element software (Abaqus, Fluent, MSC Marc)
- Image reconstruction software (Mimics)
- High performance server (Windows Server 2008 HPC with 24 nucelus, 192 GB RAM and a 5TB disk)
- Perfusion bioreactor system
- Bose ElectroForce BioDynamic bioreactor system

Biomedical Signal Processing and Interpretation

- Server for high performance biomedical signal processing
- Beat-to-beat arterial blood pressure and haemodynamic monitor equipment
- Polysomnographic equipment available in the sleep laboratory of collaborating hospital
- Sensors for cardiac, respiratory and sleep biomedical signals
- Snoring analyzer equipment (SNORYZER)
- Databases of biomedical signals from hospitals and animal laboratories
- BIOPAC system for multichannel cardiac and respiratory biomedical signal acquisition

Artificial Olfaction

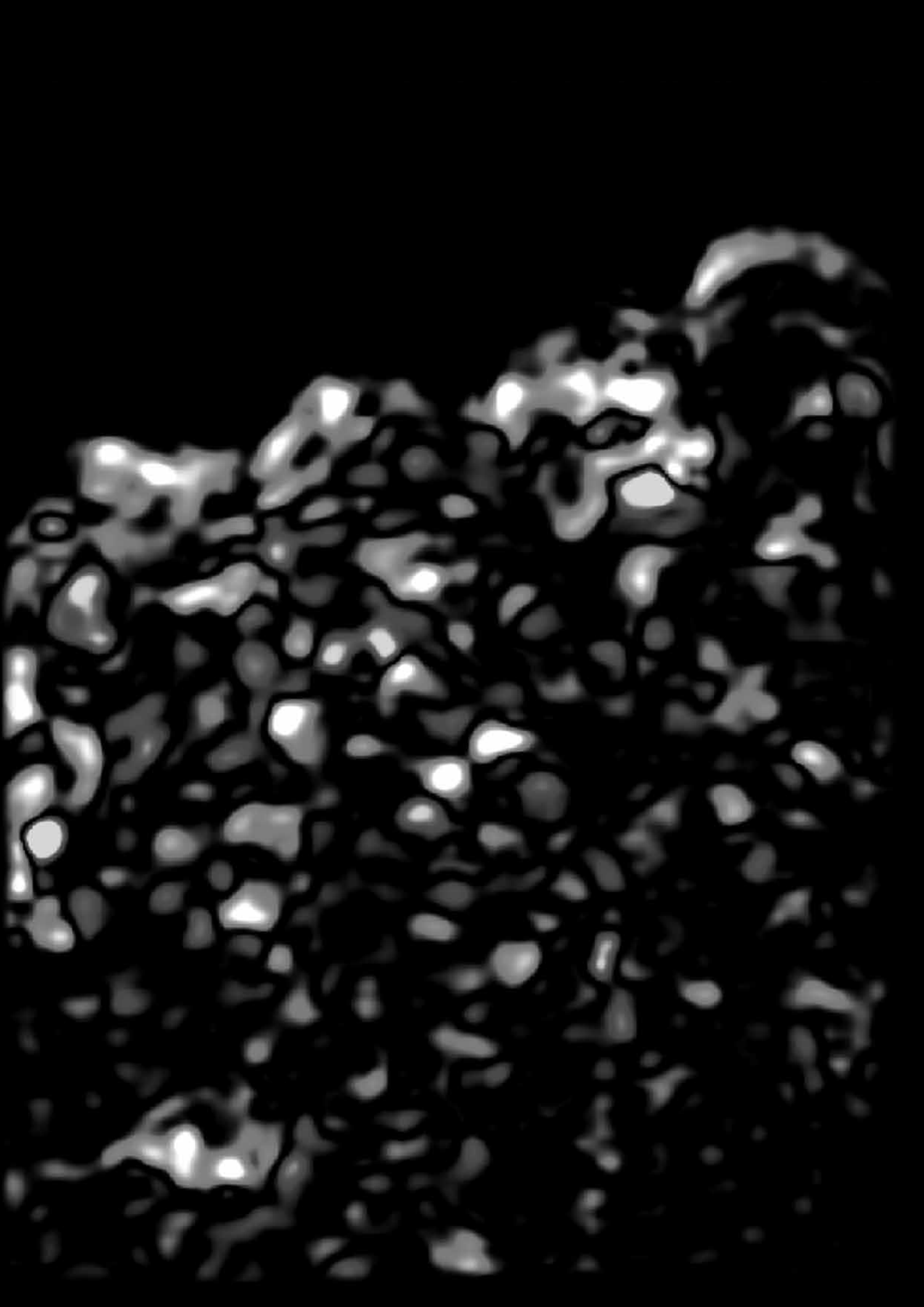
- VocMeter Electronic Nose
- Infrared Camera
- NST 3320 Electronic Nose
- Climate-controlled Chamber adapted for atmosphere modification
- Computer equipment and general purpose electronic instrumentation
- Gas chromatograph/mass spectrometer
- Gas sensor test station, with associated equipment for excitation, data logging and mixture generation
- Ion mobility spectrometer
- Computing cluster with 32 processors
- Automated headspace sampler
- ThermoScientific
- Temperature and humidity gas conditioner
- Photolonization detector
- Double-column gas chromatography system with flame ionization detector
- Olfactive port for gas chromatography
- Head-space sampler
- UV-IMS (ultraviolet-ion mobility spectrometry)
- Owlstone vapor generator
- Infusion pumps K-systems

Neuroengineering

- Dual-micromanipulator electrophysiology setup
- UV laser scanning direct-lithography system
- 64-channel multielectrode array amplifier
- Pipetting robot (Freedom EVP75)
- Mini-pipetting robot
- Nonlinear microscope setup
- Lasers: He-Ne, femtopower high – power femtosecond fiber laser

Robotics

- Experimental robotized kitchen composed of a robot, several adapted cupboards, a kitchen counter, and a PC for robot and environment control
- KUKA lightweight robot. Robot specially designed for mobility and interaction with humans and a priori unknown environments. It is equipped with a control environment developed by the research team to program anatomic constraints in order to operate in virtual environments.



IBEC INITIATIVES

Institutional Projects and Activities

NANOMED SPAIN

Spanish Nanomedicine Platform

Nanomed Spain, the Spanish Nanomedicine Platform, is a forum managed by IBEC that brings together public research centres, hospitals, companies and government representatives to unite public and private interests in the development of common strategies. The Platform represents the interests of its stakeholders in the burgeoning and multidisciplinary area of nanomedicine.

In 2009, the activity of Nanomed Spain was mainly focused on leveraging its relationship and that of its members with European policy makers and researchers, both at bilateral and multilateral level. The Platform coordinated the Spanish contribution to the European research agenda in this field, which has subsequently been summarized in *Roadmaps in Nanomedicine Towards 2020* published by the European Technology Platform on Nanomedicine. It also boosted Spanish participation in EuroNanoMed ERA-NET, an initiative undertaken to facilitate and expedite the transfer of innovations resulting from academic research to industrial and clinical applications. Another remarkable achievement has been the establishment of NanoMed-UII, a technical office in charge of fostering the participation of Spanish companies in European projects.

Last year NanoMed Spain also contributed to innovations in other healthcare-related sectors, strengthening its links with institutions in areas such as animal healthcare and innovative medicine.

PRINCIPAL ACTIVITIES:

- **NanoMed-UII**

NanoMed-UII is a value-added service providing support and advice to Spanish companies on how to strengthen their international activity and profile through participation in nanomedicine projects funded by the European Union Seventh Framework Programme (FP7). Nanomed-UII was launched in January 2009 as one of the international innovation units financed by the Centro para el Desarrollo Tecnológico Industrial and the Spanish Ministry of Science and Innovation.

In addition to providing a consultancy service advising companies on how to prepare projects and create consortia, in July 2009 NanoMed-UII organised networking events in Barcelona and Santiago de Compostela. NanoMed-UII has also fostered Spanish participation in events promoting new consortia, such as the EuroNanoForum held in Prague last June. This conference was a key European event in the area of transfer of nanotechnology from research to industrial production processes, products, and applications.

- **UK-Iberia collaboration**

In 2009, NanoMed Spain began collaborating with the health technologies and nanotechnology Knowledge Transfer Networks in the United Kingdom. The aim was to bring the communities of both research fields closer together, encouraging collaboration and the transfer of technology for the benefit of patients. The first UK-Iberia Nanomedicine Workshop was a good opportunity to begin consolidating this collaboration. NanoMed Spain was also invited to participate in the third UK NanoForum.

- **Collaboration with other platforms**

NanoMed Spain was the organiser, together with Innovative Medicines Innitiative-Spain, of the 2nd Annual Conference of the Biomedical Technological Platforms. The conference took place in Madrid on 27 and 28 January 2009.

- **Representation of the Spanish nanomedicine community at several events**

NanoMed Spain represented the Spanish nanomedicine community at Nanotech 09 held in Tokyo from 17 to 20 February 2009. It also participated in the Trends in Nanotechnology summit in Barcelona from 8 to 11 September and the 3rd Conference – Spain at the FP7 in Seville at the end of March.

EURONANOBIO

IBEC participated in this FP7 project to draw up plans for a European infrastructure in nanobiotechnology (FP7-CSA, February 2009-February 2010). The aim of EuroNanoBio was to define the key features of this future European nanobiotechnology infrastructure and the roadmap needed to achieve the desired goal. The project started with an in-depth analysis of the success factors behind the leading centres, nodes and clusters in the EU and elsewhere, focussing on their current capabilities in scientific research, technology transfer, education, and communication. The objective was to establish what the features of the future European infrastructure should be, the role of the various stakeholders, and the steps required to achieve the ideal situation.

NANO2MARKET

The focus of this FP7-sponsored project (FP7-CSA, July 2009-July 2010) is to identify best practices for the protection and exploitation of intellectual property in the context of the technological development of nano-based innovation, in a wide range of industrial sectors. The participation of IBEC in this project is mostly concerned with the transfer of nanotechnologies to healthcare and other bio-related markets.

European Technological Platform on Nanomedicine (ETPN)

A voting member of ETPN since 2008, the IBEC has contributed as an invited expert body, through its director and the Institutional Projects Unit, to Roadmaps for Nanomedicine Towards 2020. This key document in the area of nanomedicine was drawn up to advise the European Commission on future R&D investment needed to ensure successful translation of the results of research into the related sectors of medical and pharmaceutical technologies.

The European Federation of Biotechnology (EFB)

The IBEC represents the European Alliance in Nanobiotechnology (NaBiA) in the European Federation of Biotechnology and chairs the Nanobiotechnology Section. NaBiA was created in January 2009 through the merger of the membership of two Networks of Excellence, Frontiers and Nano2Life. Its mission is to consolidate the nanobiotechnology community created in the course of these two strategic projects.

Strategic Alliances

Groups from the UB and the UPC Associated with the IBEC

In 2009, the IBEC continued to collaborate with the University of Barcelona (UB) and the Polytechnic University of Catalonia (UPC) on joint research programs. Under an agreement signed in 2006, the IBEC funds ten PhD scholarships a year, one for each associated group:

- **Biomaterials, Biomechanics and Tissue Engineering (UPC)**
- **Biomedical Signals and Systems Unit (UPC)**
- **Robotics and Vision Unit (UPC)**
- **Instrumentation and Bioengineering Unit (UPC)**
- **Ionizing Radiation Dosimetry Unit (UPC)**
- **Graphical Computer Science Unit (UPC)**
- **Bioelectronics Unit (UB)**
- **Biophysics and Bioengineering Unit (UB)**
- **Microbiology Unit (UB)**
- **Surface Science and Nanotechnology Unit (UB)**

Biomedical Research Networking Center in Bioengineering, Biomaterials and Nanomedicine (CIBER-BBN)

Founded in 2006, CIBER-BBN is one of Spain's Biomedical Research Networking Centers (CIBERs). The primary aim of these consortia is to create large multidisciplinary and multi-institutional networks of research centres that will integrate basic and clinical research. CIBER-BBN, which is financed by the Instituto de Salud Carlos III, works in a number of areas including bioengineering, biomedical imaging, biomaterials, tissue engineering, and nanomedicine. Research is focused on disease prevention, diagnostics systems, and technologies for specific therapies, such as regenerative medicine and nanotherapies. IBEC works closely with CIBER-BBN, playing a role in the organisation and taking part in its research groups to help them carry out their work. The two institutions also share technical research equipment.

Fundació Clínic - Hospital Clínic

IBEC is working with both the Fundació Clínic and the Hospital Clínic in Barcelona to promote applied research across all three institutions.

The Catalan Institution for Research and Advanced Studies (ICREA)

ICREA is a foundation supported by the Catalan Government. Its aim is to recruit for the Catalan R&D system top scientists capable of leading new research groups, strengthening existing groups, and setting new lines of research on the right track. To achieve its objectives, the foundation works closely with Catalan universities and research centres based in Catalonia through long-term agreements that allow ICREA researchers to participate in research groups in these universities and centres. Four IBEC group leaders are ICREA research professors.

Catalan Researcher Mobility Support Node

IBEC supports the work of the Catalan Researcher Mobility Support Node, a body set up to attract researchers from all over the world to Catalonia and to meet their needs during their stay. All of Catalonia's universities and a number of research centres are members of the Node, which is an initiative of the Catalan Foundation for Research and Innovation (FCRI).

The BioRegion of Catalonia (Biocat)

Biocat is the organization that coordinates, develops and promotes the biotechnology, biomedicine and medical technology sectors in Catalonia. Its mission is to make Catalonia an international reference in terms of high quality research, competitive networks and an increasingly dynamic knowledge transfer system. IBEC contributes to the BioRegion programme by taking part in the BioRegió Forum. This forum is an advisory body actively involved with all the organizations associated with Biocat. IBEC has played an active role in the initiative by creating a medical technology cluster in Catalonia, which is run by Biocat.

Memorandums of Understanding

IBEC collaborates with other institutions and research centres on joint projects, exchange staff members, and share research facilities and equipment. During 2009, the Institute has signed memorandums of understanding with:

- **The Bellvitge Institute for Biomedical Research (IDIBELL)**
- **National Institute for Materials Science (NIMS)**
- **Interstaatliche Hochschule für Technick Buchs (NTB)**

Nanoaracat

Nanoaracat is a protocol that establishes a framework for collaboration between the regional governments of Aragon and Catalonia to foment and coordinate R&D projects in nanoscience and nanotechnology. IBEC is one of 17 institutions involved in this initiative and is a member of the scientific and monitoring committees.

Seminars and Lectures

IBEC Seminars

Throughout the year, a number of international experts, scientists who work with our research teams on certain projects and some of the IBEC group leaders were invited to give lectures as part of the 2009 IBEC Seminars programme. The aim of these events is to provide an overview of the state-of-the-art research in various fields and to give the audience the opportunity to discuss recent research with the guest speakers.

- *Bionanoscience: Mechanisms of Regulated Interaction, Switching and Control at the Single Molecule Level*
Prof. Dario Anselmetti
Experimental Biophysics and Applied Nanoscience, Bielefeld University and the Bielefeld Institute for BioPhysics and NanoScience, Germany

- *Extracellular Matrix Dynamics at the Cell-Material Interface*
Prof. George Altankov
Institute for Bioengineering of Catalonia and ICREA, Spain

- *Immunodiagnostics: New Trends Based on Novel Nano and Micro Biotechnological Approaches*
Prof. M. Pilar Marco
Applied Molecular Receptors Group (AMRG), Institute of Advanced Chemistry of Catalonia - CSIC and CIBER-BBN, Spain

- *Integration of Imaging, Modeling and Simulation: Towards the VPH in the Clinics*
Prof. Alejandro Frangi
Center for Computational Imaging & Simulation Technologies in Biomedicine, Pompeu Fabra University; CIBER-BBN, and ICREA, Spain

- *Understanding the Psychological Dimensions in the Perceptual Space of Smells as a Basis to Develop Sensory Maps of Odors*
Dr. Manuel Zarzo Castelló
Technical University of Valencia, Spain

- *Experimental Strategies in Applied Nanomedicine: In Vitro and In Vivo Validation Approaches for Therapeutic Nanoconjugates*
Prof. Simó Schwartz
Molecular Biology and Biochemistry Research Center for Nanomedicine, Vall d'Hebron University Hospital, Spain

- *The Role of Extracellular Matrix and Organ Architecture*
Prof. Mina J. Bissell
Life Sciences Division. Lawrence Berkeley National Laboratory, USA

- *Marrying Materials Science, Microtechnologies, Biomedicine and the Life Sciences - a Perspective from 10 Years Research in Uppsala*
Prof. Fredrik Nikolajeff
BioMEMS Group, Angstrom Laboratory, Uppsala University and Uppsala Berzelii Technology Centre for Neurodiagnostics, Finland

- *Noninvasive Imaging Procedures in Biomedical Research*
Prof. Jerónimo Blanco
Catalan Cardiovascular Sciences Institute - CSIC, Spain

- *DNA-Based Organization of Matter on Surfaces*
Prof. Ramon Eritja
Institute of Advanced Chemistry of Catalonia - CSIC and Institute for the Research in Biomedicine, Spain

- *Polymer-Drug Conjugates: a Novel 'Technology Platform' for Tissue Regeneration and Cancer Treatment*
Dr. María Jesús Vicent
Polymer Therapeutics Laboratory, Príncipe Felipe Research Centre, Spain

- *The Olfactory System of Insects Suggests a Random Kernel Method for Classification*
Dr. Thomas Nowotny
University of Sussex, United Kingdom

- *Mathematical Modelling of Treatment Strategies to Enhance Bone Regeneration*
Prof. Hans Van Oosterwyck
Division of Biomechanics and Engineering Design, Katholieke Universiteit Leuven, Belgium

- *Optical Nano-Tools for Immunanoscopy*
Prof. Maria Garcia-Parajo
Institute for Bioengineering of Catalonia and ICREA, Spain

- *A Medical View of Robotics Evolution in Surgery*
Dr. Javier F. Magrina
Division of Gynecologic Oncology, Mayo Clinic, USA

- *Artificial Photosynthetic Reaction Centers Studied with Various Scanning Probe Microscopes*
Prof. Emeritus Masamichi Fujihira
Tokyo Institute of Technology, Japan

- *Calcium Phosphate Foams for Bone Regeneration*
Prof. Maria Pau Ginebra
Biomaterials, Biomechanics and Tissue Engineering Group, Department of Material Sciences and Metallurgical Engineering, Technical University of Catalonia, Spain

- *Nanomedicines and Delivery of Biopharmaceutics*
Prof. Bruno Sarmento
Department of Pharmaceutical Technology of the Faculty of Pharmacy of University of Porto and Department of Pharmaceutical Sciences of the Instituto Superior de Ciências da Saúde - Norte, Portugal

- *Active Organization of Membrane Components in Membranes of Living Cells: a Role for Cortical Actin*
Prof. Satyajit Mayor
Cellular Organization and Signaling Group, National Centre for Biological Science, Bangalore, India

- *Breath Analysis with Gas Sensor Arrays for Lung Cancer Detection*
Prof. Corrado di Natale
Department of Electronic Engineering, Università degli Studi di Roma "Tor Vergata", Italy

- *Computational Modelling of Transport Phenomena within Engineered Tissue*
Prof. Gabriele Dubini
Politecnico di Milano, Italy

PhD Discussions Seminars

These seminars are intended to encourage the participation of PhD students, providing a forum where they can present the results of their research and discuss it with fellow students and researchers. Throughout 2009, 14 PhD students participated in these sessions. Additionally, in order to help the students in their career development and provide them with skills not directly related to science, five consultants gave lectures on potential career paths inside and outside the academia, science dissemination and technology transfer.

Conferences and Symposia

2nd IBEC Symposium on Bioengineering and Nanomedicine

Internationally renowned scientists and IBEC researchers met at the Symposium of the Institute for Bioengineering of Catalonia to present details of their most recent research in the fields of bioengineering and nanomedicine.

- 14 -15 April 2009
- World Trade Center, Barcelona
- 184 attendees
- 10 keynote speakers
- 59 posters

ISOCS Summer School 2009

IBEC organised the Summer School of the International Society for Olfaction and Chemical Sensing.

- 28 September - 2 October 2009
- Sant Andreu de Llavaneres, Barcelona
- IBEC, ISOCS, Neurochem
- 17 attendees
- 13 expert professors

2nd China-Europe Symposium on Biomaterials in Regenerative Medicine

This symposium hosted by IBEC organized to provide a forum for the discussion of recent advances, to build relationships between European and Chinese researchers, and to promote collaboration in future research projects.

- 17 - 20 November 2009
- Petit Palau, Palau de la Música Catalana, Barcelona
- IBEC, ESB, CCBM
- 154 attendees
- 87 oral presentations
- 5 keynote speakers
- 67 posters

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