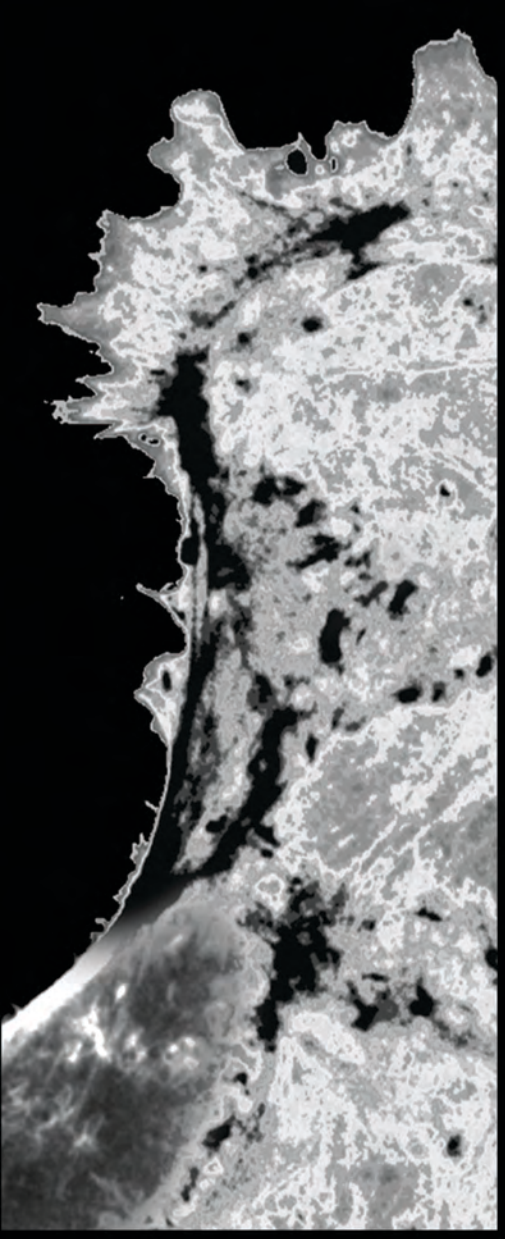
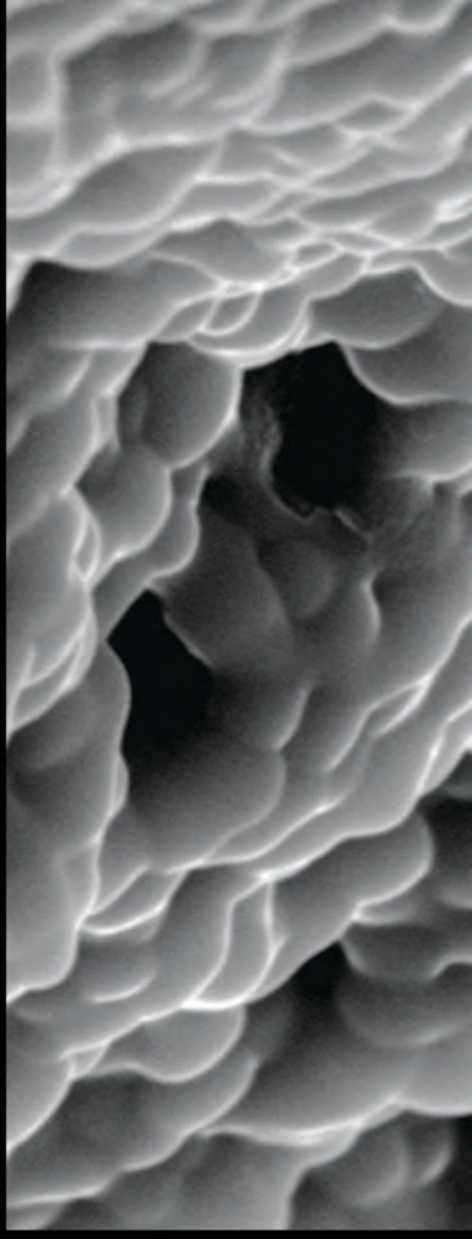
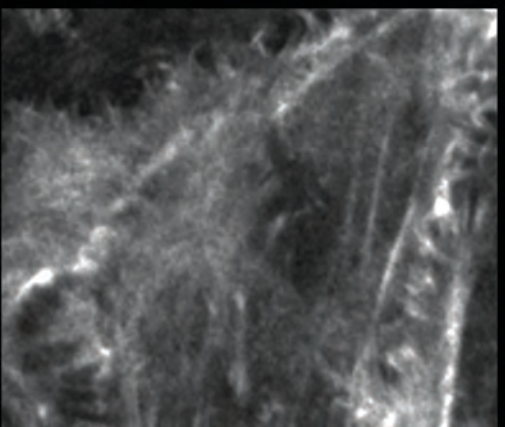
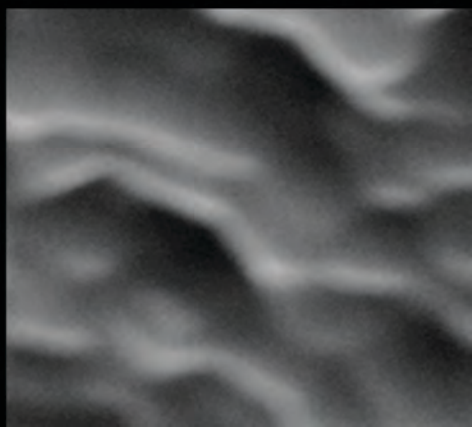




IBEC Annual Report 2012

ibec Institute for bioengineering of Catalonia





Institute for bioengineering of Catalonia

IBEC Annual Report 2012

Introduction

As we sail from 2012 into 2013, we feel rather like a ship emerging safe and sound after being battered by some unexpected bad weather.

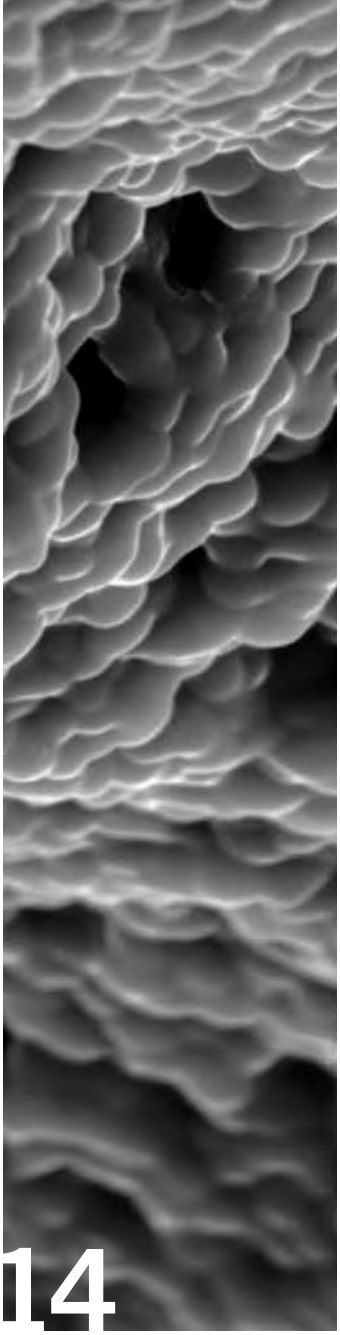
The year saw some hard and unexpected challenges for the institute, not generated from within, but entirely due to the continuing financial crisis that plagues the country. It is in this critical economic moment, when growth and activity expansion of our groups and of IBEC as a whole could be compromised, that we have devoted special efforts to stabilize and consolidate our present position. As we do so, we have to identify policies that will make us develop, grow faster and take competitive advantage when we emerge from the present economic crisis. With every new challenge comes new opportunities, and re-evaluating IBEC's strategies in the face of impending difficulty has shed fresh light on where our priorities might be and on the best ways to fulfil and continue to build upon our missions.

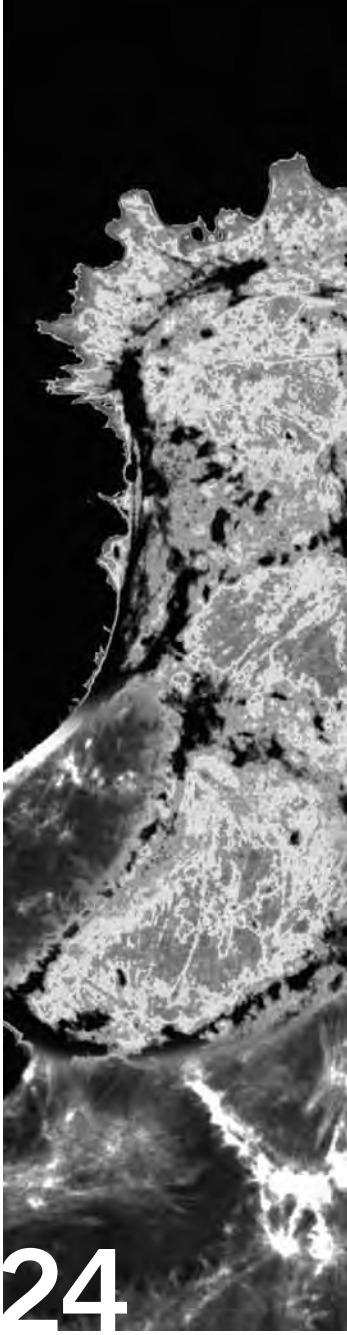
One aspect which continues to be a major area of new interest is the institute's forging into truly interdisciplinary research with the advent of our three 'flagships', Nanomedicine, Cell Engineering and Intelligent Healthcare. This is a very innovative project that only few research institutes have the privilege to develop, interdisciplinarity not being an asset that many scientific institutions are able to exhibit. Within these three areas, the diverse IBEC groups will combine their varying expertise to achieve the kind of critical mass that is needed to tackle some of the most topical and ambitious health issues in our society today. In 2012 IBEC's flagships enjoyed a first year of funding from Fundació La Caixa under the institutional project 'Sistemes de diagnòstic i teràpia basats en la integració de noves tecnologies nano bio info i cogno', providing the 'Strategic Research Innovation Initiative' (SRI^2) within which the three flagships will frame their interdisciplinary projects. In times such as these, private funding is crucial for us to be able to fulfil our mission to conduct high quality investigation to find solutions for novel, affordable medical technologies.

Another new and important step with which IBEC is facing the crisis head-on is by implementing its new Tenure Track procedure. This initiative enables continued growth, rejuvenation of scientific staff, provides opportunities for young scientists, and will ensure that IBEC maintains scientific excellence to face the future with a consolidated and sustainable institute. The Tenure Track process, in which existing or new senior researchers are established on a career path alongside an evaluation process, supports IBEC's current structure, incorporates external and leverages internal talent.

Despite the crisis having affected individuals personally, since governmental decisions have affected the wages of most of our personnel, the level of practical support we are able to offer our scientists has remained constant, with each of the administrative groups finding solutions to enable them to continue their efforts unabated. Such loyalty and understanding is the fabric that holds a medium-sized institute such as IBEC – small enough to retain an atmosphere of familiarity and cordiality but large enough to represent a competitive player when it comes to attracting international talent – together, especially during troubled times. The constant faith displayed by its workforce that IBEC will get through the times of hardship and emerge triumphant on the other side is all the encouragement we need to continue.

Josep A. Planell
Director of IBEC





Contents

2012 in review
News highlights

February

Green light for regeneration projects

At the beginning of the year, the two IBEC-led CIBER-BBN tissue regeneration projects that were earmarked for funding by the EU's ERA-NET EuroNanoMed initiative in 2011 received the national support they need to get started.

'Nanostructured Gel for Cellular Therapy of Degenerative Skeletal Disorders' (STRUCTGEL), coordinated by Molecular Dynamics at Cell-biomaterial Interface group leader George Altankov, combines partners from Spain, Germany, France and Turkey to tackle degenerative skeletal tissue disorders such as osteoarthritis by designing an implant able to influence site-specific tissue regeneration.

'Angiogenic nanostructured materials for non-consolidating bone fractures' (nAngioFrac), coordinated by Josep Planell's Biomaterials for Regenerative Therapies group, aims to develop tailored biodegradable and bioactive nanostructured scaffolds to ensure the correct release of calcium to promote tissue repair in pseudarthrosis, which results from inadequate healing after a bone fracture and sometimes during development. Its partners are from Spain, France and Poland.

March

Microscope development project for sub-surface imaging at the nanoscale

On 1st March IBEC's Nanoscale Bioelectrical Characterization group, headed by Gabriel Gomila, became a partner in a new EU-funded collaborative project set to develop a new tool for non-destructive 3D nanoscale structural characterization, the Volumetric Scanning Microwave Microscope (VSMM).

'Volumetric Scanning Microwave Microscopy Analytical and Research Tool for Nanotechnology' (V-SMMART Nano) involves three research and three industry partners from the UK, France, Spain, Austria, Italy and Germany. The VSMM will probe *in situ* the reflection and transmission of microwaves from and through material surfaces, measuring complex permittivity, conductivity, resistivity and magnetic response. The microscope will be easy to use and optimized for accurate measurements from the start. In addition, it will use SPM cantilever-probe technology to ensure compatibility with a range of other SPM-based tools.

"Effective tools and methodologies for sub-surface imaging at the nanometre scale are essential to explore the structural and chemical composition of biological materials and other systems," explains Gabriel. "Doing this will help us understand real-life systems such as nanoparticle drug uptake in biological cells, domain structure in ferroelectric devices, or trap mechanisms in solar cells." His group at IBEC will contribute their expertise in the application of 3D tomographic imaging in living cells to the project, as well as providing the technology to perform initial validation measurements and cantilever testing.

EU funding for research into Alzheimer's and prioniopathies

Also in March, a project involving IBEC through its affiliation with CIBERNED was approved by the EU for funding.

The EU Joint Programme – Neurodegenerative Disease Research (JPND) initiative selected four new international research projects under a transnational call between 21 countries. JPND aims to tackle one of the biggest challenges facing society, namely that of neurodegenerative diseases, and specifically the optimization of biomarkers and the harmonisation of their use.

The project, 'Biomarker-based diagnosis of rapid progressive dementias – optimization of diagnostic protocols' (DEMTEST), which was proposed by CIBERNED and coordinated by the University Medical Center Göttingen in Germany, counts Molecular and Cellular Neurotechnology group leader José Antonio del Río as one of its partners. His group will contribute by analyzing and harmonizing the

Left: the IBEC stand at the Saló de l'Ensenyament Education Show in March. Right: In May IBEC officially began a collaboration agreement with Barcelona's Vall d'Hebron Research Institute (VHIR)

Tau samples, a protein associated with microtubules that is implicated in Alzheimer's disease, of the European Biobanks.

The sweet smell of success

IBEC had a very popular stand at the Saló de l'Ensenyament Education Show in Barcelona in March. The booth, which showcased the BOND project and the world of olfaction, was swamped with young visitors keen to learn about the institute's research and job opportunities.

More than 80,000 people attended the fair, which is coordinated by the Generalitat of Catalonia's Department of Education of the Ministry of Economy and Knowledge. IBEC's stand was featured on both La 1's midday news and Barcelona TV during their coverage of the event.

April

10th "Recerca en directe" Science Fair

Another of IBEC's outreach efforts gained media coverage in April when Barcelona TV focused on the institute's robotics installation at the annual "Recerca en directe" science fair. 'Relating to Robots' enabled participants to perform a teleoperation with a robot and to control a robotic hand by contracting their own muscles.

The event, which is co-organized by the PCB and the CatalunyaCaixa Foundation every year, was held at Barcelona's famous La Pedrera on 24th-26th April. It aims to bring science closer to the public and to promote science as a career to students.

A journey through the technological revolution

IBEC associate director Josep Samitier officially opened the Tecnorrevolución exhibition at Barcelona's CosmoCaixa museum in April. Josep acted as scientific advisor to the exhibition, which provides an interactive overview of the rapid technological developments that have resulted from the convergence of nanotechnology, biotechnology, ICT and cognitive science (NBIC).

The exhibition, which will be on show at the CosmoCaixa museum until May 2013, comprises twenty interactive modules allowing the public to experience for themselves the radical new applications made possible by NBIC.

May

IBEC and VHIR sign collaboration agreement

In May IBEC officially began a collaboration agreement with the Vall d'Hebron Research Institute (VHIR) in Barcelona. Signed by IBEC director Josep A. Planell and VHIR's Joan Comella, the agreement formalised the institutes' joint participation in scientific projects and their shared development of innovative technologies for health, as well as their collaboration in technology transfer activities and knowledge exchange. It also consolidates the exchange of researchers between the institutes, the scientific and technical organization of joint conferences, seminars and events, and establishes conditions for the sharing of relevant facilities available at both institutes.

June

IBEC joins forces with IGTP

Further collaboration agreements were signed in June, this time with the Institut d'Investigació en Ciències de la Salut Germans Trias i Pujol (IGTP) to carry out and promote scientific and translational research.

The general agreement consolidated and enhanced the long-term previous collaboration of the Hospital Germans Trias i Pujol, one of the major hospitals in Catalonia, with IBEC's

News highlights *continued*

Biomedical Signal Processing and Interpretation group, as well as promoting new collaborations with other IBEC groups. The aim of the second, specific agreement was to create a joint research Unit between IBEC and IGTP, to be coordinated by Raimon Jané, head of the Biomedical Signal Processing and Interpretation group, and Miquel Àngel Gasull of IGTP.

New generation robots – inspired by plants

June also saw the start of the three-year European project PLANTOID, of which IBEC's Nanobioengineering group is a partner, which aims to design and develop robots inspired by plants.

Coordinated by the Center for Micro-BioRobotics (CMBR) of the Istituto Italiano di Tecnologia, the project "Innovative Robotic Artefacts Inspired by Plant Roots for Soil Monitoring (PLANTOID)", which is funded within the European Commission's prestigious Future and Emerging Technologies Open (FET-Open) scheme, aims to create robots called Plantoids which, combining a new generation of hardware and software technologies, will be able to imitate the behaviour of plant roots. An interdisciplinary scientific consortium comprising engineers, plant biologists and computer scientists will carry out the project, which also involves the University of Florence and the Polytechnic Federal School of Lausanne.

In their contribution to the project, the Nanobioengineering group at IBEC will focus on the chemical sensors that root apices need to recognize different substances in the soil. Every Plantoid will be made up of a root apex – comprising sensors, actuators and control units – and a robotic trunk, which are mechanically connected via a long structure. They will be useful for tasks such as environmental exploration and monitoring, offering adaptive control and communication capabilities.

September

Start of the first IBEC Junior Group Leaders

This month, the three candidates selected by the International Scientific Committee for IBEC's new Tenure Track scheme started in their new capacity as Junior Group Leaders.

Eduard Torrents, Elisabeth Engel and Pere Roca-Cusachs, who were all previously senior researchers in IBEC groups, were selected on the basis of several excellence criteria, including the scientific quality and feasibility of the projects they proposed, as well as the potential impact of their research. Other factors considered included the added value offered by the new projects to the current IBEC research programme, and the ability of the selected candidates to carry out efficient group leadership and management.

The Tenure Track process will last four years, during which the resources available to the Junior Group Leaders will be laboratory space, an internal budget, and all the support that Group Leaders receive from IBEC. At the end of the third year, the Junior Group Leaders will be evaluated by IBEC's International Scientific Committee. A positive evaluation, taking into account a further five-year project proposal, will allow the candidate to become a full Group Leader.

October

NanoMed Spain document remembers late founder

October saw the launch in Madrid of a new NanoMed Spain publication, 'Hoja por la Innovación en Nanomedicina en España' (White Paper on Innovation in Nanomedicine in Spain), which diagnoses the country's R&D&I capacities in the field so far and presents the potential opportunities, challenges and recommendations for the future.

The event, which took place at the Ministerio de Economía y Competitividad, included a presentation by IBEC associate director Josep Samitier as coordinator of the NanoMed Spain platform, as well as a round table involving IBEC director Josep A. Planell. Other participants at the event included representatives from the nationwide members of the platform from both research and industry.

'Hoja por la Innovación en Nanomedicina en España' is dedicated to one of the founders of NanoMed Spain, Joan Albert Vericat, whom Josep Samitier described as "a pioneer, part of that small group of people able to peer into the future and envisage the changes that will occur". Dr. Vericat died in July 2012.

November

Industry/research collaboration leads to fast-track for eye therapy

Within the framework of the Biomedical Research Networking Center in Bioengineering, Biomaterials and Nanomedicine (CIBER-BBN), in November IBEC signed an agreement with pharmaceutical company Ferrer and the universities of Valladolid and the Basque Country to work towards developing a stem cell-based therapy to regenerate the surface of the eye.

The researchers have been working on the reconstruction of the ocular surface using bone marrow stem cells, which are grown on a matrix which reproduces the eye tissue and then implanted in the patient, and IBEC's role has been to develop functionalized biomaterials that support and stimulate stem cells growth to enable re-epithelization of the damaged cornea. These scaffolds can be sutured to the patient's eye and will offer a temporary support to deliver the stem cells to the eye surface in order to regenerate it.

After six years of work, which has been led by the IOBA institute at the University of Valladolid, it is planned within the four-year timeframe of the new agreement to test the robustness of the trials, which have demonstrated promising results so far, with a view to achieving an introduction into clinical practice.

A day of discovery for all the family

Twenty members of the general public attended IBEC's Open Doors Day in October, which was entitled 'La Bioenginyeria per a Tothom'.

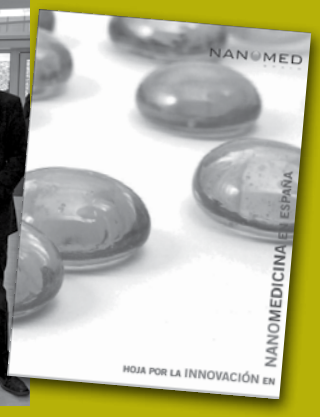
The day, which was held as part of this year's nationwide Setmana de la Ciència, welcomed a mix of people, with the oldest attendee in her 70s and the youngest 20. The participants – who ranged from parents of researchers to friends of administration staff and even a group of biological systems engineering undergraduates from the UPC – were fascinated and full of questions about the concepts they heard about, which included biomaterials, artificial olfaction, robotics and iPSC.

Presidency of SEIB for IBEC group leader

An IBEC group leader was elected as president of the Sociedad Española de Ingeniería Biomédica (SEIB) at its annual meeting (CASEIB) in San Sebastián in November.

Raimon Jané, head of IBEC's Biomedical Signal Processing and Interpretation group, will take up the post for the next four years, and is the society's sixth president since its foundation in 1978.

SEIB is the main scientific society in Spain devoted to biomedical engineering, and exists to promote and foster contact amongst companies, professional, researchers and students working in all branches of the field. It belongs to international societies such as the International Federation for Medical and Biological Engineering (IFMBE) and the European Alliance for Medical and Biological Engineering and Science (EAMBES) as the representative organisation for the field in Spain.



Left: Open Doors day at IBEC in November. Centre: group leader Raimon Jané takes on the role of president of the Sociedad Española de Ingeniería Biomédica (SEIB). Right: the new NanoMed Spain publication, 'Hoja por la Innovación en Nanomedicina en España'

2012 in review
Scientific highlights

January

Why cells misbehave

The olfactory system is one part of the human body that can renew itself, and it does this by using olfactory ensheathing cells (OECs) to guide newly formed axons towards the central nervous system. OECs have been transplanted to see if this ability also works to promote axonal regeneration in spinal cord injuries and neural diseases; but OECs need to move or migrate homogeneously and cohesively in order to be able to perform their task of guiding the axons, and factors in the spine area affect their behaviour so that they move individually or in the wrong direction.

In a study published in the journal *Cellular and Molecular Life Sciences* in January, IBEC researchers figured out exactly what it is that makes certain cells misbehave in particular circumstances, by using cell tracking and traction force microscopy to analyze OEC migration and its mechanical properties over myelin, an insulating material around axons in the brain and central nervous system. "Our results show that these cells express all the components of what's called the Nogo receptor complex, a combination of receptors used by myelin to inhibit the movement of the OECs," explains José Antonio del Río, group leader at IBEC. "If Nogo is inhibited with a protein called NEP1-40, the OECs could perform in the 'correct' way, as they do in the olfactory system, and aid axonal growth."

February

Developing a new solution to treat atherosclerosis

A scientific project involving IBEC and three other European research centres will offer a novel, minimally-invasive treatment to patients suffering from atherosclerosis – when fat, cholesterol, and other substances build up in the artery walls and form solid structures called plaques – thanks to funding awarded by the European Commission.

"The Grail" will develop a bioactive and bioresorbable scaffold able to locally regenerate the vessel after endovascular surgery in patients with the disorder.

"This *in vivo* deployable scaffold, which won't require mechanical removal, will offer an alternative treatment to mechanical re-channelling or bypassing of obstructed arteries," explains Elisabeth Engel, junior group leader in IBEC's Biomaterials for Regenerative Therapies group, which will carry out the research. "Using a regenerative approach compatible with current minimally invasive surgical techniques, the scaffold will substitute the diseased and stiffened area of artery and be repopulated by resident and circulating cells."

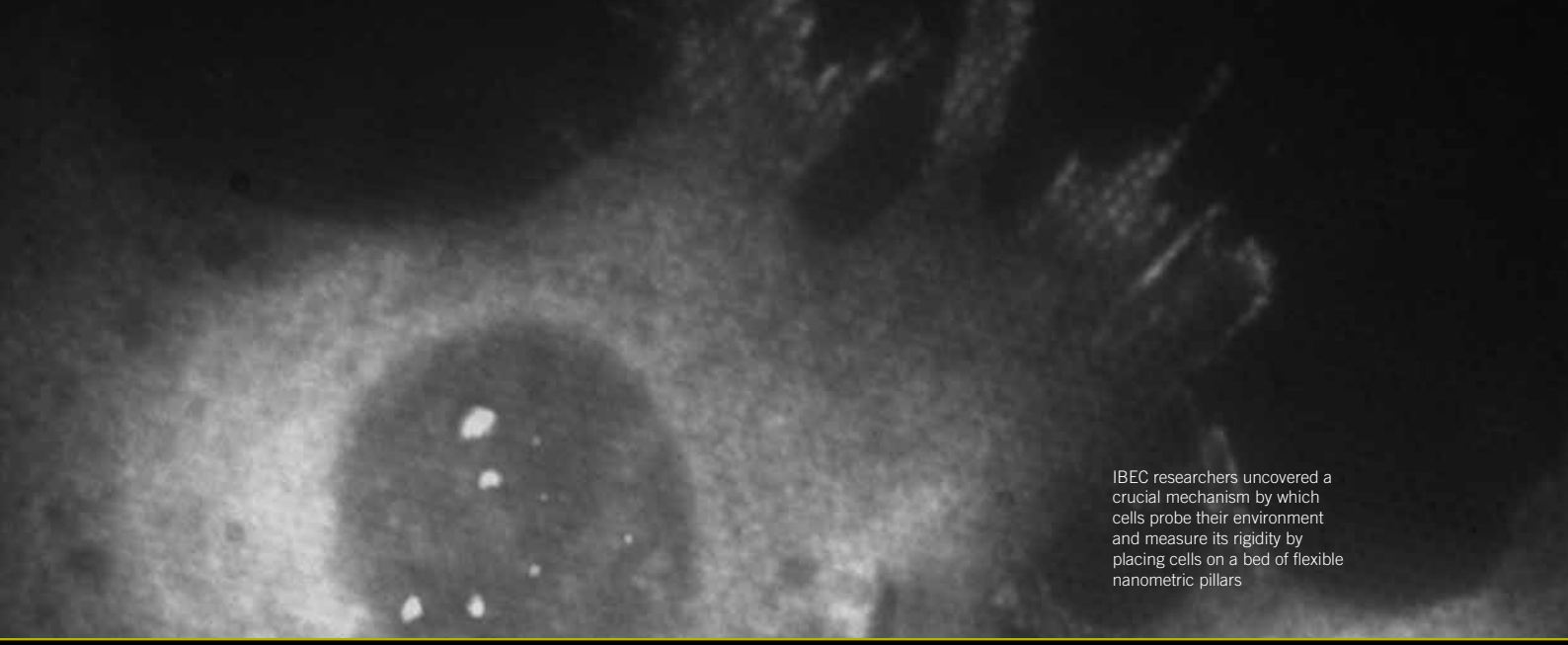
March

Understanding age-related disease

Researchers at IBEC have made an important leap towards understanding Parkinson's disease (PD), which affects around 5% of the population by age 85. Previously, it wasn't clear whether induced pluripotent stem cells (iPSCs) were able to shed any light on age-related illnesses. However, in monitoring iPSCs from patients with two types of Parkinson's alongside a healthy control group, the researchers witnessed the changes in the dopaminergic neurons that are necessary for the onset of the disease — and pinpointed the trigger for these changes.

"We mimicked the ageing process outside the body by culturing three types of iPSCs: those from genetic PD patients, sporadic PD patients and a healthy control group," explains Ángel Raya, who leads the Control of Stem Cell Potency group at IBEC. "We saw that the ones from both types of PD patients exhibited the changes in dopaminergic neurons necessary for the development of the disease, but not the ones from the healthy patients."

This reveals that susceptibility to non-hereditary PD should be coded in patients' genomes just as clearly as other patients' tendency to the hereditary kind, and it's also the first time that the spontaneous phenotypes that lead to



IBEC researchers uncovered a crucial mechanism by which cells probe their environment and measure its rigidity by placing cells on a bed of flexible nanometric pillars

sporadic PD have been described. The researchers were also able to identify that the neuronal alteration leading to both types of PD are the result of altered autophagy.

The mattress test: cells do it too

Just as people are picky about the type of mattress they want to sleep on, so are cells. In fact, the rigidity of the cellular environment is so important that it can be the determining factor in whether a stem cell will differentiate into bone or fat, or whether a cell behaves normally or turns cancerous.

In a paper published in *PNAS* in March, IBEC researchers uncovered a crucial mechanism by which cells probe their environment and measure its rigidity by placing cells on a bed of flexible nanometric pillars. "By tracking the movement of these pillars, we were able to map how cells exert forces on their environment with a resolution never achieved before," explains junior group leader Pere Roca-Cusachs. "Using this technique, we found that the rigidity sensor in cells is a small complex of not more than one micrometer long." The researchers saw, too, that the cell possesses multiple copies of this complex, all of which apply a constant displacement of 60 nanometers – less than 1/10000th of a millimeter. These results take researchers a step closer to understanding how cells interact with their surroundings; in turn, this opens doors to being able to predict or control cell behaviour.

June

How the nose knows

In June, scientists at IBEC shed new light on how chemical information is coded and processed in the animal olfactory system, gaining a valuable new insight for designers of artificial olfaction systems. They looked at the ability of the early rat olfactory system to detect odours and analysed their results by quantifying the number of smells that could be coded by a particular set of odour receptors (ORs).

"There's a complex arrangement of OR neurons in the system which are distributed over the nasal epithelium, and the number of types depends on the species," explains Santiago Marco, IBEC's Artificial Olfaction group leader. "We looked at the role played by this diversity and these varying quantities in encoding chemical information."

As different neurons respond to a different set of odours, the researchers classified rats' olfactory receptors according to their receptive range (RR) when exposing them to a large number of odours – an immense feat, due to the large number of receptors. They also looked at the capacity to discriminate depending on distribution, and the correlation among receptors. "We found that the ORs are not particularly selective, but that the system has a remarkably low overlap of sensors and good coverage of the odour space," says Santiago. "For sensors with low correlation, adding more to the set maximizes the coding capacity of the system." From this, the researchers surmise that biology has evolved toward a combination of more selective sensors for critical odours and a collection of less selective ones to cover larger areas.

Cells mind the gap

During development, injury and in various diseases, gaps appear in the epidermis, which have to be quickly filled in. Two possible mechanisms have been suggested for this: the closure of cells like the strings of a purse over a gap, and the extension of cellular protrusions by the cells surrounding the gap, which will eventually seal it.

In an attempt to understand the closure of naturally occurring gaps, the groups of Xavier Trepat at IBEC and Benoit Ladoux at the Mechanobiology Institute in Singapore developed a unique strategy to induce well-defined gaps within epithelial cells and monitor the dynamics of gap closure in the absence of cell injury. "Our observations showed that the cells around the edge of the gap protrude arm-like extensions (lamellipodia) into it and gradually fill it," explains Ester Anon, the first author of the paper published in *PNAS*. "These cells take the role of leader and crawl into the gap."

This study is significant in understanding the basic mechanics of gap closure in tissues, and the elegant system developed will enable further work towards unraveling the mechanics of gap closure.

Scientific highlights *continued*

July

‘Fingerprinting’ nanoscale objects and viruses

Scientists working at the nanoscale have long had to rely on chemical labeling in target objects to detect their presence and physical distribution, but labeling molecules can give misleading results about their properties. In July, IBEC scientists in collaboration with the Centro National de Biotecnologia (CNB-CSIC) in Madrid perfected a new technique that uses an electrostatic force microscope (EFM), a type of atomic force microscope, to unambiguously identify nano-objects with no need for labels.

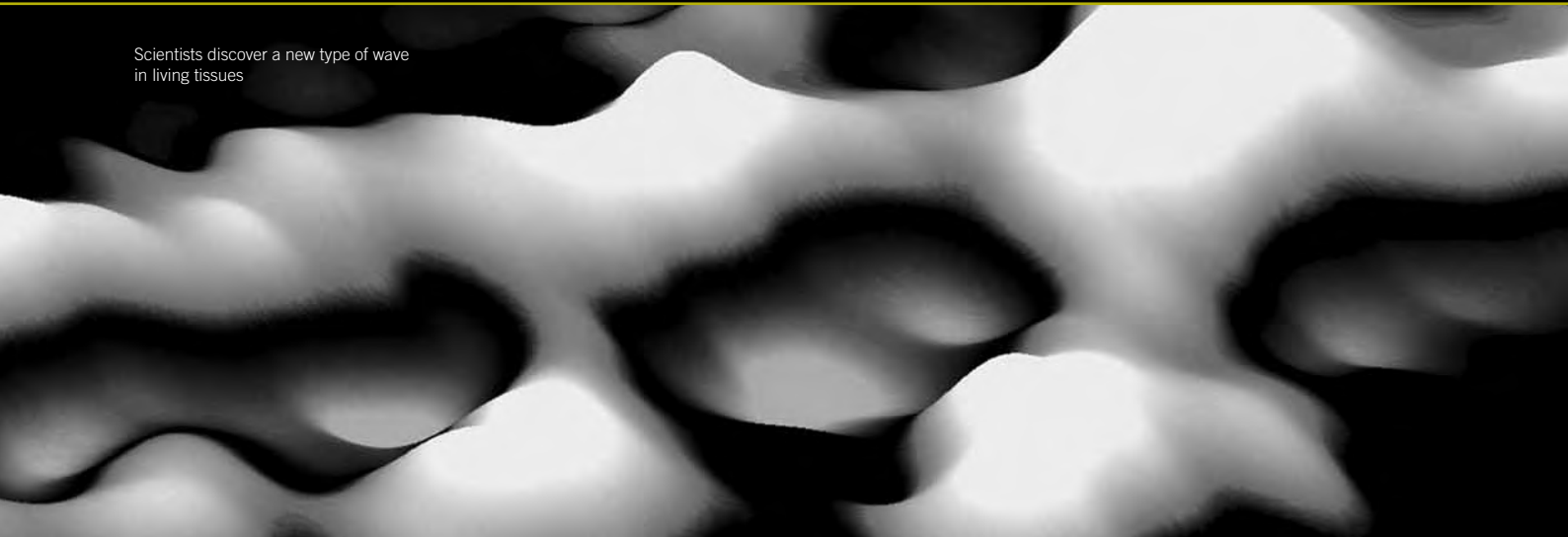
All objects exhibit a characteristic ‘dielectric constant’, or permittivity, which gives an indication of how the material they are made of reacts to an applied electric field. By using EFM, the researchers applied the electric field to the nano-objects using the nano-tip, and sensed the tiny movement of the lever induced by the dielectric responses of the objects. “When we had quantified their dielectric constants precisely, we were then able to use these as a ‘fingerprint’ to discriminate objects of identical shape but different composition, which would otherwise be impossible to recognize without labeling,” explains Laura Fumagalli, lead author on the study in *Nature Materials*.

The key developments the researchers made to achieve this were to increase the electrical resolution of the microscope by almost two orders of magnitude, so they were able to detect ultra-weak forces. They also used geometrically stable nano-tips, as well as a precise method of modeling their results that takes into account the physics of a system and all its geometrical artifacts.“Our method, an non-invasive way of determining the internal state of objects and correlate these with their functions without slicing or labeling, will be an invaluable tool in many areas,” says Gabriel Gomila, co-author of the study and group leader at IBEC. “Our new technique promises to shed light on questions about the dielectric properties of newly developed nanocomposites and hybrid nanodevices, and can tell us at how small a scale a dielectric object can retain its properties – in other words, how small we can go.”

Scientists discover a new type of wave in living tissues

When an organism develops or heals wounds, or when tumours metastasize, cells undergo massive collective movements. Despite decades of research, the mechanisms underpinning these movements remain poorly understood. In July, scientists at IBEC discovered that large cell movements occur in a wave-like manner.

In studying the motion of cell clusters, the scientists



Scientists discover a new type of wave in living tissues

detected evidence of wave-like crests of deformation launched at the edges of the clusters and propagating from cell to cell at roughly twice the speed at which cells were moving. "Imagine watching a traffic jam from above," says Integrative Cell and Tissue Dynamics group leader Xavier Trepat, whose discovery was published in *Nature Physics*. "You'll see a similar kind of wave effect as some cars edge forward and others follow after a slight delay to fill the gaps. Unlike cars, however, cells are able to push and pull from each other, so the phenomenon is much richer."

The group's findings establish a pattern of stress and strain reiterated in time and space across a multicellular tissue, something which has never before been observed, and which is a likely candidate for the driving force behind the activation of the networks responsible for the cellular invasion typical of cancer.

Smart biomaterial promotes angiogenesis

IBEC researchers have stuck tissue engineering gold with the creation of a new 'smart' biomaterial that triggers angiogenesis by providing the biochemical and mechanical cues needed for the process to begin.

Researchers in Josep Planell's Biomaterials for Regenerative Therapies group reveal their calcium phosphate glass/PLA composite that itself promotes the mobilization and differentiation of endothelial progenitor cells – those that become the cells making up the lining of blood vessels. "Successful tissue repair hinges on being able to recreate the right environment, so that the biomaterial not only acts as a scaffold for the new tissue but also contributes to the activation of the regeneration process," explains Elizabeth Engel. "We've understood the importance of the local microenvironment in determining what happens to cells thanks to recent advances in the understanding of stem cell biology and mechanosensing."

Their low-cost and easy-to-make composite sends biochemical and mechanical cues to activate two cell signaling pathways that set the bone marrow-derived endothelial progenitor cells into action. With time they home into the right place, differentiate into the right kind of cells and start to branch into the tree-like structures we associate with blood vessels.

September

Imaging the electrocatalytic activity of single nanoparticles

Nanoparticle catalysts are used in making polymers and biofuels, synthesising new drugs, pollution control devices and fuel cell technology, and both characterising them and finding more effective ones is vital. In the paper published in August, IBEC's senior researcher in the Nanoprobes and Nanoswitches group, Ismael Díez-Pérez – in collaboration with researchers at Arizona State University's Biodesign Institute – revealed an innovative way to measure the catalytical reactions of single nanoparticles, as well as multiple particles printed in arrays.

"Most catalytic materials made in labs contain varying nanoparticles with different electrocatalytical activities, but until now it has only been possible to measure the average properties across all of them, and not the properties of individual ones," Ismael explains. "If we can measure single nanoparticle catalytical reactions, we can figure out how the size, crystal orientation, and composition of the nanoparticle relates to the efficiency of a catalytical reaction."

In the study, nanoparticles are investigated using a new technique developed by the same group, plasmonic electrochemical imaging. This works by optically imaging electrochemical reactions based on surface plasmon resonance, a detection process that occurs when a polarized light hits a prism covered by a thin metal layer. "We measure electrochemical reactions not by looking at the electrodes, but by concentrating on the reactions near them," says Ismael. "These cause changes in light reflectivity, which the new technique converts to an optical image."

Using the technique, the researchers were not only able to investigate individual nanoparticles, but could also study the electrocatalytic activity of platinum nanoparticles printed in a microarray, showing for the first time the feasibility of high-throughput screening of catalytic nanoparticle activity.

November

JACS success for Nanoprobes group

The Nanoprobes and Nanoswitches group ended the year with a paper in JACS that sheds new light on ways to make and operate molecular electronic devices.

'Current-Voltage Characteristics and Transition Voltage Spectroscopy of Individual Redox Proteins', which had graduating PhD student Juan Manuel Artés as first author, described how the group used an electrochemical scanning tunneling microscope (ECSTM) to measure the current-voltage characteristics of individual redox-active proteins – in other words, those involved in electron transfer – such as azurin.

"Understanding the voltage-dependence of molecular conductance is essential to characterize molecular electronics devices," explains Juanma, who defended his PhD thesis in November 2012. "By calculating and analyzing the range of transition voltage in individual electron-transferring molecules, we add a new dimension to our conductance measurements."

Their results revealed that a low transition voltage, or TV, is advantageous to the fabrication and operation molecular electronic devices – for example, nanoscale wires, transistors or rectifiers – for different applications.

Organisation

Directorate

Director Josep A. Planell
Associate Director Josep Samitier
Managing Director Àlex de Jaureguizar (until July 2012)

The IBEC foundation

Board of Trustees

PRESIDENT

Hble. Sr. Boi Ruiz i Garcia
Minister of Health Government of Catalonia (GENCAT)

FIRST VICE-PRESIDENT

Hble. Sr. Andreu Mas-Colell
Minister of Economy and Knowledge GENCAT

SECOND VICE-PRESIDENT

Excm. i Mgfc. Sr. Dídac Ramírez i Sarrió
President University of Barcelona (UB)

Excm. i Mgfc. Sr. Antoni Giró Roca
President Technical University of Catalonia (UPC)

MEMBERS

Sr. Antoni Castellà i Clavé
Secretary for Universities and Research
Ministry of Economy and Knowledge, GENCAT

Sr. Josep Maria Martorell i Rodón
Director General for Research
Ministry of Economy and Knowledge, GENCAT

Dr. Carles Constante i Beitia
Director General for Regulation, Planning and Health Resources
Ministry of Health, GENCAT

Dra. Marta Aymerich i Martinez
Head of Health Research and Innovation
Ministry of Health, GENCAT

Dr. Jordi Alberch Vié
Vice-President for Research UB

Dr. Sílvia Atrián Ventura
Vice-President for Innovation and Knowledge Transfer UB

Dr. Xavier Gil Mur
Vice-President for Scientific Policies UPC

Dr. Ana Isabel Pérez Neira
Vice-President for Research UPC

SECRETARY

Sr. Josep Maria Alcoberro Pericay
CERCA, Ministry of Economy and Knowledge, GENCAT

International Scientific Committee

PRESIDENT **Prof. Jean-Louis Coatrieux**
Professor Laboratoire Traitement du Signal et de l'Image, INSERM, University of Rennes, France

Prof. Luigi Ambrosio
Director Institute of Composite and Biomedical Materials, University of Naples, Italy

Mr. Léonard Aucoin
President InfoVeille Santé Ltee, Canada

Prof. Paolo Dario
Director Polo Sant'Anna Valdera, Scuola Superiore Sant'Anna, Italy

Prof. Jeffrey J. Fredberg
Professor of Bioengineering and Physiology
Harvard School of Public Health, USA

Prof. Günter R. Fuhr
Director Fraunhofer Institute for Biomedical Engineering, Germany

Prof. Samuel I. Stupp
Director Institute for Bionanotechnology in Medicine, Northwestern University, USA

Prof. Bernt E. Uhlin
Professor of Molecular Biology Umeå University, Sweden

Standing Committee

PRESIDENT

Sr. Josep Maria Martorell i Rodón
Director General for Research
Ministry of Economy and Knowledge, GENCAT

MEMBERS

Dra. Marta Aymerich i Martinez
Head of Health Research and Innovation
Ministry of Health, GENCAT

Dr. Jordi Alberch Vié
Vice-President for Research UB

Dr. Xavier Gil Mur
Vice-President for Scientific Policies UPC

SECRETARY

Sr. Josep Maria Alcoberro Pericay
CERCA, Ministry of Economy and Knowledge, GENCAT

INSTITUTIONAL PROJECTS

Head of Institutional Projects Arantxa Sanz

Project Manager Roger Rafel (until May 2012); Marta Soler

INFRASTRUCTURE

Head of Infrastructure Isabel Oliveira

Laboratory Technicians Laura Gómez, Cristina Rivero

IT

IT Manager Juli Bafaluy

IT Technician Francisco Contreras

FINANCE

Head of Finance Ana González

Purchasing Technician Mayte Muñoz

Accounting Technician Francisco Buenestado

Finance Assistant Victoria López

HUMAN RESOURCES

Head of Human Resources Carol Marí

HR Technician Ricard Rius

Occupational Hazards Prevention Technician Jordi Martínez

GENERAL PROJECTS

Head of General Projects
Teresa Sanchis

Project Managers Javier Adrián, Ester Rodríguez, Juan Francisco Sangüesa, Robert Fabregat (until August 2012)

COMMUNICATIONS AND OUTREACH

Head of Communications and Outreach
Vienna Leigh

Coordinator of Events Pilar Jiménez

Coordinator of Media Relations and Branding Àngels López

Communications and Outreach Assistant
Marta Redón

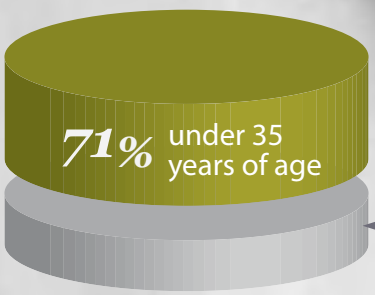
FUNDING SERVICES

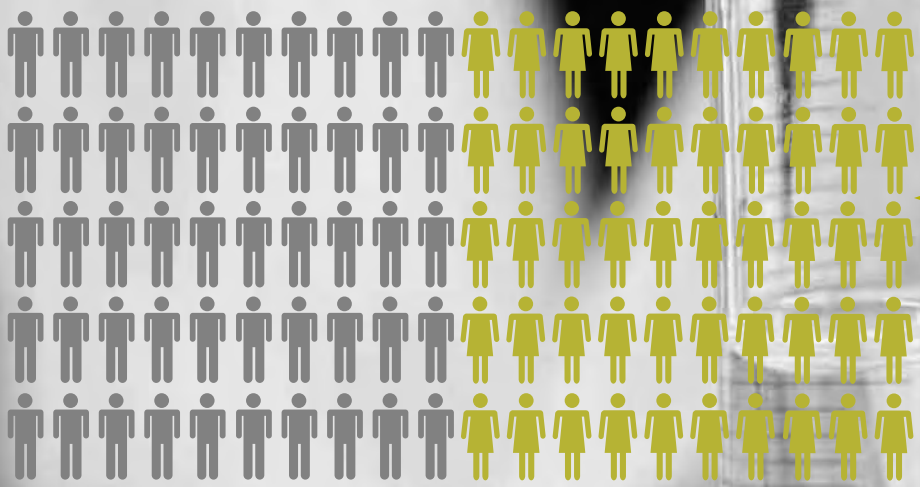
Funding Services Manager
Esther Gallardo

Assistant to the Director Pilar Ciriquián
Assistant to the Associate Director Judith Forné

IBEC Administration
(Support services)

Statistics


71% under 35 years of age
29% over 35


50% of staff in 2012 were female

In 2012 IBEC's staff of researchers and expert technicians numbered 226. Some work on an in-house basis, some come from the University of Barcelona or the Technical University of Catalonia, and some are funded through programmes that support the recruitment of research staff such as the Bosch i Gimpera Foundation, ICREA and the Ramón y Cajal programme (MEC).

IBEC also employs a staff of 27 people to carry out support activities.

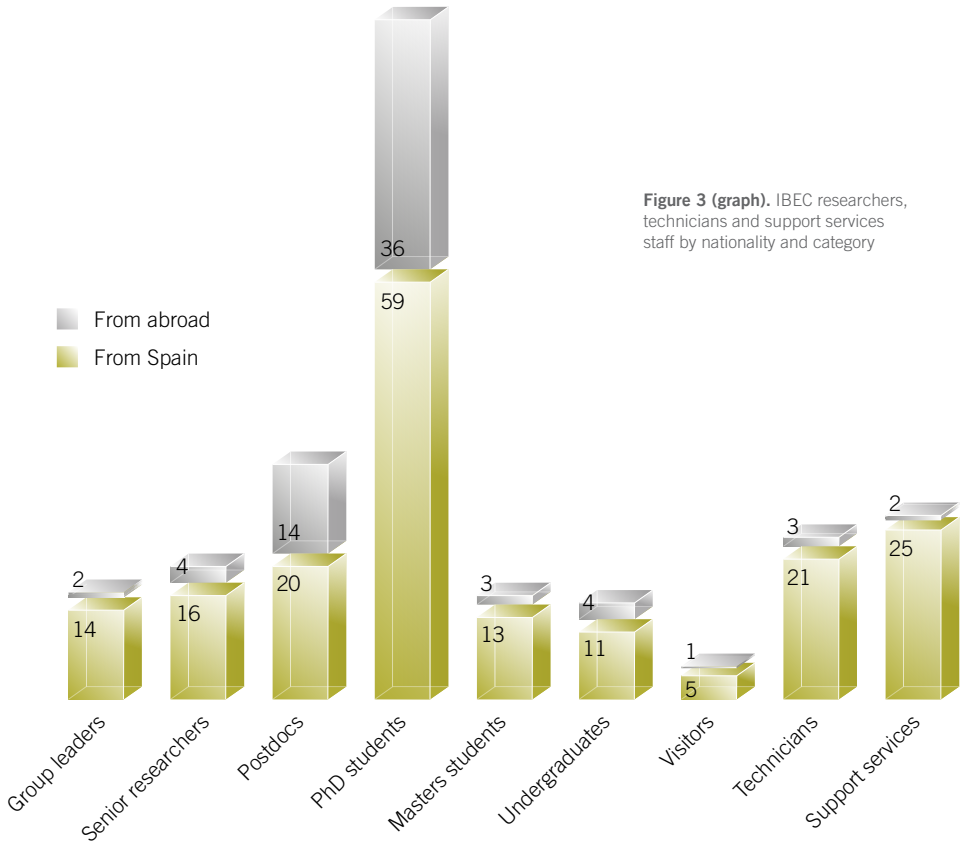


Figure 3 (graph). IBEC researchers, technicians and support services staff by nationality and category

Opposite: **Figures 1 & 2.** IBEC researchers, technicians and support services staff by age and gender

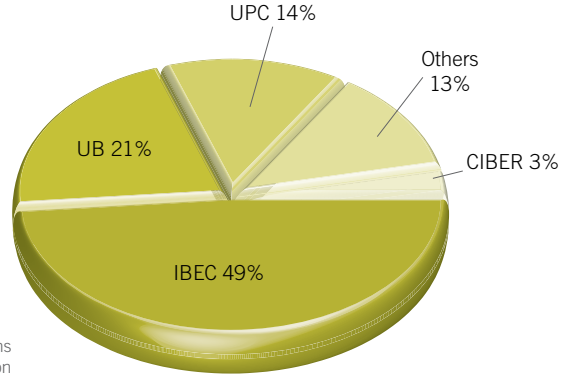


Figure 4 (pie chart). IBEC researchers and technicians by associated or contracting institution

The 253 personnel at IBEC in 2012 (including administration staff) represented

23 countries

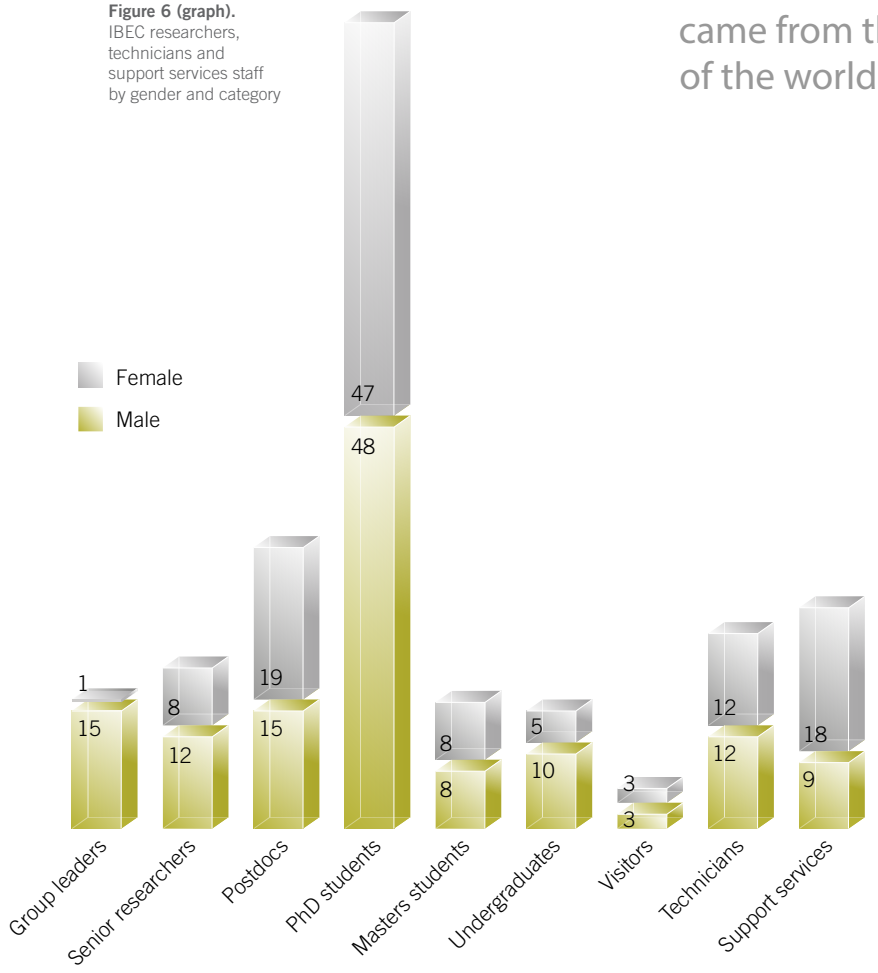
Figure 5 (map). IBEC researchers, technicians and support services staff by nationality

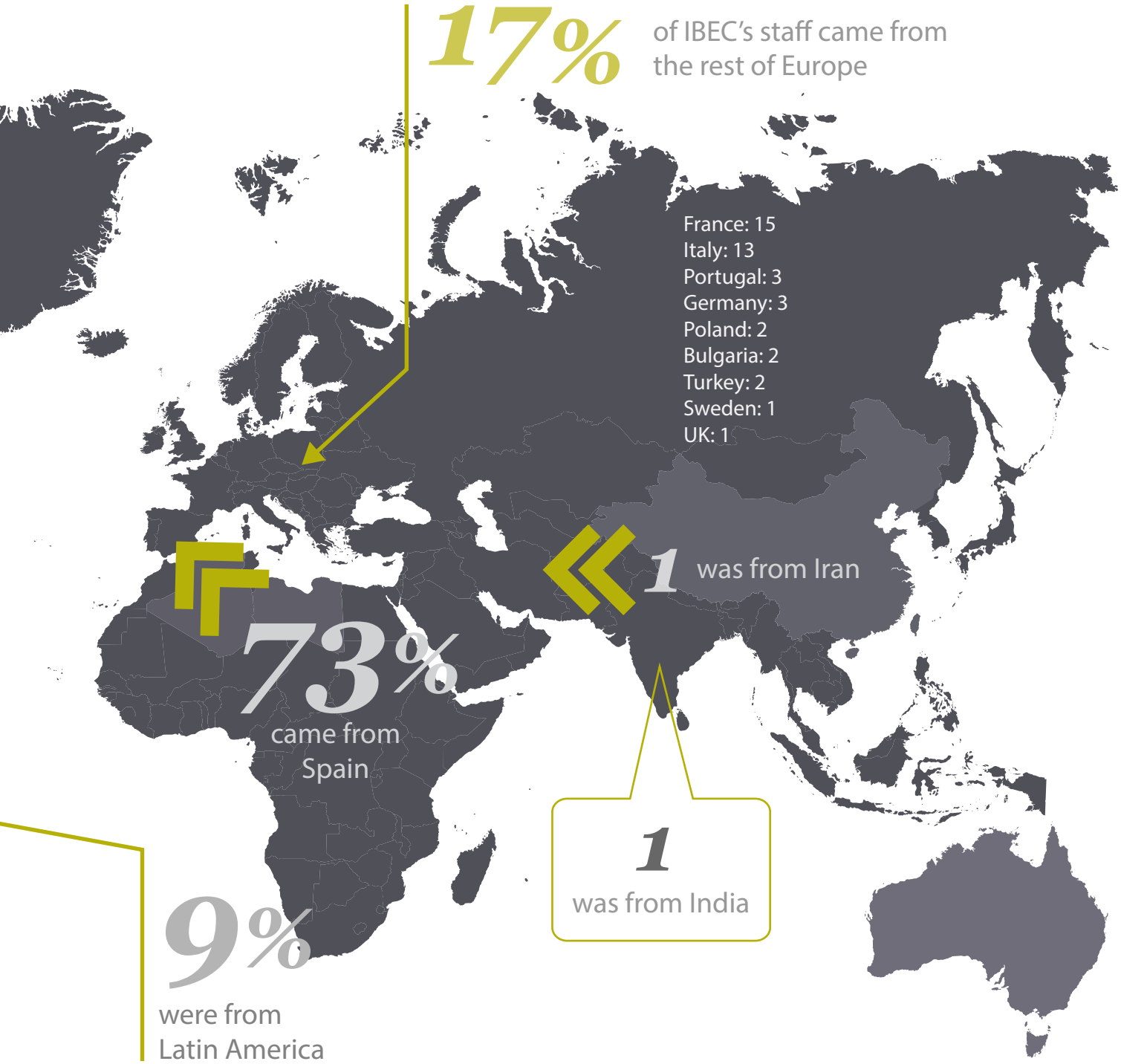
2 came from the United States

1% came from the rest of the world

Mexico: 6
Chile: 3
Colombia: 3
Venezuela: 3
Cuba: 2
Ecuador: 2
Argentina: 1
Brazil: 1
Panama: 1
Uruguay: 1

Figure 6 (graph). IBEC researchers, technicians and support services staff by gender and category





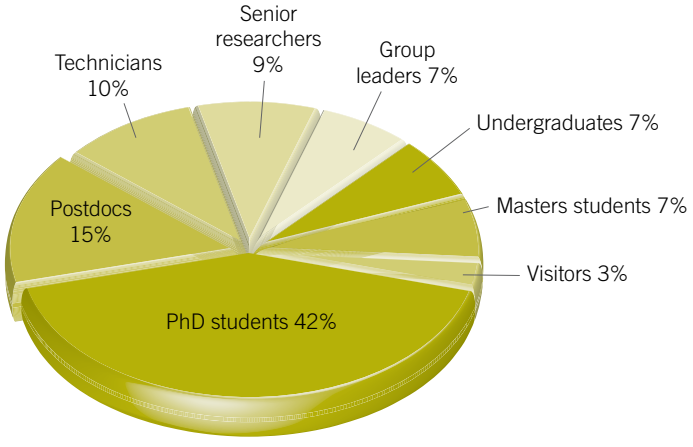


Figure 7 (pie chart). IBEC researchers and technicians by category

6% of research staff had stays in labs outside IBEC in 2012

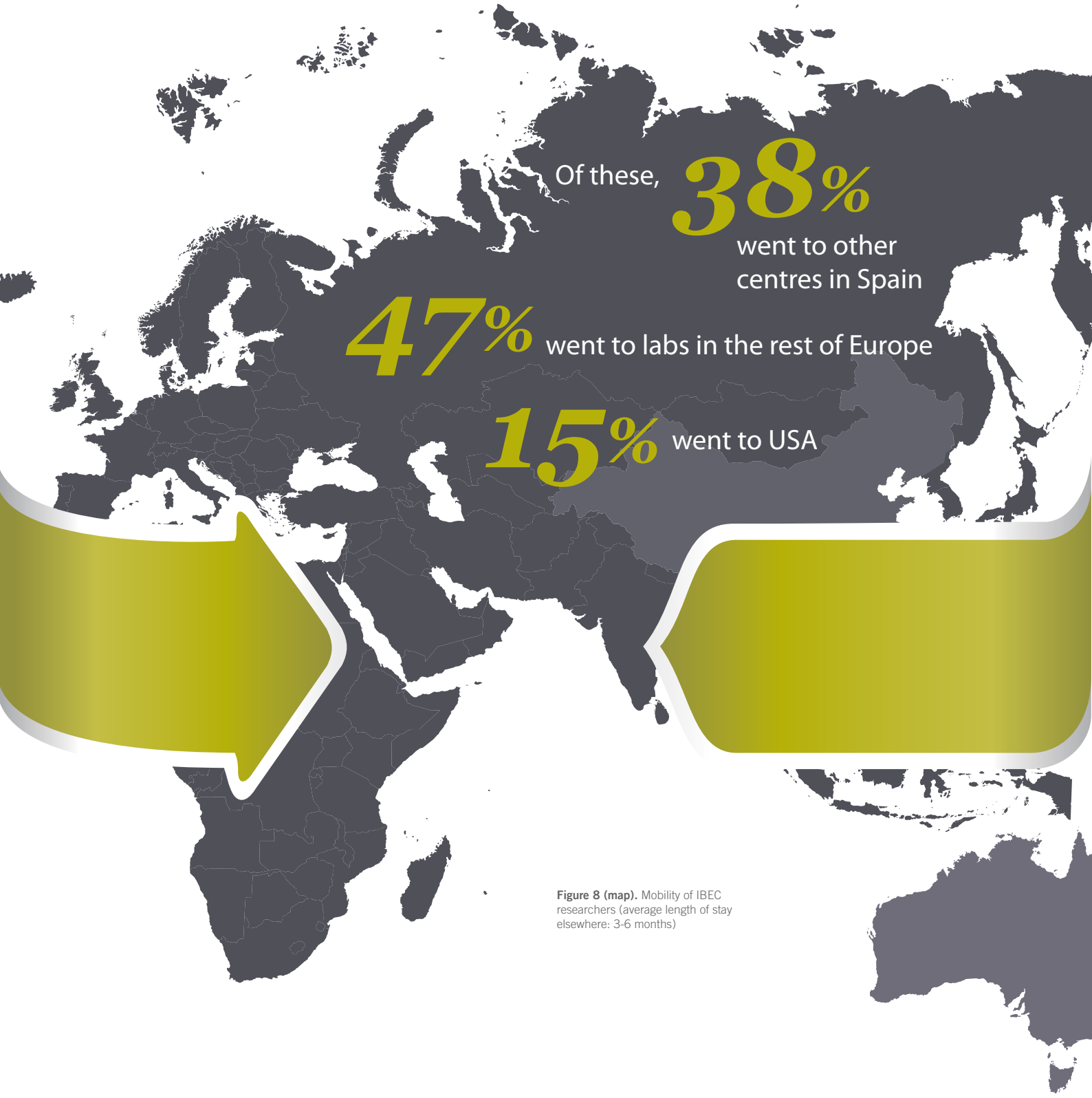


Figure 8 (map). Mobility of IBEC researchers (average length of stay elsewhere: 3-6 months)

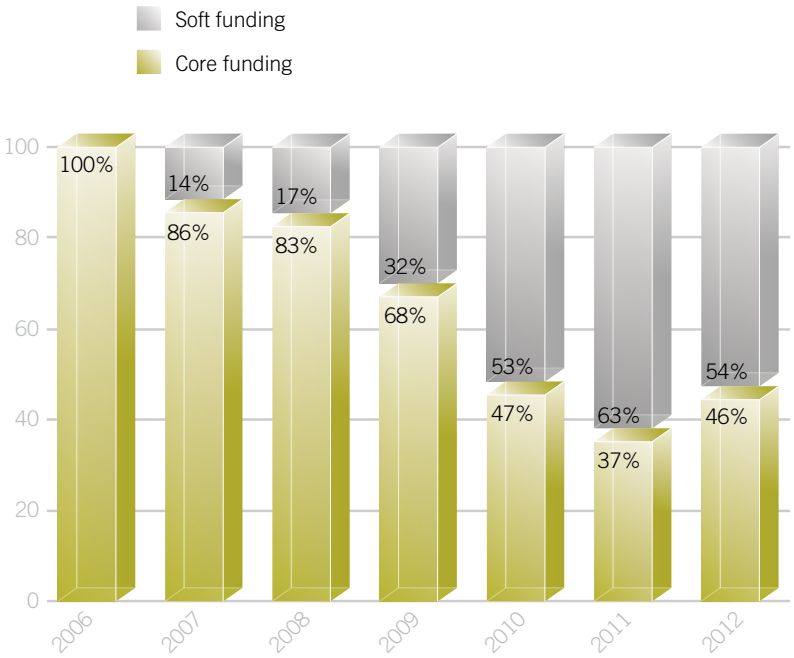


Figure 9 (graph). Percentage of funding from core v. soft sources. Core funding is funding from trustees. Soft funding includes competitive projects (funded by sources such as the EU's FP7 programme, the Spanish Ministry of Science or the Catalan Ministry of Research); Industry contracts; funding from private institutions; others.

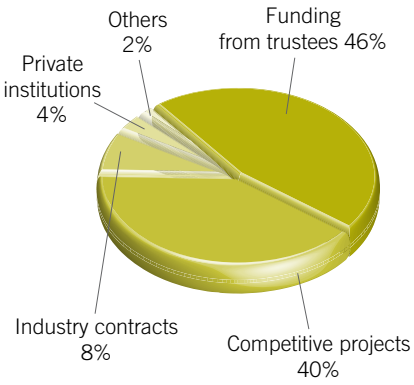


Figure 10 (pie chart).
Funding sources in 2012

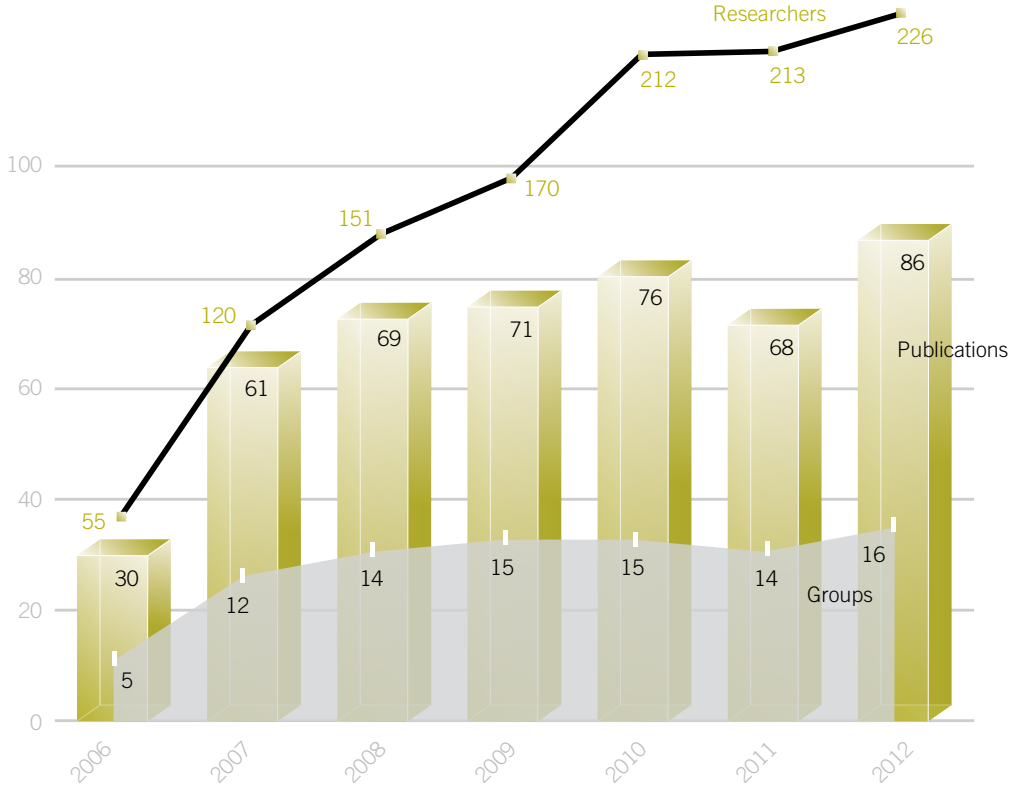
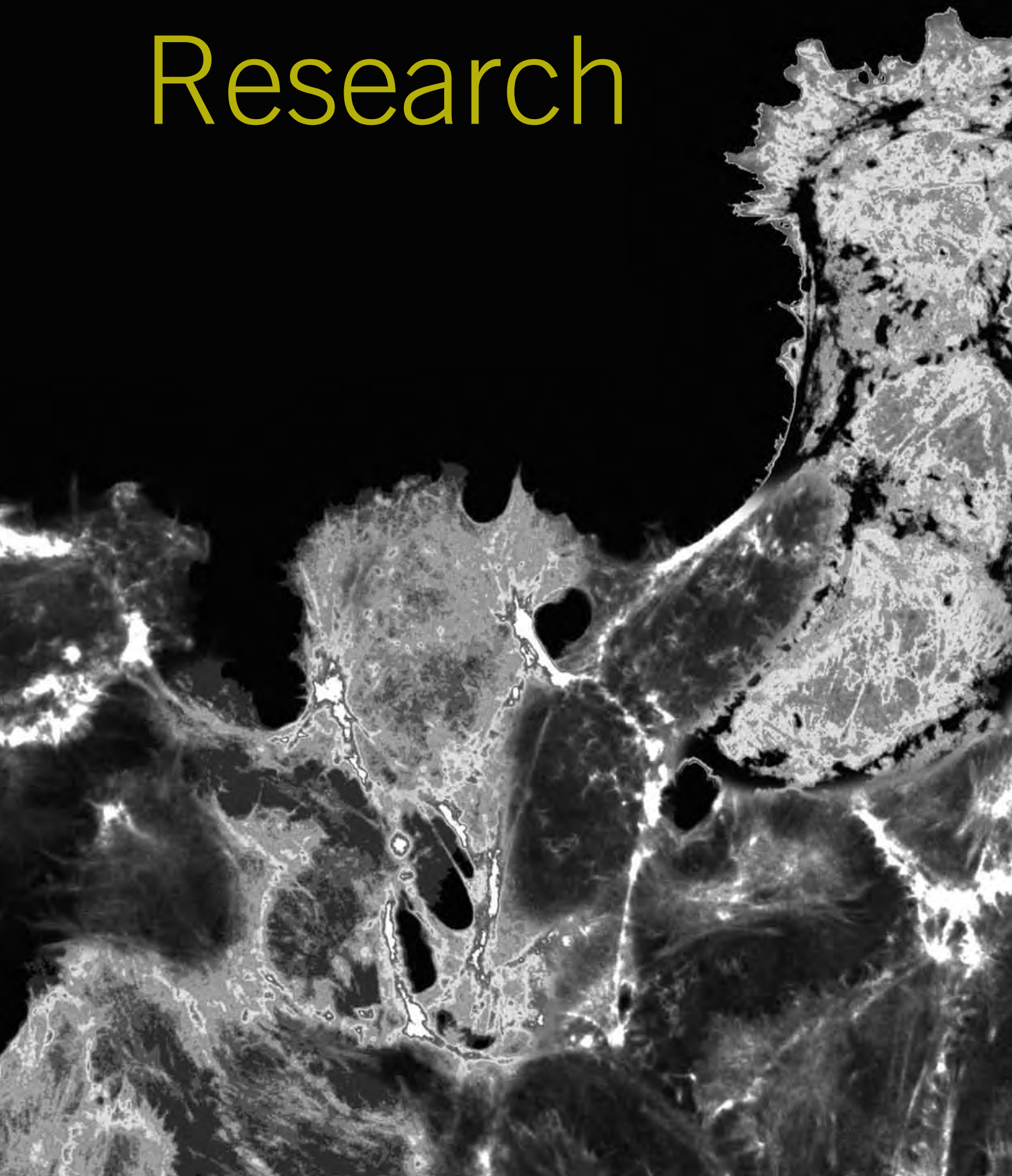


Figure 11 (graph). Number of research groups; number of publications; number of research staff

Research



IBEC's groups and their activities are organised into six research programmes.

Microbial Biotechnology and Host-Pathogen Interaction

Group leader: Antonio Juárez

Postdoctoral researchers: Manuela Dietrich, Sonia Paytubi, Mario Huttener

PhD student: Francesca Staffieri

Laboratory technicians: Carmen Jaramillo, Sonia Aznar

Visitors: Adrià Pereiro, Ana Arós, Gabriela Méndez de Vigo, Blanca Scarsciotti i Soler

Cellular Biotechnology programme

Microbial Biotechnology and Host-Pathogen Interaction

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. A group of proteins is currently the focus of our research: nucleoid-associated proteins (NAPs) that contribute to DNA architecture and modulate gene expression. We are interested in unravelling the role played by two of these proteins – Hha and H-NS – in the regulation of virulence and of plasmid transfer. *Escherichia coli* pathotypes such as enteroaggregative *E. coli* are the subject of our research. Owing to their key modulatory functions, these proteins are interesting targets to combat bacterial infections.

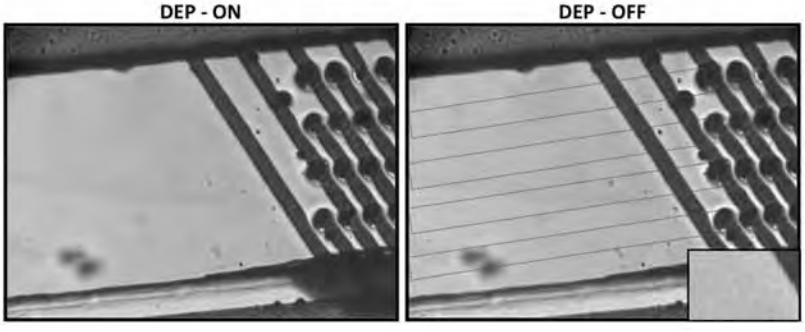
2. Bacterial plasmids and their role in transmission of multidrug resistance markers

A main concern with bacterial infections is the selection of isolates that are resistant to several antimicrobial drugs. The transmission of the ability of bacterial cells of simultaneously resist to several antimicrobial drugs is accomplished in many instances by plasmids. These genetic elements can be transmitted from one cell to another, and modify the phenotype of the recipient cell. We are trying to understand the molecular mechanisms whereby *Salmonella* incorporates IncHI1 plasmids and becomes multiresistant to several antibiotics.

3. Application of nanotools of bacterial biotechnology

3.1. Dielectrophoresis (DEP). We have previously shown 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) to: a) study the effect of electric fields on bacterial cell physiology; b) combine DEP with other molecular protocols for detection and identification of different types of cells.

3.2. 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 (page 61), we intend to use electrical-AFM to characterize the bacterial cell envelope. We also plan to use this approach to analyze the structural and physiological properties of bacterial living cells.



Trapping of *Escherichia coli* cells in a dielectrophoresis chip

Research projects

■ **INTERMODS** Interconexiones de módulos plasmídicos y los genomas de bacterias patógenas (2008-2013).
PI: **Antonio Juárez** (managed by UB)
MICINN, Consejo Superior de Investigaciones Científicas (CSIC)

■ **MEJORAVE1** Mejora sanitaria y de productos cármicos de ave.
PI: **Antonio Juárez**
Industrial project with Mevet, S.A / CZ Veterinaria, S.A.

■ **REGENTERO** Proteínas restringidas a la familia *Enterobacteriaceae*: implicación en la transferencia génica horizontal y virulencia.
PI: **Antonio Juárez**
MICINN

Publications

■ Cendra, M.d.M., Juárez, A. & Torrents, E. (2012). Biofilm modifies expression of ribonucleotide reductase genes in *Escherichia coli*. *PLoS ONE*, 7 (9), e46350

■ Gil, F.J., Rodriguez, A., Espinar, E., Llamas, J.M., Padullés, E. & Juárez, A. (2012). Effect of oral bacteria on the mechanical behavior of titanium dental implants. *The International Journal of Oral & Maxillofacial Implants*, 27 (1), 64-68

Collaborations with other research centres

Prof. Josep Casadesús Universidad de Sevilla, Spain

Prof. Charles Dorman, Trinity College, Dublin

Prof. F. García del Portillo Centro Nacional de Biotecnología, Madrid, Spain

Dr. Gabriel Gomila IBEC (page 61)

Prof. Mike Hughes University of Surrey, UK

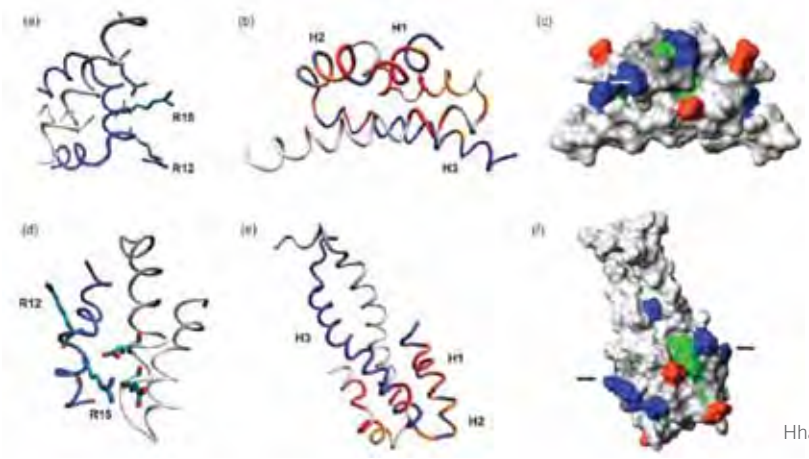
Dr. Rodrigo Martínez-Duarte École Polytechnique Fédérale de Lausanne, Switzerland

Prof. Miquel Pons Organic Chemistry Dept., University of Barcelona, Spain

Prof. Josep Samitier IBEC (page 52)

Scientific equipment and techniques

- Thermocycler (PCR)
- Protein and DNA electrophoresis
- Process of biomolecule production
- Protein expression and purification systems
- Technology of microbial culture facilities
- Dielectrophoresis equipment



Hha perturbing H-NS structure

Molecular and Cellular Neurobiotechnology

Group leader: José Antonio del Río
Senior researcher: Rosalina Gavín
Postdoctoral researchers: Ana Bribián, Vanessa Gil, Óscar Seira, Sílvia Vilches
PhD students: Patricia Carulla, Sara Nocentini, Cristina Vergara, Diego Reginensi
Masters students: Agata Mata, Eric García
Undergraduate student: Andreu Matamoros
Technicians: Giovanna Tormen, Natalia Ruiz

Cellular Biotechnology programme

Molecular and Cellular Neurobiotechnology

During 2012, the research group has developed several studies aimed at understanding some processes of development and neurodegeneration of the central nervous system (CNS).

Role of PrPc in the nervous system. We have demonstrated, in collaboration with other groups, the role of the cellular prion protein (PrP^c) in neural stem cell proliferation and differentiation, in particular oligodendrocyte precursor cells (OPCs). Our data indicate that PrP^c influences oligodendrocyte proliferation in the developing and adult CNS. OPCs that lack PrP^c proliferate more vigorously at the expense of a delay in differentiation, which correlates with changes in the expression of oligodendrocyte lineage markers. In addition, numerous NG2-positive cells were observed in cortical regions of adult PrP^c knockout mice, although no significant changes in myelination can be seen, probably due to the death of surplus cells (Bribian *et al.*, 2012)

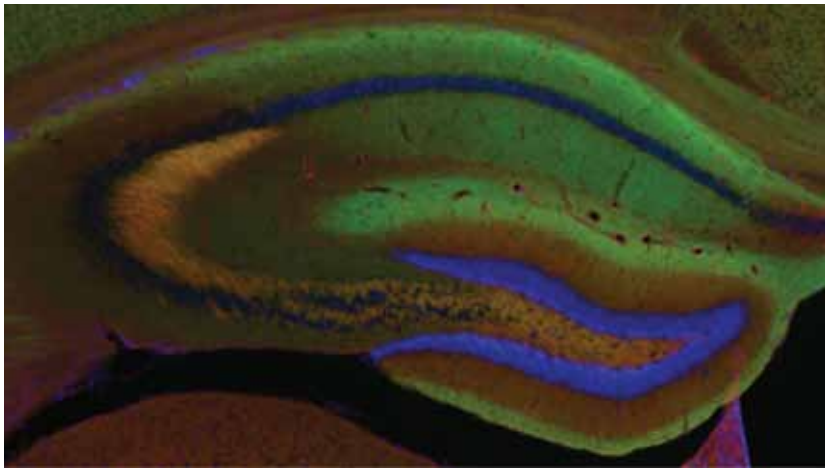
In addition, our data indicate that PrP^c also modulate glutamatergic neutransmission by acting at the cell membrane together with the glutamate receptor subunits Glur6/7 and the postsynaptic density protein PSD-95. Thus the absence of PrP^c induces epilepsy by lacking the interaction with the glutamate receptor. In addition, we demonstrated that an intracellular kinase JNK3 is a target of PrP^c mediated signaling. These data have been included in a perspectives report in *Prion* (Llorens & Del Río, 2012).

NeuroMEMs. New platforms for neural culture and analysis. From the technological point of view, the group published a methodological review in *Nature Protocols* on the usefulness of three-dimensional culture with hydrogels in neurobiological studies. The method is easy and is generally reproducible and only few specific details can be taken into account during its development. The degree and behavior of axonal growth or neural migration can be seen directly by using eGFP transgenic mice as a source of neural tissue or by immunostaining (Gil & Del Río, 2012).

Regenerative neuroscience. Moreover, in collaboration with other IBEC groups, we have characterized the role of myelin-associated proteins and its intracellular signaling cascades in the development of cell therapies using olfactory ensheathing cells. These cells are inhibited by myelin. In collaboration with Xavier Trepat's group (page 49) we have determined for the first time the behavior of these cells using biomechanics and traction force analysis (Nocentini *et al.*, 2012). Current experiments of our groups are directed to avoid this inhibition in order to increase the effectiveness of this cell type after spinal cord lesion.

Finally, group members have collaborated on the study of the analysis of Neuregulin-1/Erb4 signaling in OPCs migration (Ortega *et al.*, 2012) as well the role of the Semaphorin 4F during its maturation (Armendariz *et al.*, 2012).

Current experiments. Current experiments are directed to develop optogenetic non-invasive bioessays to analyze neuronal migration during brain development. In this collaboration with Ángel Raya's group (page 33) we have generated transgenic mice with the expression of switchable fluorochromes under specific promoters to label particular neural populations. In particular the migration of pioneer neurons, Cajal-Retzius cells, is already being analyzed using these transgenic mice.



Example of LEICA SP5 spinning disk confocal microscopy picture showing one example of hippocampus in the new mouse Cre/lox models generated by the group. In the example, labeled axons of CAMKII positive cells are labeled in yellow or green after recombination and fluorochrome switch

Research projects

- **PRIORITY** Protecting the Food Chain from Prions: Shaping European Priorities through Basic and Applied Research (2009-2013).
PI: **José Antonio Del Río** (managed by UB)
Integrated collaborative project within the framework of EU-FP7

- **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

- **DEMTEST** Biomarker based diagnosis of rapid progressive dementias – optimization of diagnostic protocols (2012-2014).
PI: **José Antonio Del Río**
Instituto Carlos III, "Optimización de Biomarcadores y la Armonización de su uso"

- Grup de recerca consolidat (2009-2013).
PI: **José Antonio Del Río**
Agència de Gestió d'Ajuts Universitaris i de Recerca (AGAUR), Convocatòria d'ajuts per donar suport a les activitats dels grups de recerca de Catalunya (SGR 2009)

- Análisis del papel de PRPC como mediador de la hiperfosforilación de tau en enfermedades neurodegenerativas (2012-2015).
PI: **Rosalina Gavín Marín**
Fondo de investigaciones Sanitarias de la Seguridad Social

Publications

- Gil, V. & del Río, J.A. (2012). Analysis of axonal growth and cell migration in 3D hydrogel cultures of embryonic mouse CNS tissue. *Nature Protocols*, 7 (2), 268-280

- Nocentini, S., Reginensi, D., Garcia, S., Carulla, P., Moreno-Flores, M.T., Wandosell, F., Trepat, X., Bribian, A. & del Río, J.A. (2012). Myelin-associated proteins block the migration of olfactory ensheathing cells: an *in vitro* study using single-cell tracking and traction force microscopy. *Cellular and Molecular Life Sciences*, 69 (10), 1689-1703

- Ortega, M. C., Bribián, A., Peregrín, S., Gil, M.T., Marín, O. & de Castro, F. (2012). Neuregulin-1/ErbB4 signaling controls the migration of oligodendrocyte precursor cells during development. *Experimental Neurology*, 235 (2), 610-620

- Bribián, A., Fontana, X., Llorens, F., Gavín, R., Reina, M., García-Verdugo, J.M., Torres, J.M., de Castro, F. & del Río, J.A. (2012). Role of the cellular prion protein in oligodendrocyte precursor cell proliferation and differentiation in the developing and adult mouse CNS. *PLoS ONE*, 7 (4), e33872

- Armendáriz, B.G., Bribian, A., Pérez-Martínez, E., Martínez, A., de Castro, F., Soriano, E. & Burgaya, F. (2012). Expression of Semaphorin 4F in neurons and brain oligodendrocytes and the regulation of oligodendrocyte precursor migration in the optic nerve. *Molecular and Cellular Neuroscience*, 49 (1), 54-67

■ Llorens, F. & del Río, J.A. (2012). Unraveling the neuroprotective mechanisms of PrPC in excitotoxicity. *Prion*, 6 (3), 245-251

Collaborations with other research centres

Dr. Jung Keun Hyun Dankook University, Yongin, Korea

Prof. Javier de Felipe Instituto Cajal, Consejo Superior de Investigaciones Científicas (CSIC), Madrid, Spain

Dr. Fernando de Castro Hospital Nacional de Parapléjicos, Toledo, Spain

Dr. Adolfo Lopéz de Munain Hospital de Donostia, San Sebastian, Spain

Prof. Jose Manuel García Verdugo Facultad de Ciencias, Universidad de Valencia, Spain

Prof. Fernando Albericio Institute for Research in Biomedicine (IRB), Barcelona, Spain

Dra. Miriam Royo Institute for Research in Biomedicine (IRB), Barcelona, Spain

Prof. Josep A. Planell IBEC (page 65)

Prof. Josep Samitier IBEC (page 52)

Prof. Xavier Trepat IBEC (page 49)

Prof. Ángel Raya IBEC (page 33)

Prof. Jesús Ávila and Prof. Francisco Wandosell Consejo Superior de Investigaciones Científicas (CSIC), Universidad Autónoma de Madrid, Spain

Prof. Isidro Ferrer Institut d'Investigació Biomèdica de Bellvitge. University of Barcelona, Spain

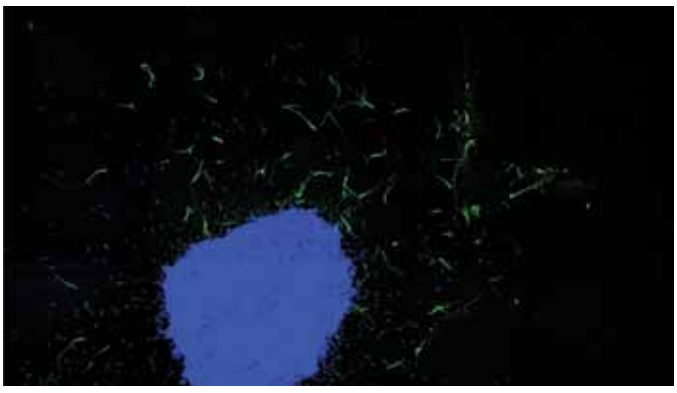
Prof. Marc Tessier-Lavigne Genentech, Inc., South San Francisco, USA

Prof. Fanny Mann Developmental Institute of Marseille Luminy, Université de la Méditerranée, Marseille, France

Prof. Yutaka Yoshida Division of Developmental Biology, Cincinnati Children's Research Foundation, Cincinnati, Ohio, USA

Scientific equipment and techniques

- Neural stem cell culture
- Microscopy facility (Olympus BX61 and Olympus IX71 with LCi culture system)
- Electroporation system (BTX 600)
- Pressure microinjection system
- Protein expression and purification systems
- Technology of neuronal culture facilities (2D and 3D)
- Lentiviral production and characterization
- Gradient thermocycler (PCR)
- Protein and DNA electrophoresis
- *In situ* hybridization oven



Example of LEICA SP5 spinning disk confocal microscopy picture showing Cajal-Retzius cells (green) migrating in a hydrogel 3D culture

Control of Stem Cell Potency

Group leader: Ángel Raya

Postdoctoral researchers: Sergio Mora, Adriana Rodríguez, Senda Jiménez

PhD students: Claudia Di Guglielmo, Isil Tekeli, Juan Luís Vázquez

Masters student: Laia Gregori

Undergraduates: Anna Garcia, Sara Tamagno, Patricia Isabel da Sousa Marques, Cybil Nelson

Senior technicians: Yvonne Richaud, Lluís Martorell

Laboratory technician: Cristina García

Visiting students: Isaac Canals, Andrea Acevedo, Carla Codina, Tomàs López, Patricia Martínez, Cristina Resina Del Campo, Alejandro Rodríguez, Laura Benevelli, Teresa Galera

Cellular Biotechnology programme

Control of Stem Cell Potency

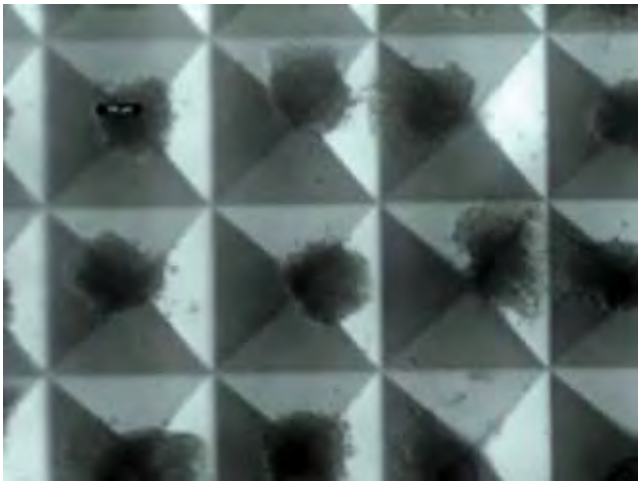
During embryo development, the potency of the zygote is deployed through coordinated and stereotypical changes in cell behaviors and processes of tissue patterning, ultimately resulting in the formation of an entire, highly complex organism in a relatively short period of time. Throughout this process, the developmental potency of individual cells, i.e. their ability to give rise to cells of a different type than their own, is progressively lost, so that somatic cells in adult individuals retain very limited potency (such as in rare adult stem cells) or show no potency at all.

Our laboratory is interested in understanding the mechanisms that govern the degree of potency of human somatic cells, and how it can be experimentally increased for conditions where doing so may be of biomedical relevance. Specifically, the context in which we investigate these issues is mainly centred on the paradigm of cardiac regeneration/repair.

Heart-related diseases are the main cause of mortality in the world, with ischemic heart disease being the single most frequent condition accounting for the death toll. This results from the very limited ability of the mammalian heart to regenerate on its own, and underscores the pressing biomedical need to finding ways for potentiating this ability (heart regeneration) and/or providing new cardiac cells to replace the lost or damaged ones (heart repair). We pursue the first approach by studying the process of heart regeneration in the zebrafish, an organism with a remarkable capacity for regeneration. Natural regeneration is a biologically fascinating phenomenon in which somatic cells may regain developmental potency, and we hope that understanding the molecular and cellular mechanisms that control this process will help devising strategies to potentiate the regeneration of adult mammalian hearts.

For achieving heart repair, in turn, our research is aimed at generating functional human heart muscle cells that could be used for transplantation. For this purpose, we investigate ways to manipulate the developmental potency of human somatic cells so they become pluripotent (i.e. regain the potency of cells in the early embryo), and then study how these so-called induced pluripotent stem cells (iPSC) can be instructed to differentiate into functional cardiomyocytes. In addition, since iPSC can be generated from disease-carrying cells, many laboratories including ours are exploring the possibility of using patient-specific iPSC to generate disease-relevant cell types in which to investigate the pathogenic mechanisms of disease initiation and/or progression.

Overall, our research takes advantage of a variety of experimental paradigms (zebrafish heart regeneration, human iPSC generation and differentiation), approached from a multi-disciplinary perspective, ranging from bioengineering approaches to 3D stem cell differentiation to single-cell genetic lineage tracing analyses and genetic manipulation of human cells, aimed at tackling important current issues in biology and biomedicine, such as the mechanisms that control the establishment and maintenance of developmental potency, the initiation and progression of the regenerative process, and the differentiation and functional maturation of human cardiomyocytes, and the development of genuinely human models of human disease.



Human iPS cells aggregated to form embryoid bodies

Research projects

■ **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, FCCI-ACI-E

■ Human pluripotent stem cells and zebrafish heart regeneration as experimental tools to understand cardiac muscle cell differentiation (2009-2012)
PI: **Ángel Raya**
MICINN, Investigación fundamental no orientada.

■ Generación de un modelo neuronal dopaminérgico a partir de células madre pluripotentes inducidas de pacientes con enfermedad de Parkinson asociada a mutaciones en el gen LRRK2
PI: **Ángel Raya**
ISCII; Convocatoria de financiación interna para proyectos cooperativos de CIBERNED

■ **HEMO-iPS** Use of patient-specific induced pluripotent stem cells to improve diagnosis and treatment of Hemophilia A
PI: **Ángel Raya**
ISCIII; E-Rare JTC 2011

■ **CELLSCAFF-CART** Reparación de Cartílago Articular mediante Ingenieria de Tejidos *in situ*: modelo *in vivo* (iPSC)
PI: **Ángel Raya**
MICINN; Fomento de la cooperación científica internacional (FCCI) ACI-Promociona

■ Zebrafish heart regeneration and human pluripotent stem cells as models to understand human cardiac muscle cell differentiation
PI: **Ángel Raya**
EMBO

Publications

■ Sánchez-Danés, A., Richaud-Patin, Y., Carballo-Carbajal, I., Jiménez-Delgado, S., Caig, C., Mora, S., Di Guglielmo, C., Ezquerra, M., Patel, B., Giralt, A., Canals, J.M., Memo, M., Alberch, J., López-Barneo, J., Vila, M., Cuervo, A.M., Tolosa, E., Consiglio, A. & Raya, Á. (2012). Disease-specific phenotypes in dopamine neurons from human iPS-based models of genetic and sporadic Parkinson's disease. *EMBO Molecular Medicine*, 4 (5), 380-395

■ Futterer, A., Raya, Á., Llorente, M., Izpisua-Belmonte, J.C., de la Pompa, J.L., Klatt, P. & Martinez, A.C. (2012). Ablation of Dido3 compromises lineage commitment of stem cells *in vitro* and during early embryonic development. *Cell Death and Differentiation*, 19 (1), 132-143

■ McLenachan, S., Menchon, C., Raya, Á., Consiglio, A. & Edel, M.J. (2012). Cyclin A(1) is essential for setting the pluripotent state and reducing tumorigenicity of induced pluripotent stem cells. *Stem Cells and Development*, 21 (15), 2891-2899

■ Sánchez-Danés, A., Consiglio, A., Richaud, Y., Rodríguez-Pizà , I., Dehay, B., Edel, M., Bové, J., Memo, M., Vila, M., Raya, Á. & Izpisua Belmonte, J.C. (2012). Efficient generation of A9 midbrain dopaminergic neurons by lentiviral delivery of LMX1A in human embryonic stem cells and induced pluripotent stem cells. *Human Gene Therapy*, 23 (1): 56-69

Conference paper:

■ Ranaldo, G., Richaud-Patin, Y., Lombardo, A., Grosso, C., Talmon, M., Raya, A., Naldini, L., Schinco, P. & Follenzi, A. (2012). A novel iPSC-based strategy to correct the bleeding phenotype in Hemophilia A. In *15th Annual Meeting of the American Society of Gene and Cell Therapy (ASGCT), Philadelphia, USA (2012/05/01),"Molecular Therapy"*, 20, S251-S251, Nature Publishing group

Collaborations with other research centres

Anne Weber/Anne Dubart Inserm, Le Kremlin-Bicêtre Cedex, France

Manuel Galiñanes Hospital Universitari Vall d'Hebron, Barcelona, Spain

Patrizia Dell'Era Università degli Studi di Brescia, Italy

Miquel Vila Institut de Recerca, Hospital Universitari Vall d'Hebron, Barcelona, Spain

Eduard Tolosa Hospital Clínic, Barcelona, Spain

Pedro Muniesa Facultad de Veterinaria, Zaragoza, Spain

José López Barneo Instituto de Biomedicina (IBiS), Sevilla, Spain

Daniel Grinberg/Lluïsa Vilageliu University of Barcelona, Spain

Rafael Garesse Instituto de Investigaciones Biomédicas "Alberto Sols"/UAM, Spain

Antonia Follenzi Universita' del Piemonte Orientale, Novara, Italy

Sheng Ding Scripps Research Institute, La Jolla, USA

Jordi Barquinero Institut de Recerca, Hospital Universitari Vall d'Hebron, Barcelona, Spain

Jordi Alberch/Josep M. Canals Institut d'investigacions Biomèdiques August Pi i Sunyer (IDIBAPS), University of Barcelona, Spain

Jerónimo Blanco/Núria Rubio Centro de Investigación Cardiovascular CSIC-ICCC, Barcelona, Spain

Francisco J. Blanco Complejo Hospitalario Universitario A Coruña, Spain

Antonella Consiglio Institute of Biomedicine of the University of Barcelona (IBUB), Spain

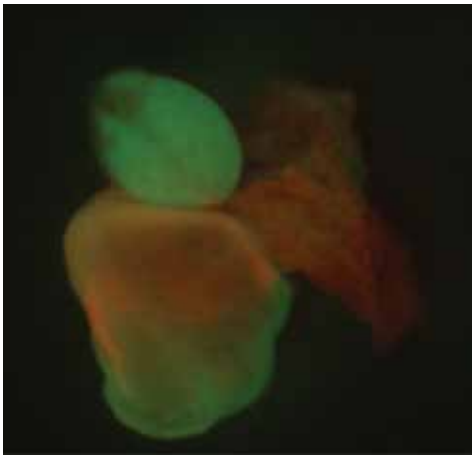
Ludovic Jullien Ecole Normale Supérieure, Paris, France

Ana Maria Cuervo Albert Einstein College of Medicine, Bronx, USA

Lorenzo Monserrat Complejo Hospitalario Universitario A Coruña, Spain

Scientific equipment and techniques

- hES/iPS cell culture station
- Zebrafish transgenesis
- Molecular biology facilities
- Stereomicroscope for picking hES colonies
- Cell culture facilities



Heart of a transgenic zebrafish showing mosaic recombination

Bacterial Infections: Antimicrobial Therapies

Junior group leader: Eduard Torrents

PhD student: Maria del Mar Cendra

Master students: Anna Crespo, David Pardo, Paula Marañón

Undergraduate student: Ariadna Boloix

Cellular Biotechnology programme

Bacterial Infections: Antimicrobial Therapies (junior group) (since September 2012)

Infectious diseases constitute a tenacious and major public-health problem all over the world. The emergence and increasing prevalence of bacterial strains that are resistant to available antibiotics demand the discovery of new therapeutic approaches. In addition, there is an urgent need for reliable and rapid detection of infecting bacteria and its pattern of resistance to antibiotics. The existing methods usually take more than 24 hours.

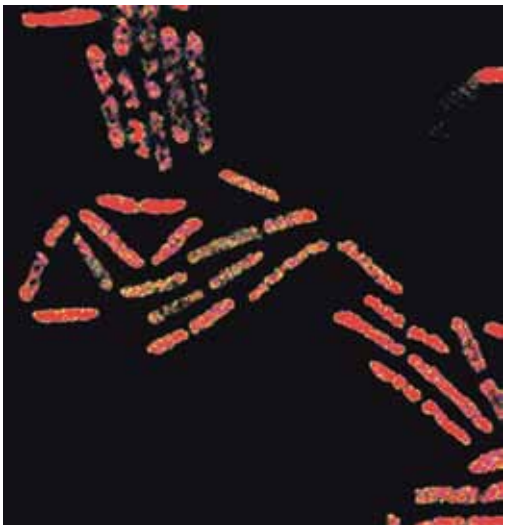
Bacterial DNA synthesis open new horizons in the discovery of new antibacterial targets due to remarkably differences to the eukaryotic system. The enzyme ribonucleotide reductase (RNR) catalyzes the reduction of ribonucleotides to the corresponding deoxyribonucleotides (dNTP) and thereby provides the building blocks for DNA synthesis and repair. Three different classes will limited sequence similarities have been described for this essential enzyme: class I (*nrdAB/nrdEF*) is oxygen dependent; class II (*nrdJ*) is indifferent to oxygen; and class III (*nrdDG*) is oxygen sensitive. The balance of the different dNTPs has to be carefully regulated and the RNR enzymes as well as its expression play important roles. In the bacterial world it is not known which transcriptional regulators are required to control the expression of the different RNR genes and their role in pathogenesis.

Our lab is interested in the identification, by means of a functional genomic and proteomic approach, such transcriptional regulatory proteins, the basis of the gene regulation of the different bacterial *nrd* genes and their role during biofilm formation and infection. It is clear that inhibition of this enzyme will avoid bacterial replication. Thus, based on our previous experience in the discovery of RNR inhibitors, in this project we will synthetize and screening new specific bacterial ribonucleotide reductase inhibitors. By using nanomedicine techniques we will develop specific nanoparticles to be highly selective and efficient to load known useful antibiotics or the new RNR inhibitors identified in this project.

Finally, we will use Lab-on-a-chip technology, and in particular dielectrophoresis, to study the electrical fields in bacterial cell physiology and also to concentrate bacterial pathogens and facilitate their detection, especially for the identification of bacteria multi-resistant to different antibiotics.

We believe this project will be beneficial to society since we explore the use of different bioengineering approaches to elucidate the ways to eradicate and diagnostic multi-drug resistant bacteria.

Structural superposition of NrdA (class I) and NrdD (class III) subunits of ribonucleotide reductase



Free living bacteria

Pseudomonas aeruginosa swimming

Research projects

- **PATHOGENOMICS** Identification of hot spots of divergence and rapidly changing genes within Shiga toxin-producing *Escherichia coli*.
PI: **Eduard Torrents**
ERA-NET PathoGenoMics: MICNN

- Ribonucleotide reductasas: una nueva diana terapéutica contra organismos patógenos en enfermos de fibrosis quística.
PI: **Eduard Torrents**
Federacion Española de Fibrosis Quística "PABLO MOTOS" 2012

- **RNRpathotarget** Redes reguladoras de la expresión génica de las distintas ribonucleotidil reductasas en bacterias
PI: **Eduard Torrents**
MICINN

Publications

- Cendra, M.D., Juárez, A. & Torrents, E. (2012). Biofilm modifies expression of ribonucleotide reductase genes in *Escherichia coli*. *PLoS ONE*, 7(9), e46350

Collaborations with other research centres

Prof. Fernando Albericio Institut de Recerca Biomèdica (IRB), Barcelona, Spain

Prof. Josep A. Planell IBEC (page 65)

Dr. Esther Julián Dept. de Genètica i de Microbiologia, Universitat Autònoma de Barcelona, Spain

Prof. Britt-Marie Sjöberg Dept. Molecular Biology and Functional Genomics, Stockholm University, Sweden

Dr. Nicolas Barnich Pathogénie Bactérienne Intestinale, Université Clermont 1, Clermont-Ferrand, France

Scientific equipment and techniques

- Gradient thermocycler (PCR)
- Molecular biology facilities
- Protein and DNA electrophoresis
- Bacterial expression systems for heterologous protein production
- Protein purification systems (FPLC; Biologic DuoFlow System From Bio-Rad)
- Technology of microbial culture facilities.
- Pressure microinjection system
- *Drosophila melanogaster* as a model host for bacterial infections
- Continuous flow system model for bacterial biofilm development
- Single Channel Fiber-Optic Oxygen Meter with microsensor

Cellular and Respiratory Biomechanics

Group leader: Daniel Navajas

Junior group leader: Pere Roca-Cusachs

Postdoctoral researchers: Jordi Alcaraz, Alberto Elosegui

PhD students: Tomàs Luque, Noelia Campillo, Anita Kosmalska

Masters students: Laura Schaedel, Juan José Urlarte, Blai Casals, Roger Oria

Undergraduate student: Víctor González

Technician: Lara Grande

Biomechanics and Cellular Biophysics programme

Cellular and Respiratory Biomechanics

The research of our groups is focused on biomechanics, that is, the study of the mechanisms and physiological implications underlying mechanical force in biology. This research is organized into two different research lines. The respiratory biomechanics line, led by Prof. Daniel Navajas, studies the mechanical behaviour of the respiratory system, and how it is altered in respiratory diseases. The biophysical mechanobiology line, led by Prof. Pere Roca-Cusachs, studies the basic physical and molecular mechanisms by which cells detect and respond to forces.

Respiratory biomechanics *(Daniel Navajas)*

Our goal 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, focusing 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.

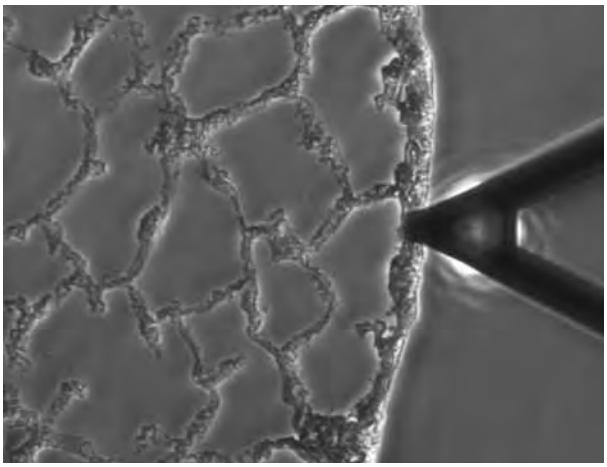
At the systemic level, we study the mechanical properties of the airway and lung tissues and the changes that occur in the context of the mechanical dysfunction associated with respiratory diseases. We study the mechanics of the upper airway in sleep apnea syndrome and on mechanical ventilation in acute and chronic respiratory failure. We biofabricate engineered lungs by recellularizing lung scaffolds with stem cells.

At the cellular level, we develop and apply cutting-edge nanotechnology and advanced biophysical techniques to probe the mechanical behaviour of cells and their mechanical interactions with their microenvironment. We study the mechanical properties of the cell and its response to inflammation and mechanical stresses and develop new approaches to differentiate stem cells using mechanical stimuli. We are developing a lung-on-a-chip model recreating the *in vivo* mechanical micro/nano-environment of lung cells.

Biophysical mechanobiology *(Pere Roca-Cusachs, Junior Group Leader)*

Every time we blink, move a hand, draw a breath, or walk, cells in our body exert, transmit, withstand, and detect forces. This mechanical interaction with the environment determines how cells proliferate, differentiate, and move, and regulates development, tumorigenesis or wound healing. Just like biochemical stimuli initiate signaling cascades, mechanical forces affect the links and conformation of a network of molecules connecting cells to the extracellular matrix.

Our research aims precisely at unraveling the mechanisms that these molecules use to detect and respond to forces, triggering downstream cell responses. To this end, we combine biophysical techniques like magnetic tweezers, Atomic Force Microscopy, and microfabricated force sensors with molecular biology and advanced optical microscopy. Using this approach, we have for instance recently unveiled a basic micron-sized molecular structure that cells use to generate forces that probe substrate rigidity (Ghassemi *et al.*, 2012, *PNAS*). We have also revealed that different integrins are adapted to sensing versus resisting forces (Roca-Cusachs *et al.*, 2009, *PNAS*) or that talin molecules can detect forces by stretching and exposing cryptic binding sites to vinculin (del Río *et al.*, 2009, *Science*). Ultimately, when we determine the molecular mechanisms that communicate cells with their environment, we will understand how forces determine development when things go right, and tumor formation when they go wrong.



Nanomechanics of lung extracellular matrix probed with atomic force microscopy

Research projects

■ Mechanical signaling driving stem cell differentiation in the lung. Lung-on-a-chip model.
PI: **Daniel Navajas**
Fondo de Investigación Sanitaria, Ministerio de Ciencia e Innovación (PI11/00089)

■ Alteración de la Nanomecánica de los neutrófilos en la lesión pulmonar inducida por el ventilador.
PI: **Daniel Navajas** (managed by UB)
ISCII, Subprograma de Proyectos de investigación en salud (FIS), Ministerio de Sanidad y Consumo

■ Fisiopatologia i Tractament de les Malalties Respiratòries (2009-2013).
PI: **A. Torres** (managed by Fundació Clínic)
Agència de Gestió d'Ajuts Universitaris i de Recerca (AGAUR). Convocatòria d'ajuts per donar suport a les activitats dels grups de recerca de Catalunya (2009-SGR-911)

■ **NANONET** Nanomechanics of intermediate filament networks.
Chair: E. Hol
Management Committee Member: **Daniel Navajas**
European Commission COST Action (BMBS-BM1002)

■ **CHROMED** Clinical tRials fOr elderly patients with MultiplE Disease.
PI: Ramon Farré (UB/IDIBAPS)
European Commission, FP7-HEALTH-2012-INNOVATION-1 Project 306093-2

■ **AFM4NanoMed&Bio** European network on applications of Atomic Force Microscopy to NanoMedicine and Life Sciences.
Management Committee Member: **Daniel Navajas**
European Commission COST Action (BMBS-TD1002)

■ Identifying molecular mechanical pathways in cells (2012-2015).
PI: **Pere Roca-Cusachs**
Proyectos de investigación fundamental no orientada, Ministerio de economía y competitividad (BFU2011-23111)

■ Mechanical pathways in cells: from molecular mechanisms to cell function (2012-2015).
PI: **Pere Roca-Cusachs**
Coordinator: **Daniel Navajas**
Career Integration Grants (CIG) Marie Curie Action within the framework of EU-FP7 (MecPath 303848)

Publications

- Ghassemi, S., Meacci, G., Liu, S., Gondarenko, A.A., Mathur, A., Roca-Cusachs, P., Sheetz, M.P. & Hone, J. (2012). Cells test substrate rigidity by local contractions on submicrometer pillars. *Proceedings of the National Academy of Sciences of the United States of America*, 109 (14), 5328-5333

- Roca-Cusachs, P., Iskratsch, T. & Sheetz, M.P. (2012). Finding the weakest link: exploring integrin-mediated mechanical molecular pathways. *Journal of Cell Science*, 125 (13), 3025-3038

- Chimenti, L., Luque, T., Bonsignore, M.R., Ramirez, J., Navajas, D. & Farre, R. (2012). Pre-treatment with mesenchymal stem cells reduces ventilator-induced lung injury. *European Respiratory Journal*, 40 (4), 939-948

- Almendros, I., Montserrat, J.M., Ramírez, J., Torres, M., Duran-Cantolla, J., Navajas, D. & Farré, R. (2012). Intermittent hypoxia enhances cancer progression in a mouse model of sleep apnoea. *European Respiratory Journal*, 39 (1), 215-217

- Acerbi, I., Luque, T., Giménez, A., Puig, M., Reguart, N., Farré, R., Navajas, D. & Alcaraz, J. (2012). Integrin-specific mechanoresponses to compression and extension probed by cylindrical flat-ended AFM tips in lung cells. *PLoS ONE*, 7 (2), e32261

- Almendros, I., Montserrat, J.M., Torres, M., Bonsignore, M. R., Chimenti, L., Navajas, D. & Farre, R. (2012). Obesity and intermittent hypoxia increase tumor growth in a mouse model of sleep apnea. *Sleep Medicine*, 13 (10), 1254-1260

- Guamán, A.V., Carreras, A., Calvo, D., Agudo, I., Navajas, D., Pardo, A., Marco, S. & Farré, R. (2012). Rapid detection of sepsis in rats through volatile organic compounds in breath. *Journal of Chromatography B*, 881-882, 76-82

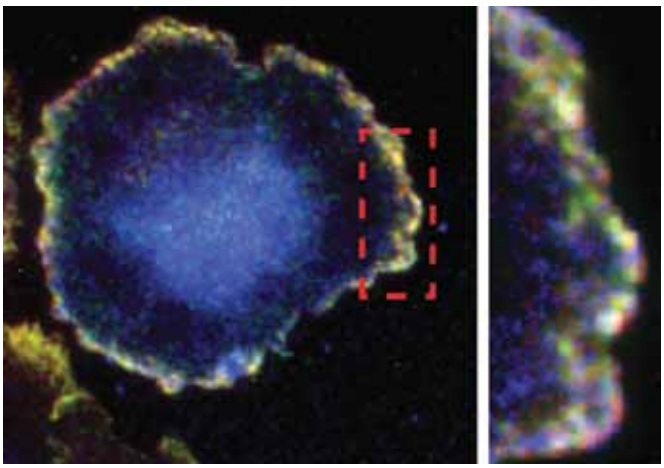
- Tsapikouni, T., Garreta, E., Melo, E., Navajas, D. & Farré, R. (2012). A bioreactor for subjecting cultured cells to fast-rate intermittent hypoxia. *Respiratory Physiology and Neurobiology*, 182 (1), 47-52

- Govoni, L., Dellaca, R.L., Penuelas, O., Bellani, G., Artigas, A., Ferrer, M., Navajas, D., Pedotti, A. & Farre, R. (2012). Actual performance of mechanical ventilators in ICU: a multicentric quality control study. *Medical Devices: Evidence and Research*, 5, 111-119

- Almendros, I., Carreras, A., Montserrat, J.M., Gozal, D., Navajas, D. & Farre, R. (2012). Potential role of adult stem cells in obstructive sleep apnea. *Frontiers in Neurology*, 3, 1-6

Book chapter:

- Waters, C.M., Roan, E. & Navajas, D. (2012). Mechanobiology in lung epithelial cells: Measurements, perturbations, and responses. In *Comprehensive Physiology*, ed. Terjung, R., 2, 1-29. John Wiley & Sons Inc., Hoboken, USA



Spreading fibroblast showing initial adhesions to the extracellular matrix containing α-actinin (green) talin (red) and β3 integrin (blue)

Collaborations with other research centres

Prof. Ramon Farré Unit of Biophysics and Bioengineering, Dept. Physiological Sciences, School of Medicine, University of Barcelona/IDIBAPS, Barcelona, Spain

Prof. J. M. Montserrat Service of Pneumology, Hospital Clinic/IDIBAPS, Barcelona, Spain

Prof. M. Sheetz Biological Sciences, Columbia University New York, USA

Prof. A. Artigas Intensive Care Service, Hospital Sabadell, Spain

Prof. A. Pedotti Bioengineering Dept., Politecnico di Milano, Italy

Prof. J. Cortiella Laboratory of Tissue Engineering and Regenerative Medicine, University of Texas Medical Branch, Galveston, USA

Prof. James Hone Mechanical Engineering, Columbia University, USA

Prof. Miguel Ángel del Pozo Centro Nacional de Investigaciones Cardiovasculares (CNIC), Madrid, Spain

Scientific equipment and techniques

- Fluorescence resonance energy transfer (FRET) microscopy
- Confocal Microcopy
- Traction Microscopy
- Live cell fluorescence microscopy
- Cell stretching
- Cell culture
- Magnetic Tweezers
- Atomic Force Microscopy
- Surface Micro/Nano-patterning

Nanoprobes and Nanoswitches

Group leaders: Pau Gorostiza and Fausto Sanz

Senior researchers: Ismael Díez, Mireia Oliva, Marina Giannotti

Postdoctoral researchers: Kay Eckelt, Ana Trapero, María Isabel Bahamonde, Núria Camarero

PhD students: Juan Manuel Artés, Antonio Bautista, Montse Enjuanes, Xavier Gómez, Javier Hoyo, Mercè Izquierdo, Montserrat López, Andrés Martín Quirós, Helena Masanas, Anna Palacios, Marta Pozuelo, Lorena Redondo, Silvia Pittolo

Masters students: Albert Cortijos, Míriam Ferrer

Undergraduates: Maria Casademont, Genís Del Pino Vives, Xavier Florenza, Coral Fustero, Héctor Sanz, Lia Lima

Technician: Ariadna Pérez

Visitors: Dario Vázquez, Alfredo Maria Gravagnuolo

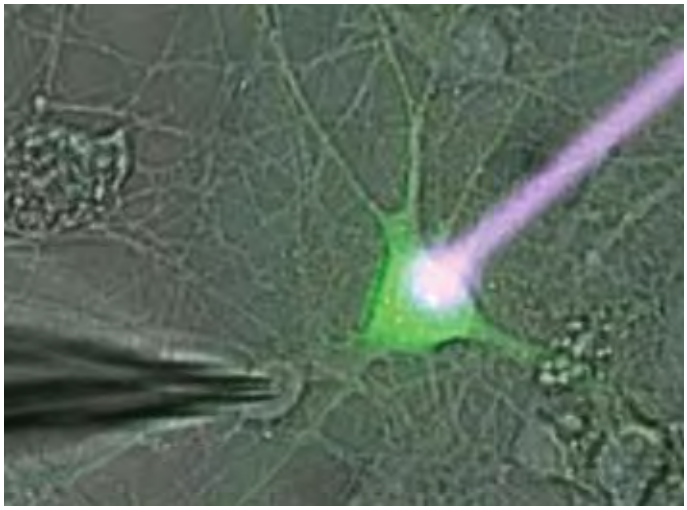
Biomechanics and Cellular Biophysics programme

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 we apply to investigate electron transfer in metal oxides and individual redox proteins.

These studies are relevant to the development of biosensors and molecular electronics devices. In particular, we have recently published a method to measure directly the distance decay constant that characterizes the rate of electron transfer (ET) in redox proteins, and we have reported single protein junctions consisting of azurin bridged between a gold substrate and the probe of an electrochemical tunneling microscope, which constitute a proof-of-principle of a single redox protein field-effect transistor. 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.

We are specifically interested in the processes of neurotransmitter secretion by exocytosis and membrane recycling by endocytosis, which are the fundamental phenomena that occur at the synaptic terminal and that participate in the communication between neurons. We have recently set up a method to control neurotransmitter exocytosis with light at the presynaptic compartment by activating a calcium-permeable, light-gated glutamate receptor (LiGluR) in cultured cells. Presynaptic expression of LiGluR in hippocampal neurons enables direct and reversible control of neurotransmission with light, and has allowed for the first time the modulation of the firing rate of the postsynaptic neuron with the wavelength of illumination.



Representation of the invasive manipulation of neuronal activity by means of a conventional glass electrode in contact with the neuron on the left, and noninvasively by means of a focalized light beam over the green neuron on the right (Photomontage: Mercè Izquierdo)

Research projects

- **OPTICALBULLET** Neurosecretion by Remote Control of Exocytosis and Endocytosis with Light (2008-2013).
PI: **Pau Gorostiza** (coordinator)
ERC Starting Independent Researcher Grant (ERC-StG) within the framework of EU-FP7

- **PASVD** Photo-activated SVD (2010-2012).
PI: **Pau Gorostiza**
Fellow: **Mª Isabel Bahamonde**
International Incoming Fellowships (IIF) Marie Curie Action within the framework of EU-FP7

- Bioelectrochemistry and Nanotechnologies (2009-SGR-277).
PI: **Fausto Sanz**
Agència de Gestió d'Ajuts Universitaris i de Recerca (AGAUR). Convocatòria d'ajuts per donar suport a les activitats dels grups de recerca de Catalunya (2009-2013)

- Development of light-modulated allosteric ligands for remote, non-invasive regulation of neuropathic pain (2010-2012).
PI: **Pau Gorostiza**
RecerCaixa, Obra Social "la Caixa"

- **FOCUS** Single Molecule Activation and Computing (2011-2013).
PI: **Pau Gorostiza** (Coordinator: Vincent Torre)
European Commission Future and Emerging Technologies proactive 7: Molecular Scale Devices and Systems FP7-ICT-2009 8.7 (270483)

- Optogenetic pacemaking to rewire neural circuits. (2012-2014).
PI: **Pau Gorostiza** (Coordinator: Artur Llobet)
Fundació Marató de TV3, Grants for Research in Neurodegenerative Diseases

- **Single-BioET** Single-molecule junction capabilities to map the electron pathways in redox bio-molecular architectures (2012-2015).
PIs: **Ismael Díez** and **Pau Gorostiza**
Marie Curie FP7-PEOPLE-IRG (International Re-integration Grants)

Publications

- Shan, X., Díez-Pérez, I., Wang, L., Wiktor, P., Gu, Y., Zhang, L., Wang, W., Lu, J., Wang, S., Gong, Q., Li, J. & Tao, N. (2012). Imaging the electrocatalytic activity of single nanoparticles. *Nature Nanotechnology*, 7 (10), 668-672

- Artés, J. M., Díez-Pérez, I. & Gorostiza, P. (2012). Transistor-like behavior of single metalloprotein junctions. *Nano Letters*, 12 (6), 2679-2684

- Díez-Pérez, I., Li, Z., Guo, S., Madden, C., Huang, H., Che, Y., Yang, X., Zang, L. & Tao, N. (2012). Ambipolar transport in an electrochemically gated single-molecule field-effect transistor. *ACS Nano*, 6 (8), 7044-7052

- Artés, J.M., López-Martínez, M., Giraudet, A., Díez-Pérez, I., Sanz, F. & Gorostiza, P. (2012). Current–Voltage characteristics and transition voltage spectroscopy of individual redox proteins. *Journal of the American Chemical Society*, 134 (50), 20218-20221

- Arimon, M., Sanz, F., Giralt, E. & Carulla, N. (2012). Template-assisted lateral growth of amyloid-β42 fibrils studied by differential labeling with gold nanoparticles. *Bioconjugate Chemistry*, 23 (1), 27-32

- Caballero-Briones, F., Palacios-Padrós, A., Calzadilla, O., Moreira, I.D.P.R. & Sanz, F. (2012). Disruption of the chemical environment and electronic structure in p-type Cu2O films by alkaline doping. *Journal of Physical Chemistry C*, 116 (25), 13524-13535

- Darwish, N., Díez-Pérez, I., Guo, S., Tao, N., Gooding, J.J. & Paddon-Row, M.N. (2012). Single molecular switches: Electrochemical gating of a single anthraquinone-based norbornylogous bridge molecule. *Journal of Physical Chemistry C*, 116 (39), 21093-21097

- Redondo-Morata, L., Giannotti, M. I. & Sanz, F. (2012). AFM-Based force-clamp monitors lipid bilayer failure kinetics. *Langmuir*, 28 (15), 6403-6410

- Redondo-Morata, L., Giannotti, M. I. & Sanz, F. (2012). Influence of cholesterol on the phase transition of lipid bilayers: A temperature-controlled force spectroscopy study. *Langmuir*, 28 (35), 12851-12860

- Redondo-Morata, L., Oncins, G. & Sanz, F. (2012). Force spectroscopy reveals the effect of different ions in the nanomechanical behavior of phospholipid model membranes: The case of potassium cation. *Biophysical Journal*, 102 (1), 66-74

- Hoyo, J., Guaus, E., Torrent-Burgués, J. & Sanz, F. (2012). Electrochemical behaviour of mixed LB films of ubiquinone - DPPC. *Journal of Electroanalytical Chemistry*, 669, 6-13
- Gorostiza, P. (2012). Control celular mediante luz. *Investigación y Ciencia*, 433, 11-12

Book chapter:

- Redondo, L., Giannotti, M. I. & Sanz, F. (2012). Stability of lipid bilayers as model membranes: Atomic force microscopy and spectroscopy approach. In *Atomic force microscopy in liquid*, eds. Baró, A. M. & Reifenberger, R.G., Wiley-VCH Verlag GmbH & Co.KGaA., Weinheim, Germany

Collaborations with other research centres

Prof. Amadeu Llebaria Institut de Química Avançada de Catalunya (IQAC-CSIC), Barcelona, Spain

Prof. Ernest Giralt Dept. de Química Orgànica, Universitat de Barcelona, Spain

Prof. Miquel Àngel Pericàs Institut Català d'Investigació Química (ICIQ), Tarragona, Spain

Dr. Piotr Bregestovski Institut de Neurobiologie de la Mediterraneé (INMED), Marseille, France

Dr. Mireia Oliva Dept. de Farmàcia i Tecnologia Farmacèutica, Universitat de Barcelona, Spain

Dr. Artur Llobet Dept. Patología y Terapéutica Experimental, Universitat de Barcelona, Spain

Dr. Joan Torrent Escola Universitària d'Òptica i Optometria de Terrassa, Spain

Prof. Dirk Trauner Chemistry Dept., UC Berkeley, USA

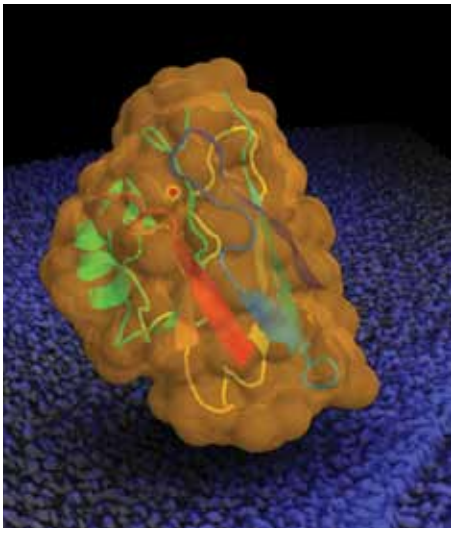
Prof. Carles Solsona Pathology and Experimental Therapeutics Dept, Universitat de Barcelona, Spain

Prof. Francisco Ciruela ICREA / Universitat de Barcelona, Spain

Prof. Jesús Giraldo Universitat Autònoma de Barcelona, Spain

Scientific equipment and techniques

- iMic molecular imaging system
- Electrochemical scanning tunnelling microscope (STM) for molecular imaging
- Asylum Research Molecular Force Probe
- Multimode SPM Nanoscope III (SCT-UB)
- Autolab potentiostat
- Patch clamp setup with Heka EPC10 amplifier
- Molecular Imaging Electrochemical STM



Crystal structure of redox protein azurin (Protein Data Bank entry: 1AZU) displaying its solvent accessible surface (gold) superimposed on the tertiary structure (rainbow) and a red sphere indicating the copper ion. When an atomically flat gold electrode is coated with azurin, the protein can be imaged under potentiostatic control by electrochemical tunneling microscopy (3D rendering of a 100x100nm^2 area shown in blue), and its electron transfer properties can be investigated by current-distance spectroscopy (Juan Manuel Artés *et al.*, 2011, *ACS Nano*)

Integrative Cell and Tissue Dynamics

Group leader: Xavier Trepat

Senior researcher: Dobryna Zalvidea

Postdoctoral researchers: Vito Conte, Anna Labernadie, Elsa Bazellières, Romaric Vincent, Ester Añón

PhD students: Agustí Brugués, Laura Casares, Pilar Rodríguez, Xavier Serra, Simón García

Masters students: Marina Uroz, Sònia Pintor

Undergraduate student: Helena Andrés

Technician: Maria Angeles Bintanel

Biomechanics and Cellular Biophysics programme

Integrative Cell and Tissue Dynamics

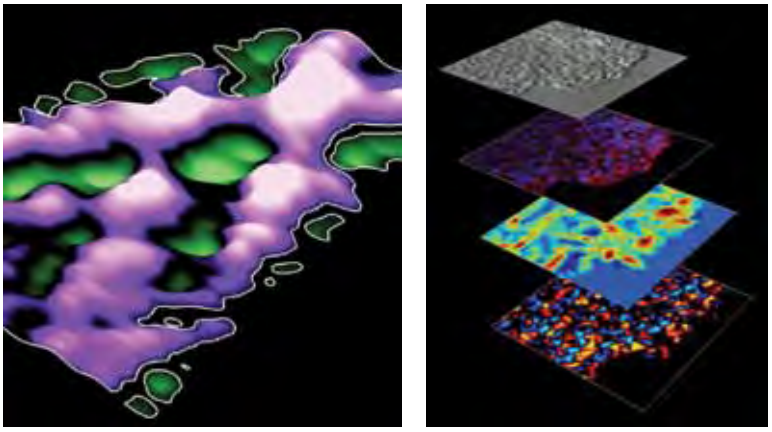
Cell motility and tissue dynamics

The ability of eukaryotic cells to migrate within living organisms underlies a wide range of phenomena in health and disease. When properly regulated, cell migration enables morphogenesis, host defense and tissue healing. When regulation fails, however, cell migration mediates devastating pathologies such as cancer, vascular disease and chronic inflammation. Our research focuses on understanding the fundamental biophysical mechanisms underlying migration both at the single cell level and at the tissue level.

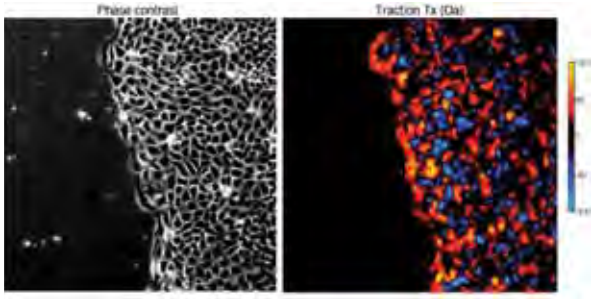
To study cell and tissue dynamics we develop new technologies to measure cellular velocities and physical forces at the cell-cell and cell-matrix interface. Using these techniques we unveiled a new mechanism of cellular guidance by intercellular physical forces we called plithotaxis. Our new tools also led to the discovery of an unanticipated mechanical wave that propagates through expanding cell sheets. This mechanical wave is a natural candidate to trigger mechanotransduction pathways during wound healing, morphogenesis, and collective cell invasion in cancer.

Cytoskeletal fragility

With every beat of the heart, inflation of the lung or peristalsis of the gut, cell types of diverse function are subjected to substantial mechanical forces. How cells sense and respond to such forces underlies fundamental biological functions including differentiation, proliferation, polarization, locomotion, invasion, gene expression and pattern formation. We recently identified a new class of universal cellular responses to mechanical forces we termed ‘cytoskeletal fluidization’ (Trepat *et al.*, 2007, *Nature*). The existence of this response class implies that the cytoskeleton of the living cell should no longer be regarded as a robust and stable scaffold but as a fragile one that is able to fluidize and quickly reorganize to adapt to its active mechanical environment. Our current research focuses on better understanding the functional implications of cytoskeletal fluidization and elucidating the underlying physical mechanisms.



Left: waves of cellular deformation propagate across expanding tissues. Right: our lab has developed techniques to simultaneously map cell velocities, cytoskeletal structure, intercellular stresses, and cell-substrate tractions (from top to bottom)



Traction forces exerted by a migrating cell sheet (*Nature Physics*, 2009)

Research projects

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

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

- Mechanics of Monolayer Migration (2011-2016).
Co-Investigator: **Xavier Trepat** (PI: Jeffrey Fredberg)
National Institutes of Health, USA

Publications

- Serra-Picamal, X., Conte, V., Vincent, R., Anon, E., Tambe, D.T., Bazellieres, E., Butler, J.P., Fredberg, J.J. & Trepat, X. (2012). Mechanical waves during tissue expansion. *Nature Physics,* 8 (8), 628-634

- Anon, E., Serra-Picamal, X., Hersen, P., Gauthier, N.C., Sheetz, M.P., Trepat, X. & Ladoux, B. (2012). Cell crawling mediates collective cell migration to close undamaged epithelial gaps. *PNAS*, 109 (27), 10891-10896

- Nocentini, S., Reginensi, D., Garcia, S., Carulla, P., Moreno-Flores, M.T., Wandosell, F., Trepat, X., Bribian, A. & Del Río, J.A. (2012). Myelin-associated proteins block the migration of olfactory ensheathing cells: an *in vitro* study using single-cell tracking and traction force microscopy. *Cellular and Molecular Life Sciences*, 69 (10), 1689-1703

Book chapter:

Trepat, X., Chen, Z. & Jacobson, K. (2012). Cell Migration. In *Comprehensive Physiology*, ed. Terjung, R., 2, 2369–2392. John Wiley & Sons Inc., Hoboken, USA

Collaborations with other research centres

Julien Colombelli Institute for Research in Biomedicine (IRB), Barcelona, Spain

Eduard Batlle Institute for Research in Biomedicine (IRB), Barcelona, Spain

Roger Guimerà Univeristat Rovira i Virgili, Tarragona, Spain

Roberto Mayor University College London, UK

Erik Sahai Cancer Research, UK

Benoit Ladoux Université Paris 7, France

Jim Butler & Jeff Fredberg Harvard University, Boston

Scientific equipment and techniques

- Soft Lithography
- Micro/Nano fabrication
- Cell stretching
- Live Confocal Microcopy
- Magnetic Tweezers
- Magnetic Twisting Cytometry
- Monolayer stress microscopy
- Traction microscopy

Nanobioengineering

Group leader: Prof. Dr. Josep Samitier

Senior researchers: Elena Martínez, Mateu Pla, Antoni Homs, Anna Lagunas, Mònica Mir

Postdoctoral researchers: Maria Bulwan, Margarita Alvira, Zi Qiu Tong, Beatriz Prieto, Juan José Valle, Patrizia Iavicoli

PhD students: Sabine Oberhansl, Wilmer Alfonso Pardo, Cristina Casas, Oscar Castillo, Jordi Comelles, Beatriz Del Moral, Maria Teresa Galán, Albert Garcia, Verónica Hortigüela, Sergio Martínez, Ana Mª Oliva, Luís Rigat, Marta Sanmartí, Maria Valls, José Luis Sebastián, Rosa Letizia Zaffino, César Parra, Juan Pablo Agusil, Marilia Barreiros dos Santos, Bogachan Tahirbegi

Masters students: Ana Carro, Núria Codina

Undergraduate students: Carla Sánchez, Héctor Sangüesa, Alicia Reyes

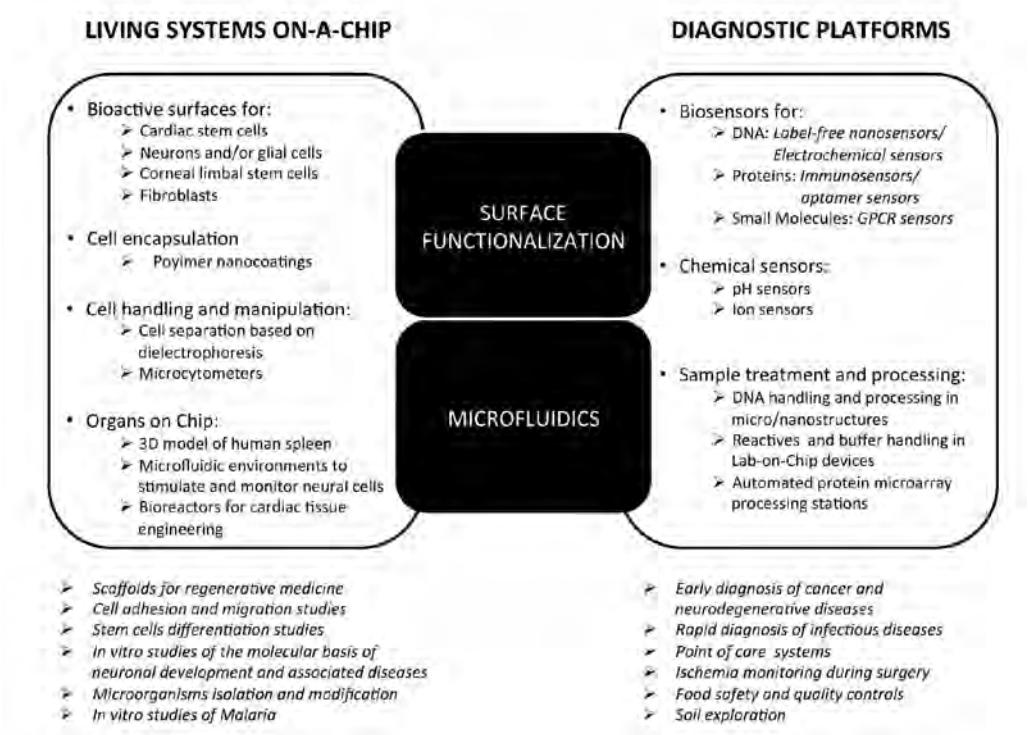
Technicians: Juan Manuel Álvarez, Miriam Funes, David Izquierdo, María de los Reyes Malavé, Javier Soraluce

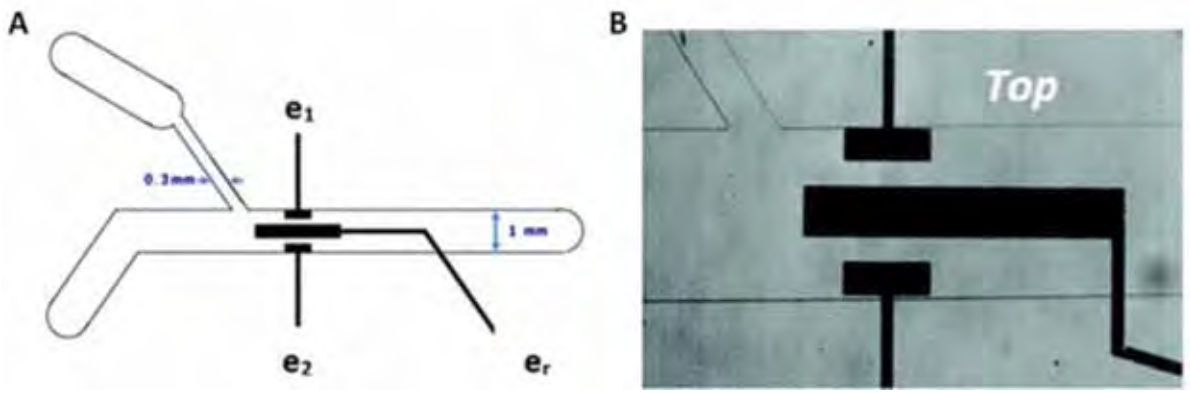
Visitors: Benjamin Martyn, Ahn Young Chang, Nataly Silva, Mariana Isabel De Niz

Nanobioengineering

The Nanobioengineering group is a truly multidisciplinary team composed by researchers coming from very diverse backgrounds (chemistry, physics, material science, electronic engineering, pharmacy and molecular biology) and working together in applying nanotechnology to the development of new biomedical systems and devices. The main activities of the group involve the physical and chemical functionalization of materials for the development of new integrated biosensor platforms and "living systems on-a-chip". The technologies and results obtained in the laboratory are employed mainly in medical applications ranging from portable devices for Point-of-Care diagnostics to implantable scaffolds for regenerative medicine.

The main research lines and projects carried out by the group, focused on clinical and industrial issues, are summarized below:





Schematics (A) and microscopic image (B) of a microfluidic device with 3 integrated biosensors. From Parra-Cabrera et al., 2012.

Research projects

- **BOND** Bioelectronic Olfactory Neuron Device (2009-2013).
  Coordinator: **Josep Samitier** (for the UB)
  Technical Manager: **Gabriel Gomila** (page 61)
  Collaborative project (NMP) within the framework of EU-FP7

- **PLANTOID** Innovative Robotic Artefacts Inspired by Plant Roots for Soil Monitoring
  PI: **Josep Samitier**
  EU- FP7-ICT-FET-Open

- **OligoCODEs** Universal Diagnostic Platforms Based On Oligonucleotide Codified Nanoparticles and DNA Microarray Sensor Devices
  PI: **Josep Samitier**
  MICINN

- **LABINACHIP** Nuevos métodos para la fabricación de dispositivos microfluídicos (2010-2012).
  PI: **Josep Samitier**
  Centro para el Desarrollo Tecnológico Industria (CDTI), Industria de la Ciencia

- Development of innovative tools for Ochratoxin A risk assesment (2011-2012).
  PI: **Beatriz Prieto** (coordinator)
  Agència de Gestió d'Ajuts Universitaris i de Recerca (AGAUR), Comunitat de Treball dels Prineus (CTP).

- Diagnóstico y pronóstico de cáncer de próstata mediante nanobiosensores híbridos multianalito (2011-2013).
  PI: **Josep Samitier, Elena Martinez** (coordinator)
  MICINN, Instituto de Salud Carlos III. Subprograma de Proyectos de investigación en salud (FIS)

- **CARDIO-STEM** Terapias regenerativas con células madre para el fallo cardíaco (2009-2014).
  PI: **Josep Samitier**
  MICINN, ACI-E Medicina Regenerativa

- Desarrollo de Tecnologías en Bionanomedicina para diagnóstico y terapia
  PI: **Josep Samitier**
  Industrial project with Fundación Marcelino Botín

- Desarrollo de una nueva tecnología lab-on-a-chip para la detección y cuantificación de secuencias de ADN/ARN (biomarcadores).
  PI: **Josep Samitier**
  Industrial project with GENOMICA S.A.U.

- Suport al desenvolupament i integració de sistemes de "point-of-care" pel diagnòstic mèdic de malalties respiratòries (dins del projecte TheraEDGE).
  PI: **Josep Samitier**
  Industrial project with BIOKIT, S.A.

- Grup de recerca consolidat (2009-2013).
  PI: **Josep Samitier**
  Agència de Gestió d'Ajuts Universitaris i de Recerca (AGAUR). Convocatòria d'ajuts per donar suport a les activitats dels grups de recerca de Catalunya (SGR 2009).

Publications

- Oberhansl, S., Hirtz, M., Lagunas, A., Eritja, R., Martinez, E., Fuchs, H. & Samitier, J. (2012). Facile modification of silica substrates provides a platform for direct-writing surface click chemistry. *Small*, 8 (4), 541-545

- Mir, M., Tahirbegi, I.B., Valle-Delgado, J. J., Fernàndez-Busquets, X. & Samitier, J. (2012). *In vitro* study of magnetite-amyloid β complex formation. *Nanomedicine: Nanotechnology, Biology and Medicine*, 8 (6), 974-980

- Lagunas, A., Comelles, J., Martínez, E., Prats-Alfonso, E., Acosta, G.A., Albericio, F. & Samitier, J. (2012). Cell adhesion and focal contact formation on linear RGD molecular gradients: study of non-linear concentration dependence effects. *Nanomedicine: Nanotechnology, Biology and Medicine*, 8 (4), 432-439

- Parra-Cabrera, C., Sporer, C., Rodriguez-Villareal, I., Rodriguez-Trujillo, R., Homs-Corbera, A. & Samitier, J. (2012). Selective *in situ* functionalization of biosensors on LOC devices using laminar co-flow. *Lab on a Chip*, 12 (20), 4143-4150

- Esquivel, J.P., Colomer-Farrarons, J., Castellarnau, M., Salleras, M., del Campo, F.J., Samitier, J., Miribel-Catala, P. & Sabate, N. (2012). Fuel cell-powered microfluidic platform for lab-on-a-chip applications: Integration into an autonomous amperometric sensing device. *Lab on a Chip*, 12 (21), 4232-4235

- Esquivel, J.P., Castellarnau, M., Senn, T., Löchel, B., Samitier, J. & Sabaté, N. (2012). Fuel cell-powered microfluidic platform for lab-on-a-chip applications. *Lab on a Chip* 12 (1), 74-79

- Yang, C., Lates, V., Prieto-Simón, B., Marty, J.-L. & Yang, X. (2012). Aptamer-DNAzyme hairpins for biosensing of Ochratoxin A. *Biosensors and Bioelectronics*, 32 (1), 208-212

- Tort, N., Salvador, J.P., Avino, A., Eritja, R., Comelles, J., Martinez, E., Samitier, J. & Marco, M.P. (2012). Synthesis of steroid-oligonucleotide conjugates for a DNA site-encoded SPR immunosensor. *Bioconjugate Chemistry*, 23 (11), 2183-2191

- Penon, O., Novo, S., Duran, S., Ibanez, E., Nogues, C., Samitier, J., Duch, M., Plaza, J.A. & Perez-Garcia, L. (2012). Efficient biofunctionalization of polysilicon barcodes for adhesion to the zona pellucida of mouse embryos. *Bioconjugate Chemistry*, 23 (12), 2392-2402

- Caballero, D., Martinez, E., Bausells, J., Errachid, A. & Samitier, J. (2012). Impedimetric immunosensor for human serum albumin detection on a direct aldehyde-functionalized silicon nitride surface. *Analytica Chimica Acta*, 720, 43-48

- Valle-Delgado, J.J., Liepina, I., Lapidus, D., Sabaté, R., Ventura, S., Samitier, J. & Fernàndez-Busquets, X. (2012). Self-assembly of human amylin-derived peptides studied by atomic force microscopy and single molecule force spectroscopy. *Soft Matter*, 8 (4), 1234-1242

- Calò, A., Sanmartí-Espinal, M., Iavicoli, P., Persuy, M.A., Pajot-Augy, E., Gomila, G. & Samitier, J. (2012). Diffusion-controlled deposition of natural nanovesicles containing G-protein coupled receptors for biosensing platforms. *Soft Matter*, 8 (46), 11632-11643

- Campas, M., Garibo, D. & Prieto-Simon, B. (2012). Novel nanobiotechnological concepts in electrochemical biosensors for the analysis of toxins. *Analyst*, 137 (5), 1055-1067

- Comelles, J., Hortiguela, V., Samitier, J. & Martinez, E. (2012). Versatile gradients of covalently bound proteins on microstructured substrates. *Langmuir*, 28 (38), 13688-13697

- Villar-Pique, A., de Groot, N.S., Sabaté, R., Acebrón, S.P., Celaya, G., Fernàndez-Busquets, X., Muga, A. & Ventura, S. (2012). The effect of amyloidogenic peptides on bacterial aging correlates with their intrinsic aggregation propensity. *Journal of Molecular Biology*, 421 (2-3), 270-281

- Kuphal, M., Mills, C.A., Korri-Youssoufi, H. & Samitier, J. (2012). Polymer-based technology platform for robust electrochemical sensing using gold microelectrodes. *Sensors and Actuators B: Chemical*, 161 (1), 279-284

- Urban, P., Valle-Delgado, J.J., Moles, E., Marques, J., Diez, C. & Fernandez-Busquets, X. (2012). Nanotools for the delivery of antimicrobial peptides. *Current Drug Targets*, 13 (9), 1158-1172

- Juanola-Feliu, E., Colomer-Farrarons, J., Miribel-Català, P., Samitier, J. & Valls-Pasola, J. (2012). Market challenges facing academic research in commercializing nano-enabled implantable devices for in-vivo biomedical analysis. *Technovation*, 32 (3-4), 193-204

- Gallach, D., Torres-Costa, V., García-Pelayo, L., Climent-Font, A., Martín-Palma, R. J., Barreiros-Das-Santos, M., Sporer, C., Samitier, J. & Manso, M. (2012). Properties of bilayer contacts to porous silicon. *Applied Physics A: Materials Science and Processing*, 107 (2), 293-300

■ Azevedo, S., Diéguez, L., Carvalho, P., Carneiro, J. O., Teixeira, V., Martínez, E. & Samitier, J. (2012). Deposition of ITO thin films onto PMMA substrates for waveguide based biosensing devices. *Journal of Nano Research*, 17, 75-83

■ Diéguez, L., Caballero, D., Calderer, J., Moreno, M., Martínez, E. & Samitier, J. (2012). Optical gratings coated with thin Si3N4 layer for efficient immunosensing by optical waveguide lightmode spectroscopy. *Biosensors*, 2 (2), 114-126

Book chapters:

■ Martínez, E., Pla-Roca, M. & Samitier, J. (2012). Micro/nanopatterning of proteins using a nanoimprint-based contact printing technique. In *Nanotechnology in Regenerative Medicine - Methods and Protocols (Methods in Molecular Biology),* eds. Navarro, M. & Planell, J. A., 811, 79-87. Springer New York, USA

■ Sanmartí, M., Iavicoli, P. & Samitier, J. (2012). Biosensors for diagnostic based on olfactory receptors. In *Nanomedicine in Diagnostics*, ed. Rozlosnik, N., 120-150. Science Publishers, Jersey, UK

■ Zaffino, R. L., Pardo, W. A., Mir, M. & Samitier, J. (2012). Electrochemical DNA biosensors at the nanoscale. In *Biosensors and Cancer*, ed. Preedy, V. R. & Patel, V., 62-84. Science Publishers, London, UK

Collaborations with other research centres

Prof. Fernando Albericio Institut de Recerca Biomédica (IRB), Barcelona, Spain

Dr. José Antonio Andrades, Universidad de Málaga, Spain

Prof. Joan Bausells Centro Nacional de Microelectrónica (CNM-CSIC), Barcelona, Spain

Prof. Albert van den Berg University of Twente, The Netherlands

Prof. Andre Bernard Institut für Mikro- und Nanotechnologie (MNT-NTB), Buchs, Switzerland

Prof. H. Börner Max-Planck Institute of Colloids and Interfaces, Golm, Germany

Prof. Josep Maria Canals University of Barcelona, Spain

Dr. Matthew Dalby University of Glasgow, Glasgow, UK

Prof. Paolo Dario Scuola Superiore Sant'Anna (SSSA), Pontedera, Italy

Prof. Ramón Eritja Institut de Recerca Biomédica (IRB), Barcelona, Spain

Prof. E. Faszewski Wheelock College, Boston, USA

Prof. G. Fuhr FhG Biomedicine, St. Ingbert, Germany

Dr. Juan C. Izpisúa Centro de Medicina Regenerativa (CMRB), Barcelona, Spain

Dr. Nicole Jaffrezic Université Claude Bernard Lyon 1, France

Dr. Graham Johnson Uniscan Instruments Ltd, Buxton, UK

Dr. Mª Pilar Marco Institute of Chemical and Environmental Research, Barcelona, Spain

Prof. Jean-Louis Marty Université de Perpignan Via Domitia, France

Prof. Barbara Mazzolai IIT Center for Micro-BioRobotics (CMBR), Pontedera, Italy

Dr. Edith Pajot Biology of Olfaction and Biosensors group (BOB) at INRA, Jouy-en-Josas, France

Dr. M. Lluïssa Pérez Dept. Farmacología, University of Barcelona, Spain

Dr. Hernando del Portillo Centro de Investigación en Salud Internacional de Barcelona (CRESIB), Barcelona, Spain

Dr. Jaume Reventós Hospital Vall d'Hebrón, Barcelona, Spain

Prof. L. Reggiani Nanotechnology Laboratory, INFM, Lecce, Italy

Prof. Daniel Riveline Laboratory of Cell Physics ISIS/ IGBMC, Strasbourg

Prof. M. Sampietro Politecnico di Milano, Italy

Prof. Molly M. Stevens Imperial College, London, UK

Dr. Christophe Vieu Laboratoire d'analyse et d'architectures des systèmes (LAAS-CNRS), Toulouse, France

Industry partners:

Biokit S.A. (Werfen group)

Genomica S.A.U. (Zeltia group)

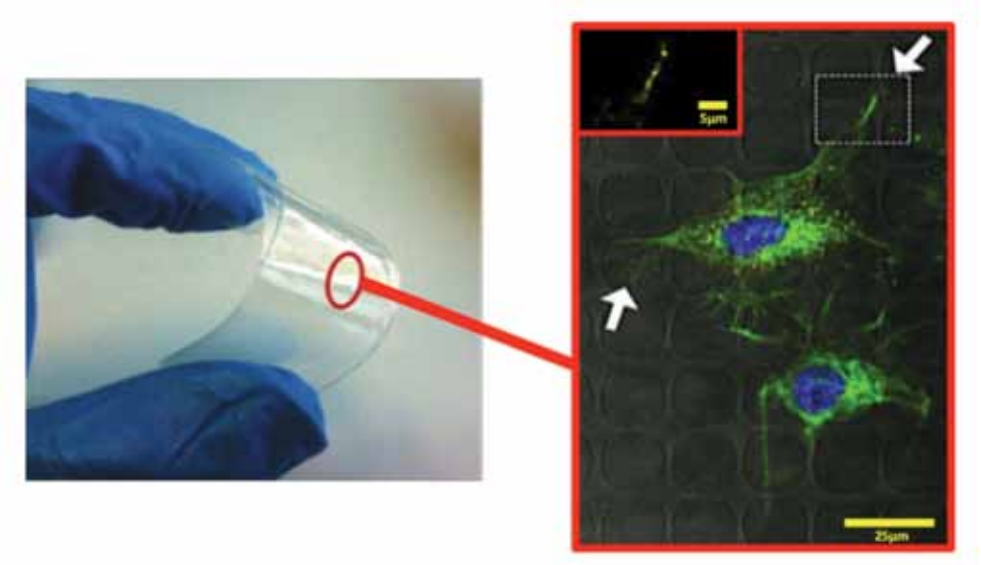
Tallers Fiestas S.L.

Enantia S.L.

Microfluidic ChipShop GmbH

Scientific equipment and techniques

- Nanofabrication and nanomanipulation
  - Automatized microcontact printing system (custom-made)
  - Dip-Pen Nanolithography system (DPN)
  - Nanoplotter NPM
  - Nanotechnology Platform (PCB): equipment for hot embossing lithography, polymer processing and photolithography, chemical wet etching, e-beam evaporation
- Characterization
  - Surface Plasmon Resonance (SPR)
  - Quartz crystal microbalance (QCM)
  - Optical Waveguide Lightmode Spectroscope (OWLS)
  - Atomic Force Microscope (AFM)
  - Optical Microscopes (white light/epifluorescence)
  - Impedance spectroscopes
  - Precision Impedance Analyzer
  - Sub-femtoamp Remote SourceMeter Instrument
- Molecular/cell biology
  - Biological safety cabinet (class II)
  - Microwell plate readers
  - Protein and DNA electrophoresis systems
  - Nanodrop spectrophotometer
- Microfluidics
  - High precision syringe pumps
  - Peristaltic pumps



Cell Culture platform containing microenvironments based on highly tunable gradients of covalently bound proteins (fibronectin) on topographically modified poly(methyl methacrylate). (Right) High-magnification confocal image of 3T3 cells at a "high" fibronectin density region on a microstructured surface (100 ng cm–2). (Inset) Detail of formation of focal contacts at the cell periphery. White arrows point to the interaction of cell protrusions with the topography. From Comelles, J., et al., 2012.

Nanomalaria

Senior researcher: Xavier Fernández-Busquets

PhD students: Ernest Moles, Patricia Urbán, Joana Marques

Nanobiotechnology programme

Nanomalaria (joint group)

The Nanomalaria group is a sub-group of the Nanobioengineering lab (page 52) with joint affiliation with the Centre de Recerca en Salut International de Barcelona (CRESIB) and support from both. It stems from an official agreement signed in 2010 to facilitate collaboration in certain areas of common interest. This proposed the establishment of a mixed unit of personnel from both institutes aimed at developing diagnostic and therapeutic nanomedicine-based systems to be applied to malaria.

Our research interests are in the following areas:

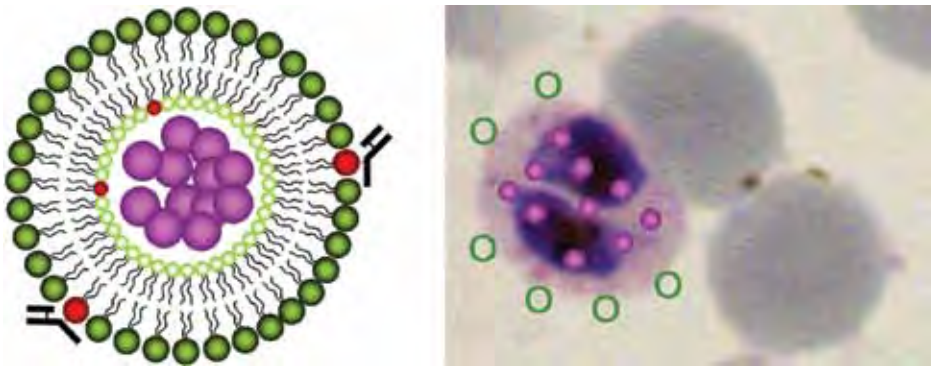
1. Optimization of the nanovectors being currently developed with the objective of exploring sustained drug release strategies inside *Plasmodium*-infected red blood cells (pRBCs). This will imply the development of suitable polymeric nanovectors for drug encapsulation to be used either as intraliposomal carriers or for direct delivery.

2. Improvement of the targeting agents used to direct nanovectors to pRBCs, including the molecular engineering of specific antibodies and the development of new targeting molecules of low immunogenicity such as glycosaminoglycans and nucleic acids.

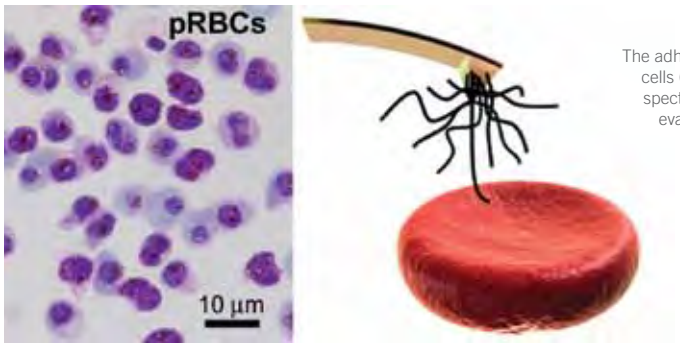
3. Exploration of the suitability of hollow (immuno)liposomes as carriers for the targeted delivery of phospholipids toxic for *Plasmodium*.

4. Investigation of the use of peptides derived from antimicrobial ribonucleases as antimalarial agents.

5. Study of the possible presence of functional amyloids on *Plasmodium* cells and of the feasibility of developing an amyloid-based vaccination strategy. Here we will apply our ample expertise on amyloid peptide research to the study of the merozoite surface protein 2 (MSP2), which has been described to form amyloid fibrils *in vitro*.



Left: a cartoon of a quantum dot-containing liposome functionalized with half-antibodies against *Plasmodium falciparum*-infected red blood cells. Right: a graphical scheme of the performance of such immunoliposomal nanovector when added to a *P. falciparum* culture containing both infected and non-infected cells



The adhesion of heparin to *Plasmodium*-infected red blood cells (pRBCs) has been probed by single-molecule force spectroscopy, as a pioneering approach to quantitatively evaluating heparin-pRBC interactions at the individual molecule level

Research projects

- Exploration of new efficient targeting molecules for nanovector-mediated antimalarial drug delivery (2012-2014).
PI: **Xavier Fernández-Busquets**
Biotechnology Programme, MICINN, Spain (BIO2011-25039)

- Group for the study of self-aggregating proteins (2009-2014).
PI: **Xavier Fernández-Busquets**
Consolidated Research Group certified by the Generalitat de Catalunya, Spain (2009-SGR-760)

- **NANOMALNET** Exploración de nuevas moléculas direccionadoras eficientes para la liberación de antimaláricos.
PI: **Xavier Fernández-Busquets** (partner)
MICINN

Filed patents

- **Amphoteric polyamidoamines in the treatment of malaria** (Filing date 14th November 2012)
Inventors: Ranucci, Elisabetta; Ferruti, Paolo; Fenili, Fabio; Manfredi, Amedea & Mauro, Nicolò (Università degli Studi di Milano); ***Urbán, Patricia*** *&* ***Fernández-Busquets, Xavier*** *(IBEC / CRESIB).*
Ref. number: EP12192633.1 F

Publications

- Valle-Delgado, J.J., Liepina, I., Lapidus, D., Sabaté, R., Ventura, S., Samitier, J., & Fernàndez-Busquets, X. (2012) Self-assembly of human amylin-derived peptides studied by atomic force microscopy and single molecule force spectroscopy. *Soft Matter* 8, 1234-1242

- Urbán, P., Valle-Delgado, J.J., Moles, E., Marques, J., Díez, C., & Fernàndez-Busquets, X. (2012) Nanotools for the delivery of antimicrobial peptides. *Current Drug Targets* 13, 1158-1172

- Mir, M., Tahirbegi, I.B., Valle-Delgado, J.J., Fernàndez-Busquets, X., & Samitier, J. (2012) *In vitro* study of magnetite-amyloid β complex formation. *Nanomedicine NBM* 8, 974-980

- Villar-Piqué, A., de Groot, N.S., Sabaté, R., Acebrón, S.P., Celaya, G., Fernàndez-Busquets, X., Muga, A., & Ventura, S. (2012) The effect of amyloidogenic peptides on bacterial aging correlates with their intrinsic aggregation propensity. *J. Mol. Biol.* 421, 270-281

Conference paper:

- Moles, E., Urbán, P., Marques, J., Valle-Delgado, J.J., Díez, A., Prieto, B., & Fernàndez-Busquets, X. (2012) Towards a magic bullet against malaria: Paul Ehrlich revisited. In *Proceedings of the 3rd International Conference on Nanotechnology: Fundamentals and Applications*, 7-9 August 2012, Montreal, Quebec, Canada. International ASET Inc.

Scientific equipment and techniques

- Zeiss Primostar microscope
- Shake 'N' Stack (Thermo Hybaid) hybridization oven
- BIO-RAD electrophoresis system for agarose and polyacrylamide gels

Nanoscale Bioelectrical Characterization

Group leader: Gabriel Gomila

Senior researcher: Laura Fumagalli

Postdoctoral researchers: Annalisa Calò, Jordi Otero

PhD students: Aurora Dols-Pérez, Daniel Esteban, Georg Gramse, Marc Van Der Hofstadt

Masters students: Payman Mosaffa, Tina Wiegand

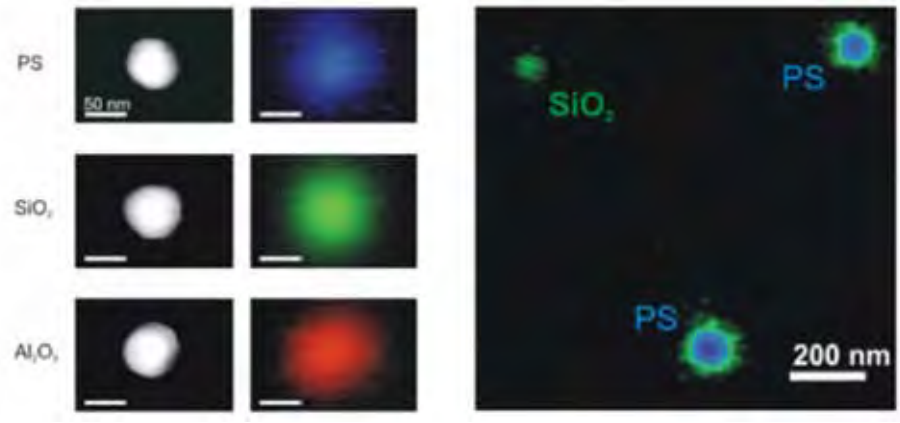
Nanobiotechnology programme

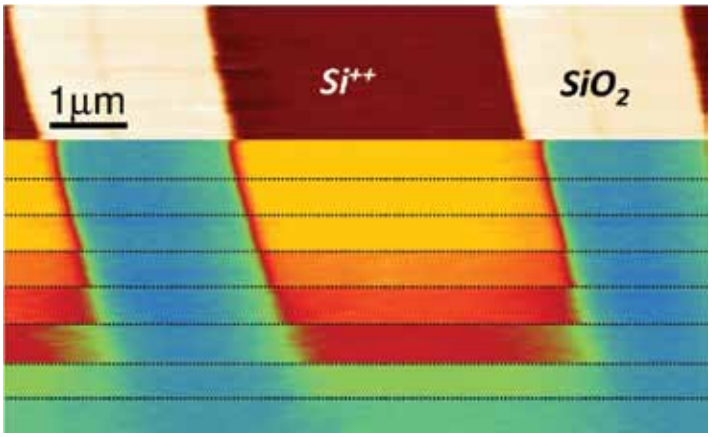
Nanoscale Bioelectrical Characterization

The main goal of our research group is to develop new experimental setups based on atomic force microscopy and theoretical frameworks enabling the measurement of the electrical properties of biological samples at the nanoscale (for example, biomembranes, single viruses or single bacteria). Our main objective is to contribute to develop new label-free biological characterization methods and new electronic biosensors.

During 2012 we demonstrated for the first time the possibility to measure with high accuracy the dielectric properties of small scale objects down to 10 nm in radius by means of electrostatic force microscopy. The high accuracy and spatial resolution achieved enabled us the material identification of single dielectric nanoparticles and of single viruses without the use of any labeling molecule. Moreover, we have extended this methodology to the liquid environment reaching a spatial resolution down to 100 nm. Finally, we have completed the study of natural nanovesicles containing olfactory receptors and its absorption onto solid supports for biosensor applications, and the preparation and mechanical characterization of multicomponent-multiphase supported lipid bilayers stable in air for use as lipid raft model systems in dry air conditions.

Left: Topography (left column) and dielectric (right column) images of polystyrene (PS), silicon dioxide (SiO_2) and aluminum oxide (Al_2O_3) nanoparticles of 20 nm radius measured on different graphite substrates and with different tips, with radii between 5 nm and 7 nm. By matching the maximum dielectric signal measured at the centre of the nanoparticles with theoretical calculations, which include the nanoparticle and tip geometries, we obtained the dielectric constant of each nanoparticle material, ε_r=2.69, 4.47 and 8.75, respectively, in good agreement with the corresponding bulk materials. Right: Dielectric image of an unknown mixture of nanoparticles. By obtaining the dielectric constant of each nanoparticle we could identify the material composition of the nanoparticles in a label-free way





(Upper image) Topography and (lower image) dielectric images of 20 nm thin and 2.5 µm wide SiO_2 microstripes on a doped Silicon substrate obtained in electrolyte solutions. Dielectric images were obtained at constant height at 100 nm from the Silicon baseline with an electrolyte with ion concentration of 1mM and with 0.5 V applied. The applied frequency in the dielectric image was changed from 20 MHz to 0.1MHz every ten lines to show how the image contrast depends strongly on the frequency of the applied voltages and disappears at low frequencies

Research projects

- **ELECTROBACTERIA** Nanotools and nanotechniques for bioelectric studies in single bacteria cells (2011-2013).
PI: **Gabriel Gomila**
MICINN (TEC2010-16844)

- **AFM4NanoMed&Bio** European network on applications of Atomic Force Microscopy to NanoMedicine and Life Sciences (2010-2015).
PI: **Gabriel Gomila** (Management Committee Substitute Member)
EU COST Action TD1002

- **BOND** Bioelectronic Olfactory Neuron Device (2009-2013).
Technical Manager and WP leader: **Gabriel Gomila**
Coordinator: **Josep Samitier** (for the UB; see page 34)
Collaborative project (NMP) within the framework of EU-FP7

- **V-SMMART Nano** Volumetric Scanning Microwave Microscopy Analytical and Research Tool for Nanotechnology (2012-2015)
PI: **Gabriel Gomila**
European FP7-NMP-SME project

Publications

- Fumagalli, L., Esteban Ferrer, D., Cuervo, A., Carrascosa, J. & Gomila, G. (2012). Label-free identification of single dielectric nanoparticles and viruses with ultraweak polarization forces. *Nature Materials*, 11, (9), 743-826

- Calò, A., Sanmartí, M., Iavicoli, P., Persuy, M.-A., Pajot-Augy, E., Gomila, G. & Samitier, J. (2012). Diffusion-controlled deposition of natural nanovesicles containing G-protein coupled receptors for biosensing platforms. *Soft Matter*, 8 (46), 11632-11643

- Gramse, G., Gomila, G. & Fumagalli, L. (2012). Quantifying the dielectric constant of thick insulators by electrostatic force microscopy: effects of the microscopic parts of the probe. *Nanotechnology*, 23 (20), 205703

- Gramse, G., Edwards, M., Fumagalli, L. & Gomila, G. (2012). Dynamic electrostatic force microscopy in liquid media. *Appl. Phys. Lett.*, 101 (21), 213108

Collaborations with other research centres

Prof. Adam Cohen Simonsen Department of Physics and Chemistry, University of Southern Denmark

Prof. Jose L. Carrascosa Department of Structure of Macromolecules, Centro Nacional de Biotecnología, Spain

Prof. Joan Bausells Centro Nacional de Microelectrónica de Barcelona-CSIC, Spain

Prof. Edith Pajot-Augy Neurobiologie de l'olfaction et la prise alimentaire, Institut National de la Recherche Agronomique, Jouy-en-Josas, France

Dr. Manel Puig Departament d'Electrònica, University of Barcelona, Spain

Prof. Marco Sampietro Laboratorio di Strumentazione Analogica e Materiali Polimerici, Politecnico di Milano, Italy

Dr. Adriana Gil Nanotec Electronica S.L., Madrid, Spain

Prof. Lino Reggiani National Nanotechnology Laboratory, Universita del Salento, Lecce, Italy

Scientific equipment and techniques

- Cypher Atomic Force Microscope (Asylum Research)
- 2 Cervantes Atomic Force Microscopes (Nanotec Electronica)
- Easy Scan 2 Atomic Force Microscope (Nanosurf)
- AxioImager A1m Reflection Optical Microscope (Zeiss) equipped with a AxioCam ERc5s (Zeiss)
- HF2LI digital lock-in amplifier (Zurich Instruments)
- CompactStat portable electrochemical interface and impedance analyzer (Ivium Technologies)
- 2 eLockIn204 4-phase Lock-In amplifiers (Anfatec)
- Keithley 6430 sub-femtoAmp remote sourcemeter (Keithley)

Biomaterials for Regenerative Therapies

Group leader: Josep A. Planell

Senior researchers: Elisabeth Engel, Oscar Castaño, Miguel Angel Mateos, Melba Navarro

Postdoctoral researchers: Soledad Pérez

PhD students: Zaida Álvarez, Claudia Navarro, Xavier Puñet, Aitor Sánchez, Nadège Sachot, Riccardo Levato, Tiziano Serra, Arlyng González

Masters students: Laura Corredor, Juan Crespo, Jacob Holter, Charlène Bartoli, Martin Donnay, Laurent Puech, Maarten Blokzijl, Ana Azevedo

Technician: Belén González

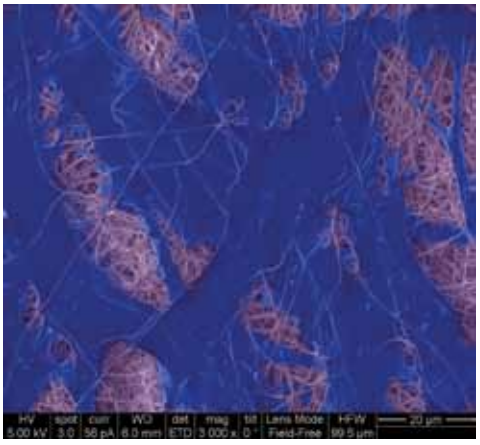
Visitors: Mar Ausió Navarro, Douglas Clift

Biomaterials for Regenerative Therapies

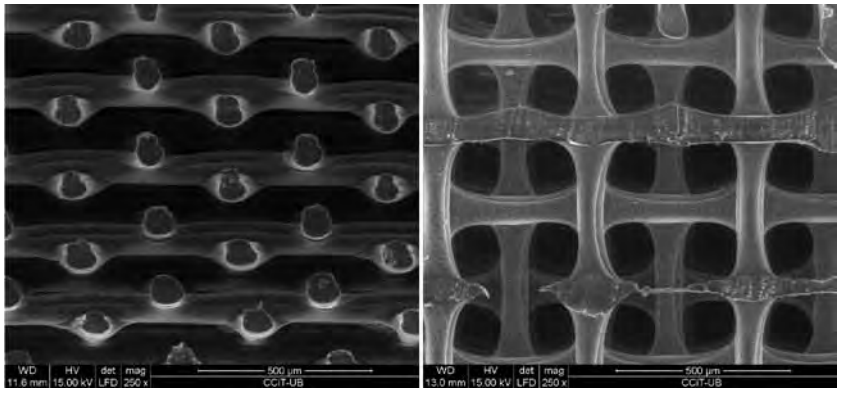
Tissue engineering of bone, vascular, neural and skin tissue / Development of biomaterials for tissue regeneration (biodegradable polymers, calcium phosphate glasses, composites, hybrids) / Scaffolds fabrication: solvent-casting, rapid prototyping, electrospinning, micro-nano particles / Research at the biointerface between surface materials and biological entities / Surface functionalization / Stem cells research / Mesenchymal stem cells differentiation (Bone Regeneration), Endothelial Progenitor cells from Bone Marrow (Angiogenesis and Endothelisation), and Neural progenitor cells (Neural Regeneration).

Research in the Biomaterials for Regenerative Therapies group is devoted to the development of innovative biomaterials and scaffolds for tissue regeneration. Bioactive and biodegradable materials are developed and studied and their interactions with biological entities are investigated both from their fundamental aspects and their specific applications for tissue engineering purposes, the aim of which is the repair and the functional restoration of tissues or organs by means of 3D scaffolds, cells and signals.

The group masters its own techniques to synthesize and to process biomaterials such as biodegradable polymers, calcium phosphate glasses and glass-ceramics, and their combination into composites and hybrids. Different fabrication techniques such as solvent-casting, rapid prototyping, electrospinning and micro-nano particles production allow the obtention of 3D scaffolds with tuned geometry, inner architecture, handleability, mechanical properties and surface properties, useful for different clinical applications. In this direction, surface functionalisation with different biochemical cues to signal the biological environment as well as the incorporation of topographical and mechanical features have been optimized. The group has also the capacity to isolate and culture stem and precursor cells for the *in vitro* biological characterization of the developed scaffolds for tissue engineering.



Rat mesenchymal stem cells attached to hybrid PLA/glass electrospun fibres



Three-dimensional biodegradable Rapid Prototyping scaffold, transversal view (left); upper view (right)

In 2012, important progress was made towards the synthesis of new materials with ion release properties and angiogenic/osteogenic potential. New methods for the fabrication of 3D scaffolds and biodegradable nano and microparticles were developed and optimized. Electrospun polymer fiber-based scaffolds have been developed for skin wound healing and neural regeneration. Rapid prototyping (RP) scaffolds with well-defined and reproducible architectures were set as platforms for studying bone regeneration and the inflammatory response. Injectable microparticles were developed and tested as potential cell carriers, paying particular attention to cell adhesion, proliferation and differentiation as well as migration. Elastin-like Recombinant Polymers (ELR) promoting mineralization have also been explored. The combination of these materials and controlled manufacturing processes, together with their biofuncionalization has allowed the development of new customized biodegradable systems for different clinical applications such as ophthalmology, nervous system, skin, tendon and bone.

Calcium Sensing Receptor as a Target in Healing Therapies (*Elisabeth Engel, Junior Group Leader*)

Stem cell fate is influenced by a number of factors and interactions that require robust control for safe and effective regeneration of functional tissue. Coordinated interactions with soluble factors, other cells, and extracellular matrices define a local biochemical and mechanical microenvironment with complex and dynamic regulation that stem cells sense. In order to successfully employ healing therapies (a sub-discipline in regenerative medicine) it becomes necessary to understand these interactions as to later replicate the “regenerative niche architecture” for therapeutical benefit. Calcium is an important first and second messenger in biological systems with many functions already described, and new ones arising constantly. Calcium concentrations in extracellular fluids vary markedly, and are particularly high at sites of injury or infection. The main objective of this project is to use biomaterial scaffolds that release calcium ions or agonist to activate regeneration and achieve a self healing procedure by means of biomaterials.

Research projects

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

- **THE GRAIL** Tissue in Host Engineering Guided Regeneration of Arterial Intimal Layer.
PI: **Josep A. Planell** (partner)
EU - Cooperation - HEALTH

- **nAngioFrac** Angiogenic nanostructured materials for non-consolidating bone fractures.
PI: **Josep A. Planell** (coordinator)
EU - EURONANOMED

- Evaluación biológica de materiales bioactivos, biomiméticos y multifuncionales para la regeneración ósea (2010-2012).
PI: **Elisabeth Engel**
MICINN, Investigación fundamental no orientada

- Grup de recerca consolidat (2009-2013).
PI: **Josep A. Planell**
Agència de Gestió d'Ajuts Universitaris i de Recerca (AGAUR). Convocatòria d'ajuts per donar suport a les activitats dels grups de recerca de Catalunya (SGR 2009)

- **VALOR** Development of a wound dressing for the treatment of vascular ulcers that promotes revascularization and tissue regeneration (2011-2013).
PI: **Melba Navarro**
AGAUR – Ajuts destinats a incentivar els projectes i les activitats de valorització de recerca i de tecnología (VALOR 2010)

- Study of the *in vitro* inflammatory response of biodegradable scaffolds for tissue engineering (2011-2013).
PI: **Melba Navarro**
MICINN, Acción Integrada (Portugal)

- Andamios diseñados para promover una vascularización eficiente para fracturas óseas no consolidadas.
PI: **Josep A. Planell** (coordinator)
MICINN

- Bioactive biomaterials design and development for skin regeneration based on controlled ion release signaling.
PI: **Elisabeth Engel**
MICINN

Filed patents

- **Biopolímeros biodegradables funcionalizados con colágeno que comprenden células de epitelio del limbo esclerocorneal para la reconstrucción de la superficie ocular** (Filing date 28th June 2012)
Inventors: Calonge Cano, Margarita; López Paniagua, Marina; Galindo De la Rosa, Sara; Nieto Miguel, Teresa & De la Mata Sampedro, Ana (IOBA-UVA/CIBER-BBN); ***Planell Estany, Josep A.*** *(IBEC/UPC/CIBER-BBN);* ***Mateos Timoneda, Miguel A****. &* ***Engel López, Elisabeth*** *(IBEC).*
Ref. number: P201231006 / ES2080.7

Publications

- Mattotti, M., Alvarez, Z., Ortega, J.A., Planell, J.A., Engel, E. & Alcántara, S. (2012). Inducing functional radial glia-like progenitors from cortical astrocyte cultures using micropatterned PMMA. *Biomaterials*, 33 (6), 1759-1770

- Gustavsson, J., Ginebra, M.P., Planell, J.A. & Engel, E. (2012). Electrochemical microelectrodes for improved spatial and temporal characterization of aqueous environments around calcium phosphate cements. *Acta Biomaterialia*, 8 (1), 386-393

- Tejeda-Montes, E., Smith, K.H., Poch, M., López-Bosque, M.J., Martín, L., Alonso, M., Engel, E. & Mata, A. (2012). Engineering membrane scaffolds with both physical and biomolecular signaling. *Acta Biomaterialia*, 8 (3), 998-1009

- Levato, R., Mateos-Timoneda, M.A. & Planell, J. A. (2012). Preparation of biodegradable polylactide microparticles via a biocompatible procedure. *Macromolecular Bioscience*, 12 (4), 557-566

- Navarro, M., Pu, F. & Hunt, J.A. (2012). The significance of the host inflammatory response on the therapeutic efficacy of cell therapies utilising human adult stem cells. *Experimental Cell Research*, 318 (4), 361-370

- Aguirre, A., Gonzalez, A., Navarro, M., Castano, O., Planell, J.A. & Engel, E. (2012). Control of

microenvironmental cues with a smart biomaterial composite promotes endothelial progenitor cell angiogenesis. *European Cells and Materials*, 24, 90-106

- Gustavsson, J., Ginebra, M.P., Planell, J. & Engel, E. (2012). Osteoblast-like cellular response to dynamic changes in the ionic extracellular environment produced by calcium-deficient hydroxyapatite. *Journal of Materials Science-Materials in Medicine*, 23 (10), 2509-2520

- Pegueroles, M., Tonda-Turo, C., Planell, J.A., Gil, F.J. & Aparicio, C. (2012). Adsorption of fibronectin, fibrinogen, and albumin on TiO2: Time-resolved kinetics, structural changes, and competition study. *Biointerphases*, 7 (48), 13

- Ambrosio, L., Guarino, V., Sanginario, V., Torricelli, P., Fini, M., Ginebra, M.P., Planell, J.A. & Giardino, R. (2012). Injectable calcium-phosphate-based composites for skeletal bone treatments. *Biomedical Materials*, 7 (2), 1-10

- Noailly, J., Ambrosio, L., Elizabeth Tanner, K., Planell, J. & Lacroix, D. (2012). *In silico* evaluation of a new composite disc substitute with a L3–L5 lumbar spine finite element model. *European Spine Journal*, 21 (5), 675-687

- Shin, S.-H., Purevdorj, O., Castano, O., Planell, J.A. & Kim, H.-W. (2012). A short review: Recent advances in electrospinning for bone tissue regeneration. *Journal of Tissue Engineering*, 3 (1), 2041731412443530

Conference paper:

- Serra, T., Navarro, M. & Planell, J.A. (2012). Fabrication and characterization of biodegradable composite scaffolds for tissue engineering. In *5th International Conference on Advanced Research and Rapid Prototyping, Leiria, Portugal (2011),"Innovative Developments in Virtual and Physical Prototyping"*. Taylor & Francis, Leiden, The Netherlands

Book:

- Navarro, M. & Planell, J.A. (2012). *Nanotechnology in Regenerative Medicine*. Springer, New York, USA

Book chapters:

- Castaño, O., Eltohamy, M. & Kim, H.W. (2012). Electrospinning technology in tissue regeneration. In *Nanotechnology in Regenerative Medicine - Methods and Protocols (Methods in Molecular Biology)*, eds. Navarro, M. & Planell, J.A., 811, 127-140, Springer, New York

- Navarro, M. & Planell, J.A. (2012). Is nanotechnology the key to unravel and engineer biological processes? In *Nanotechnology in Regenerative Medicine - Methods and Protocols (Methods in Molecular Biology)*, eds. Navarro, M. & Planell, J.A., 811, 1-16, Springer, New York, USA

- Navarro, M. & Planell, J.A. (2012). Composite scaffolds for bone tissue engineering. In *Encyclopedia of Composites*, eds. Nicolais, L., Borzacchiello, A. & Lee, S.M., 544-558, John Wiley & Sons, New Jersey, USA

Collaborations with other research centres

Dr. Joelle Amedee INSERM, Bordeaux, France

Dr. Soledad Alcántara Grup de Desenvolupament Neural, IDIBELL, University of Barcelona, Spain

Dr. Luigi Ambrosio Centro di Recerca Interdipartimental Biomateriali, Università di Napoli, Italy

Dr. Matteo Santin School of Pharmacy and Biomolecular Sciences, University of Brighton, UK

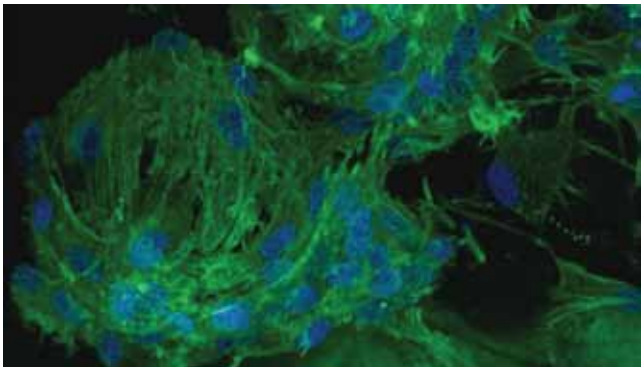
Dr. Jeffrey Hubbell Institute of Bioengineering, École Polytechnique Fédérale de Lausanne, Switzerland

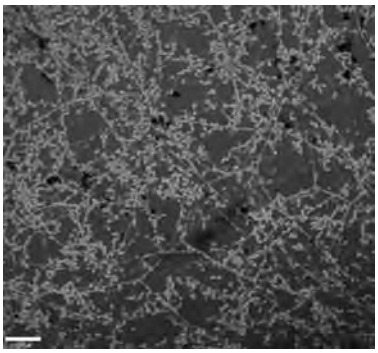
Dr. José Carlos Rodríguez-Cabello Dept. de Física de la Materia Condensada, Universidad de Valladolid, Spain

Dr. Juan Rojo Universidad Complutense de Madrid, Spain

Dr. Julio San Román Dept. of Biomaterials, Institute of Polymer Science and Technology, CSIC, Madrid, Spain

Rat mesenchymal stem cells attached to polylactic acid microspheres





Elastin-like polymers gel forming aggregates in the form of globules giving rise to fiber-like structures

Dr. Manuel Doblaré Group of Structural Mechanics and Materials Modelling, Institute of Engineering Research, (I3A), Universidad de Zaragoza, Spain

Dr. Margarita Calonge Institute of Ophthalmobiology (IOBA), Universidad de Valladolid, Spain

Dra. Anita Ignatius Institut für Unfallchirurgische Forschung und Biomechanik, University of Ulm, Germany

Dr. Francisco Blanco Complejo Universitario Juan Canalejo, La Coruña, Spain

Dr. Julia Buján Dept. de Ciencias Morfológicas y Cirugía, Facultad de Medicina, Universidad de Alcalá de Henares, Spain

Dr. Matilde Alonso Dept. de Física de la Materia Condensada, Universidad de Valladolid, Spain

Dr. María Vallet Regí Facultad de Farmacia, Universidad Complutense de Madrid, Spain

Dr. Jerónimo Blanco Institut de Ciències Cardiovasculars de Catalunya and CSIC, Barcelona, Spain

Dr. Álvaro Mata PCB Nanotechnology Platform, Barcelona, Spain

Dr. Mário Barbosa Instituto Nacional de Engenharia Biomédica (INEB), Oporto, Portugal

Prof. Francesco Serino Department of Vascular Surgery, Istituto Dermatologico dell'Immacolata (IDI), Rome, Italy

Prof. James Kirkpatrick Institute of Pathology, Johannes Gutenberg University, Mainz, Germany

Dr. Nick Rhodes Dept. of Clinical Engineering, University of Liverpool, UK

Prof. Hae-Won Kim Institute of Tissue Regeneration Engineering (ITREN), Dankook University, Cheonan, Korea

Dr. Izabella Rajzer Institute of Textile Engineering and Polymer Materials, University of Bielsko-Biala, Poland

Dr. Małgorzata Lewandowska Faculty of Materials Science & Engineering, WUT Warsaw University of Technology, Poland

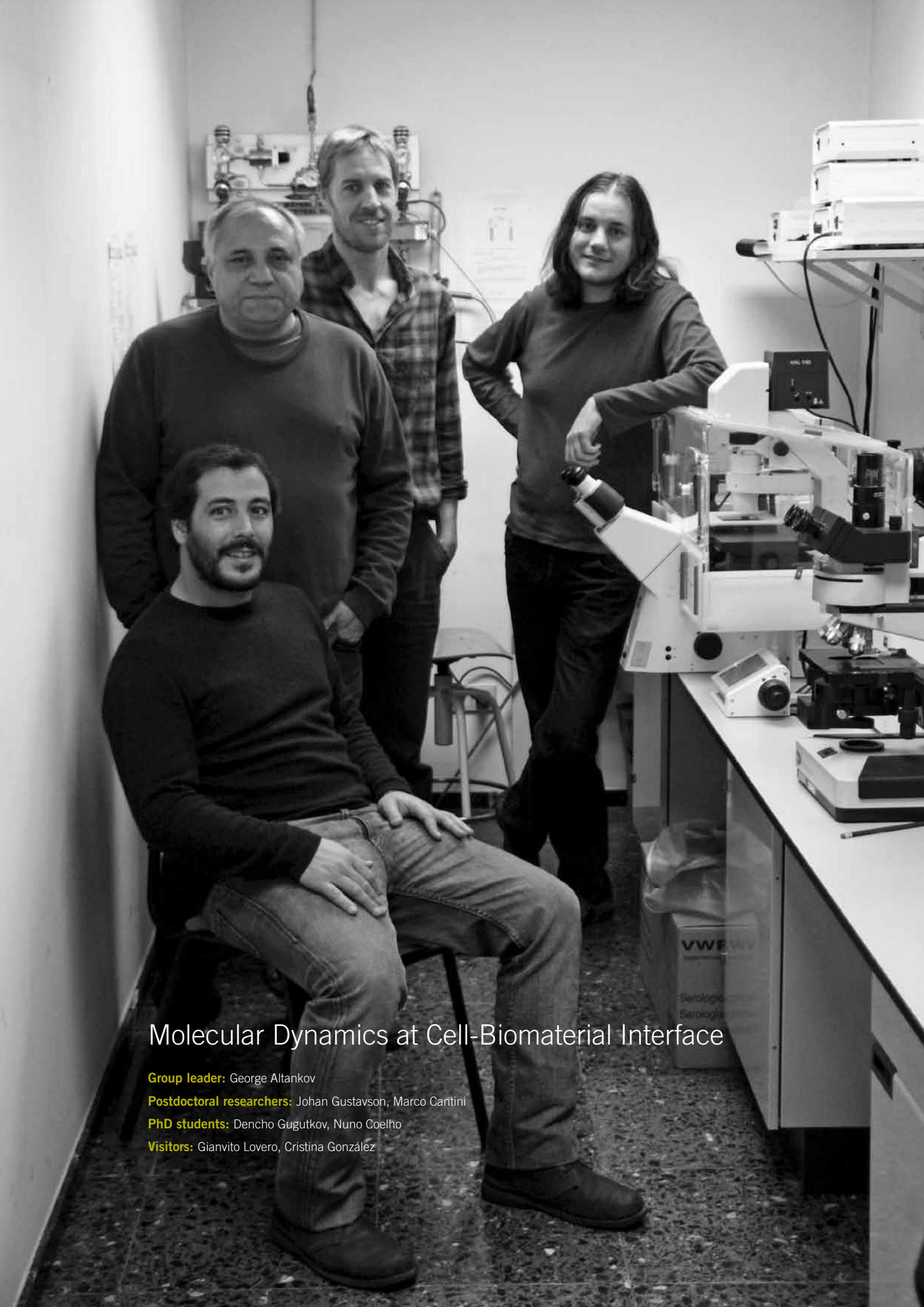
Dr. José Becerra Ratia Dept. Biología Celular, Genética y Fisiología, Universidad de Málaga, Spain

Dr. José Antonio Andrades Gómez Dept. Biología Celular, Genética y Fisiología, Universidad de Málaga, Spain

José Ramón Sarasua Biopolymers and Thermoplastics Materials Group,University of the Basque Country (EHU-UPV), Spain

Scientific equipment and techniques

- Surface characterization equipment (contact angle, Z potential, quartz crystal microbalance, nanoindenter)
- Cell culture facilities
- Molecular Biology equipment: protein and DNA electrophoresis
- Thermocycler (PCR)
- Rapid prototyping tool
- Peptide synthetiser
- Combustion furnace
- Electrospinning device
- Spin-coater
- Vibrational viscosimeter
- Ion selective electrodes for Ca^{2+}, Na^{+}, K^{+}, and pH
- ElectroForce® BioDynamic® test instrument



Molecular Dynamics at Cell-Biomaterial Interface

Group leader: George Altankov

Postdoctoral researchers: Johan Gustavson, Marco Cantini

PhD students: Dencho Gugutkov, Nuno Coelho

Visitors: Gianvito Lovero, Cristina González

Biomaterials, Implants and Tissue Engineering programme

Molecular Dynamics at Cell-Biomaterial Interface

We are interested in cell-biomaterial interaction, and more specifically, on the dynamic formation of the provisional extracellular matrix (ECM) – the thin protein layer that cells recognize, produce, and remodel at the materials interface. We aim to learn how this process affects the biocompatibility of materials, and if can be controlled by engineering the materials' surface properties. With this aim in mind, we perform systematic studies in the following directions:

Remodeling of ECM proteins at cell-biomaterials interface

ECM remodeling occurs in various physiological and pathological processes, such as normal development, wound healing and angiogenesis, but also in atherosclerosis, fibrosis, ischemic injury and cancer. It consists of two fundamental processes; assembly and degradation. The organization of ECM is fundamental for biology and medicine, and it proteolytic degradation is a physiological mechanism for the removal of excess ECM. Although matrix remodeling is a subject of extensive biomedical research, the way it is related to the biocompatibility of materials is poorly understood and is therefore a hot topic of our research.

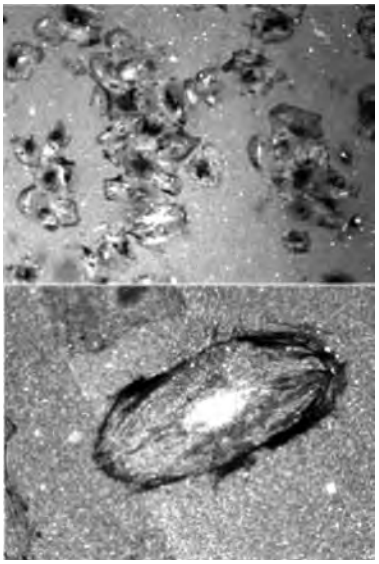
ECM organization at the biomaterial interface depends on the allowance of cells to rearrange adsorbed matrix proteins. We anticipate that materials that bind proteins loosely will support the arrangement of a provisional ECM, while stronger binding provokes its degradation.

Materials surface driven assembly of ECM proteins at the nanoscale

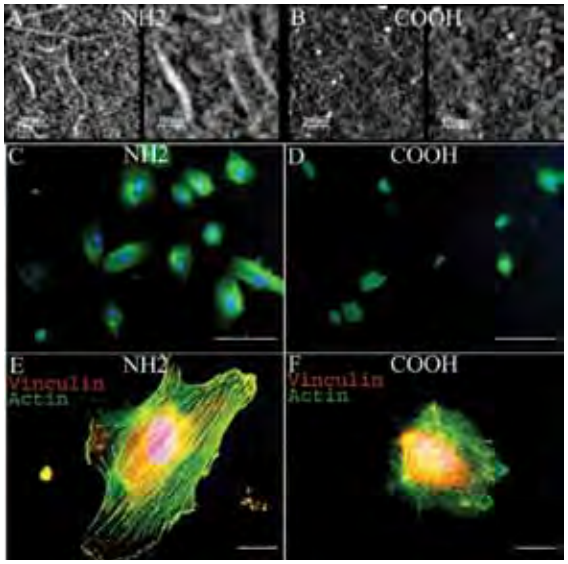
Upon adsorption at material interfaces, proteins may assemble spontaneously, and this interaction has significant consequences for their biological response. Recently we have employed distinct silane-inspired chemistries and polymer compositions to create model substrates with tailored densities of -OH, -COOH, -NH_2 and -CH_3 groups, thus varying the chemistry, charge and hydrophilic/hydrophobic balance. In a series of communications combining AFM and other nanoindentation techniques, we have described a novel phenomenon of substratum-driven protein assembly depicting the fate of various matrix proteins such as fibronectin, collagen IV, vitronectin and fibrinogen at the biomaterials interfaces of the model described above. Specifically, we show that by varying the density of chemical functions, one can tailor both the assembly and degradation of proteins. Following these findings we aim to control ECM remodeling by engineering specific material properties. Understanding the behavior of ECM proteins on flat biomaterials interface further boosts an important bioengineering target - the biohybrid organ technologies based on two-dimensional protein layers that mimic the arrangement of the natural basement membrane.

Electrospinning of nanofibers from natural and synthetic polymers for guiding cellular behavior

In solution, proteins can form structures of various shapes, including fibers with a diameter of only a few nanometers and with lengths up to centimeters. A fascinating possibility to mimic similar ECM structures is to engineer protein-like or matrix protein-containing nanofibers via electrospinning



Pericellular proteolysis of adsorbed FITC-labeled vitronectin (dark zones) by HUVECs adhering for 5 hours on CH3 functionalized substrata. Part of the protein is rearranged in a linear pattern



AFM images of adsorbed native collagen type IV from a solution of 50 mg/ml for 30 minutes on NH_2 (A) and COOH (B) functionalized surfaces, showing cellular network-like protrusions on the NH2 and aggregated morphology on COOH. It results in a distinct difference in the efficiency of cellular interaction: endothelial cells are better spread on NH_2 (C, E) while rounded on COOH (D, F). (Coelho *et al.*, 2010)

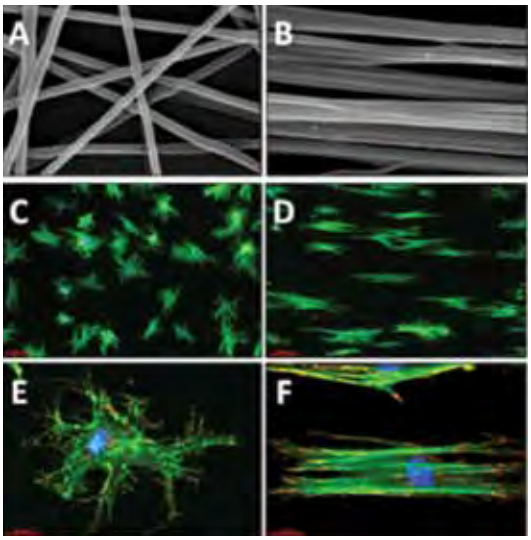
technology. For that purpose we are developing electrospun nanofibers from natural (e.g. fibrinogen) and synthetic polymers (e.g. PLA, PEA) in order to direct desired cellular response via spatially organized cues (e.g. fiber size and geometrical organization) as well as by tailoring their chemical and mechanical properties.

Nanofibers-based 3D constructs to provide cells with spatially organized stimuli

Examining hierarchical biology in only two dimensions (i.e. cells confined to a monolayer) is in most cases insufficient, as cells typically exhibit unnatural behavior if excised from native three-dimensional (3D) tissues. Within the European STRUCTGEL project (under our coordination) we are developing 3D biohybrid constructs that combine the structural and biological properties of electrospun nanofibers with the optimized mechanical properties of specific hydrogels in order to provide stem cells with relevant spatial orientation in three dimensions.

Creating dynamic stem cell niches using stimuli-responsive biomaterials

In addition to engineering the spatial configuration of cellular microenvironments, we are also interested in addressing the dynamic (i.e. temporal) aspects of the stem cell niche. To do that we take advantage of stimuli-responsive polymers to obtain control over an artificial cell-adhesive environment via dynamically altering either cell-cell (using cadherin-like ligands) or cell-matrix (using ECM proteins) interactions. By modulating the strength of adhesive protein-to-substratum interactions we aim to control the stem cell adhesive machinery, and which allows us to mimic the dynamic conditions of the stem cell niche.



Hybrid nanofibers of PLA and fibrinogen deposited in random (A) and aligned (B) configurations. Human mesenchymal stem cells adhere to the fibers and acquire a stellate-like (C & E) or elongated (D & F) morphology, depending on the fiber orientations (vinculin is immunostained in red and actin in green)

Research projects

■ **STRUCTGEL** Nanostructured gel for cellular therapy of degenerative skeletal disorders (2012-2014).
PI: **George Altankov** (coordinator)
EU - EuroNanoMed

■ **FIBROGELNET** Network for development of soft nanofibrous construct for cellular therapy of degenerative skeletal disorders (2013-2016).
PI: **George Altankov** (coordinator)
EU - FP7-PEOPLE-2012-IAPP

■ **HEALINSYNERGY** Materiales que inducen la fibrilogenesis de la fibronectina para producir microambientes sinergicos en los factores de crecimiento (2013-2015).
PI: **George Altankov**
MICINN, MAT2012-38359-C03-03

■ **FIBROGEL** Bioinspired nanofibrous gel for tissue engineering of cartilage and bone (2010-2012).
PI: **George Altankov**
MICINN, Proyectos Internacionales, European-Latin American Network for Science and Technology (EULANEST)

■ **MATIX DYNAMICS** Matrix dynamics at the cell-biomaterials interface (2009-2012).
PI: **George Altankov**
MICINN, Investigación fundamental no orientada

Publications

Book chapter:

■ Pecheva, E., Pramatarova, L., Hikov, T., Hristova, K., Altankov, G., Montgomery, P. & Hanawa, T. (2012). Electrodeposition of hydroxyapatite-nanodiamond composite coating on metals, interaction with proteins and osteoblast-like cells. In *Electrodeposition: Properties, processes and applications Electrical Engineering Developments*, ed. Mohanty, U.S., 233-253, Nova Publishers, Hauppauge, USA

Collaborations with other research centres

Center for Biomaterials, Technical University of Valencia, Spain

Institute of Pharmacy, Martin Luther University, Halle, Germany

National University of la Plata, Argentina

Institute of Biomedical Science, Federal University of Rio de Janeiro, Brazil

Institute for Biophysics and Institute of Solid State Physics, Bulgarian Academy of Sciences, Sofia, Bulgaria

Institute of Cytology of the Russian Academy of Science and Institute of Neurology named after Prof. A.L.Polenov, St. Petersburg, Russia

Industrial collaborations:

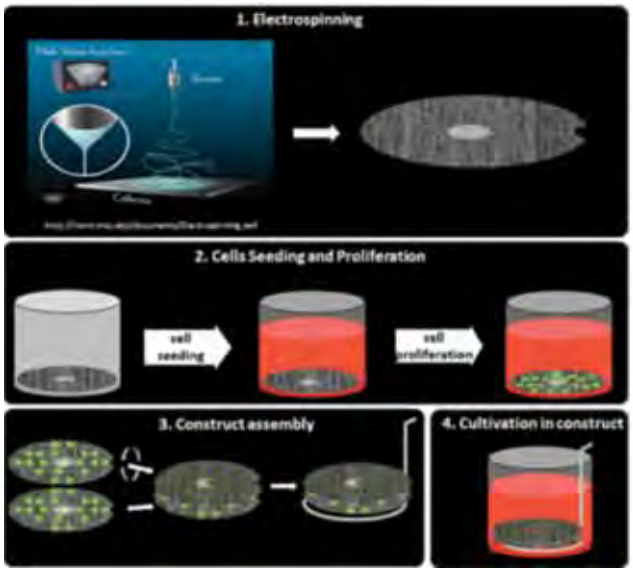
Bio-Elpida, France

Genekam Biotechnology A.G, Germany

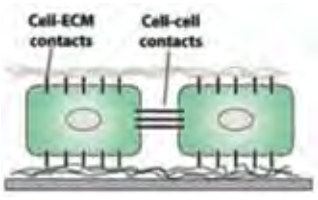
Scientific equipment and techniques

- Universal fluorescent microscope for performing dynamic studies with living cells
- Full facilities for cell culturing
- Electrospinning device designed for the production of nanofibers from natural and synthetic polymers
- Laboratory freeze-dryer (Telstar Cryodos)
- Spectrofluorometer Fluormax 4 (Horiba, Jobin Yvon)
- Complete chromatographic and electrophoretic equipment
- Flow chamber setup for measuring the strength of cell adhesion
- Equipment for photo-polymerization processes
- Programmable compact spin coater

Schematic illustration of the STRUCTGEL concept



Stimuli-responsive polymers are used to spatio-temporally control cell-cell and cell-ECM interactions in the microenvironment



Biomechanics and Mechanobiology

Group leader: Damien Lacroix (until February 2012)

Senior research associate: Jérôme Noailly

Postdoctoral researchers: Andrea Malandrino, Andy Olivares, Cecile Perrault (until February 2012)

PhD students: Carlos Ruiz, Themis Toumanidou, Aura María Cardona, Sara Barreto (until February 2012)

Masters students: Claire Chasse, Rafael Hernández

Undergraduate students: Adam Thelwall, Ernest Bosch, Albert Peiret, Ozan Vardal, Edouard Fulchin (until February 2012)

Technician: Antonio José Sánchez (until February 2012)

Visitors: Helena Bragulat, Gerard Jiménez

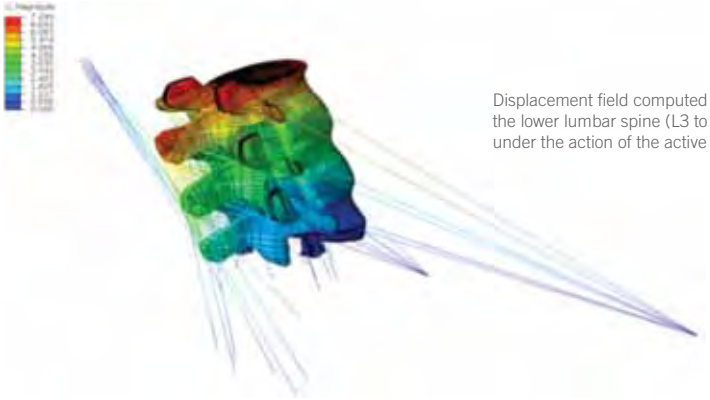
Biomaterials, Implants and Tissue Engineering programme

Biomechanics and Mechanobiology

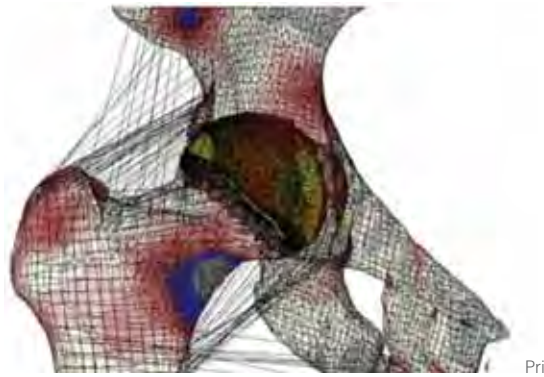
Research in the group of Biomechanics and Mechanobiology focuses mainly on (i) the interactions between tissue multiphysics and biological processes, and (ii) how these interactions can affect the functional biomechanics of organs. Numerical methods based mostly but not exclusively on FE modelling are used to describe both the tissues at the organ level, and the tissue-cell interactions at the tissue and cellular levels. The numerical concepts developed are tested against *in vivo* and *in vitro* data, which allows model validations. Emphasis is given in the study of load transfer of organ conditions onto the cells or onto tissues, with or without treatment simulations. Calculations are based on mechano-regulation and/or on biophysical concepts to predict different cell environments over time.

Most tissue and biophysical models developed so far aimed to study one of the most complex organs of the musculoskeletal system, namely the spine. Thorough knowledge about the functional biomechanics of the lumbar spine has been acquired along the time in relation to computational simulations (*J Biomech*, 40, 2414-25; *Biomech Model Mechanobiol*, 10, 203-19). To capture as best as possible the communications between organ and tissue biomechanics, studies of advanced tissue models has been performed, in relation to the vertebrae (*Mater Lett*, 78, 154-58), the intervertebral discs (*J Mech Behav Biomed Mater*, 4, 124-41; *Comput Meth Biomech Biomed Engin*, in press) and to the muscles (*J Biomech*, 45, S484). In particular, these models allowed thorough identification of the tissue parameters expected to alter cell nutrition in a deforming intervertebral disc (*PLoS Comput Biol*, 7, e1002112), leading to further relations between tissue condition and cell viability (*J Tiss Eng Regen Med*, 6, 389).

The numerical stability of these models is also one target of the explorations performed within the group (*Biomaterials for spinal surgery*, Part I, Chap 5, 144-232, Woodhead Publishing Ltd; *J Biomech*, 45, S600), in order to ensure the coupling to lower scale biophysical models. Also, models have been used to for implant simulations focussed either on clinical (*J Appl Biomat Biomech*, 4, 135-42), or on design questions (*Eur Spine J*, 21, S675-87). Beyond the spine domain, both knowledge and know-how acquired are being transferred to the exploration of the cardiovascular system, and ongoing clinical collaborations are contributing to the adaptation of the numerical methods to study problems related to the lower limbs (*J Biomech*, 45, S163).



Displacement field computed in a finite element model of the lower lumbar spine (L3 to L5-S1 intervertebral disc) under the action of the active muscle fascicles in flexion



Principal stress predictions in a model of the human hip joint

Research projects

- **MySpine** Functional prognosis simulation of patient-specfic spinal treatment for clinical use (2011-2014)
PI: **Jérôme Noailly**
Collaborative project within the framework of EU-FP7

- **THE GRAIL** Tissue in Host Engineering Guided Regeneration of Arterial Intimal Layer
PI: **Josep A. Planell** (partner)
EU - Cooperation - HEALTH

Publications

- Olivares, O. & Lacroix, D. (2012). Simulation of cell seeding within a three-dimensional porous scaffold: A fluid-particle analysis. *Tissue Engineering Part C: Methods*, 18 (8), 624-631

- Malandrino, A., Fritsch, A., Lahayne, O., Kropik, K., Redl, H., Noailly, J., Lacroix, D. & Hellmich, C. (2012). Anisotropic tissue elasticity in human lumbar vertebra, by means of a coupled ultrasound-micromechanics approach. *Materials Letters*, 78, 154-158

- Noailly, J., Ambrosio, L., Elizabeth Tanner, K., Planell, J. & Lacroix, D. (2012). *In silico* evaluation of a new composite disc substitute with a L3–L5 lumbar spine finite element model. *European Spine Journal*, 21 (5), 675-687

Book chapters:

- Noailly, J. & Lacroix, D. (2012). Finite element modelling of the spine. In *Biomaterials for Spinal Surgery – Part I: Fundamentals of Biomaterials for Spinal Surgery*, eds. Ambrosio, L. & Tanner, K.E., 144-232, Woodhead Publishing Ltd, Cambridge, UK

- Olivares, A. L. & Lacroix, D. (2012). Computational methods in the modeling of scaffolds for tissue engineering. In *Studies in Mechanobiology, Tissue Engineering and Biomaterials*, ed. Gefen, A., 1-20, Springer Berlin Heidelberg, Heidelberg, Germany

Conference papers:

- Toumanidou, T., Fortuny, G., Lacroix, D. & Noailly, J. (2012). Constitutive modelling of the lumbar spine musculature. In *10th International Symposium on Computer Methods in Biomechanics and Biomedical Engineering (CMBBE), Berlin, Germany (11-14/04/2012), proceedings: SS12:* In silico *modelling of the spinal disc degeneration*, 693-699. ARUP

- Ruiz, C., Noailly, J. & Lacroix, D. (2012). Material discontinuities create fluid flow instabilities in intervertebral disc poroelastic finite element models. In *10th International Symposium on Computer Methods in Biomechanics and Biomedical Engineering (CMBBE), Berlin, Germany (11-14/04/2012), proceedings: SS12:* In silico *modelling of the spinal disc degeneration*, 142-147. ARUP

- Olivares, A.L., Perrault, C. M. & Lacroix, D. (2012). Cell seeding optimization in 3D scaffold under dynamic condition: Computational and experimental methods. In

10th International Symposium on Computer Methods in Biomechanics and Biomedical Engineering (CMBBE), Berlin, Germany (11-14/04/2012), proceedings: SS12: In silico *modelling of the spinal disc degeneration*, 906-911. ARUP

- Malandrino, A., Noailly, J. & Lacroix, D. (2012). Mechanical effect on metabolic transport and cell viability in the intervertebral disc. In *10th International Symposium on Computer Methods in Biomechanics and Biomedical Engineering (CMBBE), Berlin, Germany (11-14/04/2012), proceedings: SS12:* In silico *modelling of the spinal disc degeneration*, 248-253. ARUP

Collaborations with other research centres

Prof. Damien Lacroix University of Sheffield, UK

Prof. Stephen Fergusson ETH Zurich, Switzerland

Dr. Màrius Valera Hospital de la Santa Creu i Sant Pau, Barcelona, Spain

Dr Ignacio Proubasta Hospital de la Santa Creu i Sant Pau, Barcelona, Spain

Dr. Joan Carles Monllau Hospital de la Santa Creu i Sant Pau, Barcelona, Spain

Dr Péter Pál Varga National Center for Spinal Disorders, Budapest, Hungary

Dr. Aron Lazary National Center for Spinal Disorders, Budapest, Hungary

Prof. Christian Hellmich Vienna University of Technology - Institute for Mechanics of Materials and Structures, Vienna, Austria

Dr. Josep Maria Font Universitat Politècnica de Catalunya BarcelonaTech, Barcelona, Spain

Dr. Luigi Ambrosio Institute of Composite and Biomedical Materials - National Research Council of Italy, Naples, Italy

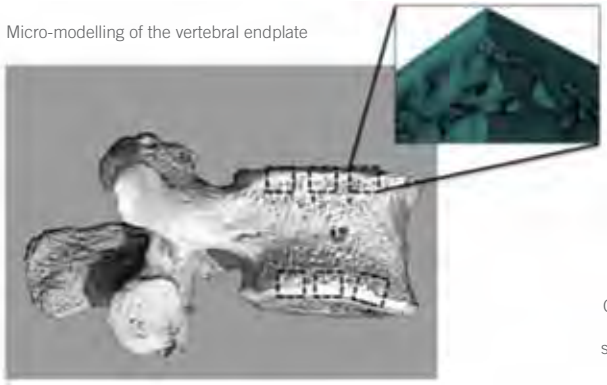
Prof. Marie-Christine Ho Ba Tho Compiègne University of Technology, Compiègne, France

Prof. Keita Ito Eindhoven University of Technology, Eindhoven, The Netherlands

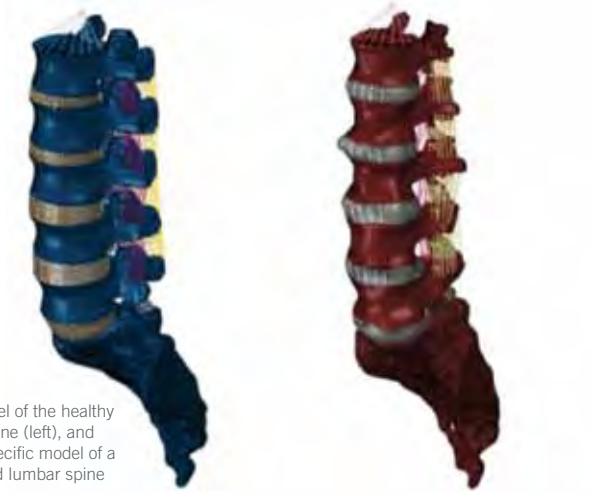
Prof. Hans-Joachim Wilke Institute of Orthopaedic Research and Biomechanics, University of Ulm, Germany

Scientific equipment and techniques

- High performance computing infrastructure (48 cores, 256 GB RAM and over 11TB disc space, machine virtualization)
- Image reconstruction and finite element software
- Bose ElectroForce BioDynamic bioreactor system (orthopedic and cardiovascular configurations)
- Microfluidic chamber
- Perfusion bioreactor system



Micro-modelling of the vertebral endplate



Generic model of the healthy lumbar spine (left), and specimen-specific model of a degenerated lumbar spine

Artificial Olfaction

Group leader: Santiago Marco

Senior researcher: Agustín Gutiérrez

Postdoctoral researcher: Juan Manuel Jiménez

PhD students: Ana Guamán, Ariadna Bartra, Lluís Fernández, Sergio Oller, Erola Pairó, Víctor Pomareda, Milad Avazbeigi

Undergraduate students: Raquel Leiva, Raquel Santano

Technicians: Nil Franch, Pablo Meca, Antonio Jesús Buendia

Visitors: Achim Lilienthal, Bernd Friedl, Selda Güney

Medical Signals and Instrumentation programme

Artificial Olfaction

Artificial olfaction (AO) systems are intelligent chemical instruments for the detection of volatile compounds and smells. These systems usually combine an array 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 miniaturized 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 2012 included the following:

Analysis of olfactory bulb activity maps:

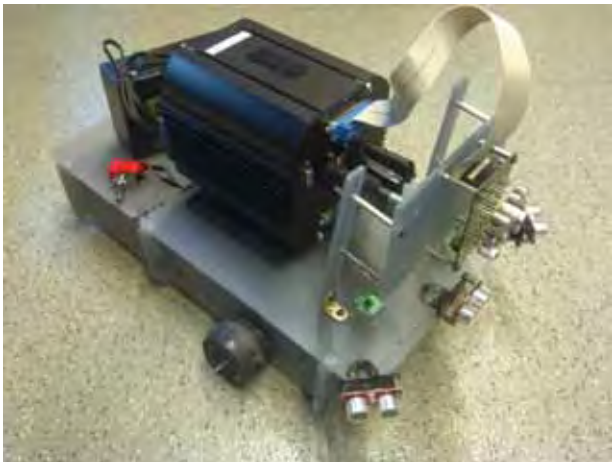
- We have done a cluster analysis of the activity of the olfactory bulb in response to a large set of odorants. Clustering results show only a minor number of stable clusters that subdivide hierarchically in finer cluster with lower stability.
- From glomerular activity maps in the olfactory bulb, we have studied the distribution of receptive ranges. The olfactory bulb displays a large diversity of receptive ranges, from very selective to broadly tuned receptors. The study using information theory tools shows that sets of broadly selective sensors with low correlation values are the optimum setup for chemical coding.

Ion Mobility Spectrometry:

- We have proposed a blind source separation technique (NMF) for preprocessing non-linear ion mobility spectra and after building quantitative multivariate models.
- We have explored the detection of TCA in wine (cork taint) and biogenic amines with ion mobility spectrometers and we have determined the limits of detection that can be achieved without any preconcentration.

Genomic signals:

- We have proposed a detector of transcription factor binding sites in genomic sequences based on numerical coding of DNA followed by multivariate statistics. The method improves on PSSM methods and equals methods that consider interdependences with a much lower computational cost.



Neuromorphic Odor robot including chemical sensor arrays and embedded computational models of the insect olfactory system developed in the NEUROCHEM project (joint development with UPC and UPF)

Research projects

- **SMART-IMS** Procesado de Señal para Espectroscopia de Movilidad de Iones: Análisis de Fluidos Biomédicos y Detección de Sustancias Tóxicas.
PI: **Santiago Marco**
MICINN

- **BIOENCODE** Estudio comparativo de la capacidad de codificación de información química de sistemas biológicos y artificiales.
PI: **Agustín Gutiérrez**
MICINN

- **SOMNO-ALERT® P-10** Drowsiness Detection in drivers.
PI: **Santiago Marco**
Industrial project with FICOSA

- Intelligent signal processing for sensor systems in bioengineering (2009-2013).
PI: **Santiago Marco**
AGAUR, Convocatòria d'ajuts per donar suport a les activitats dels grups de recerca de Catalunya (2009-SGR-753)

Publications

- Pairó, E., Maynou, J., Marco, S. & Perera, A. (2012). A subspace method for the detection of transcription factor binding sites. *Bioinformatics*, 28 (10), 1328-1335

- Fonollosa, J., Gutierrez-Galvez, A. & Marco, S. (2012). Quality coding by neural populations in the early olfactory pathway: Analysis using information theory and lessons for artificial olfactory systems. *PLoS ONE*, 7 (6), e37809

- Udina, S., Carmona, M., Pardo, A., Calaza, C., Santander, J., Fonseca, L. & Marco, S. (2012). A micromachined thermoelectric sensor for natural gas analysis: Multivariate calibration results. *Sensors and Actuators B: Chemical*, 166-167, 338-348

- Karpas, Z., Guamán, A.V., Calvo, D., Pardo, A. & Marco, S. (2012). The potential of ion mobility spectrometry (IMS) for detection of 2,4,6-trichloroanisole (2,4,6-TCA) in wine. *Talanta*, 93, 200-205

- Guamán, A.V., Carreras, A., Calvo, D., Agudo, I., Navajas, D., Pardo, A., Marco, S. & Farré, R. (2012). Rapid detection of sepsis in rats through volatile organic compounds in breath. *Journal of Chromatography B*, 881-882, 76-82

- Falasconi, M., Gutierrez-Galvez, A., Leon, M., Johnson, B.A. & Marco, S. (2012). Cluster analysis of rat olfactory bulb responses to diverse odorants. *Chemical Senses*, 37 (7), 639-653

- Pomareda, V., Guamán, A.V., Mohammadnejad, M., Calvo, D., Pardo, A. & Marco, S. (2012). Multivariate curve resolution of nonlinear ion mobility spectra followed

by multivariate nonlinear calibration for quantitative prediction. *Chemometrics and Intelligent Laboratory Systems*, 118, 219-229

- Marco, S. & Gutiérrez-Galvez, A. (2012). Signal and data processing for machine olfaction and chemical sensing: A review. *IEEE Sensors Journal*, 12 (11), 3189-3214

Conference paper:

- Bartra, A., Meca, P., Guamán, A., Pardo, A., Marco, S. & Montesi, A. (2012/07/05). A feasability study of drowsiness detection using driving behaviour parameters In *IEEE Intelligent Vehicles Symposium*, Alcala de Henares, Spain (2012), 111-116

Collaborations with other research centres

Prof. Enrique Ruspini European Center for Softcomputing, Mieres, Asturias, Spain

Dr. Lourdes Arce Dept. Química Analítica, Universidad de Córdoba, Spain

Dr. Alexandre Perera and Prof. Pere Caminal Centre de Recerca en Enginyeria Biomèdica, Universitat Politècnica de Catalunya, Barcelona, Spain

Prof. Krishna Persaud Chemoreception Group, University of Manchester, UK

Dr. Zeev Karpas Nuclear Research Institute, Israel

Dr. J. Fonollosa and Prof. Ramon Huerta Biocircuits Lab, University of California in San Diego, USA

Scientific equipment and techniques

- Gas chromatograph/mass spectrometer (Thermoscientific) with robotic head-space sampler
- 2 Infusion pumps K-systems
- 6 channel Owlstone vapor generator plus humidity control
- Ion Mobility Spectrometer: Gas Detector Array (Airsense Analytics GmbH)
- Computing and General Purpose Electronic Instrumentation
- Field Asymmetric Ion Mobility Spectrometer (Owlstone)
- Corona Discharge Ion Mobility Spectrometer
- Ultraviolet Ion Mobility Spectrometer

Ultraviolet-Ion Mobility Spectrometer from GAS, Germany

Biomedical Signal Processing and Interpretation

Group leader: Raimon Jané

Senior researchers: José Antonio Fiz, Beatriz Giraldo, Abel Torres

Postdoctoral researchers: Ainara Garde, Christian Morgenstern, Jordi Solà

PhD students: Leonardo Sarlabous, Andrés Arcentales, Manuel Lozano, Oiane Urra, Luis Estrada, Joana Mesquita

Masters students: Alejandro Calvo, Mirella López, Beatriz Martínez, Juan Pablo Téllez

Technician: Maria Puy Ruiz de Alda

Medical Signals and Instrumentation programme

Biomedical Signal Processing and Interpretation

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. We explore new methods and techniques for multichannel and multimodal acquisition, processing, modelling and interpretation of clinically relevant information from biomedical signals. Our main objective is to improve the non-invasive diagnosis capability through the characterization of physiological phenomena, and to enhance early detection of major diseases and cardiac, respiratory and sleep disorders.

The specific objectives of the group are the proposal and design of novel signal processing algorithms and the development of a new biosignal databases developed jointly with hospitals to assess and validate the performance of the developed algorithms. To validate the clinical information of some new surface signals, we developed specific invasive/non-invasive protocols with the collaboration of our hospital partners. Currently, we are also studying the proposed algorithms in animal models to test performance in studies with well-controlled physiological conditions.

The group focuses its research in a translational way to promote that scientific and technology contributions can be transferred. Currently, our scientific prototypes are used in the hospitals for research purpose and for industrial developments.

Highlights in 2012:

- We have proposed a new method to classify subjects according to their Sleep Apnea Hypopnea Syndrome (SAHS) severity through snoring signals (*Medical Engineering Physics* 34, 1213-1220), in collaboration with the Hospital Germans Trias i Pujol, Badalona.
- We have studied an original definition of regular and irregular snores and developed a new adaptive detection method, as a novel powerful tool for screening SAHS severity in clinical applications (*Medical & Biological Engineering & Computing* 50, 373-381), in collaboration with the Hospital Germans Trias i Pujol, Badalona.
- We have studied the feasibility and efficacy of an automatic noninvasive analysis method for the differentiation of obstructive and central hypopneas based solely on a single-channel nasal airflow signal (*Respiration*, 2012, DOI: 10.1159/000342010), in collaboration with the Institute of Biomedical Engineering (Karlsruhe), the Klinikum Bethanien and the company MCC-Med, Germany.
- We analyzed the periodic breathing during ascent to extreme altitude quantified by spectral analysis of the respiratory volume signal as indicator of a subject's condition at high altitude during physical exercise (IEEE-EMBC 2012, 707-710), in collaboration with the University Hospital of Zurich, Switzerland.
- We proposed a new method to non-invasive assessment of the diaphragm muscle efficiency (*Journal of Electromyography and Kinesiology*, DOI:10.1016/j.jelekin.2012.12.007), in collaboration with the Hospital Germans Trias i Pujol, Badalona.
- We developed new methods to classify patients with mechanical ventilation to predict successful weaning process (IEEE-EMBC 2012, 698-701 and 4349-4352), in collaboration with the Hospital de Sant Pau, Barcelona.
- We designed and analysed multimodal signals from a rat model of SAHS in collaboration with Daniel Navajas' group at IBEC (page 40) and the Biophysics and Bioengineering Unit of the School of Medicine, University of Barcelona.

Respiratory sound detection and interpretation in a novel single channel portable device for snore-based screening of Sleep Apnea-Hypopnea Syndrome (SAHS)

Research projects

- **MIMCRID** Multimodal invasive and non-invasive biomedical signal interpretation and modelling in cardiac, respiratory and neurological disorders (2011-2013).
PI: **Raimon Jané** (Coordinator)
MICINN

- Respiratory sounds analysis.
PI: **Raimon Jané**
Health Sciences Research Institute, Germans Trias I Pujol Foundation

Publications

- Mesquita, J., Solà-Soler, J., Fiz, J.A., Morera, J. & Jané, R. (2012). All night analysis of time interval between snores in subjects with sleep apnea hypopnea syndrome. *Medical and Biological Engineering and Computing*, 50 (4), 373-381

- Solà-Soler, J., Fiz, J. ., Morera, J. & Jané, R. (2012). Multiclass classification of subjects with sleep apnoea-hypopnoea syndrome through snoring analysis. *Medical Engineering and Physics*, 34 (9), 1213-1220

- Fiz, J.A. & Jané, R. (2012). Snoring Analysis. A Complex Question. *Journal of Sleep Disorders: Treatment & Care*, 1 (1), 1-3

Conference papers:

- Chaparro, J.A., Giraldo, B.F., Caminal, P. & Benito, S. (2012). Performance of respiratory pattern parameters in classifiers for predict weaning process. In *34th Annual International Conference of the IEEE - Engineering in Medicine and Biology Society (IEEE -EMBC) San Diego, USA (28/08-01/09/2012),* 4349-4352. IEEE

- Garde, A., Giraldo, B.F., Jane, R., Latshang, T.D., Turk, A.J., Hess, T., Bosch, M.M., Barthelmes, D., Hefti, J. P., Maggiorini, M., Hefti, U., Merz, T.M., Schoch, O.D. & Bloch, K.E. (2012). Periodic breathing during ascent to extreme altitude quantified by spectral analysis of the respiratory volume signal. In *34th Annual International Conference of the IEEE - Engineering in Medicine and Biology Society (IEEE -EMBC) San Diego, USA (28/08-01/09/2012),* 707-710. IEEE

- Giraldo, B.F., Gaspar, B.W., Caminal, P. & Benito, S. (2012). Analysis of roots in ARMA model for the classification of patients on weaning trials. In *34th Annual International Conference of the IEEE - Engineering in Medicine and Biology Society (IEEE -EMBC) San Diego, USA (28/08-01/09/2012),* 698-701. IEEE

- Mesquita, J., Poree, F., Carrault, G., Fiz, J.A., Abad, J. & Jane, R. (2012). Respiratory and spontaneous arousals in patients with Sleep Apnea Hypopnea Syndrome. In *34th Annual International Conference of the IEEE - Engineering in Medicine and Biology Society (IEEE -EMBC) San Diego, USA (28/08-01/09/2012),* 6337-6340. IEEE

■ Sarlabous, L., Torres, A., Fiz, J. ., Morera, J. & Jane, R. (28/08-01/09/2012). Evaluation and adaptive attenuation of the cardiac vibration interference in mechanomyographic signals. In *34th Annual International Conference of the IEEE - Engineering in Medicine and Biology Society (IEEE -EMBC) San Diego, USA (28/08-01/09/2012),* 3400-3403. IEEE

■ Garde A., Laguna, P., Giraldo, B.F., Jané, R. & Sörnmo, L. (2012). Ensemble-based Time Alignment of Biomedical Signals. In *7th International Workshop on Biosignal Interpretation (BSI2012)*, Como, Italy, 2-4 July 2012, pp. 1-4

■ Chaparro, J., Giraldo, B.F., Caminal, P. & Benito, S. (2012). Comportamiento de parámetros del patrón respiratorio en clasificadores para la predicción del proceso weaning. In *XXX Congreso Anual de la Sociedad Española de Ingeniería Biomédica, San Sebastián, Spain (CASEIB 2012, 19-21/11/2012), "Libro de Actas",* 1-4. Sociedad Española de Ingeniería Biomédica, San Sebastián, Spain

■ Torres, A., Sarlabous, L., Fiz, J.A. & Jané, R. (2012). Evaluación de diferentes algoritmos adaptativos para la atenuación de la interferencia cardiaca en señales mecanomiográficas simuladas. In *XXX Congreso Anual de la Sociedad Española de Ingeniería Biomédica, San Sebastián, Spain (CASEIB 2012, 19-21/11/2012), "Libro de Actas",* 1-4. Sociedad Española de Ingeniería Biomédica, San Sebastián, Spain

■ Lozano, M., Fiz, J.A. & Jane, R. (2012). Análisis multicanal de sonidos respiratorios en acústica pulmonar: aplicación clínica en pacientes asmáticos. In *XXX Congreso Anual de la Sociedad Española de Ingeniería Biomédica, San Sebastián, Spain (CASEIB 2012, 19-21/11/2012), "Libro de Actas",* 1-4. Sociedad Española de Ingeniería Biomédica, San Sebastián, Spain

■ Sarlabous, L., Torres, A., Fiz, J.A. & Jané, R. (2012). Reducción de interferencia cardíaca en señales MMG diafragmáticas registradas durante un protocolo de carga incremental sostenida mediante el algoritmo RLS. In *XXX Congreso Anual de la Sociedad Española de Ingeniería Biomédica, San Sebastián, Spain (CASEIB 2012, 19-21/11/2012), "Libro de Actas",* 1-4. Sociedad Española de Ingeniería Biomédica, San Sebastián, Spain

■ Garde, A., Giraldo, B.F., Jané, R., Latshang, T.D., Turk, A.J., Hess, T., Bosch, M.M., Barthelmes, D., Hefti, J.P., Maggiorini, M., Hefti, U., Merz, T. M., Schoch, O.D. & Bloch, K.E. (19-21/11/2012). Estudio de la respiración periódica en el ascenso a altitudes extremas a partir de la señal de volumen respiratorio. In *XXX Congreso Anual de la Sociedad Española de Ingeniería Biomédica, San Sebastián, Spain (CASEIB 2012, 19-21/11/2012), "Libro de Actas",* 1-4. Sociedad Española de Ingeniería Biomédica, San Sebastián, Spain

■ Urra, O., Fiz, J.A., Abad, J. & Jané, R. (2012). Beyond the reach of AHI: identifying key markers for improved systematic diagnosis of SAHS. In *XXX Congreso Anual de la Sociedad Española de Ingeniería Biomédica, San Sebastián, Spain (CASEIB 2012, 19-21/11/2012), "Libro de Actas",* 1-4. Sociedad Española de Ingeniería Biomédica, San Sebastián, Spain

Collaborations with other research centres

Dr. Salvador Benito Emergency Unit of the Hospital de la Santa Creu i Sant Pau, Barcelona, Spain

Prof. Dr. Konrad Bloch Pulmonary Division, University of Zurich, Switzerland

Prof. Armin Bolz Institute of Biomedical Engineering. University of Karlsruhe, Germany

Prof. Manuel Doblaré Grupo de Mecánica Estructural y Modelado de Materiales, Universidad de Zaragoza, Spain

Prof. Ramon Farré Unitat de Biofísica i Bioenginyeria, Facultat de Medicina, Barcelona, Spain

Prof. Alejandro Frangi Grupo de Imagen Computacional y tecnologías de Simulación en Biomedicina (CISTIB), Universidad Pompeu Fabra, Spain

Dr. Joaquim Gea Servei Pneumologia, Hospital del Mar-IMIM, Barcelona, Spain

Prof. Antonio Bayes Genis Grup ICREC, Servei Cardiología Hospital Universitari Germans Trias i Pujol, Barcelona, Spain

Dr. Alfredo Hernández Laboratoire Trataiment du Signal et de l'Image. Université de Rennes 1, Instituto Francés de Salud (INSERM), France

Dr. Eric Laciar Departamento de Electrónica y Automática. Universidad Nacional de San Juan, Argentina

Prof. Pablo Laguna Instituto de Investigación de Aragón (I3A). Universidad de Zaragoza, Spain

Dr. Josep Morera Prat Servicio de Neumología. Hospital Germans Trias i Pujol, Badalona, Spain

Prof. Javier Pavía Grupo de Imagen Médica (GIB), Universidad de Barcelona, Spain

Prof. Dr. Thomas Penzel Interdisciplinary Sleep Center, Charité University Hospital, Berlin

Prof. Winfried J. Randerath Institut für Pneumologie, Klinik Bethanien, Solingen, Germany

Prof. Domènec Ros Grupo de Imagen Médica (GIB), Universidad de Barcelona, Spain

Prof. Andrés Santos Grupo de Tecnologías de Imágenes Médicas (BIT), Universidad Politécnica de Madrid, Spain

Dr. Matthias Schwaibold MCC-Med GmbH & Co. KG, Karlsruhe, Germany

Prof. Dr. Lotfi Senhadji Laboratoire Traitement du Signal et de l'Image (LTSI), Université de Rennes 1, Institut National de la Santé et de la Recherche Médicale (INSERM), France

Dra. Marta Sitges IDIBAPS, Servei de Cardiologia, Hospital Clínic de Barcelona, Spain

Prof. Leif Sörnmo Signal processing group. Lund University. Sweden

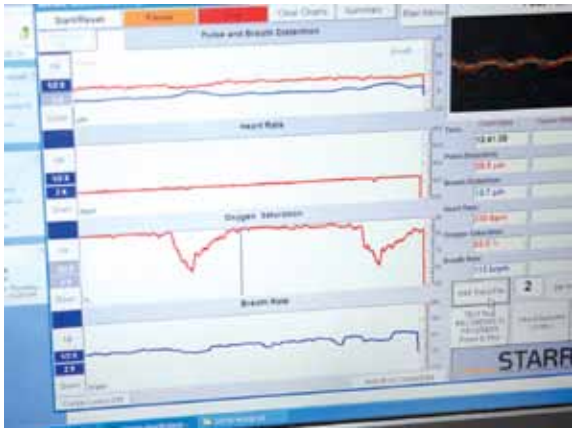
Prof. Dr. Jaume Veciana Grupo de Nanociencia Molecular y Materiales Orgánicos del Instituto de Ciencia de Materiales de Barcelona (NANOMOL-CSIC), Barcelona

Prof. Andreas Voss University of Applied Sciences, Jena, Germany

Scientific equipment and techniques

- Research laboratory with full equipment for acquisition and processing of biomedical signal to test new sensors and to define clinical protocols (preliminary tests and control subjects)
- Non-invasive Vital Signs Monitor for small lab animals (mice and rats) (Mouse-Ox Plus)
- BIOPAC system for multichannel cardiac and respiratory biomedical signal acquisition
- Databases of biomedical signals from hospitals and animal laboratories
- Snoring analyzer equipment (SNORYZER)
- Sensors, electrodes and microphones to obtain cardiac, respiratory, neural, muscular and sleep biomedical signals
- Polisomnographic equipment available in the Sleep Laboratory of collaborator hospital
- Beat to beat arterial blood pressure and haemodynamic monitor equipment
- Computing server for high performance biomedical signals

Multimodal biosignal interpretation in a SAHS rat model



Robotics

Group leader: Alícia Casals

Senior researchers: Joan Aranda, Manel Frigola

PhD students: Eduard Bergés, Xavier Giralt, Albert Hernansanz, Olga Mur, Vijaykumar Rajasekaran, Luis Ernesto Amigo

Masters students: Xavier Marimon, Lluís Sala, Emma Federici

Undergraduate student: Marina Victorio

Technician: Manuel Vinagre

Robotics

Research on robotics in medicine deals with the close interaction between people and robots. IBEC's Robotics group designs and develops intelligent robotic systems to assist people with disabilities, as well as medical personnel. This involves acquiring detailed knowledge about the behaviour and intentions of users, their capabilities, and their physical interaction with the robot. The aim is not only to develop an interface adapted to both their needs and the requirements of the tasks, but also to facilitate fine tuning of the level of cooperation between the user and the machine, taking into account the user's abilities.

Our main project in rehabilitation focuses on the design and development of robot control strategies for a simultaneous operation of a neurorobot and a motor neuroprosthesis. The project intends to advance in the "assist-as-needed" concept; that is, based on the acquisition of biological, physiological and physical data (such as fatigue, interaction forces, intention, etc), an orthotic device – an exoskeleton – is controlled by the user's volitional commands. Robot control based on such heterogeneous sets of data and signals requires the development of adaptive control strategies dealing with a high interpretation level. In our research, a special effort is dedicated to developing adequate compliant control strategies, which ensure safe interaction during physical contact between human and robot.

The research of the group does not focus uniquely on improving ergonomics, efficiency and safety, but also on the transfer of this technology for its clinical applicability. Thus, our research on surgical robotics has led to the creation of a spin-off, Rob Surgical Systems S.L., which is currently working in the regulatory process of a new robotic system. The aim is to progressively advance in new robot surgical techniques with the goal of reducing stress for 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.

At present, the research team also is working within an FP7 Coordinated Action, EuRoSurge. This work not only focuses on technical aspects, but also on ethical and legal aspects that limit the commercial expansion of surgical robots.

Surgical robotics facilities (with CREB-UPC)

Multimodal perception for robot control in neurorehabilitation

Research projects

- **EuRoSurge** European Robotic Surgery.
PI: **Alícia Casals**
Coordination Action FP7-ICT-2011-7

- **HYPER** Hybrid NeuroProsthetic and NeuroRobotic Devices for Functional Compensation and Rehabilitation of Motor Disorders (2009-2014).
PI: **Alícia Casals**
MICINN, Actividad Investigadora CONSOLIDER – INGENIO 2010

- **IPRES** Interacción persona robot en entornos semiestructurados bajo criterios de permitividad.
PI: **Alícia Casals** (partner)
MICINN

- **InHANDS** Interactive robotics for Human Assistance iN Domestic Scenarios (2013-2014).
PI: **Joan Aranda**
Recercaixa

Publications

- Amat, J., Casals, A. & Montano, L. (2012). Research and Automatic technological transference. *Revista Iberoamericana de Automatica e Informatica Industrial*, 9 (1), 32-33

Conference papers:

- Amigo, L.E., Fernandez, Q., Giralt, X., Casals, A. & Amat, J. (2012). Study of patient-orthosis interaction forces in rehabilitation therapies. In *4th IEEE RAS & EMBS International Conference on Biomedical Robotics and Biomechatronics (BioRob), Roma, Italy (24-27/06/2012), "IEEE Conference Publications"*, 1098-1103. IEEE

- Antelis, J.M., Montesano, L., Giralt, X., Casals, A. & Minguez, J. (2012). Detection of movements with attention or distraction to the motor task during robot-assisted passive movements of the upper limb. In *Annual International Conference of the IEEE. California, USA (28/08-01/09/2012), "Engineering in Medicine and Biology Society (EMBC)"*, 6410-6413. IEEE

- Hernansanz, A., Amat, J. & Casals, A. (2012). Virtual Robot: A new teleoperation paradigm for minimally invasive robotic surgery. In *4th IEEE RAS & EMBS International Conference on Biomedical Robotics and Biomechatronics (BioRob), Roma, Italy (24-27/06/2012), "IEEE Conference Publications"*, 749-754. IEEE

- Hernansanz, A., Zerbato, D., Gasperotti, L., Scandola, M., Casals, A. & Fiorini, P. (2012). Assessment of virtual fixtures for the development of basic skills in robotic surgery. In *Computer Assisted Radiology and Surgery (CARS 2012), Pisa, Italy (18/05/2012), "International Journal of Computer Assisted Radiology and Surgery", 7 (Supplement 1) - Surgical Modelling, Simulation and Education*, S186-S188. Springer

Book chapters:

- Muñoz, L.M., Ponsa, P. & Casals, A. (2012). Design and development of a guideline for ergonomic haptic interaction. In *Advances in Intelligent and Soft Computing*, ed. Hippe, Z. S., Kulikowski, J. L. & Mroczek, T., 99: 15-29. Springer, Chennai, India

- Abolmaesumi, P., Joskowicz, L., Navab, N., Jannin, P., Hernansanz, A., Zerbato, D., Gasperotti, L., Scandola, M., Fiorini, P. & Casals, A. (2012). Improving the development of surgical skills with virtual fixtures in simulation. In *Information Processing in Computer-Assisted Interventions*, eds. Abolmaesumi, P., Joskowicz, L., Navab, N. & Jannin, P., 7330, 157-166, Springer, Chennai, India

Collaborations with other research centres

Dr. Josep M. Tormos Fundació Institut Guttmann, Barcelona, Spain

Dr. Ángel Gil Hospital de Tetraplégicos de Toledo, 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

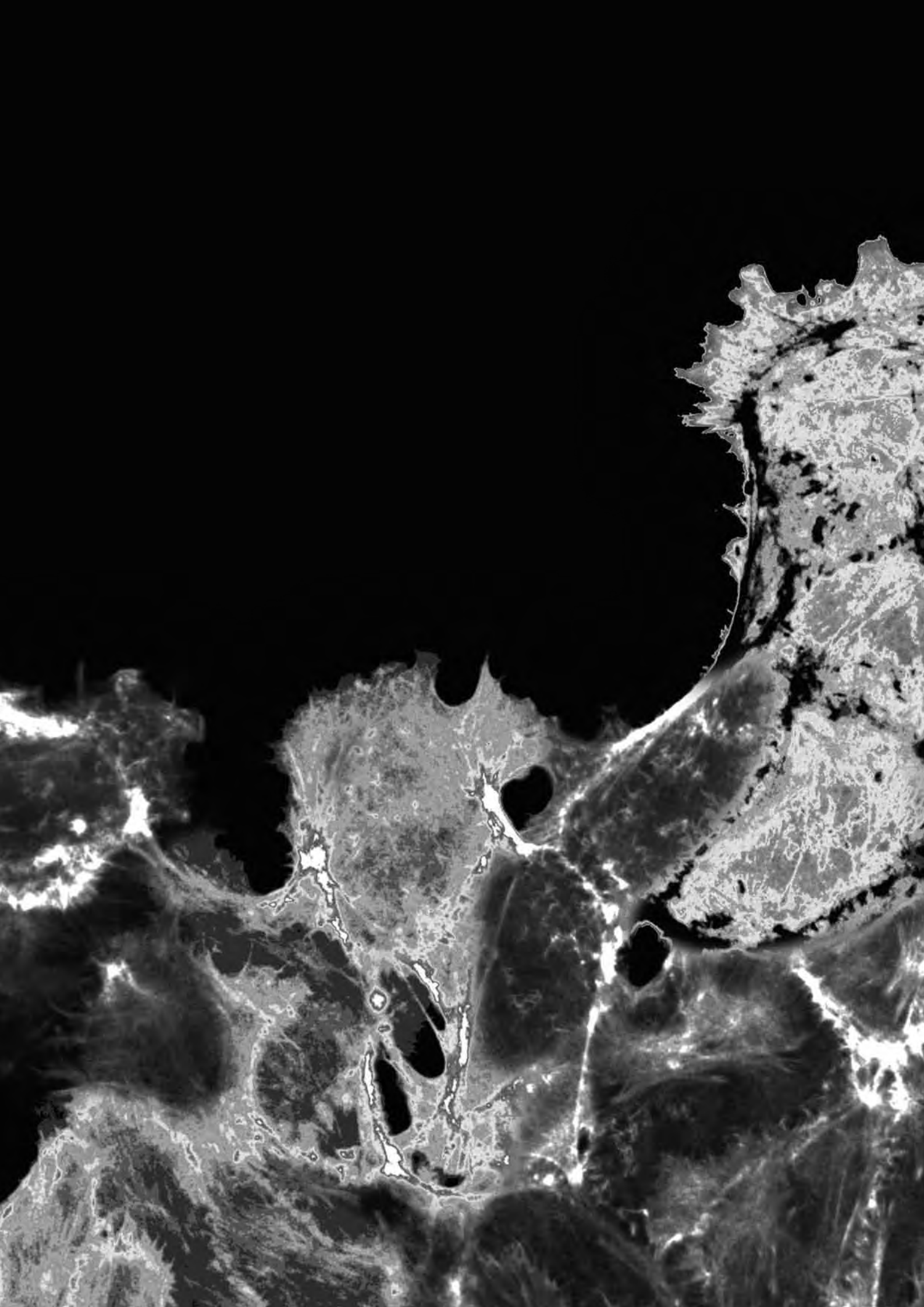
Dr. Javier Magriñá Mayo Clinic, Scottsdale, Arizona, USA

Salvador Riera Centre per a la Vida Independent, Barcelona, Spain

Prof Paolo Fiorini Università degli Studi di Verona, Verona, Italy

Scientific equipment and techniques

- Basic electronics laboratory equipment
- A 50' 3D monitor
- 6D magnetic positioning sensors (Polhemus)
- Ultrasound probe: B-Ultrasonic Diagnostic Equipment Model WED-2000
- 2 PC with multiprocessor architecture (Tesla C2050)
- A BCI working platform based on an Emotiv Epoc headset (EEG acquisition system)
- KUKA lightweight robot specially designed for mobility and interaction with humans and *a priori* unknown environments. It is equipped with a control environment developed by the team to program anatomic constraints to operate in virtual environments
- Computer controlled LED-based lighting system for the operating room
- Experimental robotized kitchen composed of a robot, several adapted cupboards, a kitchen counter and a PC for robot and environment control



Networking

Partnerships

While most of IBEC's funds come from the Generalitat de Catalunya, the University of Barcelona and the Technical University of Catalonia, an increasing proportion comes from national and international competitive research funding, ranging from large instruments such as the EU's Framework Programmes to independent or national foundations. Both projects and people are funded, with IBEC proud to be able to claim three group leaders with their own support from one of the most prestigious sources, ICREA, in 2012.

The Catalan Institution for Research and Advanced Studies (ICREA) is a foundation supported by the Catalan Government. Its aim is to recruit top scientists for the Catalan R&D system to lead new research groups, strengthen existing ones and set up new lines of research. To achieve its objectives, the foundation works closely with Catalan universities and research centres through long-term agreements that allow ICREA researchers to participate in research groups in these centres.

In 2012, three of IBEC's group leaders were ICREA research professors: Ángel Raya (Control of Stem Cell Potency group, page 33), George Altankov (Molecular Dynamics at Cell-Biomaterial Interface, page 71) and Pau Gorostiza (Nanoprobes and Nanoswitches, page 45).

IBEC's institutional project 'Sistemes de diagnòstic i teràpia basats en la integració de noves tecnologies nano bio info i cogno', supported by Fundació La Caixa, completed its first year in 2012. It provides the 'Strategic Research Innovation Initiative' (SRI^2) within which IBEC's three 'flagships' – Nanomedicine, Cell Engineering and Intelligent Healthcare – will frame their interdisciplinary projects.

The two-year grant from Fundació La Caixa is a pilot initiative to fund diverse types of institutional projects or schemes (see Technology Transfer section, page 103, for more information).

IBEC and the Centre de Recerca en Salut International de Barcelona (CRESIB) have an official agreement, signed in 2010, in order to facilitate collaboration in certain areas of common interest. This proposed the establishment of a mixed unit of personnel from both institutes aimed at developing diagnostic and therapeutic nanomedicine-based systems to be applied to malaria (see Nanomalaria group, page 58). In 2012 this initiative was favourably reviewed to continue, with an extra focus on knowledge transfer to the clinic (see Technology Transfer section, page 103, for more information).

IBEC's collaboration with the Fundación Botín, a Spanish private institution, is in regard to the technology transfer of results obtained by the Nanobioengineering group (page 52) led by associate director Josep Samitier (see Technology Transfer section, page 103, for more information).

One of Spain's Biomedical Research Networking Centres (CIBERs), CIBERNED is composed of 63 research groups working on basic and clinical research into neurodegenerative diseases. CIBERNED projects are financed by the Instituto de Salud Carlos III.

- **BESAD-P** Biomarkers of Early Stages of Alzheimer Disease Prevention (2010-2012).
PI: **Jose Antonio del Río**

- Red española de investigación en enfermedades neurológicas PRY-114 (2009-2012).
PI: **Jose Antonio del Río**

Founded in 2006, the Biomedical Research Networking Center in Bioengineering, Biomaterials and Nanomedicine (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.

Ongoing CIBER-BBN projects during 2012

- **BIOGELANGIO** Biomimetic extracellular matrices for angiogenic activation and anti-inflammatory activity in regenerative medicine.
PI: **Josep Planell**

- **Bioproterial** Biological activity of matrix proteins at the cell-material interface.
PI: **Josep Planell**; **George Altankov**

- **BIOSCAFF-EYE** Bio-engineered stem cell niches (BioSCniche) in ocular surface reconstruction for corneal blindness: from basic research to clinical trials.
PI: **Josep Samitier**; **Josep Planell**

- **ES-CELLTHERAPY** Use of human pluripotent stem cells as vehicles for localized delivery of therapy to brain tumors. PI: **Ángel Raya**; **Josep Planell**

- **INDI-MUSICA** Indexes obtained from computational models and multiscale-multimodal biomedical signals for the diagnosis of cardiac pathologies.
PI: **Raimon Jané**

- **MUDIRES** Multimodal Diagnosis by Interpretation of Multiscale Signals in the Respiratory System.
PI: **Raimon Jané** (coordinator); **Daniel Navajas**

- **NACRE** New Approaches for Cartilage Regeneration.
PI: **Ángel Raya**

- **NANOFABRY** Desarrollo de nanomedicinas para terapia enzimática sustitutiva en la enfermedad de Fabry
PIs: **Fausto Sanz** (for the UB)
Fundación Marató de TV3

- **NANOXEN** Use of optical molecular nanoswitches to control nervous functions in *Xenopus tropicalis*.
PIs: **Fausto Sanz** (for the UB); **Pau Gorostiza**

- **NANOXEN+** *Xenopus tropicalis* as an optogenetic and photopharmacological platform.
PIs: **Fausto Sanz** (for the UB); **Pau Gorostiza**

- **NANOMEDIAG** Nanobioanalytical platforms for improved medical diagnosis of infections caused by pathogen microorganisms.
PI: **Josep Samitier**

- **NANO-TRANS-BRAIN** Nanocarriers for antiapoptotic drug transport across the Blood-Brain-Barrier.
PI: **Fausto Sanz** (for the UB)

- **OLIGOCODES** Universal Diagnostic Platforms Based On Oligonucleotide Codified Nanoparticles and DNA Microarray Sensor Devices.
PI: **Josep Samitier**

- **REWOUND** Elastic Like Recombinant polymers for wound healing applications.
PI: **Ángel Raya**; **Josep Planell**

- **SCAFFTIDE 3D** 3D scaffolds and implants functionalized and reinforced with recombinant protein polymers for regenerative medicine.
PI: **Josep Planell**

- **TELTIS** Titanium-supported engineered bone tissue for orthopaedic surgery
PI: **Ángel Raya**; **Josep Planell**

- **ULTRASEN-4BIO** Characterization and validation of novel ultrasensitive piezoresistive all-organic sensors for multimodal biomedical signals
PI: **Raimon Jané** (coordinator)

—

- **CIBERES** Centro de investigación en red de enfermedades respiratorias.
PI: **Daniel Navajas**
CIBERES is a multidisciplinary and multi-institutional research network in respiratory diseases including 35 research groups (and about 400 individuals) located around the country in 9 autonomous communities.

Research agreements and MoUs

IBEC constantly pursues opportunities to collaborate on a long-term basis with other world-class national or international research institutes with an agreement or Memorandum of Understanding (MoU), with particular emphasis on clinical translation. Such agreements aim to promote exchange of researchers to execute projects, the dissemination of information, sharing of resources and organization of joint activities, and the implementation of cooperative research between them.

Groups from the UB and the UPC Associated with IBEC

In 2012, IBEC continued to collaborate with the University of Barcelona (UB) and the Polytechnic University of Catalonia (UPC) on joint research programmes. Under an agreement signed in 2006, 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)

Memoranda of Understanding

By the beginning of 2012, IBEC had MoUs in place with the following organisations: the Fundació Clínic/Hospital Clínic, Barcelona; the Bellvitge Institute for Biomedical Research (IDIBELL), Barcelona; the National Institute for Materials Science (NIMS), Tsukuba, Japan; Korea's Institute of Tissue Regeneration Engineering (ITREN); and the University of Warwick's Centre for Cognitive and Neural Systems, UK.

During 2012, IBEC forged new or renewed links with the following organisations:

Vall d'Hebron Research Institute (VHIR)

In May 2012, IBEC signed a collaboration agreement with the Vall d'Hebron Research Institute (VHIR) in Barcelona. Signed by IBEC director Josep A. Planell and VHIR's Joan Comella, the agreement formalised the institutes' joint participation in scientific projects and their shared development of innovative technologies for health, as well as their collaboration in technology transfer activities and knowledge exchange. It also consolidated the exchange of researchers between the institutes, the scientific and technical organization of joint conferences, seminars and events, and establishes conditions for the sharing of relevant facilities available at both institutes.

After the signing of the agreement, which was held in the University Hospital Vall d'Hebron, the first official VHIR-IBEC meeting took place, in which research group heads Manuel Galiñanes and Miquel Vila (VHIR) and Ángel Raya (page 33) and José Antonio del Río (page 29) from IBEC presented some of their research projects.

Institut d'Investigació en Ciències de la Salut Germans Trias i Pujol (IGTP)

In June 2012 IBEC signed two collaboration agreements with the Institut d'Investigació en Ciències de la Salut Germans Trias i Pujol (IGTP) to carry out and promote scientific and translational research. The general agreement consolidated and enhanced the long-term previous collaboration of the Hospital Germans Trias i Pujol, one of the major hospitals in Catalonia, with IBEC's Biomedical Signal Processing and Interpretation group (page 84), as well as promoting new collaborations with other IBEC groups.

The aim of the second, specific agreement was to create a joint research Unit between IBEC and IGTP, to be coordinated by Raimon Jané, head of the Biomedical Signal Processing and Interpretation group, and Miquel Àngel Gasull of IGTP.

Interstaatliche Hochschule für Technick Buchs (NTB)

A collaborative research agreement between IBEC and the Interstaatliche Hochschule für Technick Buchs (NTB) was renewed in 2012. Stemming from a long-term informal collaboration between IBEC's Nanobioengineering lab (page 42) and the Switzerland-based institute, the relationship was formalised in 2009 and promotes a cooperative approach to the development of new nanotechnology-based methods for the fabrication of sensor arrays and microfluidic structures for lab-on-chip devices.

Barcelona Macula Foundation

Towards the end of the year IBEC signed a Memorandum of Understanding with the Barcelona Macula Foundation to jointly promote their respective activities in the context of biomedicine. The agreement seeks to establish permanent relations between IBEC and the foundation to generate shared scientific and technological opportunities, as well as regulating research projects that the entities will develop together. Among other things, the collaboration provides for the exchange of scientific and technical staff, joint participation in scientific projects and shared development of innovative health interventions.

The Barcelona Macula Foundation conducts and support research on diseases of the retina and macula that cause blindness and that have no effective treatment, in order to restore or prevent the loss of vision. Its main focus of interest is macular and retinal degeneration, such as atrophic age-related macular degeneration, retinitis pigmentosa and Stargardt disease, for which there is currently no cure.

Fundació Joan Costa Roma

The Fundació Joan Costa Roma (JCRF), set up in 1998 by the Consorci Sanitari de Terrassa, is a non-profit organization with the aim of promoting outreach and education to improve health systems and quality of life. In addition, they develop research projects addressed to improving and optimizing resources in life sciences.

On 17th December 2012, a memorandum of understanding was signed between JCRF and IBEC, and the first collaborations are being set up with the Biomaterials for regenerative therapies (page 65) and Control of stem cell potency (page 33) groups.

Institutional agreements and projects

In its role as the country's leading research institute in bioengineering and nanomedicine, IBEC manages or is a partner of several national and international initiatives with a range of goals including bringing together entities to network and share resources, providing advice and support, organising events, or acting as a representative, collective voice or expert consultant for stakeholders or funders.

NANOMED SPAIN

The Spanish Nanomedicine Platform (NanoMed Spain) 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. NanoMed Spain represents the interests of its stakeholders in the burgeoning and multidisciplinary area of nanomedicine, and is supported by the Spanish Ministry of Science and Innovation (MICINN).

In 2012, the activity of NanoMed Spain was focused on:

- Contributing to define the Spanish position in relation to HORIZON 2020, the continuation of the European Commission's Seventh Framework Programme (FP7), in all aspects related to the application of nanotechnology to healthcare (see *Representation of the Spanish nanomedicine community at international level*, below).
- Collaboration with other sectors which can benefit from the application of nanotechnology to healthcare, such as the food and environment industries (see *Collaboration with other platforms: Launch of the Nanosafety Task Group*, below).
- Improvement of communication tools and strategies to disseminate NanoMed Spain's activities and those of its members, including a new and improved website, monthly newsletter and a Twitter profile.
- The presentation in October in Madrid of the document 'Hoja por la Innovación en Nanomedicina en España' (White Paper on Innovation in Nanomedicine in Spain), which maps the current country's R&D&I capacities through an intensive survey and analyses the results in order to make recommendations to accelerate the market and clinic´s uptake of nanomedicine innovation. The launch, which took place at the Ministerio de Economía y Competitividad, included a presentation by IBEC associate director Josep Samitier as coordinator of the NanoMed Spain platform, as well as a round table involving IBEC director Josep A. Planell. Other participants at the event included representatives from the nationwide members of the platform from both research and industry.

  'Hoja por la Innovación en Nanomedicina en España' is dedicated to one of the founders of NanoMed Spain, Joan Albert Vericat, who died in July 2012. The 64-page document is available to view or download at the IBEC and NanoMed Spain websites.
- Representation of the Spanish Nanomedicine Platform members at international level, with particular stress in the relation with the Commission and the European Platform on Nanomedicine (ETPN).

PRINCIPAL ACTIVITIES of NANOMED SPAIN:

Collaboration with other platforms

- Launch of the Nanosafety Task Group: On 7th June, four technological platforms (Sustainable Chemistry, Materials, Industrial Safety and Nanomedicine) presented in Madrid (MINECO) their commitment to the creation of a Nanosafety Task Group, to which each of them will contribute complementary expertise. The meeting summoned 50 experts from private and public sectors, and provided the starting point to carry out a study, via the Platforms' members, to detect industry needs and available knowledge.
- Collaboration with Biomedical Knowledge Platforms (Innovative Medicines, Medical Technologies, Biotech Markets): Ongoing efforts to celebrate networking events which bring together the diverse industrial sectors related to nanomedicine, to encourage open innovation and foster private-public collaboration.
- Channelling the platform's members' relationships with the regulatory authorities and co-ordinating

efforts for a more rational regulatory framework for nano-drugs and nano-diagnostics: NanoMed Spain participated with a lecture at a workshop for the Agencia Española De Medicamentos (AEMPS).

- Working along with the Oficina Española de Patentes y Marcas (OEPM, Spanish Patents and Trademarks Office) to disseminate relevant information in IP protection, valorization and exploitation opportunities in the relevant areas across the diverse stakeholders.

Representation of the Spanish nanomedicine community at international level

- NanoMed Spain participated in Industrial Technologies 2012, which was held in Aarhus, Denmark on 19th-21st June. This event attracted 160 high profile international speakers from industry, government and research to discuss visions for European research and industry in 2020, how Europe can succeed in the face of global competition, and the form and impact of the successor to FP7, HORIZON 2020, the next EU Framework Programme for Research and Innovation.
- Later in the year, NanoMed Spain participated in the European Technological Platform on Nanomedicine (ETPN) General Assembly in London on 30th-31st October. The meeting included the elaboration of a first draft of a white paper on how nanomedicine could be funded during HORIZON 2020, which was started to be discussed across the ETPN membership. The draft will be presented to the Commission in its final version during 2013.

Contributing to communication and dissemination of nanomedicine in Spain

NanoMed Spain's new website was given a radical overhaul in order to improve channels of communication and to provide an effective 'meeting point' for all stakeholders and interested parties. As well as a fresh new design, the site features more frequently updated news, events and sector developments and activities.

Brand new sections include a technology portfolio and a section devoted to master's degrees and specialized programmes in emerging areas in health.

GRUP
Connect-EU
Nanobio + Nanomed

IBEC coordinates the Connect-EU Nanobio+Nanomed working group, which also involves other centres such as ICFO, ICN, IQAC-CSIC and ICMAB-CSIC as core members, as well as two companies, Aromics and Advancell. The Connect EU working groups, which cover a range of strategic sectors, have been funded during 2011-2012 by the Catalan Government. They aim to promote and reinforce Catalan participation in the EU's instruments for research funding such as FP7 and its successor, HORIZON 2020.

As a core task, the Connect-EU Nanobio+Nanomed working group has elaborated an Strategic Research Agenda (SRA) based upon local R&D strengths and industry interests. This SRA defines priorities in innovative applications for the pharmaceutical, medtech and environmental industries whose development might be funded through European projects.

Connect-EU group activities have centred on building up a close relation with the European Commission, to present and defend the SRA. Bilateral meetings have been held with high officers from the KBBE, NMP and HEALTH programmes to discuss the Catalan Nanobio/Nanomed priorities and how to fit them into HORIZON 2020. Two members of the core group (Arantxa Sanz, IBEC, and Carme Plasencia, Aromics) were invited to evaluate the pilot call of the HEALTH programme for innovative SMEs.

At the end of September 2012 representatives from IBEC participated in the Connect-EU conference at Barcelona's World Trade Centre. Organized by ACC1Ó, the Generalitat's Agència de Gestió d'Ajuts Universitaris i de Recerca (AGAUR) and CERCA (page 102), the day's events focused on FP7 opportunities in 2012, as well as introducing HORIZON 2020, which will take over from FP7 in 2014. IBEC Associate Director Josep Samitier chaired the session centred on the HEALTH programme.

Strategic alliances

Several organisations exist at a local or national level to consolidate research efforts in particular fields, coordinate and encourage greater visibility for the activities of research centres, or bring together similar entities with a common goal from different regions.

IBEC is a member or partner of the following organisations and initiatives.

The Associació Catalana d'Entitats de Recerca (ACER) is an independent association which was established in 2003 to bring together non-profit R&D institutions, as well as helping to define scientific and research priorities and policies in Catalonia. Its ultimate goal is to help consolidate the region as an international leader in scientific and technological research and to optimize the management and implementation of the member centres in the areas they represent, which includes social sciences and humanities, life sciences and health sciences, natural mathematics and technology.

In July 2012 IBEC hosted the ACER General Assembly, and at the end of the year the institute received a visit from ACTec (Associació Catalana de Tecnologia) representatives as part of a joint initiative between ACER and ACTec, in which members of technology centres visit research centres to identify possible collaborations.

Biocat is the organization that coordinates, develops and promotes the biotechnology, biomedicine and medical technology sectors in Catalonia. Its mission is to make the region 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, 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 (see below).

Along with BIOCAT, IBEC is a member of a consortium to prepare a proposal for the Knowledge and Innovation Communities (KICs) of the European Institute of Innovation and Technology (EIT). KICs are public-private partnerships that combine entities, such as universities, research centres, companies, technology platforms and business schools, to come up with innovations, solutions to societal challenges and new innovation models and thereby boost innovation and entrepreneurship. The first three KICs, on Climate Change, Information and Communication Technologies and Sustainable Energy, were designated in December 2009, and a new wave of KICs will be set up by 2014.

The EIT is a body of the European Union established to increase European sustainable growth and competitiveness by reinforcing the innovation capacity of the EU by developing a new generation of innovators and entrepreneurs.

Fostered by IBEC and under BIOCAT's leadership, BioNanoMed Catalunya is an alliance of research centres, hospitals and companies to share know-how and resources and facilitate new developments in nanomedicine. International collaboration, in particular European-related opportunities, is channelled through the Connect-EU working group.

Increasing visibility for the network's emerging activities is a key element in the agenda. In 2012, the organisation of a Catalan/British meeting to help companies and research institutes from both countries identify new business opportunities in the field, which took place in July. The Nanotechnology for Healthcare Forum, organised by BioNanoMed Catalunya in collaboration with NanoKTN, Biocat and UK Trade & Investment (UKTI)/ British Consulate General. BioNanoMed Catalunya also

contributed to the Industry-Academia-Clinic Forum "New trends in nanomedicine for oncology diagnostics and therapy" on 25th October, which was organised by Biocat and CIBER-BBN.

The CERCA Institute is the Government of Catalonia's means of supervising, supporting and facilitating the activities of Catalan research centres. IBEC is one of the 47 CERCA centres.

The aims of CERCA are to encourage and maximise synergies and coordination between centres and improve their positioning, visibility and research impact. It contributes to the centres' international presence, facilitates and fosters the adoption of common policies in management, scientific development and knowledge transfer, contributes to strengthening exchange with the best centres and universities in the world, and fosters the recruitment and retention of talent on an international level.

A voting member of the European Technological Platform on Nanomedicine (ETPN) since 2008, 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 Health UB Campus (HUBc) project, led by the University of Barcelona, brings together about 30 training institutions, research and knowledge transfer in health sciences, mainly around the campus of the Medical and Hospital San Juan de Dios, the campus Health Sciences with the University Hospital of Bellvitge, ICO, IDIBELL, Biopol'H, and Barcelona Innovation Zone. On 21 October 2010, HUBc achieved recognition by the Ministries of Education and Science and Innovation as a campus of international excellence.

Nanoaracat is a protocol that establishes a framework for collaboration between the regional governments of Aragon and Catalonia to promote 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.

The Virtual Physiological Human (VPH) Institute for Integrative Biomedical Research is an international not-for-profit organisation incorporated in Belgium in 2011, whose mission is to ensure that the Virtual Physiological Human is fully realised, universally adopted and effectively used both in research and the clinic. To date, the institute represents over 67 public and private institutions active in VPH research, including many academic, clinical and industrial key players in the area of *in silico* medicine.

Jérôme Noailly, senior research associate in the Biomechanics and Mechanobiology group, is IBEC delegate of the VPH Institute.

Technology Transfer

Technology transfer activities at IBEC

Breakthrough innovation can only happen if research discoveries leave the lab and reach the market and the users. Translating discoveries into market-ready products require an effective liaison with industry, as well as knowledge on intellectual property protection and exploitation.

The technologies that meet our criteria for commercialization are developed into products and therapies through collaborations and alliances with other research organizations, companies and clinicians, and the creation of new start-ups. The IBEC researchers are supported by the Corporate Projects Unit along the tech transfer and the translation processes, so our most promising results address the market's, and ultimately, the patient's needs in the most efficient manner.

Smart approaches in the treatment of malaria

The joint unit of IBEC and the Barcelona Centre for International Health Research (CRESIB), headed by Dr. Xavier Fernández-Busquets (page 58), is a collaborative initiative with the mission to develop new diagnostic and therapeutic systems for malaria. Specifically, they aim to demonstrate the feasibility of nanovectors as antimalarial drugs or carriers of other existing drugs. These new strategies efficiently target antimalarial drugs at *Plasmodium*-infected red blood cells, thus enhancing the therapeutic index and minimizing toxicity.

Two different approaches have yielded very promising results during 2012 (see under Filed Patents, page 60). Their work on polyamidoamines (PAAs) with amphoteric properties combined with protein conjugates, in collaboration with the Università degli Studi di Milano (Italy), as well as their activities on heparin-containing conjugates, used either on their own or encapsulating a further antimalarial drug, might become a new class of potent anti-malarial agents.

New biopolymers with eye-epithelial cells for tissue regeneration: Eye-scaff

On 30th October 2012, the Biomaterials for regenerative therapies group (page 65), together with the Institute for Research in Ophthalmobiology of Valladolid University and the University of the Basque Country, all members of CIBER-BBN (page 96), signed an agreement with Ferrer International in order to develop Eye-scaff. This new compound constitutes biodegradable biopolymers functionalized with collagen that also include corneoescleral limb epithelial stem cells for eye surface tissue reconstruction.

During the next four years, the partners will try to clinically verify and optimize the efficacy of this new therapy, having initially showed good results in a small amount of patients with opaque cornea. The usual approach to tackle this disorder, which affects 10m people globally and can lead to blindness, is a corneal transplant.

Light-regulated drugs for neurologic therapies

In December 2012, ICREA Research Professor Pau Gorostiza of the Nanoprobes and Nanoswitches group (page 45) was awarded the ERC Proof of Concept (PoC) grant for the project Therapeutic Applications of Light-regulated Drugs (THERALIGHT). PoC grants, which launched in 2011, are specifically aimed at researchers who have already been awarded an ERC grant, enabling them to establish the innovation potential of ideas arising from their ERC-funded research projects, bridging the gap between lab research and the earliest stage of a marketable innovation.

Pau's group has developed an innovative approach to control the activity of drugs against G-protein coupled receptors with light in cell culture systems, particularly two different regulators of receptors with a significant role in Parkinson's Disease and peripheral pain pathways. The PoC grant will allow this promising line to go a step further by testing his new methods in animal models to

identifying biomedical applications where light regulation provides unique advantages and opportunities with a strong commercial potential.

Rob Surgical Systems S.L.

The spin-off company Rob Surgical Systems S.L. started its activities in December 2011, with IBEC and the UPC both taking equity ownership in the company and supporting its development. The company's core business is minimally invasive surgery robotic systems, and its in-house technology, represented by the prototype BITRACK, has arisen from the research performed by the Robotics group led by Alícia Casals (page 89).

BITRACK offers better control, visualization and ergonomics to the surgeon while increasing comfort and safety for the patient,minimizing the risk of infections, hemorraghias and shortening the recovery period. Hospitals acquiring the system can expect an overall reduction of costs.

In 2012, Rob Surgical Systems negotiated an agreement with Barcelona's Hospital Clínic to carry out pre-clinical (2013) and clinical (2014) validation of the recently completed BITRACK prototype. It also celebrated a first meeting of its Advisory Clinical Board and finished its business plan and financial roadmap.

Somnoalert®

IBEC, UB and industry partner Ficosa have joined forces to develop a new technology to combat dozing off when driving. The drowsiness alerter, Somnoalert®, is a smart phone application that uses inertial sensors and GPS data to detect movements that are characteristic of nodding off at the wheel, such as deviation from the driving lane or sudden corrections. A later prototype also incorporates biomedical sensors to analyze respiration data.

The patented software is one of the results of a strategic agreement signed in 2010 between IBEC's Artificial Olfaction group (page 80), the UB's Department of Electronic Engineering and Ficosa, a Barcelona-based multinational that researches, develops, produces and commercializes automobile systems and parts. The agreement spans diverse collaborative research activities.

The smart phone application Somnoalert®, aimed at combating dozing off at the wheel


ng photo-inducible CreER^{T2} recombinase
m to study zebrafish cardiac regeneration
Institute for bioengineering of Catalonia
Materials & Meth
Caged Cyclofen (cCyc) is introd
embryos of the transgenic li
ertilization (dpf) old
loxP-STOP-loxP-GFP
multi-
copy
T2 complex,
us and recombines the second transgene
cardiomyocytes are labeled by GFP
Events, outreach & communications

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 are invited to give lectures as part of the 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 developments with the guest speakers.

■ 20 January

Elena Martínez
Nanobioengineering group, IBEC
Development of Smart Surfaces for Cell Response Studies

■ 10 February

Anna Laromaine
Institut de Ciència de Materials de Barcelona (ICMAB)
Nanoparticles: interactions in 3D biological environments

■ 17 February

Mateu Pla-Roca
Nanobioengineering group, IBEC
Development of scalable technologies for multiplex protein analysis in complex samples

■ 2 March

Gustavo Deco
ICREA Research Professor, Computational Neuroscience Group, Dept of Technology, Universitat Pompeu Fabra
Ongoing Cortical Activity at Rest: The Global Attractor Structure of the Brain

■ 9 March

Gustavo V. Guinea
Dpto. Ciencia de Materiales, Universidad Politécnica de Madrid
Presentación de las actividades del Grupo de Biomateriales y Materiales Biológicos de la Universidad Politécnica de Madrid

■ 16 March

Ricard Solé
Complex Systems Group, Institut de Biologia Evolutiva, Universitat Pompeu Fabra
Evolution and computation in biological networks: beyond Turing

■ 20 April

Pere Roca-Cusachs
Cellular and respiratory biomechanics group, IBEC
Exploring the mechanical link between integrins and actin

■ 4 May

Ignacio Arganda-Carreras
Department of Brain & Cognitive Sciences, Massachusetts Institute of Technology (MIT)
Image processing tools for the study of brain connectomics

William J. Godinez
Biomedical Computer Vision Group, University of Heidelberg/German Cancer Research Center (DKFZ)
Tracking and Behavior Identification of Fluorescent Particles in Time-lapse Microscopy Images

Vasil Tsimashchuk
Biomedical Computer Vision Group, University of Heidelberg/German Cancer Research Center (DKFZ)
Analysis of Viral Surfing Based on Fluorescence Microscopy Imaging and Automatic Tracking

■ 29 June

M. Cristina Marchetti
Physics Department & Syracuse Biomaterals Institute, Syracuse University, Syracuse, USA
Modeling contractile stresses in adhesive cells and cell colonies

■ 3 July

Michelle Khine
Associate Professor in the Biomedical Engineering Dept at UC Irvine, California
Shrink-induced nanomanufacturing for on-demand biomedical tools

■ 13 July

Manel del Valle
Sensors and Biosensors group, Department of Chemistry, Universitat Autònoma de Barcelona
Electronic tongues at the Universitat Autònoma de Barcelona

■ 20 July

Jordi Fonollosa
BioCircuits Institute, University of California, San Diego
Algorithmic Mitigation of Sensor Failure: Is Sensor Replacement Really Necessary?

■ 27 July

C. Donald Combs
NCCMMS Co-Director/Vice President and Dean, School of Health Professions, Eastern Virginia Medical School
Activities at the National Center for Collaboration in Medical Modeling and Simulation (NCCMMS)

■ 14 September

G. Wayne Brodland
University of Waterloo, Canada
Using Video Force Microscopy (VFM) to Learn About the Forces That Drive Cell and Tissue Motions

■ 28 September

Matteo Santin
Brighton Studies in Tissue-mimicry and Aided Regeneration, School of Pharmacy & Biomolecular Sciences, University of Brighton
Biocompetent magnetic carriers for stem cell and VEGF release in bone regeneration

■ 5 October

Jordi Soriano
University of Barcelona
Interplay activity-connectivity: dynamics in patterned neuronal cultures

■ 19 October

Eduardo Fernandez
Universidad Miguel Hernández (Elche)
Development of a Cortical Visual Neuroprosthesis for the Blind: Challenges and Key Problems

■ 23 November

Rodrigo Martinez-Duarte
Microsystems Laboratory, École Polytechnique Fédérale de Lausanne
High throughput sample preparation using 3D carbon-electrode dielectrophoresis

■ 26 November

Lorenzo Moroni
Department of Tissue Regeneration, University of Twente, The Netherlands
Enabling 3D Fabrication Technologies to Generate Cell-Instructive Porous Biomaterials for Skeletal Regenerative Therapies

■ 14 December

Victor Puntes
Catalan Institute of Nanotechnology (ICN)
Engineering Inorganic Nanoparticles

PhD Discussions sessions

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 2012, 12 PhD students participated in these sessions. Additionally, in order to help IBEC students in their career development and provide them with additional skills, three invited speakers gave lectures on various topics.

■ 27 January

Damien Lacroix
Biomechanics and Mechanobiology group, IBEC
Complementary Skills Session: How to Become a Successful Group Leader

■ 24 February

Mar Cendra
Microbial biotechnology and host-pathogen interaction group
Ribonucleotide reductases: a paradigm of redundant enzymes in bacteria

Riccardo Levato
Biomaterials for Regenerative Therapies group
Biodegradable Microcarriers for Cell and Drug Delivery

■ 3 March

Rosa Letizia Zaffino
Nanobioengineering group
Electrochemical DNA mediated charge transport nano-sensor

Andrés Martin Quirós
Nanoprobes and nanoswitches group
Photoswitchable peptides for optical control of endocytosis

■ 11 May

Pep Pàmies
Nature Materials
Complementary Skills Session: Appealing to Nature Materials - an editor's view

■ 25 May

Jordi Comelles
Nanobioengineering group
Cell motility in gradients: competitions between topographical ratchet and chemical adhesion

Lorena Redondo
Nanoprobes and nanoswitches group
Stability of Lipid Bilayers as Model Membranes: Atomic Force Microscopy and Spectroscopy Approach

■ 6 July

Xavier Puñet
Biomaterials for regenerative therapies group
Scaffolds coating: the use of elastin-like recombinamers as ECM analogue

Bogachan Tahirbegi
Nanobioengineering group
Electrochemical sensors for ischemia monitoring inside the stomach

■ 26 October

Tomás Luque
Cellular and respiratory biomechanics group
Mechanical Properties of Decellularized Lung Matrix Probed with Atomic Force Microscopy

Lluís Fernández
Artificial Olfaction group
Variable interpretation of a bio inspired chemometric system based on a large MOX array

■ 30 November

Gaëtan Chary
FEM/CAE and numerical simulations consultant at Gammiq Consulting
Complementary Skills Session: Open source applications for science and engineering

■ 21 December

Juan Manuel Artés
Nanoprobes and nanoswitches group
Electronic properties of the redox protein azurin at the single molecule level

Óscar Castillo
Nanobioengineering group
Microfluidic deflection system for cell sorting based on negative dielectrophoresis

Events and meetings in 2012

Throughout the year

Institutional and scientific projects

Throughout the year, IBEC hosts meetings for the consortia of its ongoing institutional and scientific projects. In 2012 the scientific projects SMART-IMS, IPRES, Structgel, HYPER, Somno-Alert, nAngiofrac, BIOSCAFF, MySpine, Rewound, ULTRASEN-4BIO, Fibrogel and PLANTOID all held meetings at IBEC.

The IBEC-managed NanoMed Spain, Connect-EU Nanobio+Nanomed and Bionanomed Catalunya initiatives (see pages 99-102) also held steering committee or partner meetings here during 2012.

January

■ 23 January

CERCA managers meeting

A meeting of the managing directors of several of the Barcelona and area research institutes that are members of CERCA, the Government of Catalonia's means of supervising, supporting and facilitating the activities of the region's research centres (page 102), was held at IBEC at the beginning of the year.

March

■ 7-8 March

1st UBB-IBEC Symposium

Organised with the Biophysics and Bioengineering Unit of the University of Barcelona, the first UBB-IBEC Symposium was a 'mini symposium' on biomechanics organised by IBEC's Integrative Cell and Tissue Dynamics group leader Xavier Trepat (page 49), which involved the Cellular and Respiratory Biomechanics group of Daniel Navajas (page 40) as well as that of Ramon Farré at Barcelona's Institut d'investigacions Biomèdiques August Pi i Sunyer (IDIBAPS). A second UBB-IBEC meeting was held on 14 June 2012.

May

■ 7 May

Visit of NCI/NSF APHELION

In May, representatives of the US-based Assessment of Physical Sciences and Engineering Advances in Life Sciences and Oncology (APHELION) initiative, coordinated by the National Cancer Institute (NCI) Office of Physical Sciences – Oncology (OPSO) and the National Science Foundation (NSF), visited Barcelona and IBEC. APHELION's mission is to determine the status and trends of research and development wherein physical sciences and engineering principles are applied to cancer research and oncology in leading laboratories. The work of IBEC's Integrative Cell and Tissue Dynamics and Cellular and Respiratory Biomechanics groups was presented.

■ 10 May

Fira d'Empreses

This careers fair, organized by the University of Barcelona's physics and chemistry faculties, helps undergraduate students of these subjects to find out more about potential employers or furthering their studies, as well as improving the university's relations with the business sector.

IBEC attended the fair to offer university leavers advice and information about continuing their career at the institute as masters or PhD students.

L-r: Dr. Joan Roca, Sr. Lluís Jofre, Hble. Sr. Boi Ruiz, Dr. Xavier Gil and IBEC Director Prof. Dr. Josep A. Planell at the opening ceremony of this year's IBEC Symposium on Bioengineering and Nanomedicine

June

■ 11 June

5th IBEC Symposium on Bioengineering and Nanomedicine

The IBEC Symposium on Bioengineering and Nanomedicine is the institute's major event of the year. This, the fifth edition, took place in Barcelona's AXA auditorium and welcomed 230 participants, a record 20% of which came from outside the institute. The opening ceremony was conducted by the Hble. Sr. Boi Ruiz, Minister of Health, the UPC's Vice-Rector of Scientific Policies Dr. Xavier Gil, Dr. Joan Roca, the Director of the UB Campuses of International Excellence, and Lluís Jofre, the Generalitat's director general of universities.

The invited speakers were Bradley Nelson from ETH in Zurich, who talked about the microrobots his group is developing to treat eye diseases and the nanorobots that swim with a technique inspired by motile bacteria. Next, William Bonfield, Emeritus Professor of Medical Materials at the University of Cambridge, was able to offer the audience the best advice about clinical and commercial success with biomaterials start-ups, having sold his company Apatech Ltd last year for $330 million. Conrad Bessant from Cranfield University in the UK talked about using pattern recognition to analyse large data sets from biological samples for improved diagnostics, and finally Alejandro Frangi from the Universitat Pompeu Fabra/ University of Sheffield addressed the symposium on image-based cardiovascular modeling in the framework of the Virtual Physiological Human, particularly as applied to aneurysms in the brain.

From inside IBEC, Xavier Trepat and Antonio Juárez presented their recent work on collective cell migration and the role of bacterial plasmids as applied to antibiotics resistance respectively. Twenty-six IBEC PhD students presented their work in three-minute flash presentations.

■ 25-29 June

'Interrogations at the Biointerface' Advanced Summer School

The 'Interrogations at the Biointerface' Advanced Summer School, which is co-organized by IBEC, the Instituto de Engenharia Biomédica (INEB) and the Institute of Molecular Pathology and Immunology of the University of Porto (IPATIMUB), both in Portugal, introduced PhD students and early postdocs to advanced experimental techniques. With the focus this year on the 'self-renewal/differentiation interface', the sessions in the Control of Stem Cell Potency lab at IBEC and at the UB helped 18 students get to grips with generating human pluripotent stem cells and analysing planarian regeneration.

The lab sessions were followed by three days of lectures featuring top international speakers from biomedical engineering, stem cell proliferation, cell fate maintenance and differentiation.

Events and meetings *continued*

July

■ 11 July

Voice workshop

Former IBEC PhD student Marta Mattotti ran a one-day workshop on voice handling for scientists in the summer. A more unusual addition to the Human Resources unit's programme of training throughout the year, the workshop helped the researchers with breathing, relaxing and warm-up techniques for public speaking, such as how to combat voice tremble caused by nerves.

■ 12 July

Trobada de RRHH dels centres CERCA

In July IBEC's Human Resources team hosted the second Trobada de RRHH dels centres CERCA 'cross-fertilisation of ideas' session. Attended by 20 other HR personnel from other research centres in the area who are also members of CERCA (page 102), such as CRG, ICFO and VHIR, the event was an opportunity to share best practises, identify common problems and devise new tactics to deal with the special challenges caused by staff coming from all over the world, such as visa, tax, social security, contract and language issues.

■ 19 July

ACER General Assembly

The Associació Catalana d'Entitats de Recerca (ACER, page 101) held its General Assembly at IBEC in July. Almost all ACER partners, represented by their principal directors, were in attendance, as was the Generalitat's Secretari d'Universitats i Recerca, Antoni Castellà i Clavé. The assembly comprised a comprehensive review of ACER's activities in recent months.

September

■ 25 September

EID workshop for companies

Organized by Connect-EU (page 100), this workshop assisted companies interested in taking part in the EID (European Industrial Doctorate) grants programme. A new action within FP7's Initial Training Networks/PEOPLE programme, the grants provide joint academic and industrial training for young researchers enrolled in a doctoral programme. The action aims to improve career prospects for young researchers in both the public and private sectors, extend the traditional academic research training setting, and eliminate barriers to mobility.

October

■ 3-4 October

Complementary skills training: Presentation skills for conferences

Twelve researchers took part in this Human Resources Unit-organised training course to help improve presentation skills using Powerpoint, with scientific conferences in mind.

November

■ 9 November

Visit of UB masters students

As part of their training under the University of Barcelona's masters course in nanoscience and nanotechnology, 20 masters students visited IBEC to

learn about the reasons for having communications units in research institutes and the types of activities they undertake.

■ 15 November

Escola de Tardor ACER

The Associació Catalana d'Entitats de Recerca (ACER) (page 101) held its first Autumn School at IBEC, which was devoted to the subject of technology transfer in all partner institutions. Thirty people met to share knowledge and exchange experiences.

The meeting heralded the launch of 'TransferTec', a joint initiative with the Foment del Treball and ACTec (the Associació Catalana de Tecnologia), which allows all ACER's partner institutions to access the technology marketplace Innoget. In addition, keynote speaker and legal expert Ignasi Costas gave an in-depth analysis of the effect of the Science Act, approved this year, on the creation of spin-offs.

■ 20, 27 and 29 November

Science writing for publication

In 2012 the Human Resources unit offered a second complementary skills training session, this time a writing style course, for those wanting to hone their skills in preparing manuscripts for scientific journals. Twelve researchers took part in the three-day course.

■ 30 November

NANOXM visit

Members of Italian nanotechnology innovation cluster NANOXM paid a visit to IBEC as part of a trip to Barcelona aimed at exploring nanotechnology collaborations with Catalan research groups and companies. The 26 entrepreneurs and researchers enjoyed a focused introduction to IBEC's nanobioengineering research from senior researcher Mateu Pla. In their four-day tour of Barcelona's nanotech bodies, the representatives of prestigious Italian centres such as the Università di Siena and the Scuola Normale Superiore's Laboratorio NEST also had a chance to promote Tuscan experience in nanotechnology advancement to other centres in the city.

December

■ 5 December

ACTec visit to IBEC

As part of a joint initiative between ACER (page 101) and the Associació Catalana de Tecnologia (ACTec), in which members of technology centres visit research centres to identify possible collaborations, IBEC received a visit from ACTec representatives towards the end of the year.

In his presentation, IBEC director Dr. Josep A. Planell gave a general introduction to IBEC before focusing on some of the specific issues, while Arantxa Sanz, Head of Institutional Projects, was in attendance to lead the discussions and answer questions. The visit ended with a visit to IBEC's labs.

Head of Communications and Outreach Vienna Leigh presents the activities of the communications department to visiting masters students

Outreach activities in 2012

February

■ 15 February

ESCOLAB

Every year, IBEC takes part in the ESCOLAB initiative of the City Council of Barcelona, which introduces groups high school students into the city's research laboratories to encourage scientific vocation. In 2012 IBEC welcomed a group of third-year ESO students from the Oak House School in Barcelona. PhD students from the Nanoprobes and Nanoswitches group demonstrated atomic force microscopy using a model built for the occasion, after which the visitors and their teachers took a tour of the labs.

March

■ 19 March

First visit from Denmark

A group of 13 biotechnology students from Langkær Gymnasium near Aarhus, Denmark, visited the institute in March and took a tour of the labs, as well as hearing some presentations about specific areas of research.

■ 21-25 March

Recerca en acció

IBEC's exhibition stand at March's Saló de l'Ensenyament Education Fair in Barcelona, which showcased the BOND project and the world of olfaction, was swamped with young visitors keen to learn about the institute's research and job opportunities. The media was also on the scene, and news coverage of the event appeared on Barcelona Televisió and La 1's news programmes.

April

■ 24-26 April

Fira Recerca en Directe

The 'Live Research' fair is organized by the Parc Científic de Barcelona (PCB) with the support of the Obra Social of CatalunyaCaixa bank. It aims to improve the understanding of science by presenting research to the general public, with researchers demonstrating and explaining their methods and goals in an accessible way. In 2012 scientists from IBEC's Robotics group manned the IBEC stand at the fair with the activity 'Relating to Robots', where participants could perform a teleoperation with a robot and to control a robotic hand by contracting their own muscles. In their coverage of the fair, Barcelona TV chose to focus on IBEC, with the reporter interviewing PhD student Xavier Giralt about the demonstrations on the stand.

June

■ 16 June

Festa de la Ciència 2012

In June IBEC took part for the first time in the council-organised Festa de la Ciència in Barcelona's Parc de la Ciutadella, at which Control of Stem Cell Potency PhD student Sergio Mora gave a presentation about the work of his group on induced pluripotent stem cells.

IBEC has been building a strong programme of outreach activities in recent years, which now represents 30% of the calendar of events organized by the institute. In 2012 IBEC welcomed several visiting groups of students from abroad.

IBEC's Communication and Outreach Unit, which coordinates the outreach programme, collaborates with other bodies and organisations to order to ensure IBEC's involvement in local or national initiatives. These include the Barcelona City Council, the Parc Científic de Barcelona (PCB), the Fundació Catalana per a la Recerca i la Innovació (FCRI) and the Obra Social de CatalunyaCaixa.

July

■ 9 July

Visit from the Netherlands

In July IBEC had a visit of 15 students from TopTrack, the excellence program of the Mechanical, Maritime and Materials Engineering faculty of Delft University of Technology.

■ Throughout July

E^2C^3 Joves i Ciència programme

Three high-school students were hosted in IBEC labs for several weeks in July as part of Catalunya Caixa's E^2C^3 Youth and Science Programme, which exposes talented and motivated young students to 'real' scientific work to encourage more of them to embark on a scientific career. Helena Bragulat and Gerard Jiménez joined Biomechanics and Mechanobiology group researchers Themis Toumanidou and Andy Olivares for some hands-on experience.

October

■ 9 October

Second visit from Denmark

A second group of visitors from Denmark, this time from the Ikast-Brande Gymnasium near Herning, visited IBEC in October. This larger group of 24 biotechnology students had heard about IBEC visits from their Aarhus colleagues and enjoyed a tour of the labs and a general presentation, as well as one about biomaterials.

November

■ 22 November

Setmana de la Ciència 2012

In November twenty members of the general public attended IBEC's Open Doors Day, which was entitled 'La Bioenginyeria per a Tothom'. The day, which was held as part of this year's nationwide Setmana de la Ciència, welcomed a mix of people, with the oldest attendee in her 70s and the youngest 20. They were fascinated and full of questions about the concepts they heard about, which included biomaterials, artificial olfaction, robotics and iPSC, and a 'robotic hand' demonstration by PhD student Luis Amigo.

■ 28 and 30 November

CatalunyaCaixa's Professors i Ciència programme

IBEC took part for the first time in Fundació Catalunya Caixa's Professors i Ciència programme, in which high school teachers participate in specialized courses and workshops in the major scientific research centres in Catalonia and then take what they've learnt back to the classroom. IBEC's two-day workshop was entitled 'Biomaterials, new materials for regenerative therapies'.

Throughout the year

Visits by Barcelona schools

Throughout the year, groups of students from high schools in Barcelona and Catalonia visit IBEC. In 2012 they included Escola L'Horitzó in February, Institut d'Ensenyament Secundari El Til·ler in March, Escola Llor (Sant Boi) in April and Col·legi Natzaret Esplugues in May.

Media coverage in 2012

January

■ 10 January

Barcelona Televisió

"Descobrim l'interior d'un laboratori de robòtica"

Alícia Casals' Robotics laboratory was featured on Barcelona Televisió's programme "Connexió" on 10 January.

February

ASEBIO Boletín

"Bionanotecnologías: pautas hacia la excelencia"

In their February bulletin, the Spanish Association of Biotechnology Companies published an editorial by the president of their scientific committee Emilio Muñoz. He refers to the existence of IBEC, NanoMedSpain and CIBER-BBN as a "good reflection of the policy on advancing bionanotechnology in Spain" and says they are important "reference tools" for the sector.

Destacamus

"Alícia Casals, Cap del grup de Robòtica a l'IBEC"

IBEC's Robotics group leader Alícia Casals was the subject of the February 2012 edition of *Destacamus*, a bimonthly magazine which profiles researchers.

■ 15 February

Redacción Médica

"Las Plataformas de Investigación Biomédica apuestan por la colaboración para superar la crisis"

The 5th Annual Conference of the Biomedical Research Technology Platforms, which IBEC attended in its capacity as coordinator of the Spanish Nanomedicine Platform (NanoMed Spain), was the subject of an article in healthcare magazine *Redacción Médica*.

■ 20 February

La Vanguardia

"Un chip implantado bajo la piel libera fármacos a voluntad"

IBEC director Josep A. Planell was quoted as an expert opinion in an article in *La Vanguardia*. The story covered a new chip developed at MIT able to release drugs under the skin while dosage and timing is controlled wirelessly.

March

■ 1 March

Catalunya Vanguardista

"Desenvolupen una nova solució per tractar l'aterosclerosi"

The EU-funded "The Grail" project, in which IBEC and three other European research centres will develop a new minimally-invasive treatment for atherosclerosis patients, was covered in *Catalunya Vanguardista* magazine.

■ 20 March

El Economista and others

"Científicos españoles reproducen en el laboratorio la pérdida de neuronas que da lugar a la enfermedad de Parkinson"

The press release about the Control of Stem Cell Potency group's discovery of disease-specific phenotypes in iPS cells from Parkinsons patients was covered by several newspapers, magazines and websites including daily business newspaper *El Economista*, online science magazine *Tendencias 21*, and EuropaPress, the national news agency.

■ 21 March

La 1 and Barcelona Televisió

The sweet smell of success

Spanish national channel La 1 and Barcelona Televisió both covered IBEC's exhibition stand, which showcased the BOND project and the world of olfaction, at the Saló de l'Ensenyament Education Show in Barcelona. More than 80,000 people attended the fair.

■ 27 March

El Mundo

"El bisturí se controla con un mando a distancia"

IBEC got a mention in Spanish daily *El Mundo*, when Robotics group leader Alicia Casals gave her expert opinion about the use of robots in healthcare and the financial hurdles that impede their translation to the clinic.

■ 28 March

Diario Médico

"El Instituto de Bioingeniería de Cataluña descubre un mecanismo por el cual las células exploran su medio"

The press release about Pere Roca-Cusachs' *PNAS* paper looking at the way cells probe their environment was covered in *Diario Médico* on 28 March.

April

■ 24 April

Barcelona Televisió

"10a Fira de la Recerca en Directe, La Pedrera"

In their coverage of the Fira en Directe at La Pedrera, Barcelona TV's reporter interviewed PhD student Xavier Giralt about the robotics activities on the IBEC stand.

■ 26 April

La Vanguardia

"Los vertiginosos cambios de la 'Tecnorrevolución', en CosmoCaixa"

La Vanguardia published a news item about the inauguration of the Tecnorrevolución exhibition at Barcelona's CosmoCaixa museum, which was opened by IBEC associate director Josep Samitier.

May

■ 22 May

La Vanguardia

"Grupos de investigación del VHIR y el IBEC se unen en el fomento de la investigación e innovación"

On 22 May *La Vanguardia* covered IBEC's signing of a collaboration agreement with the Vall d'Hebron Research Institute (VHIR) in Barcelona.

June

Informacions

"Coneixement que dilueix les fronteres"

Senior research associate Jérôme Noailly of the Biomechanics and Mechanobiology group featured in an article about mobility and the opportunities offered to international researchers in the June edition of *Informacions*, a regular magazine on research, teaching and institutional activities at the UPC.

■ 6 June

Euronews

"The lifesaving device that can smell cancer"

A video about Josep Samitier and the BOND project featured on Europe's leading international news channel, Euronews, in June.

■ 13 June

Corriere della Sera

"I nuovi robot sono ispirati alle piante"

The start of the three-year European project PLANTOID, of which IBEC's Nanobioengineering group is a partner, was covered in the Italian daily newspaper *Corriere della Sera*. The project aims to design and develop robots inspired by plant roots.

Media coverage *continued*

■ 19 June

Diario Médico

"Una nueva técnica de control de las microheridas epiteliales"

The Integrative Cell and Tissue Dynamics group's *PNAS* paper was covered in *Diario Médico*. In the article, group leader Xavier Trepat explains their new experimental methods, using micropillars, to achieve standardized measures of dynamic epithelial wound closure.

■ 27 June

Emprendia

"Encuentro catalano-británico para promover negocios nanotecnológicos"

Emprendia, the first Spanish-language publication devoted to university entrepreneurship, covered the Catalan/British Nanotechnology for Healthcare Forum, for which IBEC provided scientific support.

■ 29 June

Info Prevención

"La importancia de la estandarización en un laboratorio de I+D en el que trabajan equipos de amplia diversidad cultural"

The work of IBEC's infrastructures team featured in Info *Prevencion*, the newsletter of the Fundación Prevent, a non-profit organization promoting safer work environments.

July

Per a Vèncer la Fibrosi Quística

"El combate contra la pseudomona en manos del Dr. Torrents"

Senior researcher Eduard Torrents appears several times in the July edition of the newspaper of the Associació Catalana de Fibrosi Quística, *Per a Vèncer la Fibrosi Quística*.

■ 7 July

Ideas, Inventions And Innovations

"How the rat is helping development of an artificial nose"

The press release about the Artificial Olfaction group's *PlosOne* paper on how chemical information is coded and processed in the mammalian olfactory system was covered on the website 'Ideas, Inventions And Innovations'.

■ 8 July

Le Scienze

"Riconoscimento di nano-oggetti e virus senza marcatori"

The Nanoscale Bioelectrical Characterisation group's work in *Nature Materials* about a new technique to identify nano-objects such as viruses without the need for labeling gained media coverage in Italy's *Le Scienze*, as well as on sciencedaily.com, phys.org and several other websites.

■ 10 July

Qué!

"Descubren que las células se mueven a empujones"

The Integrative Cell and Tissue Dynamics group's work in *Nature Physics*, which revealed that cell movements occur in a wave-like manner, appeared in daily newspaper *Qué!*

August

■ 27 August

Expansión

"Año de la neurociencia, recortes en I+D+i"

IBEC group leader José Antonio del Río contributed to an *Expansión* article about funding for research, in particular neuroscience, for which 2012 was a "Year of" in Spain.

October

■ 4 October

Público and Materia

"Nacen los primeros ratones sanos de ovulos procedentes de celulas madre"

IBEC group leader Ángel Raya was quoted in articles in online newspapers *Público* and *Materia*, giving his expert opinion about some research in Japan. The scientists in Kyoto achieved a litter of healthy, fertile mice 'born' from undifferentiated stem cells taken from skin.

■ 13 October

El Periódico

"Células madre (y padre)"

On October 13 *El Periódico* published an article about Nobel Prize winners John Gurdon and Shinya Yamanaka, who won the prize in medicine or physiology for their achievements in stem cell research. Towards the end of the piece, the author talks about the leading position held by Catalonia in research into stem cells, naming IBEC's Ángel Raya as one of the region's pioneers.

■ 24 October

Diario Médico

"Hoja de ruta para innovar mejor en nanomedicina"

The launch in Madrid of the NanoMed Spain publication 'Hoja por la Innovación en Nanomedicina en España' was covered in *Diario Médico* in October.

■ 30 October

EuropaPress and NCYT

"Ferrer desarrollará una terapia que, "con buenos resultados", busca regenerar la superficie ocular con células madre"

The EuropaPress and NCYT sites covered IBEC's agreement with pharmaceutical company Ferrer and the universities of Valladolid and the Basque Country to develop a stem cell-based therapy to regenerate the surface of the eye.

December

■ 20 December

Investigación y Ciencia

"Control celular mediante luz"

The Nanoprobes and Nanoswitches group's research into light as a tool to manipulate biological and pharmacological processes remotely and non-invasively was featured in *Investigación y Ciencia*, the Spanish version of Scientific American.

The Robotic's group's Xavier Giralt and Coordinator of Events Pilar Jiménez face the crowds at the Fira en Directe at La Pedrera, Barcelona

PhD theses
defended in 2012

The data shows the date of defense, the name of the student, his or her group at IBEC, the title of the PhD thesis and the awarding body.

■ 9 January

Ramiro González
Biomechanics and Mechanobiology
Biomechanical study of intervertebral disc degeneration (UPC)

■ 10 February

Andy Olivares
Biomechanics and Mechanobiology
Evaluación computacional en andamios por prototipado rápido para la ingeniería de tejidos (UPC)

■ 21 May

Adriana Sánchez-Danés
Control of Stem Cell Potency
Generation of human dopaminergic neurons from induced pluripotent stem cells to model Parkinson's disease (Universitat Pompeu Fabra, Barcelona)

■ 25 May

Nuno Coelho
Molecular Dynamics at Cell-Biomaterial Interface
Dynamic Behavior of Type IV Collagen at Cell-Biomaterials Interface (UPC)

■ 19 June

Georg Gramse
Nanoscale bioelectrical characterization
Studying Electrostatic Polarization Forces at the Nanoscale: Dielectric constant of supported biomembranes measured in air and liquid environment (UB)

■ 9 July

Gemma Mestres
Associated group (UPC)
Novel phosphate-based cements for clinical applications (UPC)

■ 10 July

Óscar Seira
Molecular and Cellular Neurobiotechnology
Estudio de las vías de señalización intracelular asociadas a las proteínas inhibitorias asociadas a la mielina (UB)

■ 13 July

Sergi Udina
Artificial Olfaction
Smart Chemical Sensors: Concepts and application (UB)

■ 16 July

Laura Pedró
Microbial biotechnology and host-pathogen interaction
Caracterització de Paràlegs de la proteïna associada al nucleoide Hha: les proteïnes YdgT, HolE i YmgB (UB)

■ 18 July

Jordi Comelles
Nanobioengineering
Biochemical gradients on Poly(methyl methacrylate) surfaces (UB)

■ 20 July

Jose Marco Balleza
Associated group (UPC)
Monitorización del patrón ventilatorio mediante tomografia por impedacia eléctrica en pacientes con enfermedad pulmonar obstructiva crònica (UPC)

■ 26 July

Andrea Malandrino
Biomechanics and Mechanobiology
Multi-scale biomechanical study of transport phenomena in the intervertebral disc (UPC)

■ 27 July

Lorena Diéguez
Nanobioengineering
Optical grating coupler biosensor and biomedical applications (UB)

■ 5 October

Ester Añón
Integrative Cell and Tissue Dynamics
Mechanisms of migration in epithelial gap closure (Université Paris Descartes)

■ 29 October

Marta Mattotti
Biomaterials for regenerative therapies
Biological response to structured and functionalized substrates for nerve tissue regeneration (UPC/UB)

■ 29 October

Sabine Oberhansl
Nanobioengineering
Construction of versatile biomolecule nano-platforms via Dip-pen Nanolithography and their application in biosensing and cell differentiation (UB)

■ 9 November

Juan Manuel Artés
Nanoprobes and nanoswitches
Electrochemical Scanning Tunneling Microscopy and Spectroscopy of the Redox Protein Azurin (UB)

■ 15 November

Lorena Redondo
Nanoprobes and nanoswitches
Stability of lipid bilayers as model membranes: atomic force microscopy and spectroscopy approach (UB)

■ 30 November

Mário Hüttener
Microbial biotechnology and host-pathogen interaction
Estudio de sistemas evolutivamente conservados de regulación coordinada de la expresión génica en bacterias (UB)

■ 4 December

Aurora Dols-Pérez
Nanoscale bioelectrical characterization
Nanoscale structural and mechanical properties of lipid bilayers in air environment (UB)

■ 10 December

Óscar Castillo
Nanobioengineering
Analysis and characterisation of biological samples in nano and microfluidic devices using AC and DC electric fields (UB)

For PhD defenses in previous years, please see www.ibecbarcelona.eu/phd

Notes

Compiled and produced by the Communications and Outreach Department, IBEC.
Texts by the Communications and Outreach Department and the staff and scientists of IBEC.

Picture credits: Marc Vergés; Maria Pujol; Christine Panagiotidis; Jordi Anguera; the Communications and Outreach Department, IBEC; the staff and scientists of IBEC.

www.ibecbarcelona.eu

Institute for bioengineering of Catalonia

Baldiri Reixac, 10-12
08028 Barcelona, Spain
Tel. +34 934 039 706
Fax. +34 934 039 702

www.ibecbarcelona.eu

Generalitat de Catalunya
Unió Europea
Fons europeu de desenvolupament regional
Una manera de fer Europa
UNIVERSITAT DE BARCELONA
UNIVERSITAT POLITÈCNICA DE CATALUNYA
Obra Social
Fundación "la Caixa"