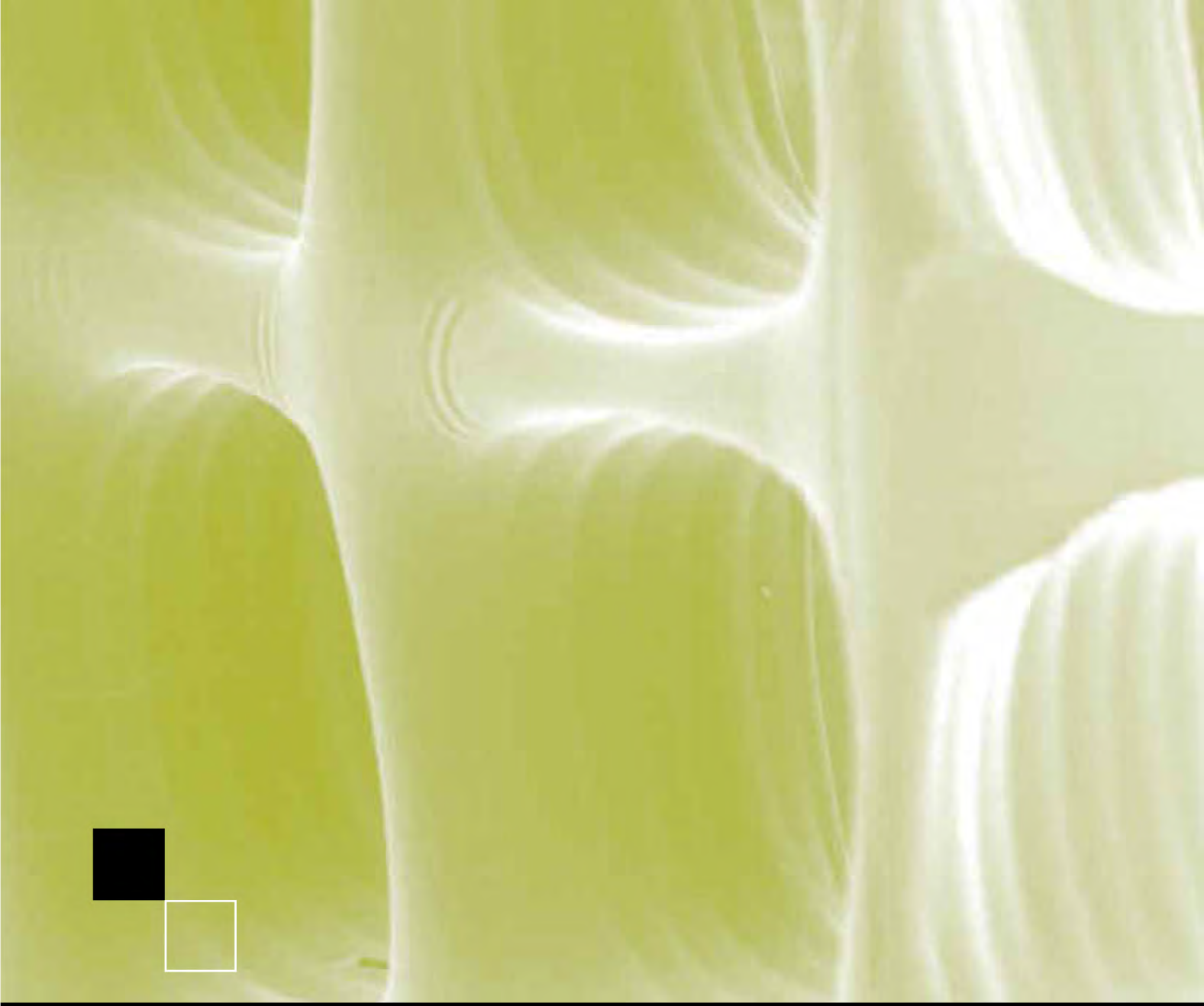

IBEC ANNUAL REPORT 2010

Institute for bioengineering of Catalonia

IBEC ANNUAL REPORT 2010

Introduction

Josep A. Planell, Director of IBEC

> IBEC is a very productive centre"
> – *Excma. Marina Geli i Fàbrega*
> *Minister for Health 2003–2010,*
> *Government of Catalonia*

It's hard to believe that 2010 was only the fourth full year of IBEC's existence as an independently functioning organisation, but the Annual Report for this year is testament to how far we've come in that short time.

We're at a stage now where our name is too narrow: we're not just bioengineers, as our strengths in nanomedicine, intelligent healthcare and cell engineering are thriving; nor are we simply Catalonia, as our influence is reaching ever further with our continued management of the Spanish Platform for Nanomedicine, our growing number of internationally collaborative projects and our Memoranda of Understanding with institutes all over the globe. As a multidisciplinary centre we continue to attract talent from abroad as well as from closer to home, not only among our scientific staff but also in our support services.

As well as casting our net wider, though, we're still remaining true to our roots. Our management of a new regional initiative, BioNanoMed Catalunya, and our leadership of the Connect-EU working group for nanobiotechnology for ACC1Ó add to efforts already being made to promote the region and its science. Our involvement in Europe-wide programmes such as the EC's Key Enabling Technologies High Level Group also provides visibility for the institute and for Catalonia's enthusiasm to contribute to the research roadmap on a European and global level. The year 2010 closed with the formation of a new group headed by our fifth scientist to be supported by the Catalan Institution for Research and Advanced Studies (ICREA), which recruits top researchers for the Catalan R&D system. Xavier Trepat, who was awarded a European Research Council (ERC) Starting Grant in 2009, and his group will bring the Biomechanics and Cellular Biophysics programme's groups up to three and will look at integrative tissue dynamics and cytoskeletal mechanics.

As far as the traditional benchmarks of success are concerned, the results speak for themselves. We're continuing our trend of publishing high and often, and we're holding up admirably against other institutes in the region. As for competitively funded projects, there was an increase of 15% in the number of those applied for in 2010. But it's not just about figures. While there are groups publishing in top-ranking journals and achieving competitive funding, we have other groups contributing in various ways to the common goal: technology transfer, for example, or offering education. With such a multidisciplinary approach comes our broad and international outlook, not only in the science that we do but also in the spirit our community as a whole.

In the current economic uncertainty we're embracing the chance to consolidate our existing projects and initiatives. Such a climate allows us to concentrate on developing our national and international visibility and bringing our research in line with the top institutes in the world. In 2010 we embraced every opportunity offered by the modern, highly networked world to attract the best young scientists, secure the most competitive funding with great collaborations and scientific ideas, and stay ahead of all our many fields. As every year, the Annual Report not only serves as a review of the hard work of the organisation throughout the year and a solid archive of our history, but also as a record of our scientific competence, our technological expertise, the talent we foster and the excellent return we continue to deliver.

Josep A. Planell
Director of IBEC

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News Highlights

First big study about the reality of nanotechnology in Catalonia

In the first half of the year IBEC, the University of Barcelona (UB), the University of Girona and the Technical University of Catalonia (UPC) announced their collaboration on a pioneering study about the capacities of development and innovation of nanobiotechnologies in the Catalan technological market. Associate director Josep Samitier was the IBEC representative of the initiative, thanks to his links with several organizations in the Catalan R+D+I system. To achieve the convergence of disciplines required by a study of this kind, participants from the UB departments of Electronics and Economics and Business Organization also came on board.

This study, the first of its kind in Catalonia, will describe the market and innovation system agents, identify present and future products and services and diagnose the state of technology and innovation transfer. Using a study sample including 358 companies and 594 consolidated research groups actively involved in the development and exploitation of nanobiotechnology in Catalonia, it will also detect the technological and formative needs and analyze its contribution to competitiveness improvement and change of economic model.

Collaboration between Warwick University and IBEC

A memorandum of understanding (MoU) in the field of Bioengineering was signed between Warwick University's Centre for Cognitive and Neural Systems and IBEC at the beginning of the summer. The agreement followed the visit of Professor Julian Gardner from the university's School of Engineering to IBEC earlier in the year, and it aims to promote the exchange of information on bioengineering between research groups, facilitate the exchange of researchers via short-term fellowships and implement cooperative research programmes in under FP7 and other competitive funding actions.

A joint Warwick–IBEC meeting in the autumn brought together researchers from both sides, and it is planned that Warwick research will be presented at the 4th IBEC Symposium in Barcelona in spring 2011.

IBEC signs agreement with Biopol'H

In September the directorate of IBEC attended the official signing of a Framework Agreement between the institute and the Biopol'H consortium, a biomedical and biotechnology cluster of health care facilities, institutions, research centres and companies. Biopol'H, which was launched in 2008, aims to work together with its partners to promote investigative research and technologically innovative activities at a national and international scale, especially in the field of nanomedicine. Several of IBEC's groups already collaborate closely with labs at the Bellvitge Institute for Biomedical

IBEC signs agreement with Biopol'H: Josep Planell, Biopol'H Director Ramon López and Josep Samitier

Research (IDIBELL) in various areas of research as part of the Biopol'H project.

The agreement will be consolidated further in the future with IBEC's planned move to the Biopol Health Science Park at Bellvitge, which neighbours other Biopol'H partners IDIBELL, the University Hospital of Bellvitge, the Catalan Institute of Oncology and the Health Sciences Campus of Bellvitge.

Spanning continents: tissue regeneration project wins EU funding

In September a multidisciplinary research project coordinated at IBEC by group leader George Altankov was selected for funding by the EU as part of the European-Latin American Network for Science and Technology (EULANEST). 'Bioinspired Nanofibrous Gel for Tissue Engineering of Cartilage and Bone' (FIBROGEL) aims to design an implant with unique properties which can influence local tissue regeneration. Using high performance materials and advanced nanotechnology, the project represents a radical step in treating injury or diseases such as osteoarthritis and osteoporosis, and will have a long-term impact on a variety of fields such as nanobioengineering and regenerative medicine.

FIBROGEL was one of just seven projects selected from a total of 65 submitted to EULANEST, an initiative funded under the EU's 6th EU Framework Programme for Research and Development (FP6). EULANEST's aim is to promote and coordinate cooperation in science and technology between EU member states and Latin American countries, and FIBROGEL's scientific partners include groups in both Brazil and Argentina.

Tecnorevolució: IBEC lends nanotech expertise to national exhibition

IBEC lends nanotech expertise to national exhibition

October saw the launch of the 'Tecnorevolució' exhibition at the CosmoCaixa science museum in Barcelona, which was created with IBEC's associate director Josep Samitier as scientific adviser. The interactive exhibits, which introduce nano- and biotechnology, cognitive science, and information and communication technology (ICT) to the general public, were created by Fundació "la Caixa", whose DG Elisa Durán officially opened the exhibition.

After its inaugural spell at the museum, the exhibition embarked on a tour of the rest of Spain. The venture was deemed so successful that the foundation decided to continue their collaboration with Josep and spend 2011 creating a larger, permanent exhibition on nanotechnology to be housed within the CosmoCaixa museum.

IBEC in figures: ICREA* group leaders, 2010

* see page 62

ICREA

All group leaders

IBEC at Fòrum Biocat 2010

Launch of White Paper on bioethics

A White paper on nanotechnology and bioethics which IBEC staff helped to prepare was presented at the Parc Científic de Barcelona on 5 October. 'Nanotechnology and Global Bioethics' was put together by the opinion group of the University of Barcelona's Bioethics and Law Observatory (OBD), of which IBEC's associate director Josep Samitier and Head of Corporate Projects Arantxa Sanz are members. The document identifies problems arising from the application of nanotechnology to biomedicine, the environment and biosafety, and addresses the social, legal and ethical implications, with the aim of guiding recommendations and encouraging transparent debate.

Telethon funds for collaborative project

In 2010 a scientific project involving IBEC researchers received a funding boost of €475,000 from Fundació La Marató de TV3. The CIBER-BBN (see page 62) project 'Desarrollo de Nanomedicinas para terapia enzimática sustitutiva en la enfermedad de Fabry' was one of just 20 biomedical projects to receive a slice of more than €7m from the foundation, which aims to foster and promote research into rare diseases, in part with its annual telethon 'La Marató de TV3'. The project aims to obtain a new therapeutic nanoconjugate for substitutive enzymatic therapy in patients with Fabry disease, a hard-to-diagnose illness caused by the deficiency of an enzyme needed to metabolize lipids, which then build to harmful levels in the eyes, kidneys, and cardio-vascular and nervous systems.

The IBEC groups of Fausto Sanz and María García-Parajo are involved in the project, which will run for another three years. The funding is awarded on a merit basis, and the amount received by the Fabry project is one of the largest portions of the €7,120,569 total.

BioNanoMed Catalunya launched

Forum Biocat on 2 December saw the first announcement of a new initiative in nanomedicine, BioNanoMed Catalunya, fostered by IBEC and the Catalan Bioregion agency, Biocat. The alliance aims to bring together researchers, hospitals and companies working in the region to share know-how and resources, facilitate new developments in nanomedicine and gain international visibility for the advances in the field that are emerging in Catalonia.

IBEC and Biocat have been working together to develop the initiative since December 2009. The other research centres initially involved include IDIBELL (with a leading role from the biomedical side), Hospital Clinic, Vall d'Hebron, ICIQ, ICFO, ICN, ICMAB, IQAC and the technological centre LEITAT Biomed. On the industry side, the core partners will be Ferrer, Grupo Lipotec and Biokit.

The alliance is a practical solution for a unique problem nanomedicine: that experts from a huge range of disciplines need to cross boundaries and work together to translate research results and lab discoveries into viable medical products and drugs. It will overcome these barriers by combining resources and expertise from multiple organizations and making the results available to stakeholders and the community. In addition, a consolidated network will be much more effective than isolated partners to contribute to critical

aims in nanotechnology deployment, such as the setting up of a regulatory framework, standards of best practice and professional training programmes.

MySpine: a virtual spine for a real problem

MySpine, or 'Functional prognosis simulation of patient-specific spinal treatment', is a major new research project coordinated by IBEC which was awarded funding by the EU at the end of 2010. MySpine aims to address the current limitations in the treatment and prognosis of back problems such as degenerative disc disease by developing a 'virtual spine' to guide clinicians in making the right decisions on how to treat various pathologies based on data specific to the patient.

"The system will take into account various factors, both from imaging data and from the activity levels of the individual," says coordinator Damien Lacroix, head of IBEC's Biomechanics and Mechanobiology group, who prepared the project together with postdoc Jérôme Noailly. "For example, spine geometries, tissue properties and loading histories – all of which vary wildly from person to person – will form the cornerstones of our predictive system, which will incorporate rational engineering approach."

The main objective of MySpine, which also involves groups from the Netherlands, Austria, France, Spain and Hungary, will be the creation of a computing platform to be used in clinical settings. This interface, as well as the tailor-made 'database' of a patient's lumbar spine, will allow clinicians to look at short- or long-term effects on tissue to explore the possible outcomes of disc degeneration based on the specific patient.

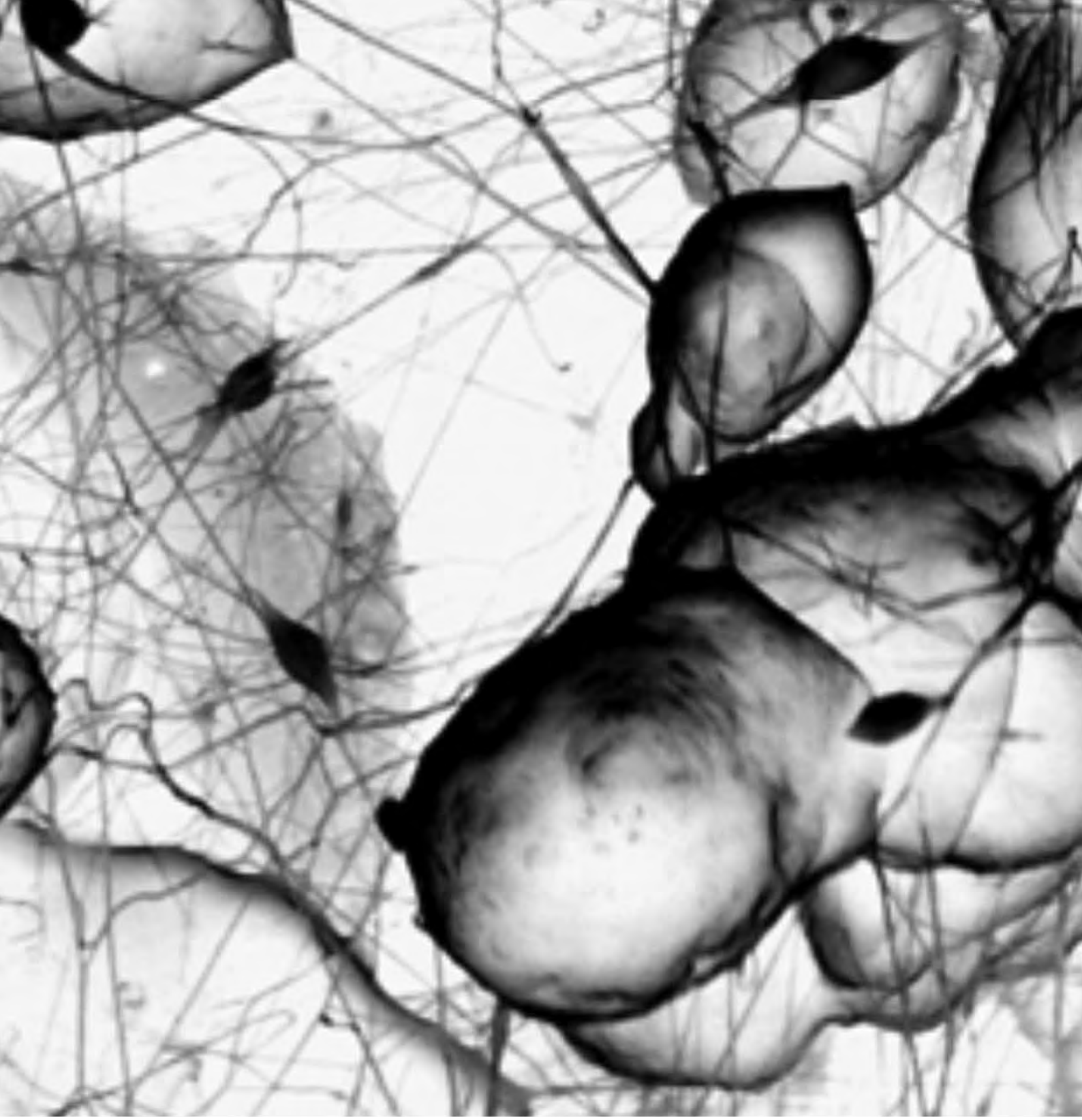
"The results will allow the recommendation of either replacement of the disc, doing nothing, or another course of treatment based on safe assessment of the risks and benefits of each simulated solution to the problem," explains Damien, who earlier in 2010 was elected President of the European Society of Biomechanics and received the European Society for Biomaterials' Jean Leray Award in Tampere in September. "It brings new engineering rationale to the decision-making process in the clinic."

IBEC director elected to the Royal Academy of Science and Arts of Barcelona

In December, IBEC director Josep Planell was elected as Academician of the Royal Academy of Science and Arts of Barcelona (RACAB). RACAB president Rafael Foguet i Ambrò presided over the ceremony, which began with Josep giving an introduction to his field of research and his work on the development of biodegradable scaffolds for bone regeneration. Then Josep's sponsor for the election, Xavier Obradors i Berenguer, addressed the audience of members, peers, colleagues and friends with a biography of Josep, concluding that "this institution will benefit greatly from Dr. Planell's knowledge and entrepreneurship, as well as his characteristic benevolence and practical sense, and his affability towards everyone who knows him". The event ended with Josep's formal acceptance into the academy by the president, who presented him with a medal and a diploma.

Membership of RACAB, which was established in 1764 under the name 'Experimental Physio-mathematical Council', is limited by number and strictly by nomination. Its members act as promoters and points of reference in the cultural arena and for Catalan society.

MySpine coordinator Damen Lacroix



Organisation

Organisation

The IBEC foundation (until December 2010)

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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

Organisational chart

Scientific and administrative structure

In 2010 IBEC's staff of researchers and expert technicians numbered 210. 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 25 people to carry out support activities.

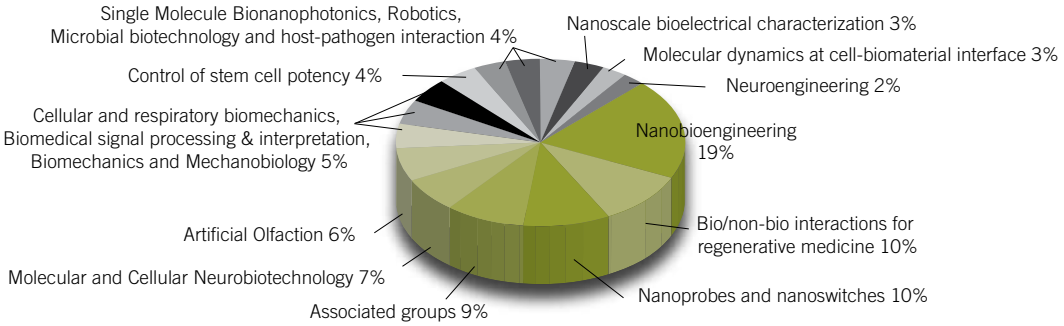


Figure 1. IBEC researchers and technicians by group

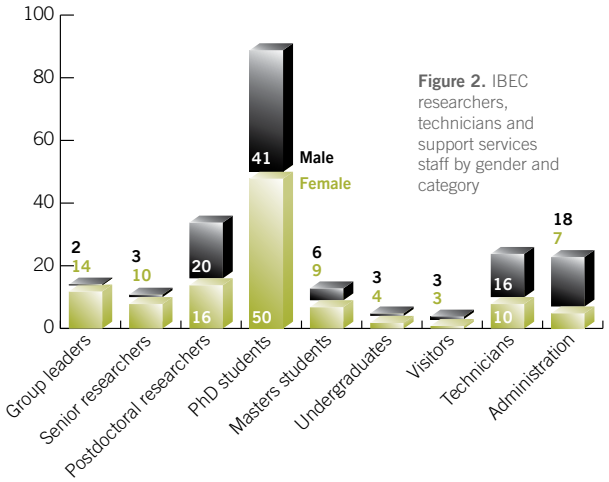


Figure 2. IBEC researchers, technicians and support services staff by gender and category

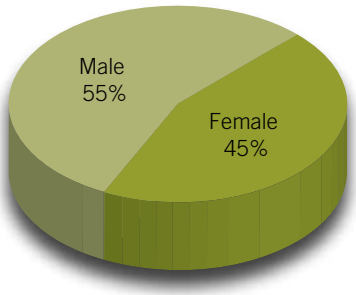


Figure 4. IBEC researchers and technicians by gender

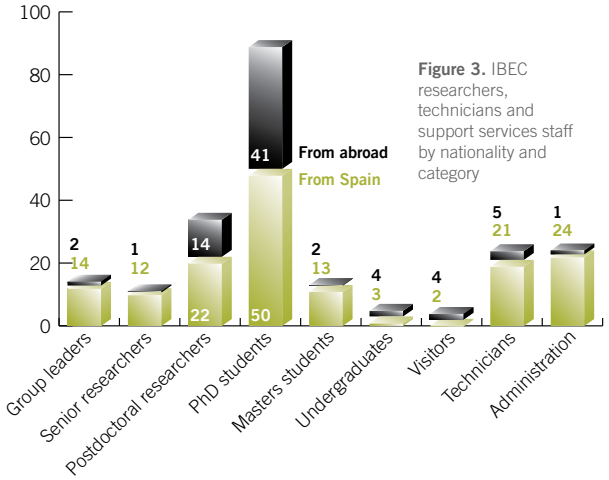


Figure 3. IBEC researchers, technicians and support services staff by nationality and category

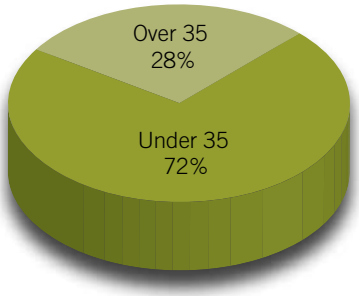


Figure 5. IBEC researchers and technicians by age

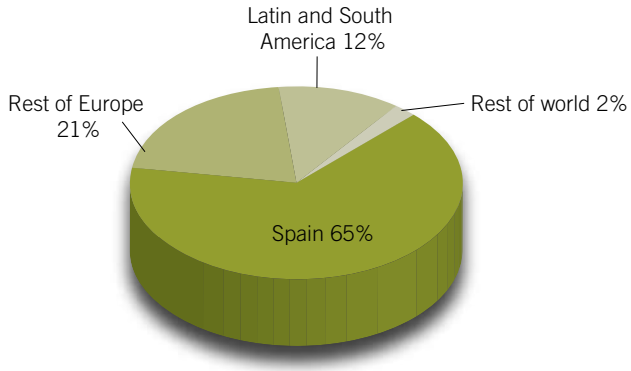


Figure 6. IBEC researchers and technicians by nationality

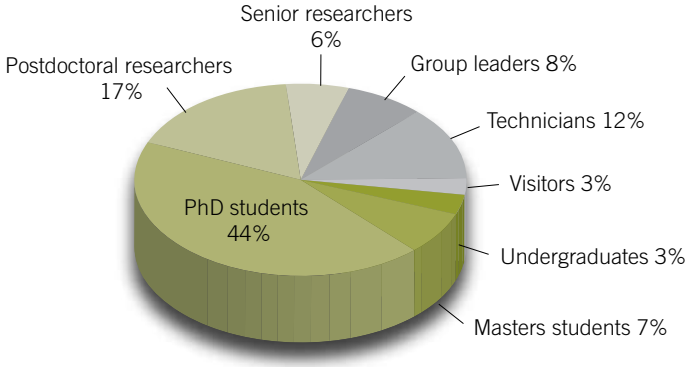


Figure 7. IBEC researchers and technicians by category

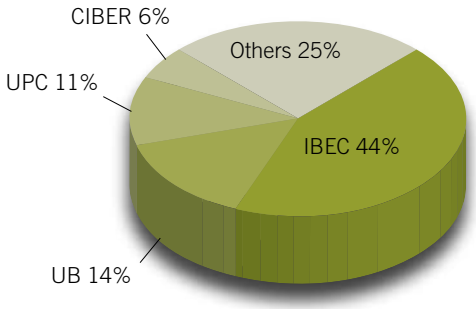


Figure 8. IBEC researchers and technicians by associated or contracting institution

Directors

Director Josep A. Planell
Associate Director Josep Samitier
Managing Director Abel Riera
Assistant to the Director Pilar Ciriquián
Assistant to the Associate Director Judith Forné

Support services

Under the Associate Director:

INSTITUTIONAL PROJECTS

Head of Institutional Projects Arantxa Sanz
Project Manager Armando Palomar

COMMUNICATIONS

Communications Manager Vienna Leigh

Under the Managing Director:

GENERAL PROJECTS

Head of General Projects Teresa Sanchis
Project Managers
Javier Adrián, Ester Rodríguez, Juan Francisco Sangüesa

INFRASTRUCTURE

Head of Infrastructure Isabel Oliveira
Laboratory Technician Laura Gómez

FINANCE

Head Of Finance Ana González
Purchasing Technician Mayte Muñoz
Accounting Technician Francisco Buenestado

HUMAN RESOURCES

Head Of Human Resources Carol Marí
HR Junior Technician Ricard Rius
Administrative Technician for Travel and Support
Marta Redón

IT

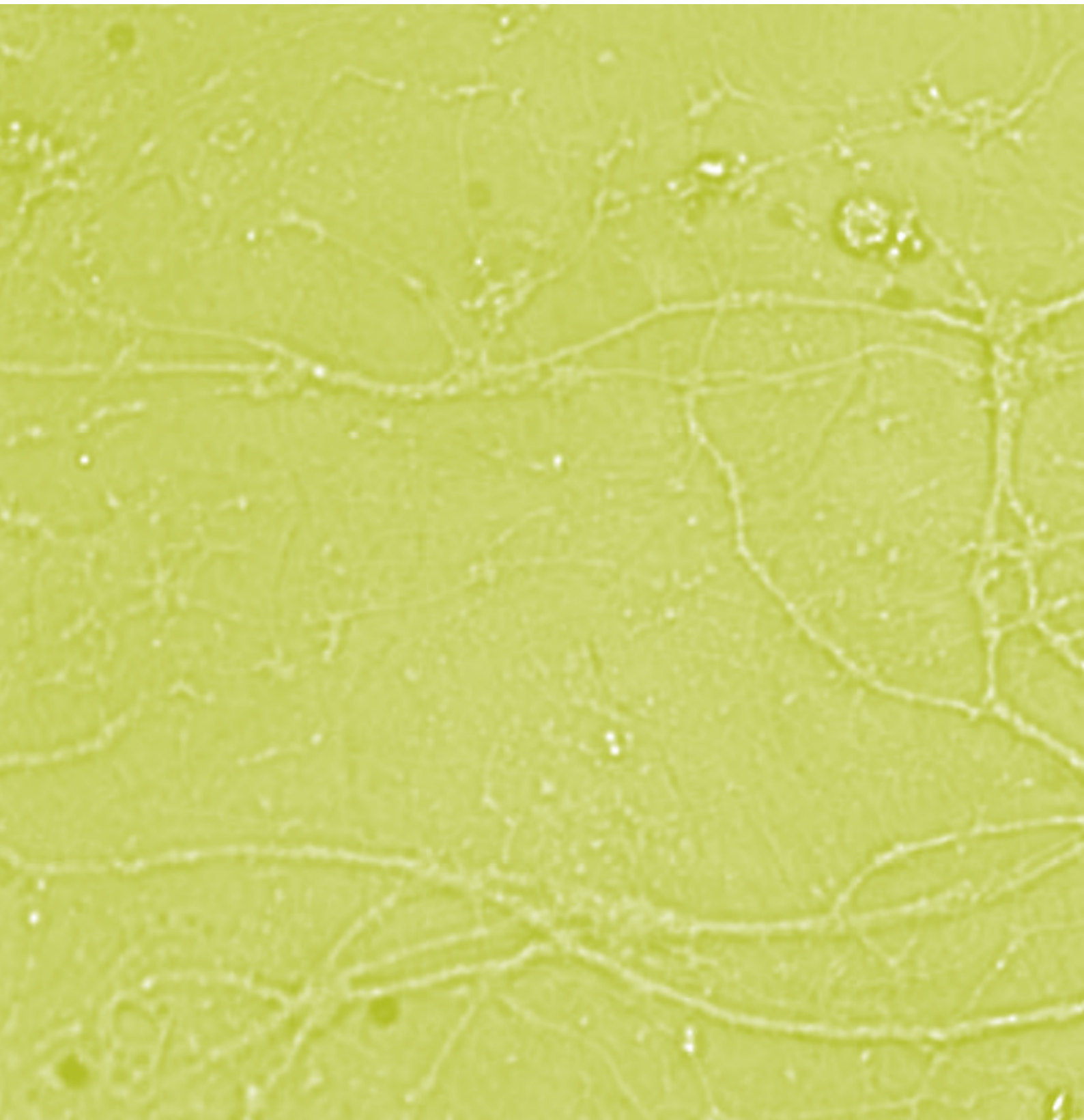
IT Manager Anton Poto

EVENTS

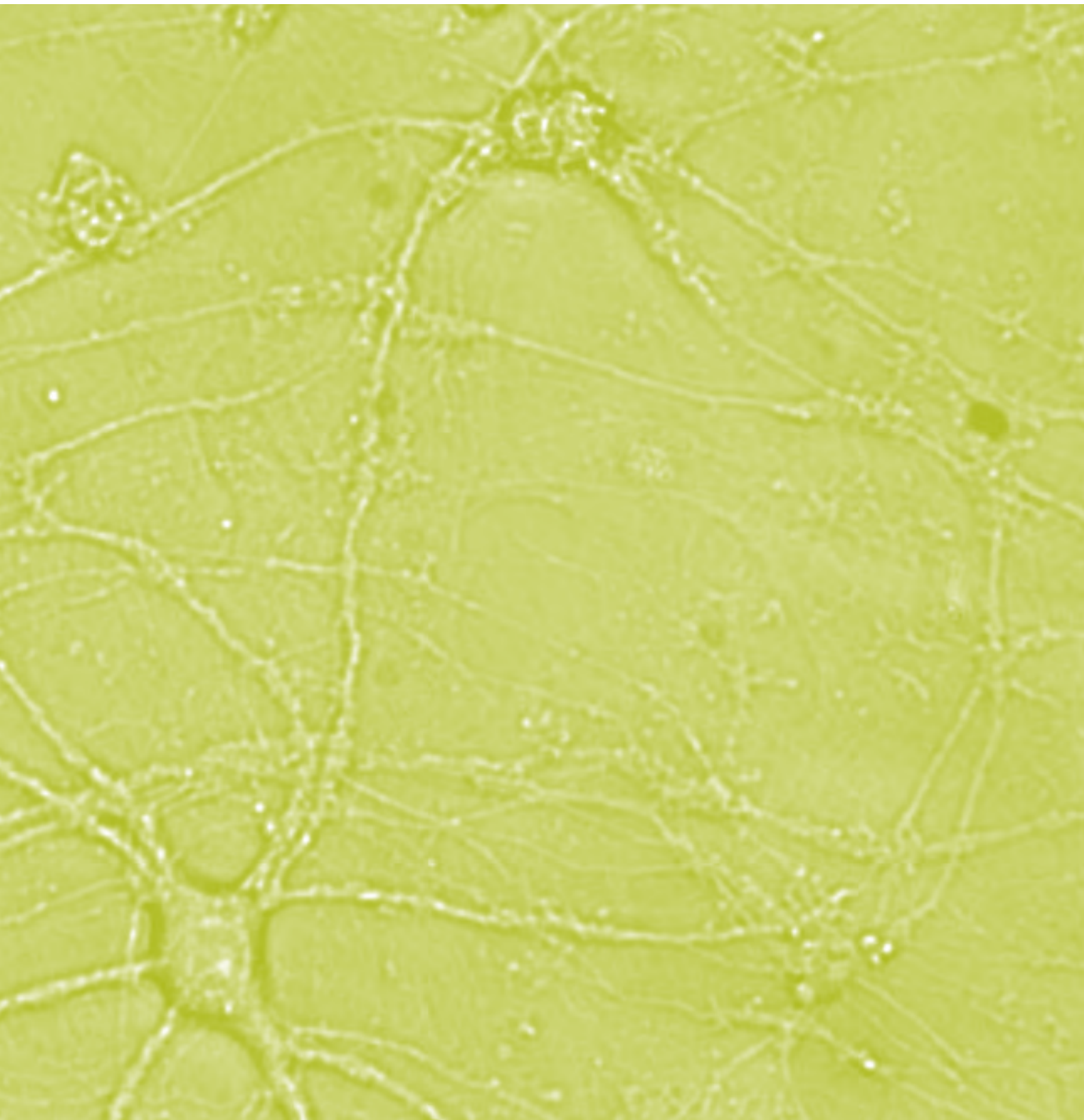
Events Manager Pilar Jiménez

FUNDING SERVICES

Funding Services Manager Esther Gallardo (interim substitute: Núria Ferrer)



Research



Research groups

IBEC's groups and their activities are organised into six research programmes: **Cellular Biotechnology**, **Biomechanics and cellular biophysics**, **Nanobiotechnology**, **Biomaterials, implants and tissue engineering**, **Medical signals and instrumentation**, and **Robotics and biomedical imaging**.

Cellular Biotechnology programme

Microbial Biotechnology and Host-Pathogen Interaction

Prof. Dr. Antonio Juárez

Senior researcher: Dr. Eduard Torrents

Postdoctoral researchers: Dr. Martin Edwards, Dr. Rosa Carmen Baños

PhD students: Nahia Barberia, Daniel Esteban, Nuria López, Maria del Mar Cendra, Laura Pedró

Masters students: Ingrid Nolla

Technicians: Mª Carmen Jaramillo

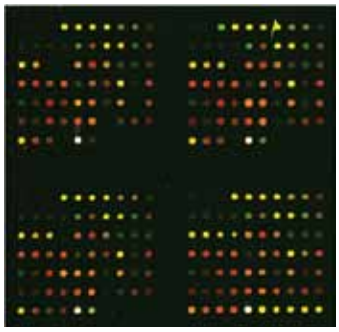
1. Structure and function of bacterial proteins that modulate virulence expression

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

2. Application of nanotools of bacterial biotechnology

2.1. Dielectrophoresis. 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) with three different objectives: a) to study the effect of electric fields on bacterial cell physiology; b) to evaluate the ability of chip designs to capture and release bacterial cells, and c) to concentrate bacterial pathogens and facilitate their detection.

2.2. Atomic force microscopy (AFM). Conventional AFM approaches have been shown to be powerful techniques for characterizing both biomaterials and biomolecules. In a joint project with the Nanoscale Bioelectrical Characterization group (page 41), we intend to use electrical-AFM to characterize the bacterial cell envelope. We also plan to use this approach to further analyze the location of bacterial proteins of unknown function predicted to be present on the bacterial cell envelope.



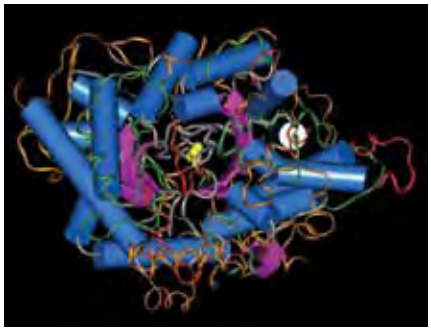


Fig. 1 (left) Representative portion of a *Salmonella typhimurium* microarray.

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

Research projects

- **PATHOGENOMICS** Identification of hot spots of divergence and rapidly changing genes within shiga toxin-producing *Escherichia coli* (2009-2012).
PI: **Eduard Torrents**
MICINN, Acciones Complementarias (ERANET).

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

- **MOLMICRO2010** VIII Reunión del Grupo de Microbiología Molecular de la Sociedad Española de Microbiología (2010-2011).
PI: **Antonio Juárez**
MICINN, Acciones Complementarias.

- Interactivity of Plasmid Modules and The Genomes of Bacterial Pathogens (2008-2013).
PI: **Antonio Juárez** (managed by UB)
MICINN, Actividad Investigadora CONSOLIDER.

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

- **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).

- Grup de recerca consolidat (2009-2013).
PI: **Antonio Juárez**
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).

- Detecció de Salmonella (2010-2011).
PI: **Antonio Juárez**
Industrial project with Mevet.

Publications

- Lundin, D., Gribaldo, S., Torrents, E., Sjoberg, B.-M. & Poole, A. (2010). Ribonucleotide reduction – horizontal transfer of a required function spans all three domains. *BMC Evolutionary Biology* 10 (1), 383.

- Jaramillo, M. D., Torrents, E., Martinez-Duarte, R., Madou, M. J. & Juarez, A. (2010). On-line separation of bacterial cells by carbon-electrode dielectrophoresis. *Electrophoresis* 31 (17), 2921-2928.

- Johansson, R., Torrents, E., Lundin, D., Sprenger, J., Sahlin, M., Sjöberg, B. M. & Logan, D. T. (2010). High-resolution crystal structures of the flavoprotein NrdI in oxidized and reduced states – an unusual flavodoxin. *FEBS Journal* 277 (20), 4265-4277.

- Torrents, E. & Sjoberg, B. M. (2010). Antibacterial activity of radical scavengers against class Ib ribonucleotide reductase from *Bacillus anthracis*. *Biological Chemistry* 391 (2-3), 229-234.

- Crona, M., Furrer, E., Torrents, E., Edgell, D. R. & Sjoberg, B.-M. (2010). Subunit and small-molecule interaction of ribonucleotide reductases via surface plasmon resonance biosensor analyses. *Protein Engineering, Design and Selection* 23 (8), 633-641.

Collaborations with other research centres

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

Prof. Miquel Pons Dept. de Química Orgànica, University of Barcelona (Spain).

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

Prof. Marc Madou University of California, Irvine (USA).

Prof. Mike Hughes University of Surrey (UK).

Prof. Josep Samitier IBEC (page 34).

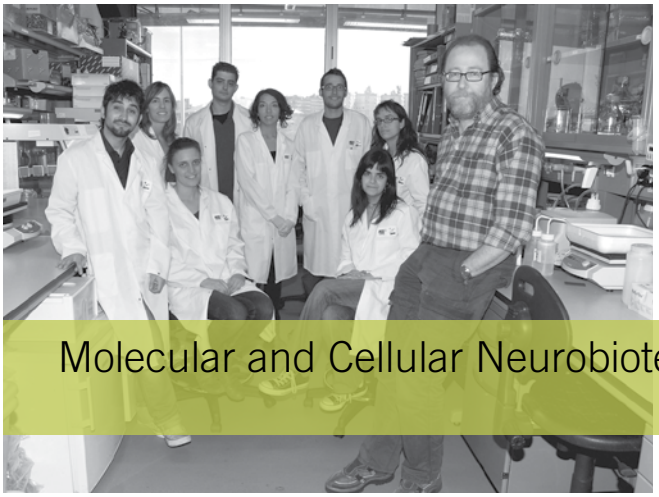
Prof. Josep A. Planell IBEC (page 43).

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

Dr. Gabriel Gomila IBEC (page 41).

Scientific equipment and techniques

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



Molecular and Cellular Neurobiotechnology

Prof. Dr. José Antonio Del Río

Postdoctoral researchers: Dr. Ana Bribián, Dr. Rosalina Gavín, Dr. Vanessa Gil, Dr. Franc Llorens, Dr. Sílvia Vilches

PhD students: Patricia Carulla, Sara Nocentini, Diego Alejandro Reginensi, Óscar Seira, Cristina Vergara

Technician: Isabel María Jiménez, Giovanna Tormen

During 2010, the research group developed several studies aimed at understanding certain development processes, neuronal plasticity and neurodegeneration of the central nervous system (CNS). Among them we have demonstrated, in collaboration with other groups, the role of an intracellular adapter Dab1 as a link between different neurodegenerative diseases (Alzheimer's disease and prion diseases). In addition we have determined the functions of a protein, OMgp, during the development and plasticity of the nervous system. This protein is very active in synaptic transmission and neural plasticity. We have also made progress in understanding the intracellular mechanisms responsible of the failure of axonal regeneration after CNS injury. In this area, we have described that the intracellular kinase GSK3β involved in the inhibitory effects of myelin-associated molecules.

In 2010 the group published a methodological review in *Nature Protocols* on the usefulness of three-dimensional culture in neuropharmacological studies. Moreover, in collaboration with other national groups, we have characterized the process of neurogenesis in the adult hippocampus and its modification by sensory or motor learning.

Finally, group members have collaborated on the study of differential miRNA expression associated with Huntington's disease.

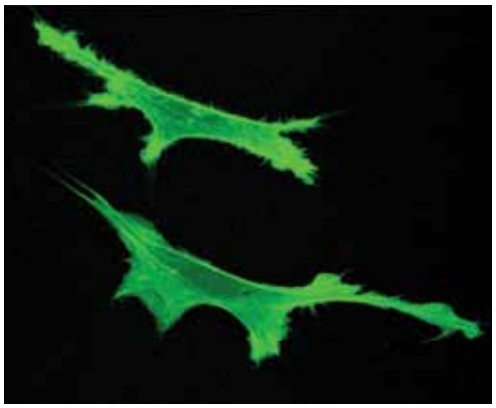


Fig. 1 Example of time lapse video using LEICA SP5 spinning disk confocal microscopy showing two olfactory ensheathing glia transiently transfected with Life Act using electroporation procedures. This observation is useful to analyze F-Actin dynamics in living cells under different substrates and only available with high speed confocal capture, and high sensitive camera ORCA 32 bits. Sequential pictures were further analyzed with Metamorph and Matlab software.

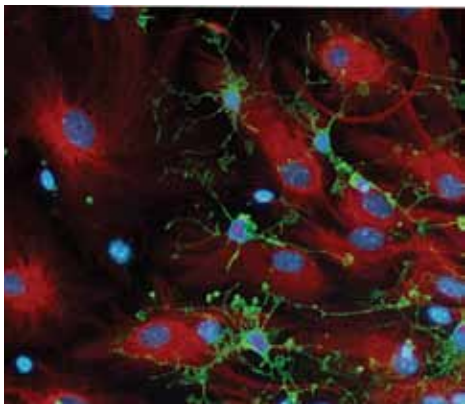


Fig. 2 Example of oligodendrocyte differentiation (green) from human neuronal stem cells *in vitro* (HNSC100). In addition to oligodendrocytes, a feed layer of astrocytes (red) are present in the culture. Cells are countestained with Hoescht. Picture obtained using an Olympus BX61 microscope equipped with a DP12L high resolution camera and an incubation chamber LCi, after 15 days in continuous time lapse analysis.

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.

- Differentiation of GABAergic interneuron subtypes in the mouse cerebral cortex (GABA cell types) (2008-2011).
PI: **José Antonio Del Río** (managed by UB)
Marie Curie Actions (PEOPLE) 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.

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

- Enfermedades neurodegenerativas (2008-2012).
PI: **José Antonio Del Río** (managed by UB)
Ministerio de Sanidad y Consumo.

- 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).

Publications

- Martí, E., Pantano, L., Bañez-Coronel, M., Llorens, F., Miñones-Moyano, E., Porta, S., Sumoy, L., Ferrer, I. & Estivill, X. (2010). A myriad of miRNA variants in control and Huntington's disease brain regions detected by massively parallel sequencing. *Nucleic Acids Research* 38 (20), 7219-7235.

- Gil, V., Bichler, Z., Lee, J. K., Seira, O., Llorens, F., Bribian, A., Morales, R., Claverol-Tinture, E., Soriano, E., Sumoy, L., Zheng, B. & del Rio, J. A. (2010). Developmental expression of the oligodendrocyte myelin glycoprotein in the mouse telencephalon. *Cerebral Cortex* 20 (8), 1769-1779.

- del Rio, J. A. & Soriano, E. (2010). Regenerating cortical connections in a dish: the entorhino-hippocampal organotypic slice co-culture as tool for pharmacological screening of molecules promoting axon regeneration. *Nature Protocols* 5 (2), 217-226.

- Gavín, R., Ferrer, I. & del Río, J. A. (2010). Involvement of Dab1 in APP processing and [beta]-amyloid deposition in sporadic Creutzfeldt-Jakob patients. *Neurobiology of Disease* 37 (2), 324-329.

- Madronal, N., Lopez-Aracil, C., Rangel, A., del Rio, J. A., Delgado-Garcia, J. M. & Gruart, A. (2010). Effects of enriched physical and social environments on motor performance, associative learning, and hippocampal neurogenesis in mice. *PLoS One* 5 (6), e11130.

- Seira, O., Gavin, R., Gil, V., Llorens, F., Rangel, A., Soriano, E. & del Rio, J. A. (2010). Neurites regrowth of cortical neurons by GSK3 beta inhibition independently of Nogo receptor 1. *Journal of Neurochemistry* 113 (6), 1644-1658.

- Messeguer, J., Masip, I., Montolio, M., del Rio, J. A., Soriano, E. & Messeguer, A. (2010). Peptoids bearing tertiary amino residues in the n-alkyl side chains: synthesis of a potent inhibitor of Semaphorin 3A. *Tetrahedron* 66 (13), 2444-2454.

- del Rio, J. A. (2010). Células y genomas. In "Biología Molecular de la Célula, Libro de problemas", (eds. Wilson, J. & Hunt, T.), Omega, 1-6

Collaborations with other research centres

Prof. Manuel Nieto Sampedro Instituto Cajal, Consejo Superior de Investigaciones Científicas (CSIC), Madrid (Spain).

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

Prof. Binhai Zheng Department of Neuroscience, University of California at San Diego, La Jolla (USA).

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

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

Dr. Jung Keun Hyun Dankook University, Yongin (Korea).

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

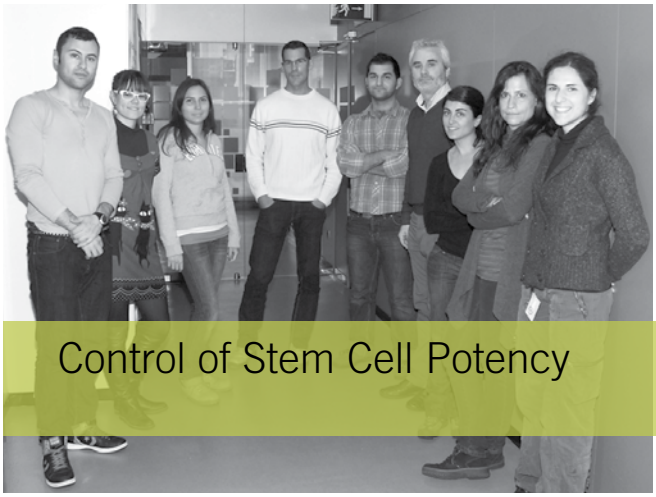
Dr. Fernando de Castro Hospital Nacional de Parapléjicos, Toledo (Spain).

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

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

Scientific equipment and techniques

- Gradient thermocyclers (PCR) and molecular biology equipment
- Neural Cell culture (2D and 3D)
- 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



Control of Stem Cell Potency

Prof. Dr. Ángel Raya

Postdoctoral researcher: Dr. Sergio Mora

PhD students: Claudia Di Guglielmo, Eduard Sleep

Masters students: Marta Lorente, Isil Tekeli

Visiting students: Mario Barilani, Isaac Canals, Jordi Farré, Sergio López, Marta Miret, Gabriella Ranaldo

Technicians: Alberto García, Dr. Senda Jiménez, Yvonne Richaud

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

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

For this purpose, we mainly use the paradigm of heart (re)generation. Overall, our research is based on the following working hypotheses:

1) Careful investigation of the mechanisms that control zebrafish heart regeneration will uncover the critical transcriptional and epigenetic features that underlie the re-acquisition of developmental potency;

2) By using a combination of specific factors and appropriate selection procedures we will be able to partially reprogram somatic cells to create multipotent cardiogenic progenitors;

3) Providing adequate extracellular cues to suitable pluripotent or multipotent progenitors will guide their intrinsic potential to generate functional myocardial tissue.

In applied research, the group is working in medicine regenerative approaches, using induced pluripotent stem cells (iPSCs) in heart muscle differentiation and cartilage regeneration. The group is also developing disease models from patients biopsies using the iPSCs technology

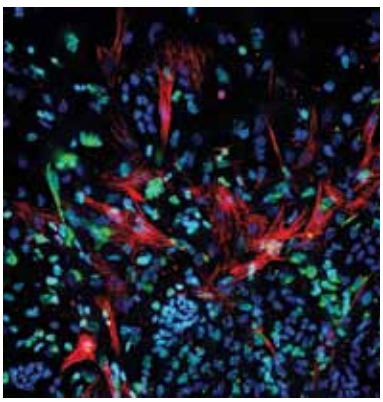


Fig. 1 Muscle cells differentiated *in vitro* from human iPS cells, stained for specific markers.

Fig. 2 Brightfield images of a zebrafish heart before (left) and after (right) decellularization. Decellularized hearts provide useful matrices to investigate extracellular cues underlying regeneration.

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, ACI-E Medicina Regenerativa.

■ **CELLSCAFF-CART** Reparación de Cartílago Articular mediante Ingenieria de Tejidos *in situ*: modelo *in vivo* (iPSC) (2010-2012).
PI: **Ángel Raya**
MICINN, Fomento de la cooperación científica Internacional (FCCI). ACI-Promociona

■ Células madre pluripotentes humanas para investigar la diferenciación muscular cardíaca (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 (2010-2011).
PI: **Ángel Raya**
MICINN, Instituto de Salud Carlos III. Convocatoria de financiación interna para proyectos cooperativos de CIBERNED.

Publications

■ Jopling, C., Sleep, E., Raya, M., Marti, M., Raya, A. & Belmonte, J. C. I. (2010). Zebrafish heart regeneration occurs by cardiomyocyte dedifferentiation and proliferation. *Nature* 464 (7288), 606-609.

■ Edel, M. J., Menchon, C., Menendez, S., Consiglio, A., Raya, A. & Izpisua Belmonte, J. C. (2010). Rem2 GTPase maintains survival of human embryonic stem cells as well as enhancing reprogramming by regulating p53 and cyclin D1. *Genes & Development* 24 (6), 561-573.

■ Raya, A., Rodriguez-Piza, I., Navarro, S., Richaud-Patin, Y., Guenechea, G., Sanchez-Danes, A., Consiglio, A., Bueren, J. & Belmonte, J. C. I. (2010). A protocol describing the genetic correction of somatic human cells and subsequent generation of iPS cells. *Nature Protocols* 5 (4), 647-660.

■ Bayes-Genis, A., Soler-Botija, C., Farré, J., Sepúlveda, P., Raya, A., Roura, S., Prat-Vidal, C., Gálvez-Montón, C., Montero, J. A., Büscher, D. & Belmonte, J. C. I. (2010). Human progenitor cells derived from cardiac adipose tissue ameliorate myocardial infarction in rodents. *Journal of Molecular and Cellular Cardiology* 49 (5), 771-780.

■ Sleep, E., Boue, S., Jopling, C., Raya, M., Raya, Á. & Belmonte, J. C. I. (2010). Transcriptomics approach to investigate zebrafish heart regeneration. *Journal of Cardiovascular Medicine* 11 (5), 369-380.

■ Navarro, S., Moleiro, V., Chinchon, R., Molina, F. J., Lozano, M. L., Samper, E., Schiedlmeier, B., Maetzig, T., Galla, M., Schambach, A., Mostoslavsky, G., Segovia, J. C., Raya, A., Guenechea, G., Baum, C., Izpisua-Belmonte, J. C. & Bueren, J. A. (2010). Generation and hematopoietic differentiation of disease-free iPSCs in mouse models of Fanconi Anemia. *Human gene therapy* 21, 1369-1369.

Collaborations with other research centres

Jordi Alberch/Josep M. Canals IDIBAPS, University of Barcelona (Spain).

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

Antoni Bayés-Genís Hospital Universitari Germans Trias i Pujol, Barcelona (Spain).

Francisco J. Blanco Complejo Hospitalario Universitario, A Coruña (Spain).

Jerónimo Blanco/Núria Rubio Cardiovascular Research Center CSIC-ICCC, Barcelona (Spain).

Juan Bueren CIEMAT, Madrid (Spain).

Antonella Consiglio IBUB, University of Barcelona (Spain).

Sheng Ding Scripps Research Institute, La Jolla (USA).

Antonia Follenzi Universita' del Piemonte Orientale, Novara (Italy).

Rafael Garesse Instituto de Investigaciones Biomédicas "Alberto Sols"/UAM (Spain).

Daniel Grinberg/Lluïsa Vilageliu University of Barcelona (Spain).

José López Barneo IBiS, Sevilla (Spain).

Pedro Muniesa Facultad de Veterinaria, Zaragoza (Spain).

Eduard Tolosa Hospital Clínic, Barcelona (Spain).

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

Scientific equipment and techniques

- Molecular biology facilities
- Cell culture facilities
- hES/iPS cell culture station
- Zebrafish transgenesis

Biomechanics and Cellular Biophysics programme

Cellular and Respiratory Biomechanics

Prof. Dr. Daniel Navajas

Senior researchers: Dr. Jordi Alcaraz, Dr. Pere Roca-Cusachs, Dr. Xavier Trepat

Postdoctoral researchers: Dr. Elsa Bazellières

PhD students: Irene Acerbi, Ester Añón, Laura Casares, Simón García, Tomás Luque, Xavier Serra

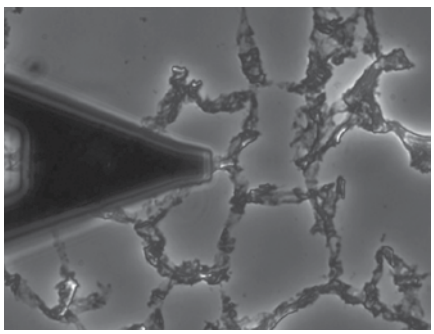
Masters student: Agustí Brugués

Technician: Maria Bintanel

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. The research is mainly focused on the mechanics of the upper airway in sleep apnea syndrome and on mechanical ventilation in acute and chronic respiratory failure.

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



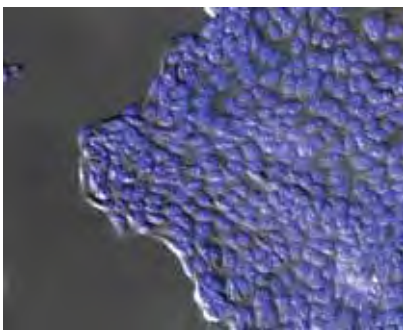


Fig. 1 (left) Probing mechanical properties of decellularized scaffolds with atomic force microscopy.

Fig. 2 (right) Normarsky image of a migrating epithelial monolayer. The cell nuclei are stained in blue.

Research projects

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

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

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

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

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

Publications

■ Trepat, X., Fabry, B. & Fredberg, J. J. (2010). Pulling it together in three dimensions. *Nature Methods* 7 (12), 963-965.

■ Moore, S. W., Roca-Cusachs, P. & Sheetz, M. P. (2010). Stretchy proteins on stretchy substrates: The important elements of integrin-mediated rigidity sensing. *Developmental Cell* 19 (2), 194-206.

■ Angelini, T. E., Hannezo, E., Trepat, X., Fredberg, J. J. & Weitz, D. A. (2010). Cell migration driven by cooperative substrate deformation patterns. *Physical Review Letters* 104 (16), 168104.

■ Park, C. Y., Tambe, D., Alencar, A. M., Trepat, X., Zhou, E. H., Millet, E., Butler, J. P. & Fredberg, J. J. (2010). Mapping the cytoskeletal prestress. *The American Journal of Physiology - Cell Physiology* 298 (5), C1245-C1252.

■ Iranzo, A., Isetta, V., Molinuevo, J. L., Serradell, M., Navajas, D., Farre, R. & Santamaria, J. (2010). Electroencephalographic slowing heralds mild cognitive impairment in idiopathic REM sleep behavior disorder. *Sleep Medicine* 11 (6), 534-539.

■ Carreras, A., Rojas, M., Tsapikouni, T., Montserrat, J. M., Navajas, D. & Farre, R. (2010). Obstructive apneas induce early activation of mesenchymal stem cells and enhancement of endothelial wound healing. *Respiratory Research* 11 (91),

■ Almendros, I., Montserrat, J. M., Torres, M., Gonzalez, C., Navajas, D. & Farre, R. (2010). Changes in oxygen partial pressure of brain tissue in an animal model of obstructive apnea. *Respiratory Research* 11, 3.

■ Lin, Y.-C., Tambe, D. T., Park, C. Y., Wasserman, M. R., Trepat, X., Krishnan, R., Lenormand, G., Fredberg, J. J. & Butler, J. P. (2010). Mechanosensing of substrate thickness. *Physical Review E* 82 (4), 041918.

■ Carreras, A., Almendros, I., Montserrat, J. M., Navajas, D. & Farre, R. (2010). Mesenchymal stem cells reduce inflammation in a rat model of obstructive sleep apnea. *Respiratory Physiology & Neurobiology* 172 (3), 210-212.

■ Guerrero, A., Embid, C., Farre, R., Navajas, D., Masa, J. F., Duran, J. & Montserrat, J. M. (2010). Sleep breathing flow characteristics as a sign for the detection of wakefulness in patients with sleep apnea. *Respiration* 80 (6), 495-499.

■ Estrada, L., Santamaria, J., Isetta, V., Iranzo, A., Navajas, D. and Farre, R. (2010). Validation of an EEG-based algorithm for automatic detection of sleep onset in the multiple sleep latency test. *Proceedings of the World Congress on Engineering* 1, 1-3.

Collaborations with other research centres

Prof. R. Farré Unitat de Biofísica i Bioenginyeria, Dept. de Ciències Fisiològiques, Facultat de Medicina, University of Barcelona / IDIBAPS (Spain).

Prof. J. J. Fredberg Physiology Program, School of Public Health, Harvard University, Boston (USA).

Prof. J. M. Montserrat Servei de Pneumologia, Hospital Clínic / IDIBAPS, Barcelona (Spain).

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

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. Benoit Ladoux Laboratoire Matière et Systèmes Complexes, Université Denis Diderot - Paris 7 (France).

Scientific equipment and techniques

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

Nanoprobes and nanoswitches

Prof. Dr. Pau Gorostiza and Prof. Dr. Fausto Sanz

Postdoctoral researcher: Dr. Mª Isabel Bahamonde, Dr. Ismael Díez Pérez, Dr. Marina Inés Gianotti, Dr. Sònia Parés

PhD students: Juan Manuel Artés, Antonio Bautista, Felipe Caballero, Javier Hoyo, Mercè Izquierdo, Helena Masanes, Andrés Martín-Quirós, Silvia Pittolo, Lorena Redondo, Andrea Ursic

Masters student: Àlex Carreté, Sònia Matencio, Anna Palacios, Josep Relat

Engineer: Dr. Jaume Palou

Technicians: Dr. Núria Camarero, Kay Eckelt

Visitors: Lia Lima, Ewa Rzad

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

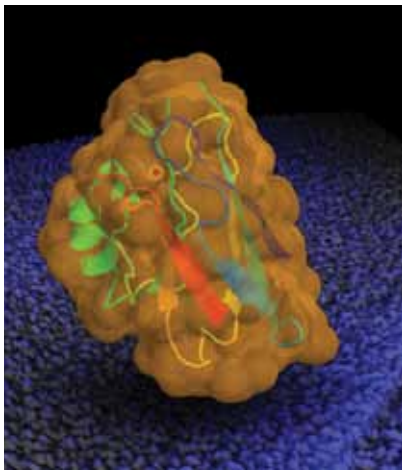


Fig. 1. Crystal structure of redox protein azurin (Protein Data Bank entry: 1AZU) displaying its solvent accessible surface (gold) superimposed on the tertiary structure (rainbow) and a red sphere indicating the copper ion. When an atomically flat gold electrode is coated with azurin, the protein can 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., *ACS Nano* 2011).

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

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.

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

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

■ Grup de recerca consolidat (2009-2013).
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 (SGR 2009).

Publications

■ Garcia-Manyes, S., Redondo-Morata, L., Oncins, G. & Sanz, F. (2010). Nanomechanics of Lipid Bilayers: Heads or Tails? *JACS* 132 (37), 12874-12886.

■ Sisquella, X., de Pourcq, K., Alguacil, J., Robles, J., Sanz, F., Anselmetti, D., Imperial, S. & Fernandez-Busquets, X. (2010). A single-molecule force spectroscopy nanosensor for the identification of new antibiotics and antimalarials. *FASEB Journal* 24 (11), 4203-4217.

■ Palacios-Padros, A., Caballero-Briones, F. & Sanz, F. (2010). Enhancement in as-grown CuInSe2 film microstructure by a three potential pulsed electrodeposition method. *Electrochemistry Communications* 12 (8), 1025-1029.

■ Garcia-Manyes, S. & Sanz, F. (2010). Nanomechanics of lipid bilayers by force spectroscopy with AFM: A perspective. *Biochimica Et Biophysica Acta-Biomembranes* 1798 (4), 741-749.

■ Caballero-Briones, F., Palacios-Padros, A., Calzadilla, O. & Sanz, F. (2010). Evidence and analysis of parallel growth mechanisms in Cu2O films prepared by Cu anodization. *Electrochimica Acta 55* (14), 4353-4358.

Collaborations with other research centres

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

Dr. Jordi Hernando Universitat Autònoma de Barcelona (Spain).

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

Prof. Carles Solsona & **Prof. Artur Llobet** IDIBELL/Dept. de Patologia i Terapèutica Experimental, Universitat de Barcelona (UB), (Spain).

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

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

Prof. Ernest Giralt Dept. de Química Orgànica, UB (Spain).

Dr. Mireia Oliva Dept. de Farmàcia i Tecnologia Farmacèutica, UB (Spain).

Dr. Teresa Montero Dept. de Fisicoquímica, Facultat de Farmàcia, UB (Spain).

Prof. Ehud Isacoff Dept. Molecular and Cell Biology, UC Berkeley (USA).

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

Scientific equipment and techniques

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

Nanobiotechnology programme

Nanobioengineering

Prof. Dr. Josep Samitier

Senior researchers: Dr. Xavier Fernández Busquets, Dr. Elena Martínez, Dr. Christian Sporer

Postdoctoral researchers: Dr. Mònica Mir, Dr. Antoni Homs, Dr. Patrizia Iavicoli, Dr. Beatriz Prieto, Dr. Anna Lagunas, Dr. Marc Castellarnau, Dr. Romén Rodríguez, Dr. Juan José Valle

PhD students: Juan Pablo Agusil, Oscar Castillo, Jordi Comelles, Lorena Diéguez, Maruxa Estévez, Mª Teresa Galán, Mathias Kuphal, Roberto Lugo, Sergio Martínez, Ernest Moles, Sabine Oberhansl, Ana Mª Oliva, Wilmer Alfonso Pardo, César Alejandro Parra, Ivón Rodríguez, Santiago Rodríguez, Marta Sanmartí, Marilia Santos, José Luis Sebastián, Islam Bogachan Tahirbegi, Patricia Urbán, Rosa Letizia Zaffino

Masters students: Juan Manuel Álvarez, Elisabet Baró, Hugo Caffaratti, Cristina Casas, Laura González, Patricia Gutiérrez, Elio Hugo Rodríguez, Turan Umut Tuzer, Raül Vado

Technicians: Eva Álvarez de Eulate, Samuel Corcobado, Miriam Funes, David Izquierdo, Dr. Reyes Malavé, Èlia Solà, Javier Soraluce

Visitor: Sofia Azevedo

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, mainly for diagnostic purposes. The main activities of the group involve the physical and chemical functionalization of materials for the study of biomolecule and cell interactions and for the development of new biosensors that will be integrated in lab-on-a-chip devices. The technology and results obtained in the laboratory are employed in medical applications ranging from portable diagnosis devices to implantable prostheses for regenerative medicine purposes. The projects carried out by the group are focused on clinical and industrial problems and are related to four convergent research lines:

1. Optical and electrochemical biosensors for clinical diagnosis and food safety applications

- DNA sensors for cancer biomarker detection
- Antibody-based sensors for pathogenic microorganisms' detection
- Aptamer-based sensors for toxins detection
- Olfactory receptor-based sensors for odorant and volatile compounds detection
- Polymer nanowires-based biosensors

2. Bio/non-bio interfaces and micro/nano-environments for biomedical studies and regenerative medicine applications

- Design, production and characterization of micro/nanoenviroments with different biocompatible materials for cell behavior studies (adhesion, proliferation, differentiation)
- Design, production and characterization of scaffolds with a topography and chemical composition controlled at the nanoscale for ocular and cardiac tissue regenerative therapies based on stem cells

3. Microfluidic systems for biological studies and lab-on-a-chip devices

- Microfluidic chip for blood/plasma filtering
- Microfluidic chip using hydrodynamic focusing for bacteria counting and sorting
- Microfluidic chip for reagent handling in POC diagnosis devices

4. Nanotechnology applied to biomolecule interaction studies

- Liposome-based nanovectors and nanoparticles for drug delivery
- Magnetic nanoparticles-biomolecules interactions and their applications

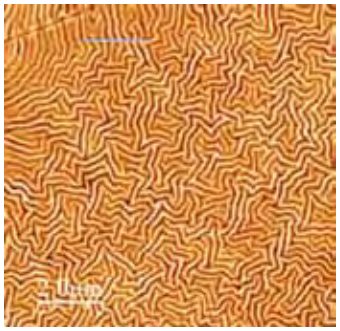


Fig 1. Atomic Force Microscopy image of wrinkles on a Polydimethylsiloxane (PDMS) surface, obtained after plasma oxidation and subsequent application of mechanical stress. © Juan Pablo Agusil

Fig 2. Schematic representation of a biosensor platform for odorant detection based on olfactory receptors. © BOND Project

Research projects

■ **BOND** Bioelectronic Olfactory Neuron Device (2009-2013).
Coordinator: **Josep Samitier** (for the UB)
Technical Manager: **Gabriel Gomila** (see page 41)
Collaborative project (NMP) within the framework of EU-FP7.

■ **ARAKNES** Array of Robots Augmenting the KiNematics of Endoluminal Surgery (2008-2012).
PI: **Josep Samitier** (managed by UB)
Collaborative project (ICT) within the framework of EU-FP7.

■ **THERAEDGE** An Integrated Platform Enabling Theranostic Applications at the Point of Primary Care (2008-2011).
PI: **Josep Samitier** (managed by UB)
Collaborative project (ICT) within the framework of EU-FP7.

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

■ **DVT-IMP** Deep Vein Thrombosis – Impedimetric Microanalysis System (2006-2010).
PI: **Josep Samitier** (managed by PCB)
Collaborative project (IST) within the framework of EU-FP6.

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

■ **NANOMEDIAG** Nanobioanalytical Platforms for Improved Medical Diagnosis of Infections Caused by Pathogen Microorganisms (2009-2011).
IP: **Elena Martínez**
MICINN, I+D+i Euroinvestigación.

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

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

■ **MINAHE3** Bio-Functionalization of Micronanotools to Study, Tag and Actuate Inside Living Cells (2009-2011).
PI: **Christian Sporer** (managed by UB)
MICINN, Investigación fundamental no orientada.

■ **NANOBIOMED** Nanotecnologías en biomedicina (2006-2010).
PI: **Xavier Fernández-Busquets** (managed by PCB)
MICINN, Actividad Investigadora CONSOLIDER.

■ Diagnóstico y pronóstico de cáncer de próstata mediante nanobiosensores híbridos multianalito (2010-2013).
PI: **Josep Samitier** (coordinator), **Elena Martinez**
MICINN, Instituto de Salud Carlos III. Subprograma de Proyectos de investigación en salud (FIS).

■ 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)

■ **LABINCHIP** (2010-2012).
PI: **Josep Samitier**
Centro para el Desarrollo Tecnológico Industria (CDTI), Industria de la Ciencia

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

■ Desarrollo des tecnologias en bionanomedicina para diagnostico y terapia (2009-2012).
PI: **Josep Samitier**
Fundación Botin

Publications

- Valle-Delgado, J. J., Alfonso-Prieto, M., de Groot, N. S., Ventura, S., Samitier, J., Rovira, C. & Fernandez-Busquets, X. (2010). Modulation of A beta(42) fibrillogenesis by glycosaminoglycan structure. *FASEB Journal* 24 (11), 4250-4261.

- Sisquella, X., de Pourcq, K., Alguacil, J., Robles, J., Sanz, F., Anselmetti, D., Imperial, S. & Fernandez-Busquets, X. (2010). A single-molecule force spectroscopy nanosensor for the identification of new antibiotics and antimalarials. *FASEB Journal* 24 (11), 4203-4217.

- Rodriguez-Villarreal, A. I., Arundell, M., Carmona, M. & Samitier, J. (2010). High flow rate microfluidic device for blood plasma separation using a range of temperatures. *Lab on a Chip* 10 (2), 211-219.

- Comelles, J., Estevez, M., Martinez, E. & Samitier, J. (2010). The role of surface energy of technical polymers in serum protein adsorption and MG-63 cells adhesion. *Nanomedicine-Nanotechnology Biology and Medicine* 6 (1), 44-51.

- Fernandez-Busquets, X., Ponce, J., Bravo, R., Arimon, M., Martianez, T., Gella, A., Cladera, J. & Durany, N. (2010). Modulation of Amyloid beta Peptide(1-42) Cytotoxicity and aggregation in vitro by glucose and chondroitin sulfate. *Current Alzheimer Research* 7 (5), 428-438.

- Estevez, M., Fernandez-Ulibarri, I., Martinez, E., Egea, G. & Samitier, J. (2010). Changes in the internal organization of the cell by microstructured substrates. *Soft Matter* 6 (3), 582-590.

- Valente, T., Gella, A., Fernandez-Busquets, X., Unzeta, M. & Durany, N. (2010). Immunohistochemical analysis of human brain suggests pathological synergism of Alzheimer's disease and diabetes mellitus. *Neurobiology of Disease* 37 (1), 67-76.

- Harder, A., Walhorn, V., Dierks, T., Fernandez-Busquets, X. & Anselmetti, D. (2010). Single-molecule force spectroscopy of cartilage aggrecan self-adhesion. *Biophysical Journal* 99 (10), 3498-3504.

- Lagunas, A., Comelles, J., Martinez, E. & Samitier, J. (2010). Universal chemical gradient platforms using poly(methyl methacrylate) based on the biotin streptavidin interaction for biological applications. *Langmuir* 26 (17), 14154-14161.

- Darwish, N., Caballero, D., Moreno, M., Errachid, A. & Samitier, J. (2010). Multi-analytic grating coupler biosensor for differential binding analysis. *Sensors and Actuators B-Chemical* 144 (2), 413-417.

- de Oliveira, I. A. M., Vocanson, F., Uttaro, J. P., Asfari, Z., Mills, C. A., Samitier, J. & Errachid, A. (2010). Characterization of a self-assembled monolayer based on a calix[4] crown-5 derivate: fabrication of a chemical sensor sensitive to calcium. *Journal of Nanoscience and Nanotechnology* 10 (1), 413-420.

- Caballero, D., Villanueva, G., Plaza, J. A., Mills, C. A., Samitier, J. & Errachid, A. (2010). Sharp high-aspect-ratio AFM tips fabricated by a combination of deep reactive ion etching and focused ion beam techniques. *Journal of Nanoscience and Nanotechnology* 10 (1), 497-501.

- Alonso, O., Canals, J., Freixas, L., Samitier, J., Dieguez, A., Vatteroni, M., Susilo, E., Cavallotti, C. & Valdastri, P. (2010). Enabling multiple robotic functions in an endoscopic capsule for the entire gastrointestinal tract exploration. *Proceedings of the 36th European Solid State Circuits Conference (ESSCIRC 2010)*, 386-389.

Collaborations with other research centres

Prof. M. Madou University of California, Irvine (USA).

Dr. Max M. Burger Novartis AG, Basel (Switzerland) and Marine Biological Laboratory, Woods Hole (USA).

Prof. E. Faszewski Wheelock College, Boston (USA).

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

Prof. D. Anselmetti Bielefeld University (Germany).

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

Dr. Graham Johnson Uniscan Instruments Ltd, Buxton (UK).

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

Dr. Matthew Dalby University of Glasgow, Glasgow (UK).

Dr. Edith Pajot INRA, Jouy-en-Josas (France).

Dr. Christophe Vieu LAAS-CNRS, Toulouse (France).

Dr. Nicole Jaffrezic Université Claude Bernard Lyon 1 (France).

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

Prof. François Rossi JRC-Ispra (Italy).

Prof. Paolo Dario SSSUP, Pisa (Italy).

Prof. M. Sampietro Politecnico di Milano (Italy).

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

Prof. José Rivas Iberian Nanotechnology Laboratory (INL), Braga (Portugal).

Prof. Vasco Teixeira Universidade do Minho, Braga (Portugal).

Prof. Joan Bausells CNM-CSIC, Barcelona (Spain).

Dr. Mª Jesús Vicent Centro Investigación Príncipe Felipe, Valencia (Spain).

Dr. Miguel Manso CMAM-UAM, Madrid (Spain).

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

Dr. Mª Pilar Marco IIQAB-CSIC, Barcelona (Spain).

Dr. Juan C. Izpisúa CMRB, Barcelona (Spain).

Dr. Mª Luisa Villahermosa Genómica SA, Coslada (Spain).

Jordi Carrera STAT-Diagnostica SL, Barcelona (Spain).

Dr. Carme Cantos ENANTIA SL, Barcelona (Spain).

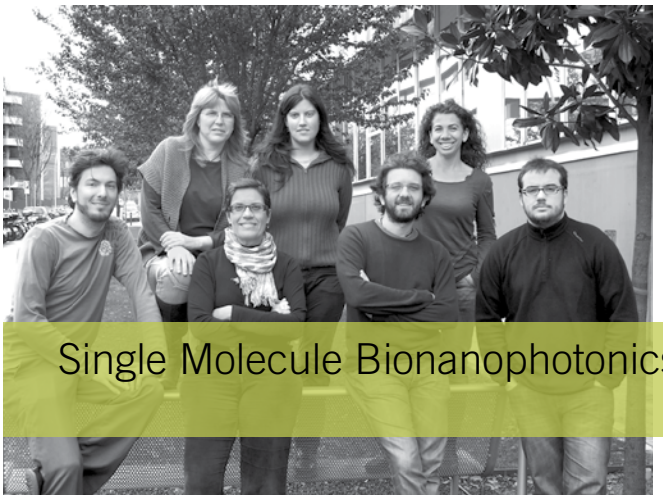
Dr. Manuel Fuentes Universidad de Salamanca, Salamanca (Spain).

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

Prof. Albert van den Berg University of Twente (The Netherlands)

Scientific equipment and techniques

- Nanofabrication and nanomanipulation
  - Automatized microcontact printing system (custom-made)
  - Dip-Pen Nanolithography system (DPN)
  - Nanoplotter NPM
  - Nanotechnology Platform (PCB): equipments 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
- Microfluidics
  - High precision syringe pumps
  - Peristaltic pumps
- Molecular/cell biology
  - Biological safety cabinet (class II)
  - Microwell plate readers
  - Protein and DNA electrophoresis systems
  - Nanodrop spectrophotometer



Single Molecule Bionanophotonics

Prof. Dr. María García-Parajo

Postdoctoral researchers: Dr. Olga Esteban, Dr. Carlo Manzo, Dr. Jeff Spector

PhD students: Ruth Diez, Gemma Pérez, Juan Andrés Torreño, Thomas Van Zanten

Technician: Merche Rivas

Visitors: Christina Eich, Meral Filiz Somunyudan

The Single Molecule Bionanophotonics group devotes its research activities to the development and application of cutting-edge optical techniques for the study of biological processes at the single molecular level and on living cells. Thus we aim to develop fluorescence techniques that combine high spatial and temporal resolution for the dual goals of probing and manipulating biological function at the level of single molecules in their native environment: the living cell.

Nanoscale imaging on intact cell membranes is obtained using near-field optical microscopy (NSOM). We also generate strong nanoscale optical fields and superfocusing by fabrication of optical nano-antennas, tuned in resonance with the photon emitters. These nano-antenna probes scanned in controlled proximity to cell membranes allow optical resolution below 30nm. High temporal resolution is achieved using fluorescence correlation spectroscopy (FCS) and Epi/Total internal reflection fluorescence microscopy (TIRF) for single emitter tracking on living cells.

Our aim is to elucidate fundamental biological questions that have important implications for health and disease. Topics that attract our attention in the biological arena are cell membrane compartmentalization at the nanoscale, leukocyte adhesion mediated by integrin receptors and pathogen recognition by cells of the immune system.

As highlights of our achievements in 2010, we succeeded in mapping nanoscale compositional connectivity mediated by cholesterol on cell membranes (*Proc Natl Acad Sci USA* 107, 15437, 2010). These findings constitute an important step towards a fuller understanding of the activation and clustering of lipid raft constituents, which amplify and strengthen preexisting interactions and mediate signal transduction across the cell membrane. On the technical side, we fabricated optical antennas at the end of aperture NSOM probes using focus ion beam technology and pioneered the application of these antennas for imaging intact cell membranes with a truly optical resolution of 30 nm (*Small* 6, 270, 2010). We are currently implementing FCS on subwavelength illumination volumes to allow, in the near future, single molecule dynamic measurements on living cells at the nanometer scale.

Fig. 1 Famous Catalan architect Antoni Gaudi (1852-1926) constantly observed and used nature as his main inspiration. The mosaic of Park Güell (left side of the image) is an example of shapes and colors Gaudi constantly used in his work. Cell membranes also have a mosaic organization composed by lipids and proteins (blue and yellow spots) but at a completely different spatial scale: the nanometer range (right). And, like Gaudi, just by "observing" – but with an advanced superresolution optical microscope – we have revealed the intricacies of this organization and their implications mediating signal transduction across the membrane.

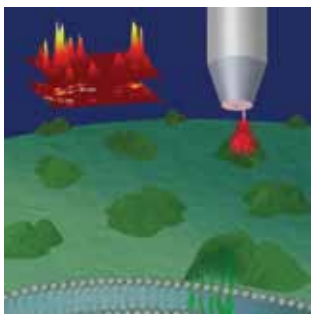


Fig. 2 Artist's impression of how a optical nanoantenna carved on a NSOM probe images individual proteins on the cell membrane with an optical resolution of 30nm. The inset shows a real superresolution image of adhesion receptors on monocytes.

Research projects

- **BIO-LIGHT-TOUCH** Advanced Near-Field Optical Tools with Biochemical Functional Recognition at the Single Molecule Level (2007-2010).
PI: **María García-Parajo** (coordinator)
Collaborative project (NEST) within the framework of EU-FP6.

- **IMMUNANOMAP.** Unraveling the Nano-Landscape of Receptors Controlling Molecular Processes of the Immune System (2007-2011).
PI: **María García-Parajo**
IBEC fellows: **Carlo Manzo**, **Thomas van Zanten**
Marie Curie Research Training Network (MCRTN) within the framework of EU-FP6.

- **PHOTONICS4LIFE** Network of Excellence for biophotonics (2009-2012).
PI: **María García-Parajo** (cluster partner)
European Network of Excellence (NoE) within the framework of EU-FP7.

- **HYBRID-NANO-CELL** Novel Hybrid Nanotechnologies to Explore Molecular Interactions at Bio-Nonbio-Interfaces (2007-2010).
PI: **María García-Parajo** (coordinator)
MICINN, Investigación fundamental no orientada.

- **MICROTIME** Microscopio óptico de barrido de campo cercano con reconocimiento bioquímico a escala molecular (2007-2010).
PI: **María García-Parajo**
MICINN, Acciones Complementarias.

- Grup de recerca consolidat (2009-2013).
PI: **María García-Parajo**
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).

- Development of nanomedicines for enzymatic replacement therapy in Fabry disease (2010-).
PI: **María García-Parajo** (managed by UB)
Fundació La Marató de TV3.

Publications

- van Zanten, T. S., Gomez, J., Manzo, C., Cambi, A., Buceta, J., Reigada, R. & García-Parajo, M. F. (2010). Direct mapping of nanoscale compositional connectivity on intact cell membranes. *Proceedings of the National Academy of Sciences of the United States of America* 107 (35), 15437-15442.

- van Zanten, T. S., Lopez-Bosque, M. J. & García-Parajo, M. F. (2010). Imaging individual proteins and nanodomains on intact cell membranes with a probe-based optical antenna. *Small* 6 (2), 270-275.

- van Zanten, T. S., Cambi, A. & García-Parajo, M. F. (2010). A nanometer scale optical view on the compartmentalization of cell membranes. *Biochimica et Biophysica Acta-Biomembranes* 1798 (4), 777-787.

- Hofer, M., Adamsmaier, S., van Zanten, T. S., Chtcheglova, L. A., Manzo, C., Duman, M., Mayer, B., Ebner, A., Moertelmaier, M., Kada, G., García-Parajo, M. F., Hinterdorfer, P. & Kienberger, F. (2010). Molecular recognition imaging using tuning fork-based transverse dynamic force microscopy. *Ultramicroscopy* 110 (6), 605-611.

- Normanno, D., van Zanten, T. S. & García-Parajo, M. F. (2010). Near-field optical microscopy: Insight on the nanometer-scale organization of the cell membrane. In "Nanoscopy and Multidimensional Optical Fluorescence Microscopy" 18, 1-28. Chapman and Hall/CRC, (ed. Diaspro, A.), New York, USA.

Collaborations with other research centres

Prof. Carl G. Figdor Nijmegen Centre for Molecular Life Sciences (NCMLS), Nijmegen (The Netherlands).

Prof. Peter Hinterdorfer Biophysics Institute, Johannes Kepler University, Linz (Austria).

Prof. Vincenzo Cerundolo Weatherall Institute of Molecular Medicine, University of Oxford (UK).

Prof. Vinod Subramaniam BPE group, University of Twente (The Netherlands).

Prof. Niek van Hulst Institut de Ciències Fotòniques (ICFO), Barcelona (Spain).

Prof. Jennifer Herek Optical Sciences group, MESA+, University of Twente (The Netherlands).

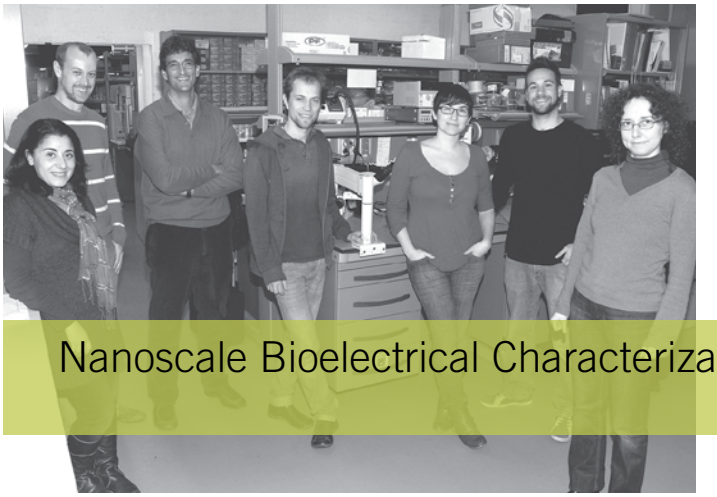
Prof. Holger Schönherr Physical Chemistry Group, University of Siegen (Germany).

Dr. Javier Martínez-Picado IrsiCaixa Foundation, Hospital Germans Trias i Pujol, Badalona (Spain).

Prof. Pedro Aramendia Physical Chemistry Group, University of Buenos Aires (Argentina).

Scientific equipment and techniques

- Aperture type near-field optical microscopy (NSOM) working under aqueous conditions
- Single-molecule-detection-sensitive scanning confocal microscopy: imaging, polarization, and wavelength sensitive
- Dual-colour wide-field/TIRF fluorescence microscopy equipped with dual colour detection (EM-CCD camera) and environmental chamber for live cell experiments
- Multi-parametric single-molecule confocal (Microtime 200) combined with epi-TIRF excitation and dual colour detection (EM-CCD camera) and liquid cell, temperature and CO2-controlled for live cell experiments
- Lasers: several helium-neon (He-Ne), argon/krypton (Ar/Kr+), ps-lasers



Nanoscale Bioelectrical Characterization

Dr. Gabriel Gomila

Senior researcher: Dr. Laura Fumagalli

Postdoctoral researchers: Dr. Annalisa Calò, Dr. Martin Edwards

PhD students: Aurora Dols-Pérez, Daniel Esteban, Georg Gramse

Masters student: Nima Moghimian

The main goal of our research line is to develop experimental setups based on atomic force microscopy and theoretical frameworks enabling us to measure and understand the electrical properties of biological samples at the nanoscale (for example, biomembranes, single biomolecules and single cells). Our broader objective is to contribute to the development of new label-free biological characterization methods and of electronic biosensors.

During 2010 we completed the instrumental and theoretical investigation aimed at developing a measuring system based on electrostatic force microscopy able to quantify the dielectric properties of biomembranes supported on any kind of supporting substrate (conductor or insulator). We also completed our work on the three dimensional electrostatic manipulation of nanoparticles.

Ongoing work includes the analysis of the nanoscale dielectric properties of single bacteria and of nanoscale vesicles carrying olfactory receptors, the latter for use in an artificial electronic olfactory biosensor. Work is also in progress on the extension of the different measuring systems to work in physiological environments for functional studies.

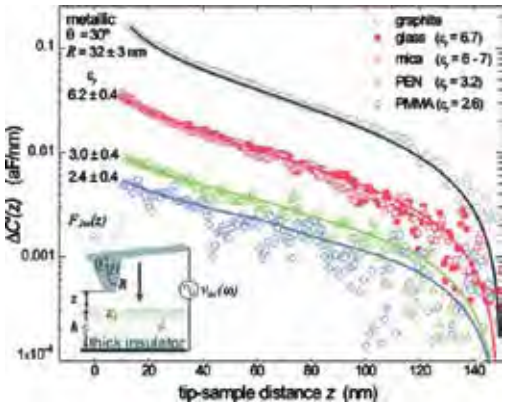


Fig. 1 Electrostatic force distance approach curves on various insulator materials (glass, mica, PEN, PMMA) demonstrating the capability of the technique to distinguish the nanoscale dielectric properties of the different materials. Symbols: experimental measurements. Continuous line: theoretical fitting.

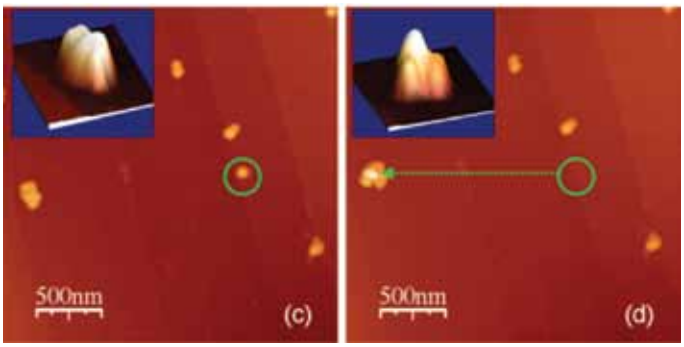


Fig. 2 Nanoscale electrostatic manipulation of 25 nm radius gold nanoparticles on a graphite substrate by means of an atomic force microscope.

Research projects

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

- **HYBRID-NANOCELL** Novel Hybrid Nanotechnologies to Explore Molecular Interactions at Bio-Non/Bio-Interfaces (2007-2010).
PI: **Gabriel Gomila** (under UB)
Coordinator: **Maria Garcia-Parajo** (see page 38)
MICINN, Investigación fundamental no orientada.

- Ayuda para la intensificación de la actividad de la investigación (2008-2010).
PI: **Gabriel Gomila** (under UB)
MEC–Generalitat de Catalunya, Programa I3.

Publications

- Fumagalli, L., Gramse, G., Esteban-Ferrer, D., Edwards, M. A. & Gomila, G. (2010). Quantifying the dielectric constant of thick insulators using electrostatic force microscopy. *Applied Physics Letters* 96 (18), 183107.

- Toset, J. & Gomila, G. (2010). Three-dimensional manipulation of gold nanoparticles with electro-enhanced capillary forces. *Applied Physics Letters* 96 (4), 043117.

Collaborations with other research centres

Prof. Lino Reggiani National Nanotechnology Laboratory, Universita dil Salento, Lecce (Italy).

Prof. Joan Bausells Centro Nacional de Microelectrónica de Barcelona-CSIC (France).

Dr. Adriana Gil Nanotec Electronica SL, Madrid (Spain).

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

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).

Scientific equipment and techniques

- Two Atomic Force Microscopes fully customized for DC and AC electric current and electrostatic force detection (Nanotec Electronica S.L.)
- Atomic Force Microscope for imaging and electrostatic force detection (Nanosurf easyScan 2)
- Optical Microscope (Zeiss AxioImager)
- Sub-Femtoamp Remote SourceMeter (Keithley 6430)
- Two digital 4-phase Lock-In amplifiers (Anfatec eLockIn204)
- Digital lock-in amplifier (Zurich Instruments HF2LI)
- Portable electrochemical interface and impedance analyser (Ivium Technologies, CompactStat)

Biomaterials, implants and tissue engineering programme

Bio/Non-Bio Interactions for Regenerative Medicine

Prof. Dr. Josep A. Planell

Senior researcher: Dr. Elisabeth Engel

Research fellows: Dr. Oscar Castaño, Dr. Miguel Angel Mateos, Dr. Melba Navarro

PhD students: Aitor Aguirre, Zaida Álvarez, Arlyng Gyveth González, Johan Gustavsson, Riccardo Levato, Marta Mattotti, Xavier Puñet, Nadège Sachot, Aitor Sánchez, Tiziano Serra

Masters students: José Luís García, Alícia Lleopart, Santosh Narshima Prathap Moola, Marc Soriano

Undergraduates: Brice Calvarèse, Celia Josa, Rodolphe Mauchauffe, Thomas van Nieuwenhuyse, Mònica Ortiz

Technicians: Belén González

Visitors: Claudia Aymerich, Raquel van Ginkel, Paula Oriach, Aurelio Salerno, Amedee Vilamitjana

The Bio/Non-Bio Interactions for Regenerative Medicine research group is focused on the development of new third-generation bioactive and biodegradable materials for the treatment of diseased or altered tissues. The strategy used is known as tissue engineering and it involves isolating and cultivating progenitor cells and developing 3D structures or matrices that these cells can use as scaffolds to regenerate the specific tissue. The purpose of these scaffolds is not only to provide support for the cells, but also to provide them with the physical, chemical and biological signals appropriate to control and guide their activity in order to trigger self-regeneration of the specific tissue in the body.

The specific objective of the research lab is to design and develop new material surfaces according to their function, using bioactive peptides or molecules able to mimic the extracellular matrix and promoting adhesion, migration and differentiation of specific cells for different tissues. The nano- and microstructure of the surface is also an important signal in terms of cell behaviour, and consequently the topographic modification of surfaces may promote desired cell activities such as preferential adhesion, migration, or even differentiation into cells of a more progenitor lineage. A number of technologies have been developed in order to produce the 3D matrices to be colonised by cells; these include robotic methods of rapid prototyping, electro-spinning, solvent casting and micro/nano particles.

The group has been working in elucidating the capacity of a composite material to induce angiogenesis *in vivo* and *in vitro*, and has proposed a model that clarifies the effect of the chemical composition and the mechanical properties of the scaffold on the formation of new vessels. Using the same polymer of the composite, we have used electrospinning to create a network that helps neurons and glial cells to grow in a permissive environment for regeneration. Cells were oriented on the aligned nanofibers and maintained its immature phenotype. Following the same method, microfibers have been functionalised with collagen and fibroblasts have grown successfully, creating a biohybrid tissue that can have applications on cornea, skin or ligament repair. Another fabrication method, rapid prototyping technique, has allowed us to obtain composite scaffolds with well-controlled structures that will be applied to bone tissue regeneration. Finally, polymer based microparticles have been developed to be used for drug and cell delivery.

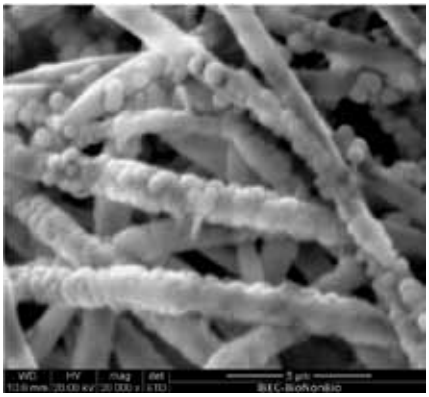


Fig. 1 (left) Electrospun nanofibers of polylactic acid containing nanoparticles of biodegradable calcium phosphate glass.

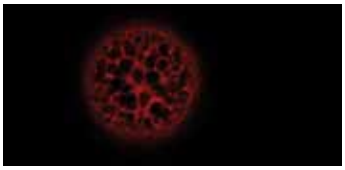


Fig. 2 (right) Confocal image of a PLGA microparticle of 60 µm.

Research projects

- **ANGIOSCAFF** Highly Porous Bioactive Scaffolds Controlling Angiogenesis for Tissue Engineering (2008-2012).
PI: **Josep A. Planell**
Other group leaders involved: **Damien Lacroix** (page 48)
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**
Other group leaders involved: **Damien Lacroix** (page 48)
Collaborative project within the framework of EU-FP7.

- **BIOFUSS** Materiales biofuncionalizados para reparación y regeneración de tejidos (2009-2011).
PI: **Josep A. Planell**
Other group leaders involved: **Damien Lacroix** (page 48)
MICINN, Investigación fundamental no orientada.

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

- Desarrollo de nuevos biomateriales para regeneración ósea (2008-2010).
PI: **Josep A. Planell** (managed by UPC)
MICINN. Acción Complementaria Internacional (Corea).

- Angiogenesis en ingeniería de tejidos (2008-2010).
PI: **Elisabeth Engel** (managed by UPC)
MICINN, co-financed by UPC and MEC.

- 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).

Publications

- Coelho, N. M., Gonzalez-Garcia, C., Planell, J. A., Salmeron-Sanchez, M. & Altankov, G. (2010). Different assembly of type iv collagen on hydrophilic and hydrophobic substrata alters endothelial cells interaction. *European Cells & Materials* 19, 262-272.

- Pegueroles, M., Aparicio, C., Bosio, M., Engel, E., Gil, F. J., Planell, J. A. & Altankov, G. (2010). Spatial organization of osteoblast fibronectin matrix on titanium surfaces: Effects of roughness, chemical heterogeneity and surface energy. *Acta Biomaterialia* 6 (1), 291-301.

- Montufar, E. B., Traykova, T., Gil, C., Harr, I., Almirall, A., Aguirre, A., Engel, E., Planell, J. A. & Ginebra, M. P. (2010). Foamed surfactant solution as a template for self-setting injectable hydroxyapatite scaffolds for bone regeneration. *Acta Biomaterialia* 6 (3), 876-885.

- Milan, J. L., Planell, J. A. & Lacroix, D. (2010). Simulation of bone tissue formation within a porous scaffold under dynamic compression. *Biomechanics and Modeling in Mechanobiology* 9 (5), 583-596.

- Koch, M. A., Vrij, E. J., Engel, E., Planell, J. A. & Lacroix, D. (2010). Perfusion cell seeding on large porous PLA/calcium phosphate composite scaffolds in a perfusion bioreactor system under varying perfusion parameters. *Journal of Biomedical Materials Research Part A* 95A (4), 1011-1018.

- Aguirre, A., Planell, J. A. & Engel, E. (2010). Dynamics of bone marrow-derived endothelial progenitor cell/mesenchymal stem cell interaction in co-culture and its implications in angiogenesis. *Biochemical and Biophysical Research Communications* 400 (2), 284-291.

- Aguirre, A., Gonzalez, A., Planell, J. A. & Engel, E. (2010). Extracellular calcium modulates *in vitro* bone marrow-derived Flk-1(+) CD34(+) progenitor cell chemotaxis and differentiation through a calcium-sensing receptor. *Biochemical and Biophysical Research Communications* 393 (1), 156-161.

- Rajzer, I., Castano, O., Engel, E. & Planell, J. A. (2010). Injectable and fast resorbable calcium phosphate cement for body-setting bone grafts. *Journal of Materials Science-Materials in Medicine* 21 (7), 2049-2056.

- Montufar, E. B., Traykova, T., Schacht, E., Ambrosio, L., Santin, M., Planell, J. A. & Ginebra, M. P. (2010). Self-hardening calcium deficient hydroxyapatite/gelatine foams for bone regeneration. *Journal of Materials Science-Materials in Medicine* 21, 863-869.

- Mateos-Timoneda, M. A. & Engel, E. (2010). Modifying biomaterial surfaces for the repair and regeneration of nerve cells. In "Surface modification of biomaterials: Methods analysis and applications" Part 2: Analytica Techniques and Applications, 325-343. Woodhead Publishing Ltd, (ed. Williams, R.). Cambridge, UK.

- Altankov, G., Groth, T., Engel, E., Gustavsson, J., Pegueroles, M., Aparicio, C., Gil, F. J., Ginebra, M.-P. & Planell, J. A. (2010). Development of provisional extracellular matrix on biomaterials interface: Lessons from *in vitro* cell culture. In "Advances in Regenerative Medicine: Role of Nanotechnology, and Engineering Principles", 19-43. Springer Netherlands, (ed. Shastri, P., Altankov, G. & Lendlein, A.), Dortrecht, The Netherlands.

- Planell, J. A., Navarro, M., Altankov, G., Aparicio, C., Engel, E., Gil, J., Ginebra, M. P. & Lacroix, D. (2010). Materials

surface effects on biological interactions. In “Advances in Regenerative Medicine: Role of Nanotechnology, and Engineering Principles”, 233-252. Springer Netherlands, (ed. Shastri, P., Altankov, G. & Lendlein, A.), Dortrecht.

- Navarro, M. & Planell, J. A. (2010). Bioactive composites based on calcium phosphates for bone regeneration. In “Advanced Bioceramics in Nanomedicine and Tissue Engineering” 441, 203-233. Key Engineering Materials, (ed. Vallet-Regí, M. & Vila, M.), Laussane.

- Navarro, M. & Michiardi, A. (2010). The Challenge of combining cells, synthetic materials and growth factors to engineer bone tissue. In “Synthetic and Integrative Biology: Parts and Systems, Design Theory and Application” Biotechnology in Agriculture, Industry and Medicine, 105-121. Nova Science Pub Inc., (ed. Barnes, J. B. & Harris, L. P.), NY.

Collaborations with other research centres

Dr. Joelle Amedee INSERM, Bordeaux (France). Dr. Alvaro Mata Plataforma de Nanotecnología, Barcelona (Spain).

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. Mateo 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).

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).

Dr. Nuria Villaboa Unidad de Investigación, Hospital Universitario La Paz, Universidad Autónoma de Madrid (Spain).

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

Dr. Juan Bellón Dept. de Cirugía, Facultad de Medicina, Universidad de Alcalá de Henares (Spain).

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

Dr. Patrick J. Prendergast Trinity Centre for Bioengineering, Trinity College Dublin (Ireland).

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

Dr. Josefa P. García-Ruiz Centro de Biologia Molecular “Severo Ochoa”, CSIC-UAM and Universidad Autonoma de Madrid (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.

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

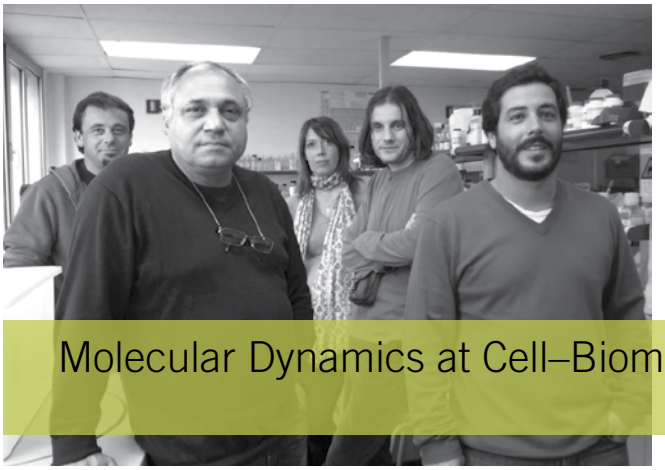
Dr. Carlos Rodríguez-Cabello / Dr. Matilde Alonso Dept. de Física de la Materia Condensada, Universidad de Valladolid (Spain).

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).

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)
- Biotool (Rapid prototyping)
- Peptide synthetiser
- Combustion furnace
- Electrospinning device
- Spin-coater
- Vibrational viscosimeter
- Ion selective electrodes for Ca2+, Na+, K+, and pH



Molecular Dynamics at Cell–Biomaterial Interface

Prof. Dr. George Altankov

PhD students: Dencho Milkov Gugutkov, Nuno Miranda Guerra Coelho, Georgi Toromanov

Undergraduate: Ulrich Spengler

Technician: Olga Zhukova

The interaction of living cells with foreign materials is fundamental for biology and medicine. We anticipate that the dynamic behaviour of matrix proteins at the biomaterials interface is a key for understanding the phenomena of biocompatibility, which is the main research topic in the group. We aim to gain distinct knowledge in this specific multidisciplinary area with a strong impact in the long term on a variety of fields such as tissue engineering, regenerative medicine and non-invasive surgery.

We perform systematic studies in the following directions:

(i) Spontaneous assembly of ECM proteins at the cell-biomaterials interface and their interaction with living cells;

(ii) Electrospinning of nanofibres from natural and synthetic polymers for guided cellular behaviour;

(iii) Cellular interaction with biomimetic hydroxiapatite nanocristals and protein composite coatings;

(iv) Remodelling of ECM proteins at the cell-biomaterials interface.

Recently we have employed distinct silane chemistry and co-polymer compositions to create model substrates with controlled density of OH, COOH, NH2 and NH3 groups, thus varying their chemical composition, charge and hydrophilic/hydrophobic balance. Combining AFM, SEM and other nanoindentation techniques we examined the early protein adsorption events at the nanoscale, corroborating them with the microscopic response of endothelial cells and fibroblasts. Apart from the paradigm that cellular interaction depends mainly on the adsorption of soluble matrix proteins, we followed the surface behaviour of other important ECM constituents (nonsoluble), such as type IV collagen and laminin-unique multifunctional matrix proteins that play a crucial role in the organization of the basement membrane. In a series of recent communications we have described a novel phenomena – substratum-induced protein assembly – involving the behaviour of fibronectin, fibrinogen, vitronectin, collagen IV and laminin. Furthermore we show that varying with the density of OH groups, one can tailor living cell–protein interaction. In general, proteins can form objects of various shapes and one fascinating possibility is to use them for guiding cellular behaviour. Recently, nanotechnology has made it possible to produce biomimetic nanofibers; using our own device we successfully electrospun nanofibres from various natural and synthetic polymers and employed them in our ongoing research projects: EULANEST (international) and MAT 2009-1440 (national).

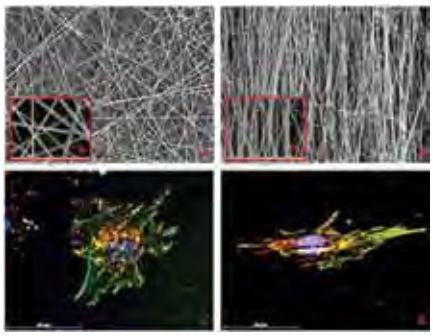


Fig. 1 A novel type of hybrid PLA-Fibrinogen nanofibres developed in our lab. They are deposited as random (a) or aligned (b) shown to induce distinct functional response of endothelial cells acquiring either stelate (c) or elongated (d) morphology, respectively (Gugutkov *et al*, 2010, in preparation).

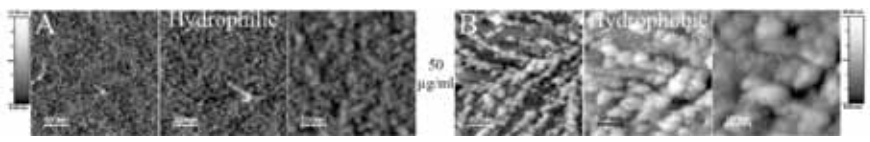


Fig. 2 AFM images of adsorbed native collagen type IV in hydrophilic (A) and hydrophobic (B) environments. Adsorption concentration and magnification increases from left to right (Coelho *et al*, 2010).

Research projects

■ **FIBROGEL** Bioinspired Nanofibrous Gel for Tissue Engineering of Cartilage and Bone (2010-).
PI: **George Altankov**
MICINN, Proyectos Internacionales, European-Latin American Network for Science and Technology (EULANEST).

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

Publications

■ Coelho, N. M., Gonzalez-Garcia, C., Planell, J. A., Salmeron-Sanchez, M. & Altankov, G. (2010). Different assembly of type iv collagen on hydrophilic and hydrophobic substrata alters endothelial cells interaction. *European Cells & Materials* 19, 262-272.

■ Toromanov, G., González-García, C., Altankov, G. & Salmerón-Sánchez, M. (2010). Vitronectin activity on polymer substrates with controlled -OH density. *Polymer* 51 (11), 2329-2336.

■ Pegueroles, M., Aparicio, C., Bosio, M., Engel, E., Gil, F. J., Planell, J. A. & Altankov, G. (2010). Spatial organization of osteoblast fibronectin matrix on titanium surfaces: Effects of roughness, chemical heterogeneity and surface energy. *Acta Biomaterialia* 6 (1), 291-301.

■ Gugutkov, D., Altankov, G., Hernandez, J. C. R., Pradas, M. M. & Sanchez, M. S. (2010). Fibronectin activity on substrates with controlled -OH density. *Journal of Biomedical Materials Research Part A* 92A (1), 322-331.

■ Shastri, V. P., Altankov, G. & Lendlein, A. (2010). Advances in regenerative medicine: Role of nanotechnology, and engineering principles. Springer (ed. Shastri, V. P., Altankov, G. & Lendlein, A.). Dortrecht, The Netherlands.

■ Salmeron-Sanchez, M. & Altankov, G. (2010). Cell-Protein-Material interaction in tissue engineering. In "Tissue Engineering", 77-102. Intech, (ed. Eberli, D.). Vukovar, Croatia.

■ Planell, J. A., Navarro, M., Altankov, G., Aparicio, C., Engel, E., Gil, J., Ginebra, M. P. & Lacroix, D. (2010). Materials surface effects on biological interactions. In "Advances in Regenerative Medicine: Role of Nanotechnology, and Engineering Principles", 233-252. Springer Netherlands, (ed. Shastri, P., Altankov, G. & Lendlein, A.). Dortrecht, The Netherlands.

■ Groth, T., Liu, Z.-M., Niepel, M., Peschel, D., Kirchhof, K., Altankov, G. & Faucheux, N. (2010). Chemical and physical modifications of biomaterial surfaces to control adhesion of cells. In "Advances in Regenerative Medicine: Role of Nanotechnology, and Engineering Principles", 253-284. Springer Netherlands, (ed. Shastri, P., Altankov, G. & Lendlein, A.). Dortrecht, The Netherlands.

■ Altankov, G., Groth, T., Engel, E., Gustavsson, J., Pegueroles, M., Aparicio, C., Gil, F. J., Ginebra, M.-P. & Planell, J. A. (2010). Development of provisional extracellular matrix on biomaterials interface: Lessons from *in vitro* cell culture. In "Advances in Regenerative Medicine: Role of Nanotechnology, and Engineering Principles", 19-43. Springer Netherlands, (ed. Shastri, P., Altankov, G. & Lendlein, A.). Dortrecht, The Netherlands.

Collaborations with other research centres

GKSS Research Centrum, Institute of Chemistry, Teltow (Germany).

Institute of Pharmacy, Martin Luther University, Halle (Saale) (Germany).

Institute for Biophysics and Institute of Solid State Physics at Bulgarian Academy of Sciences, Sofia (Bulgaria).

Centre de Biomaterials, Universitat Politècnica de València (Spain).

Federal University of Rio de Janeiro (Brazil).

National University of la Plata, Buenos Aires (Argentina).

Scientific equipment and techniques

- Advanced microscopic equipment for performing dynamic studies with living cells
- Flow chamber for measuring the strength of cell adhesion
- Experimental electrospinning device designed for production of nanofibres from various natural and synthetic polymers

Biomechanics and Mechanobiology

Dr. Damien Lacroix

Postdoctoral researchers: Jérôme Noailly, Cécile Perrault

PhD students: Sara Barreto, Aura Cardona, Andrea Malandrino, Andy Olivares, Clara Sandino, Martin Koch

Masters students: Antonio Sánchez, Igor Torrealba, Mª Sol Cabrera, Juan Parraga

Visitors: Marie Pauchard, Juan Fernando Ramírez, Andreas Schmocker

The focus of the Biomechanics and Mechanobiology research line is the study of the effect of mechanical stimuli on biological response. The group's objective is to make scientific advancements in simulations of *in vitro* and *in vivo* biomechanics and mechanobiology and in experimental *in vitro* mechanobiology. The current focus of the group is mainly on the development of simulations in spine biomechanics, tissue engineering and cell mechanics. These numerical simulations based on the finite element method are complemented with *in vitro* tests using bioreactors and microfluid chambers.

In 2010, major progress was made in all these areas of interest. In tissue engineering, a new study simulating the angiogenic process in an irregular scaffold for bone regeneration demonstrated the importance of controlling the pore architecture and mechanical loading in the formation of blood vessels and bone tissue (*Biomaterials* 31, 2446-2452). The effect of mechanical loading history in a highly porous scaffold was also found to be very critical (*Biomechanics and Modeling in Mechanobiology* 9, 583-596). For the first time, *in vitro* cell seeding and proliferation was done on a large scaffold using a perfusion bioreactor system developed within the group (*J. Biomedical Materials Research* 95A, 1011-1018). Computational fluid dynamics method was also used for the design of a bioreactor for large-scale human cartilage drafts by optimizing the uniformity of fluid flow within the bioreactor (*Biomaterials* 34, 8946-8952). In spine biomechanics, recent developments have been made in the study of collagen fibre angle and distribution within the annulus fibrosis of the intervertebral disc and in the development of a numerical method, including for the first time coupling between mechanical loading and solutes (oxygen and lactate) transport. In the area of cell mechanics, progress has been made in the development of a single cell finite element model and in the study of the effect of microfluidic flow on cell attachment.

Finally, during 2010 the group was awarded a major EU-funded project as coordinator (MySPINE – FP7-ICT-2009-6-269909) to improve treatment and prognosis of patient-specific spinal diseases. This project will start in March 2011 and will last three years.

Fig. 1 (left) Fluid flow distribution in a 3D network of new capillaries being formed around veins and arteries.

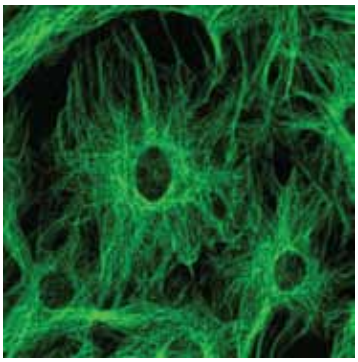


Fig. 2 (right) Confocal picture of microtubules of rat mesenchymal stem cells used to develop the single cell model.

Research projects

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

■ **BIOFUSS** Materiales biofuncionalizados para reparación y regeneración de tejidos (2009-2011).
Damien Lacroix (PI: **Josep A. Planell**)
MICINN, Investigación fundamental no orientada.

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

■ Virtual Physiological Human NoE (2008-2011).
PI: **Damien Lacroix** (cluster partner)
European NoE within the framework of EU-FP7.

■ Estudio micromecánico por elementos finitos de la columna lumbar (2009-2010).
PI: **Damien Lacroix**
MICINN, Acciones Integradas.

■ Biomechanical study of coxarthrosis in young adults (2010-2011).
PI: **Damien Lacroix**
Funded project with Hospital de Sant Pau, Barcelona.

Publications

■ Santoro, R., Olivares, A. L., Brans, G., Wirz, D., Longinotti, C., Lacroix, D., Martin, I. & Wendt, D. (2010). Bioreactor based engineering of large-scale human cartilage grafts for joint resurfacing. *Biomaterials* 31 (34), 8946-8952.

■ Sandino, C., Checa, S., Prendergast, P. J. & Lacroix, D. (2010). Simulation of angiogenesis and cell differentiation in a CaP scaffold subjected to compressive strains using a lattice modeling approach. *Biomaterials* 31 (8), 2446-2452.

■ Milan, J. L., Planell, J. A. & Lacroix, D. (2010). Simulation of bone tissue formation within a porous scaffold under dynamic compression. *Biomechanics and Modeling in Mechanobiology* 9 (5), 583-596.

■ Koch, M. A., Vrij, E. J., Engel, E., Planell, J. A. & Lacroix, D. (2010). Perfusion cell seeding on large porous PLA/calcium phosphate composite scaffolds in a perfusion bioreactor system under varying perfusion parameters. *Journal of Biomedical Materials Research Part A* 95A (4), 1011-1018.

■ Planell, J. A., Navarro, M., Altankov, G., Aparicio, C., Engel, E., Gil, J., Ginebra, M. P. & Lacroix, D. (2010). Materials surface effects on biological interactions. In "Advances in Regenerative Medicine: Role of Nanotechnology, and Engineering Principles", 233-252. Springer Netherlands, (ed. Shastri, P., Altankov, G. & Lendlein, A.). Dortrecht.

■ Prendergast, P. J., Checa, S. & Lacroix, D. (2010). Computational models of tissue differentiation. In "Computational Modeling in Biomechanics" 3, 353-372. Springer-Verlag Berlin, (ed. De, S., Guilak, F. & Mofrad, M. R. K.). Germany.

Collaborations with other research centres

Prof. Luigi Ambrosio Institute of Composite and Biomedical Materials, University of Naples Federico II (Italy).

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

Prof. Keita Ito Dept. Biomedical Engineering, Eindhoven University of Technology (The Netherlands).

Prof. Ralph Müller Institute for Biomechanics, ETH Zurich (Switzerland).

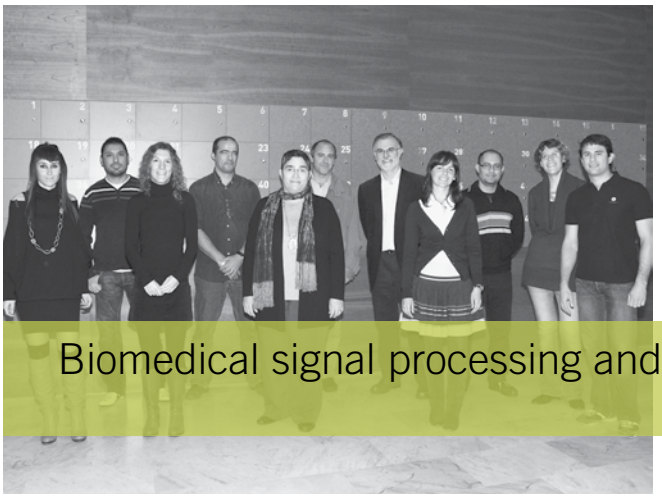
Prof. Patrick Prendergast Trinity Centre for Bioengineering, Trinity College, Dublin (Ireland).

Prof. Hans-Joachim Wilke Institute of Orthopaedic Research and Biomechanics, Universitat de Ulm (Germany).

Scientific equipment and techniques

- Finite element software (Abaqus, Fluent, TDyn, MSC Marc)
- Image reconstruction software (Simpleware, Mimics)
- High performance computing infrastructure (32 cores, 240 GB RAM and a 11TB disc space)
- Access to the Centre of Supercomputing of Catalonia (CESCA)
- Perfusion bioreactor system
- Bose ElectroForce BioDynamic bioreactor system
- Microfluidic chamber

Medical signals and instrumentation programme



Biomedical signal processing and interpretation

Prof. Dr. Raimon Jané

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

Postdoctoral researchers: Dr. Ainara Garde, Dr. Christian Morgenstern, Dr. Jordi Solà

PhD students: Joana Mesquita, Leonardo Sarlabous

Technician: Maria Puy Ruiz de Alda

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

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

The research of the group is on the field of sleep disorders related to breathing, respiratory, cardiac and neurological pathologies.

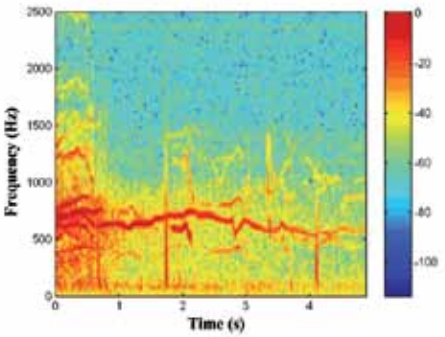


Fig. 1 (left) Analysis and interpretation of timefrequency respiratory sounds for monitoring and diagnosing asthma and obstructive lung diseases.

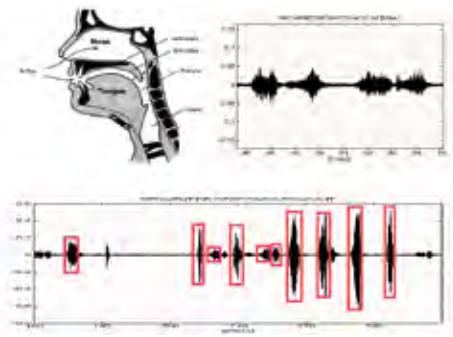


Fig. 2 (right) Advanced algorithms for early diagnosis of the obstructive sleep apnoea syndrome, through the analysis and interpretation of snoring episodes.

Research projects

- **MUBISIPRO** Multimodal Multichannel Biomedical Signal Processing (2007-2010).
PI: **Raimon Jané** (managed by UPC)
MICINN, Comisión Interministerial de Ciencia y Tecnología (CICYT).

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

- Grup de recerca consolidat (2009-2013).
PI: **Raimon Jané**
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).

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

Publications

- Garde, A., Sörnmo, L., Jané, R. & Giraldo, B. (2010). Breathing pattern characterization in chronic heart failure patients using the respiratory flow signal. *Annals of Biomedical Engineering* 38 (12), 3572-3580.

- Caminal, P., Giraldo, B. F., Vallverdu, M., Benito, S., Schroeder, R. & Voss, A. (2010). Symbolic dynamic analysis of relations between cardiac and breathing cycles in patients on weaning trials. *Annals of Biomedical Engineering* 38 (8), 2542-2552.

- Morgenstern, C., Schwaibold, M., Randerath, W. J., Bolz, A. & Jané, R. (2010). An invasive and a noninvasive approach for the automatic differentiation of obstructive and central hypopneas. *IEEE Transactions on Biomedical Engineering* 57 (8), 1927-1936.

- Garde, A., Sörnmo, L., Jané, R. & Giraldo, B. F. (2010). Correntropy-based spectral characterization of respiratory patterns in patients with chronic heart failure. *IEEE Transactions on Biomedical Engineering* 57 (8), 1964-1972.

- Fiz, J. A., Jané, R., Sola-Soler, J., Abad, J., Garcia, M. A. & Morera, J. (2010). Continuous analysis and monitoring of snores and their relationship to the apnea-hypopnea index. *Laryngoscope* 120 (4), 854-862.

- Garde, A., Schroeder, R., Voss, A., Caminal, P., Benito, S. & Giraldo, B. (2010). Patients on weaning trials classified with support vector machines. *Physiological Measurement* 31 (7), 979-993.

- Torres, A., Sarlabous, L., Fiz, j. A., Gea, J., Marti nez-Llorens, J. M., Morera, J. & Jané, R. (2010). Noninvasive measurement of inspiratory muscle performance by means of diaphragm muscle mechanomyographic signals in COPD patients during an incremental load respiratory test. *IEEE-EMBC 2010*, 2493-2496.

- Sarlabous, L., Torres, A., Fiz, J. A., Gea, J., Marti nez-Llorens, J. M., Morera, J. & Jané, R. (2010). Interpretation of the approximate entropy using fixed tolerance values as a measure of amplitude variations in biomedical signals. *IEEE-EMBC 2010*, 5967-5970.

- Morgenstern, C., Schwaibold, M., Randerath, W., Bolz, A. & Jané, R. (2010). Automatic non-invasive differentiation of obstructive and central hypopneas with nasal airflow compared to esophageal pressure. *IEEE-EMBC 2010*, 6142-6145.

- Mesquita, J., Fiz, J. A., Sola -Soler, J., Morera, J. & Jané, R. (2010). Regular and non-regular snore features as markers of SAHS. *IEEE-EMBC 2010*, 6138-6141.

- Leder, R. S., Schlotthauer, G., Penzel, T. & Jané, R. (2010). The natural history of the sleep and respiratory engineering track at EMBC 1988 to 2010. *IEEE-EMBC 2010*, 288-291.

- Garde, A., Sörnmo, L., Jané, R. & Giraldo, B. F. (2010). Correntropy-based nonlinearity test applied to patients with chronic heart failure. *IEEE-EMBC 2010*, 2399-2402.

- Correa, R., Laciar, E., Arini, P. & Jané, R. (2010). Analysis of QRS loop in the Vectorcardiogram of patients with Chagas' disease. *IEEE-EMBC 2010*, 2561-2564.

- Correa, L. S., Laciar, E., Mut, V., Giraldo, B. F. & Torres, A. (2010). Multi-parameter analysis of ECG and Respiratory Flow signals to identify success of patients on weaning trials. *IEEE-EMBC 2010*, 6070-6073.

- Arcentales, A., Giraldo, B. F., Caminal, P., Diaz, I. & Benito, S. (2010). Spectral analysis of the RR series and the respiratory flow signal on patients in weaning process. *IEEE-EMBC 2010*, 2485-2488.

Collaborations with other research centres

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

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

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

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

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

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

Prof. Dana H. Brooks Communications and Digital Signal Processing Center, Northeastern University, Boston (USA).

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

Dr. Eric Laciar Dept. Electrónica y Automática, Universidad Nacional de San Juan (Argentina).

Prof. Armin Bolz Institute of Biomedical Engineering, University of 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).

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

Dr. Salvador Benito Medicina Intensiva, Hospital de la Santa Creu i Sant Pau, Barcelona (Spain).

Dr. Josep Morera CIBERES, Servei de Pneumologia, Hospital Germans Trias i Pujol, Badalona (Spain).

Prof. Leif Sörnmo Signal processing group, Lund University (Sweden).

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

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

Prof. Ramon Farré CIBERES / IDIBAPS, Unitat de Biofísica i Bioenginyeria, Facultat de Medicina, Barcelona (Spain).

Dr. Marta Sitges IDIBAPS, Servei de Cardiologia, Hospital Clínic de Barcelona (Spain).

Prof. Winfried J. Randerath Institut for Pneumologie, Klinik Bethanien, Solingen (Germany).

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

Scientific equipment and techniques

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

Artificial Olfaction

Dr. Santiago Marco

Senior researcher:
Dr. Agustín Gutiérrez

Postdoctoral researcher:
Dr. Jordi Fonollosa

PhD students: Lluís Fernández, Ana Verónica Guamán

Marta Padilla, Erola Pairó, Víctor Pomareda, Francisco Miguel Tarzán

Technicians: Idoya Agudo, Didier Domínguez, Miguel Lechón, Sergi Udina,

Visiting students: Masoumeh Mohammadnejad, Davide Polese

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 miniaturised devices capable of analyzing an odour in seconds. The focus of our research in this field is the development of signal and data processing systems inspired by the neuronal processing of the biological olfactory pathway.

Our research in 2010 included the following:

- Within the framework of the European NEUROCHEM project for the development of biologically-inspired computational solutions, we have developed detailed neuronal models of insect mushroom bodies and integrated more abstract complete models inspired by the olfactory system of vertebrates in a neural simulator. A biomimetic olfactory epithelium was built and tested in a variety of biologically motivated scenarios. We are currently testing how models process information.
- In the context of the LOTUS project, we have developed a library of computational data analysis routines for a Differential Mobility Analyzer. Additionally, we have developed improved algorithms based on Bayesian sequential inference for the localization of odour sources. We have also developed a chemical plume simulator that allows the testing of navigation strategies.
- In cooperation with the University of Córdoba, we have developed a smart system to detect fraud in white wine samples from Ion Mobility Spectrometer signatures.
- Clustering is a major data analysis method in bioinformatics and -omics data analysis. In cooperation with the MPI for Molecular Genetics (Berlin) and the University of Brescia, we have developed a cluster validity algorithm specially suited for fuzzy clustering algorithms based on bootstrap stability.

Fig. 1 Lung cancer diagnostics by breath sampling.

Fig. 2 96 temperature modulated chemical sensor array to test redundancy and diversity coding in the olfactory system.

Research projects

■ **NEUROCHEM** Biologically Inspired Computation for Chemical Sensing (2008-2011).
PI: **Santiago Marco** (coordinator; managed by UB)
Collaborative project (ICT) within the framework of EU-FP7.

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

■ **BREATH** Exhaled breath inflammatory, oxidative stress and metabonomic biomarkers in chronic obstructive pulmonary disease and lung cancer (2009-2011).
PI: **Santiago Marco**
MICINN, Instituto de Salud Carlos III.

■ **PROSAVE²** Proyecto de Investigación en Sistemas Avanzados para un aVión más Eco-Eficiente (2010-2013).
PI: **Santiago Marco**
MICINN, Consorcios Estratégicos Nacionales en Investigación Técnica (CENIT).

■ Systems for the Detection of Explosives in Centers and Public Infrastructures (2008-2011).
PI: **Santiago Marco** (managed by UB)
MICINN, Consorcios Estratégicos Nacionales en Investigación Técnica (CENIT).

■ Prototipatge d'instrument de mesura de consum energètic - gas natural (2009-2011).
PI: **Santiago Marco**
Centre d'Innovació i Desenvolupament Empresarial (CIDEM).

■ **SOMNO-ALERT® P-10** Detección de Somnolencia (2009 -2011)
PI: **Santiago Marco**
Industrial project with FICOMIRRORS, S.A.

Publications

■ Ziyatdinov, A., Marco, S., Chaudry, A., Persaud, K., Caminal, P. & Perera, A. (2010). Drift compensation of gas sensor array data by common principal component analysis. *Sensors and Actuators B: Chemical* 146 (2), 460-465.

■ Perera, A., Pardo, A., Barrettino, D., Hierlermann, A. & Marco, S. (2010). Evaluation of fish spoilage by means of a single metal oxide sensor under temperature modulation. *Sensors and Actuators B: Chemical* 146 (2), 477-482.

■ Montoliu, I., Tauler, R., Padilla, M., Pardo, A. & Marco, S. (2010). Multivariate curve resolution applied to temperature modulated metal oxide gas sensors. *Sensors and Actuators B: Chemical* 145 (1), 464-473.

■ Falasconi, M., Gutierrez, A., Pardo, M., Sberveglieri, G. & Marco, S. (2010). A stability based validity method for fuzzy&clustering. *Pattern Recognition* 43 (4), 1292-1305.

■ Pomareda, V., Calvo, D., Pardo, A. & Marco, S. (2010). Hard modeling multivariate curve resolution using LASSO: Application to ion mobility spectra. *Chemometrics and Intelligent Laboratory Systems* 104 (2), 318-332.

■ Padilla, M., Perera, A., Montoliu, I., Chaudry, A., Persaud, K. & Marco, S. (2010). Drift compensation of gas sensor array data by orthogonal signal correction. *Chemometrics and Intelligent Laboratory Systems* 100 (1), 28-35.

■ Salleras, M., Carmona, M. & Marco, S. (2010). Issues in the use of thermal transients to achieve accurate time-constant spectrums and differential structure functions. *IEEE Transactions on Advanced Packaging* 33 (4), 918-923.

Collaborations with other research centres

Leon and Johnson Group Dept. of Neuroscience, University of California, Irvine (USA).

Dr. F. P. Gómez Hospital Clínic de Barcelona (Spain).

Prof. Paul Verschure Cognitive, Perceptive and Emotive Systems, Universitat Pompeu Fabra, Barcelona (Spain).

Prof. Anders Lansner The Brain Institute, Stockholm (Sweden).

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

Dr. D. Martínez Cortex Group, LORIA, Nancy (France).

Prof. Pere Caminal CREB, Technical University of Catalonia, Barcelona (Spain).

Prof. J.P. Rospars Insect Physiology Unit, Institut National de la Recherche Agronomique, Versailles (France).

Dr. Tim Pearce Neurolab, Dept. Engineering, University of Leicester (UK).

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

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

Prof. María Pilar Marco Applied Molecular Receptor group (AMRg), Insitute of Advanced Chemistry of Catalonia, Spanish Council for Scientific Research (IQAC-CSIC), Barcelona (Spain).

Scientific equipment and techniques

- Infrared Camera (FLIR Systems A40M)
- NST 3320 Electronic Nose
- Dycometal Climate-controlled Chamber adapted for atmosphere modification
- Computer equipment and general purpose electronic instrumentation
- Gas chromatograph/mass spectrometer (THERMOSCIENTIFIC)
- Gas sensor test station, with associated equipment for excitation, data logging and mixture generation
- Ion mobility spectrometer (Gas Detector Array by AirSense Analytics)
- Computing cluster with 32 processors
- Automated headspace sampler (Agilent)
- Temperature and humidity gas conditioner (Assay Technologies)
- Photolonization detector
- Double-column gas chromatography system with flame ionization detector (HP)
- Olfactive port for gas chromatography
- Head-space sampler (Agilent)
- UV-IMS (ultraviolet-ion mobility spectrometry)
- Owlstone vapor generator
- Infusion pumps K-systems

Neuroengineering

Dr. Enric Claverol-Tinturé

Postdoctoral researcher:
Dr. Dobryna Zalvidea

PhD students: Ricardo Morales, Eden Morales, Michael Riss, Ling Wang

Technician: Jennifer Olmos

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

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

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

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

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

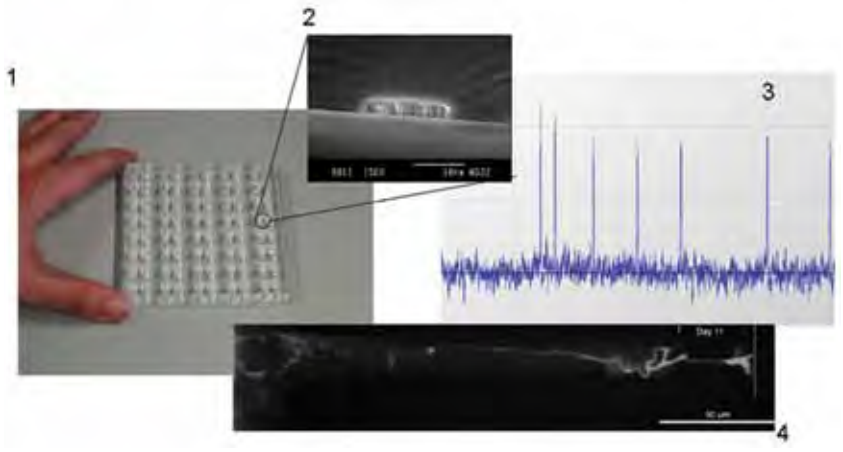


Fig. 1 Multiwell polymeric chip (1) for integrated electrophysiology on a large scale (see scanning electron microscopy — SEM — of an integrated microchannel (2).

Figs 3 and **4** show neuronal activity measured using our devices and an axon growing inside the microchannels.

Research projects

- A Novel Strategy for Development of Multielectrode Devices and Integration of Microfluidics for Recording of Neuronal Activity.
PI: **Enric Claverol-Tinturé** (managed by the UPC)
Collaborative project (FlashPoMs - Inter-Reg) within the framework of EU-FP7.

- Robotic Multielectrode System for Microcircuit Electrophysiology (2007-2010).
PI: **Enric Claverol-Tinturé**
MICINN, Comisión Interministerial de Ciencia y Tecnología (CICYT).

Publications

- Gil, V., Bichler, Z., Lee, J. K., Seira, O., Llorens, F., Bribian, A., Morales, R., Claverol-Tinture, E., Soriano, E., Sumoy, L., Zheng, B. & del Rio, J. A. (2010). Developmental expression of the oligodendrocyte myelin glycoprotein in the mouse telencephalon. *Cerebral Cortex* 20 (8), 1769-1779.

Collaborations with other research centres

Technical University of Eindhoven (Netherlands).

Ludwig-Maximilians-Universität Munich (Germany).

University of Nottingham (United Kingdom).

Vrije Universiteit, Amsterdam (The Netherlands).

DiverDrugs, S.L. (Spain).

Multi Channel Systems GmbH (Germany).

Hebrew University of Jerusalem (Israel).

University of Milano (Italy).

Scientific equipment and techniques

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

Robotics and biomedical imaging programme

Robotics

Prof. Dr. Alícia Casals

Senior researchers: Joan Aranda, Manel Frigola

PhD students: Luis Ernesto Amigo, Miquel Casamitjana, Xavier Giralt, Albert Hernansanz, Victor Sanchez

Technician: Manuel Vinagre Ruiz

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 and medical personnel. This involves acquiring detailed knowledge about the behaviour and intentions of users, 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 person and the machine, taking into account the user's abilities.

Our main project in rehabilitation is the design and development of robot control strategies for a simultaneous operation of a Neurorobot and a Motor Neuroprosthesis. The project addresses the "assist as needed" concept; that is, based on the use of biofeedback, an orthotic device (an exoskeleton) is controlled from user's volitional commands, considering also the user's capabilities (fatigue, level of motor disorder, etc) and their dynamic changes. A special effort is dedicated to developing adequate compliant control strategies, which ensure safe interaction during physical contact between human and robot.

In surgical robotics our research is focused on the design of assisted teleoperation strategies, 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. The research of the group in this area deals with physical (based on touch-force) and remote (based on vision) interaction to provide a safe and user-friendly programming and control environment.

Fig. 1 Teaching a robot how to perform therapeutic exercises.

Fig. 2 Experimentation techniques for microoperation: threading a needle through assisted teleoperation.

Research projects

- **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.

- Estudio y desarrollo de estrategias de cooperación multi-robot con arquitecturas redundantes (2009-2010).
PI: **Alícia Casals** (managed by UPC)
MICINN, Comisión Interministerial de Ciencia y Tecnología (CICYT).

- Sistema de illumincacion inteligente (2010).
PI: **Alícia Casals** (managed by UPC)
Industrial project with Telstar, funded by Fundació Parc Taulí.

Publications

- Frigola, M., Vinagre, M., Casals, A., Amat, J., Santana, F. & Torrens, C. (2010). Robotics as a support tool for experimental optimisation of surgical strategies in orthopaedic surgery. *Applied Bionics and Biomechanics* 7 (3), 231-239.

- Casals, A. (2010). Robótica en sanidad: asistencia en el quirófano y asistencia a las personas. *Automática e Instrumentación* 418, 47-50.

- Casamitjana, M., Pérez, M. C., Aranda, J., Montseny, E. & Martin, E. X. (2010). Reliable 3D reconstruction extending pixel-level certainty measures. *IEEE International Conference on Fuzzy*, 1-7.

- Casals, A., Campos, J., Giralt, X. & Amat, J. (2010). Intuitive Graphic Interface for Assisted Teleoperation in Surgical Applications. *DRHE 2010 Dependable Robots in Human Environments*, 1-6.

- Casals, A. (2010). Human–Robot cooperation techniques in surgery. *ICINCO 2010*, 1-4.

- Aranda, J., Vinagre, M., Marti n, E. X., Casamitjana, M. & Casals, A. (2010). Friendly Human-Machine Interaction in an Adapted Robotized Kitchen. *Computers Helping People with Special Needs* 1, 312-319.

- Andonovski, B., Ponsa, P. & Casals, A. (2010). Towards the development of a haptics guideline in human-robot systems. *3rd International Conference on Human System Interactions (HSI)*, 380-387.

- Amigo, L. E., Casals, A. & Amat, J. (2010). Polyarticulated architecture for the emulation of an isocentric joint in orthetic applications. *BioRob 2010*, 825-830.

Collaborations with other research centres

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

Dr. Enric Laporte Corporació Sanitària Parc Taulí, Sabadell (Spain).

Dr. Joan Antoni Hueto Hospital de la Vall d'Hebrón, Barcelona (Spain).

Dr. Carlos Torrens Hospital del Mar, Barcelona (Spain).

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

Dr. Josep M. Campistol Hospital Clínic, Barcelona (Spain).

Salvador Riera Centre per a la Vida Independent, Barcelona (Spain).

Scientific equipment and techniques

- Experimental robotized domestic environment consisting of a robot, cameras, video projector, and PC for robot and environment intelligent control

- KUKA lightweight robot. Robot specially designed for mobility and interaction with humans and *a priori* unknown environments. It is equipped with a control environment developed by the research team to program anatomic constraints in order to operate in virtual environments


MeO

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 no less than four group leaders with their own support from one of the most prestigious sources, ICREA, in 2010.

ICREA

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 2010, four of IBEC's 16 group leaders were ICREA research professors.

Fundación Botín

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 led by associate director Josep Samitier (page 34).

CIBER-BBN

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.

In 2010, IBEC also entered CIBERES (for respiratory diseases) and CIBERNED (neurodegenerative diseases), virtual research centres where member investigators participate in collaborative research programmes.

CIBER-BBN projects (all 2010-2011)

- **ES-CELLTHERAPY** Use of human pluripotent stem cells as vehicles for localized delivery of therapy to brain tumors. PI: **Ángel Raya**; **Josep Planell**
- **NACRE** New Approaches for Cartilage Regeneration. PI: **Ángel Raya**
- **NANOXEN** Use of optical molecular nanoswitches to control nervous functions in *Xenopus tropicalis*. PI: **Fausto Sanz** (under UB); **María García-Parajo**
- **NANOMEDIAG** Nanobioanalytical platforms for improved medical diagnosis of infections caused by pathogen microorganisms. PI: **Josep Samitier**
- **CELL MECHANICS** Understanding mechanotransduction and cell-substrate interaction mechanisms. Applications in cell therapy and tissue engineering. PI: **Josep Samitier**; **Josep Planell**; **Daniel Navajas**
- **OLIGOCODES** Universal Diagnostic Platforms Based On Oligonucleotide Codified Nanoparticles and DNA Microarray Sensor Devices. PI: **Josep Samitier**
- **BIOSCAFF-EYE** Bio-engineered stem cell niches (BioSC-niche) in ocular surface reconstruction for corneal blindness: from basic research to clinical trials. PI: **Josep Samitier**; **Josep Planell**
- **Bioproterial** Biological activity of matrix proteins at the cell-material interface. PI: **Josep Planell**; **George Altankov**
- **BIOGELANGIO** Biomimetic extracellular matrices for angiogenic activation and anti-inflammatory activity in regenerative medicine. PI: **Josep Planell**
- **SCAFFTIDE** 3D scaffolds and implants functionalized and reinforced with recombinant protein polymers for regenerative medicine. PI: **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**

Research agreements and MoUs

IBEC constantly pursues opportunities to combine with other research institutes with an agreement or Memorandum of Understanding (MoU) which promotes 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 2010, the 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)

Fundació Clínic - Hospital Clínic

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

Memoranda of Understanding

During 2010, IBEC signed memorandums of understanding with two more organisations, bringing its total number of MoUs up to five.

- **The Bellvitge Institute for Biomedical Research (IDIBELL), Barcelona**
- **National Institute for Materials Science (NIMS), Japan**
- **Interstaatliche Hochschule für Technick Buchs (NTB), Switzerland**
- **Institute of Tissue Regeneration Engineering (ITREN), Dankook University, Korea**

  In July 2010 a joint ITREN-IBEC-UPC workshop was organized to stimulate future collaborations and to present the research carried out at ITREN. It also highlighted the ongoing collaborations with the Nanobioengineering (page 34), Molecular and cellular neurobiotechnology (page 23) and Bio/non-bio interactions for regenerative medicine (page 43) groups and the Biomaterials, biomechanics and tissue engineering associated group at the UPC.

- **University of Warwick, UK**

  An MoU was signed in July 2010 between IBEC and Warwick University, namely the Centre for Cognitive and Neural Systems, to cover the field of bioengineering. The collaboration followed the visit of Prof. Julian Gardner to IBEC earlier in the year and aims to promote the exchange of information on bioengineering between research groups, exchange researchers via short term fellowships and implement cooperative research projects under FP7 and other competitive funding instruments.

Institutional initiatives 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 inititatives 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.

Spanish Nanomedicine Platform

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. The Platform 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 2010, the activity of Nanomed Spain was focused on:

- Contribution to the formulation of the National Innovation Strategy (E2I), launched in March. Beyond the recommendations leading to new funding opportunities such as Industria de la Ciencia and INNPACTO projects, the Platform has provided ongoing support to groups and companies to improve the results at subsequent calls.
- Coordination and production of "Nanomedicine in Spain 06-10". This document provides an overview of the main initiatives, large multidisciplinary projects and internationalization efforts undertaken under the Platform's advice and leadership in the period since the 2006 launch of "Vision de la Nanomedicina en España" which marked the beginning of Nanomed Spain's activities.
- Mapping Spanish research capacities in the diverse areas of nanomedicine (nano-based diagnostics, drug delivery and regenerative medicine) alongside interest from industrial members, with consideration towards the adaptation of the Roadmap 2020–ETPN guidelines according to the Spanish position.

PRINCIPAL ACTIVITIES of NANOMED SPAIN:

NanoMed-UII

NanoMed-UII, a value-added service providing support and advice to Spanish companies on how to strengthen their international activity and profile through participation in nanomedicine projects funded by the European Union Seventh Framework Programme (EU-FP7), was launched in January 2009. It was one of the international innovation units financed by the Centro para el Desarrollo Tecnológico Industrial (CDTI) and the Spanish Ministry of Science and Innovation. In addition to providing a consultancy service advising companies on how to prepare projects and create consortia, NanoMed-UII organised networking events and fostered Spanish participation in events promoting new consortia, including the Nanomedicine Partnering Day on 5 May in Barcelona, which attracted 130 attendants and aimed to match leading Spanish academic groups with industry interested in participating in nanomedicine-focused FP7 projects.

NanoMed-UII will run until the submission of the proposals to the 2011 FP7 calls.

Collaboration with other platforms

NanoMed Spain was the organiser, together with the Spanish Technology Platform for Innovative Medicines and the Platform on Healthcare Technology, of the 3rd Annual Conference of Technological Platforms for Biomedical Research in Barcelona on 23-24 February. This annual event has become essential to the promotion of nanotechnology applications to healthcare to the pharma and medical devices industry sectors.

NanoMed Spain also combined efforts with the Progress and Health Foundation, CIBER-BBN (page 62) and Málaga University to organise the 1st International Workshop on Nanomedicine within the NANOSPAIN conference programme (Málaga, 25 March).

Representation of the Spanish nanomedicine community at international level

NanoMed Spain regularly attends the meetings organised by its European counterpart, the European Platform on Nanomedicine (ETPN), to defend the Spanish position with regard to research priorities at European level, as well as to aid Spanish participation in international consortia. In 2010, two major events were hosted by the ETPN, both with NanoMed Spain's participation: Proposers' Day, held in Berlin on 12 April, and the ETPN General Assembly and Forum in Milan on 14-15 October. In addition, NanoMed Spain was invited to participate at the 1st International Workshop organised by the European Medicines Agency (EMA) on 2-3 September 2010. The workshop was shaped as a discussion forum on identified issues and emerging technological aspects, which may provide directions for future developments and regulatory considerations for nanomedicines.

Nano2Market

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

NANOfutures

NANOfutures, an ETIP European Technology Integrating and Innovation Platform, connects and represents relevant technology platforms that require nanotechnologies in their industrial sector and products. It is expected to provide essential input into the follow-up of the FP7 programme.

The set-up of this coordinating platform is promoted and funded by the European Commission through a FP7-sponsored project (CA), which started in October 2010. IBEC is a member of the NANOfutures–CA Steering Committee, with the aim to ensure that the Nano2Market project output is taken into account in this policy effort.

EURONANOBIO

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

Connect-EU

September 2010 saw the kick-off meeting in Barcelona of the Connect-EU programme, an initiative that aims to promote and reinforce Catalan participation in the EU's instruments for research funding such as FP7 and the forthcoming FP8. IBEC leads the Connect-EU network's Nanobio and Nanomed Working Group, which will advise ACC1Ó – the agency set up by the Catalan Government to make Catalan enterprise more globally competitive – about which are the 'hot' topics and the Catalan strengths in this field. The resulting research agenda will increase opportunities to achieve EU funding under the current and future framework programmes. Other local research centres involved in the network include ICFO, ICN and Vall d'Hebron, as well as several companies and CSIC centres.

The Connect-EU conference at Barcelona's World Trade Center on 22-23 September, which was organised by ACC1Ó and Catalan research promoters Talència, attracted more than 700 participants. The next step for the IBEC-led working group is to produce a white paper on nanobiotechnology R&D in the region to present in 2011.

BioNanoMed Catalunya

December saw the first announcement of a new initiative in nanomedicine, BioNanoMed Catalunya, fostered by IBEC and the Catalan Bioregion agency, Biocat (page 66). This alliance aims to bring together researchers, hospitals and companies working in the region to share know-how and resources, facilitate new developments in nanomedicine and gain international visibility for the advances in the field that are emerging in Catalonia. IBEC and Biocat have been working together to develop the initiative since December 2009. The other research centres initially involved include IDIBELL, with a leading role from the biomedical side, as well as Hospital Clinic, Vall d'Hebron, ICIQ, ICFO, ICN, ICMAB, IQAC and the technological centre LEITAT Biomed. On the industry side, the core partners will be Ferrer, Grupo Lipotec and Biokit.

KET – Key Enabling Technologies

IBEC's director, Josep A. Planell, is Sherpa of the EC's Key Enabling Technologies High Level Group (HLG) on Nanotechnology. Launched in July 2010, the mission of the HLG is to assess the competitive situation of technologies in the EU, analyse the available public and private R&D capacities for them, and to propose specific policy recommendations for more effective industrial deployment of KETs based on consultations of European stakeholders. The final report in 2011 will play a vital part in the implementation of the EC's Europe 2020 strategy.

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.

ACER

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 memebr centres in the areas they represent, which includes social sciences and humanities, life sciences and health sciences, natural mathematics and technology.

Most of ACER's members have close links with universities and a significant participation of the Generalitat de Catalunya as well as support from various public and private sources.

Catalan Researcher Mobility Support Node

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

Interbio

Sponsored by the EC, Interbio is an interregional cooperation programme which aims at fostering transnational cooperation, technology transfer and innovation in the fields of biotechnologies and life sciences in south-west Europe. Interbio brings together research centres, technology platforms and companies from the Barcelona, Bordeaux, Lisbon, Toulouse and Valencia regions.

Biocat: The BioRegion of Catalonia

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

Biopol'H

Biopol'H is a biomedical and biotechnology cluster of health care facilities, knowledge-generating institutions, research centres and companies from the life sciences and health sectors, in a physical environment formed by the Bellvitge Institute for Biomedical Research (IDIBELL), the University Hospital of Bellvitge, the Catalan Institute of Oncology (ICO), the Health Sciences Campus of Bellvitge (UB) and the future Biopol Health Science Park. It is located within the municipality of L'Hospitalet de Llobregat. In September 2010 the directorate of IBEC attended the official signing of a Framework Agreement between the institute and the Biopol'H consortium (see page 8).

Nanoaracat

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

European Technological Platform on Nanomedicine (ETPN)

A voting member of 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 European Federation of Biotechnology (EFB)

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

HUBc

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.

Its main strength is the high degree of specialization in the field of health, provide attraction of talents and capabilities will add the cities of Barcelona and L'Hospitalet de Llobregat to coordinate, stimulate and promote biomedicine, biotechnology and medical technologies. On 21 October 2010, HUBc achieved recognition by the Ministries of Education and Science and Innovation as a campus of international excellence.


Goal:
Robotics
3rd

Events
and communications

Seminars
and PhD Discussions

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.

- 15 January

Prof. Dr. Benoit Ladoux, Université Paris 7, France
Cell responses to their physical micro-environments

- 19 February

Prof. Dr. Jose A. del Río, IBEC
Control of neural stem cell proliferation by the cellular prion protein

- 25 February

Dipl. Ing. Matthias Schwaibold, Head of the Sleep Diagnosis and Adaptive Sleep Therapy Department, MCC GmbH & Co. KG, Karlsruhe, Germany

Prof. Dr. Armin Bolz, C.E.O., Corscience GmbH & Co. KG, Erlangen, Germany / Institute of Biomedical Engineering, Karlsruhe Institute of Technology (KIT), Karlsruhe, Germany

Prof. Dr. Thomas Penzel, Sleep Center, Department of Cardiology, Charité University Hospital, Berlin, Germany

From the idea to the product: how research in medical science and engineering improves the diagnosis and therapy of today's diseases

- 5 March

Prof. Dr. Paul F.M.J. Verschure, Catalan Institute of Advanced Research (ICREA) research professor, Technology Department, Universitat Pompeu Fabra
Understanding mind, brain and behaviour through constructing synthetic perceptive, emotive and cognitive systems

- 12 March

Prof. Dr. Josep Samitier, IBEC
Nanobiosensor array based on G-proteins-coupled olfactory receptors

- 19 March

Prof. Dr. Britt-Marie Sjoberg, Department of Molecular Biology & Functional Genomics, Stockholm University
Ribonucleotide reductase - an essential gene family with dynamic inheritance

- 9 April

Prof. Julian Gardner, Sensors Research Laboratory, School of Engineering, Warwick University, Coventry, UK
Artificial Olfaction: A Warwick Perspective

- 23 April

Prof. Xavier Navarro, Institute of Neurosciences, Dept Cell Biology, Physiology and Immunology, Universitat Autònoma de Barcelona. CIBERNED
Neural Interfaces: The Link between the Nervous System and Robotic Devices

- 21 May

Prof. Youri Koubychine, Institut de Tècniques Energètiques, Universitat Politècnica de Catalunya

Prof. Alícia Casals, IBEC

Dedicated Robotized Facility for Intraoperative Electron-Beam Irradiation Based on a Race-Track Microtron

- 31 May

BioMEMS group, Angstrom Laboratory, Uppsala University, Sweden
Ongoing projects at the Angstrom Laboratory

- 2 July

Prof. Abhay Pandit, Network of Excellence for Functional Biomaterials, National University of Ireland, Galway
Towards Functionalised Nanostructured Biomaterials Platforms

- 9 July

Prof. Artur Llobet, Laboratori de Neurobiologia, Institut d'Investigació Biomèdica de Bellvitge (IDIBELL)
Effect of Glial Secreted Factors on Synaptic Maturation

- 6 September

Prof. Dennis E. Discher, University of Pennsylvania
Matrix and Myosin in cell fate decisions: MSCs, HSCs and embryonic cardiomyocytes

- 21 September

Prof. Dr.-med. Winfried Randerath, Universitätsklinikum Bethanien, Solingen, Germany
Current pathophysiological concepts and therapeutical options for Cheyne Stokes Respiration

Dipl.-Ing. Dirk Sommermeyer, Sleep Laboratory, Department of Pulmonary Medicine, Sahlgrenska University Hospital, Gothenburg, Sweden
Prediction of cardiovascular risk from peripheral pulse wave

■ 1 October

Dr. Carlos Eduardo Semino, Bioengineering Department, Institut Químic de Sarrià – Universitat Ramon Llull, Barcelona, Spain; Translational Centre for Regenerative Medicine, Leipzig
Evidences of cellular self-organization and pattern formation during development of tissue engineering constructs

Yongmin Kim, Ph.D, Professor of Bioengineering and Electrical Engineering; Adjunct Professor of Radiology and Computer Science and Engineering, University of Washington
Translational research and technology commercialization in bioengineering

■ 15 October

Prof. C.A. van Blitterswijk, Departments of Tissue Regeneration and Membrane Technology, University of Twente, The Netherlands
Complex Tissue

■ 5 November

Prof. Laura Lechuga, Research Center on Nanoscience and Nanotechnology (CIN2: CSIC-ICN) and Networking Center on Nanomedicine (CIBER-BBN), Barcelona
Nanobiosensor platforms for point-of-care diagnostics: sensitive, realtime and label-free analysis

■ 19 November

Prof. Nora Ventosa, Institute of Materials Science of Barcelona (ICMAB-CSIC), Barcelona
Preparation of nanomedicines using green compressed fluids: From phase diagrams to production processes of industrial interest

■ 26 November

Prof. Leo Joskowicz, Computer-Assisted Surgery and Medical Image Processing Lab, School of Engineering and Computer Science, The Hebrew University of Jerusalem
Interventional radiology: Models and simulation

■ 10 December

Prof. James Sharpe, Centre for Genomic Regulation, Barcelona
A 3D finite element model of vertebrate limb development

Leo Joskowicz

PhD Discussions

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 2010, 12 PhD students participated in these sessions. Additionally, in order to help the students in their career development and provide them with additional skills, three invited speakers gave lectures on preparing and publishing research papers, entrepreneurship and career mobility.

Complementary skills sessions (invited speakers)

■ 26 February

Marta Pulido, MD, PhD, Freelance Biomedical Editor/ Consulting Editor, Institut Municipal d'Investigació Mèdica (IMIM)-Hospital del Mar Barcelona
Tips for preparing and publishing your research paper

■ 18 June

Dr. Enric Claverol, IBEC
Entrepreneurship in Science: Starting Your Own Company in Bioengineering

■ 29 October

Elisabeth Pain, Science Careers Contributing Editor
The Ins and Outs of an International Research Career

Meetings
and outreach activities

Nano2Market

A seminar was held in Barcelona to review the various case studies identified as part of Nano2Market's activities (page 65).

- February
- IBEC
- 26 people

EscoLab visit

EscoLab is an initiative of Barcelona City Council's Commission for the Promotion of Scientific Culture. It introduces high school and VET students to the city's research laboratories, with the aim to increase scientific vocation among students.

- February
- IBEC
- 60 people

Nanomediag

Meeting of the nationally-funded project 'Nanobioanalytical platforms for improved medical diagnosis of infections caused by pathogen microorganisms' (PI: Elena Martínez).

- March
- IBEC, Parc Científic de Barcelona (PCB)
- 14 people

Recerca en acció

An education fair organised by the Catalan Foundation for Research and Innovation to demonstrate the results of scientific and technological research being carried out by universities, research centers, businesses and other organizations, and to promote science and technology careers to.

- March
- Fira de Barcelona
- 70000 people

IBEC Music Festival

Private concert for and by the staff of IBEC.

- March
- Sala BeCool, Barcelona
- 200 people

Fira Recerca en Directe

The 'Live Research' fair is organized annually by the Parc Científic de Barcelona (PCB) with the support of the Obra Social Caixa Catalunya bank. Its aim is to improve understanding and awareness of science by presenting research currently being undertaken in Barcelona to the general public, with researchers manning the stands to demonstrate and explain their methods and goals in an accessible way.

In 2010 scientists from IBEC's Bio/non-bio interactions for regenerative medicine group attended the fair with an activity about the structures they are developing to facilitate bone growth.

- April
- La Pedrera, Barcelona
- 1200 people

Nanomedicine Partnering Day

NanoMed-UII's Nanomedicine Partnering Day attracted 130 attendants and aimed to match leading Spanish academic groups with industry interested in participating in nanomedicine-focused FP7 projects.

- May
- Hospital de Sant Pau, Barcelona
- 130 people

Fira d'Empreses

This Business Fair, organized by the UB's faculties of Physics and Chemistry is to facilitate the job placements of graduates and masters students and to improve relations with the business sector.

- May
- University of Barcelona
- 250 people

The 3rd IBEC Symposium on Bioengineering and Nanomedicine

3rd IBEC Symposium on Bionengineering and Nanomedicine

The IBEC Symposium is a forum where internationally prestigious experts present their most recent results in forefront areas in bioengineering and nanomedicine. It is also a platform for young researchers at the Institute to present their work. Furthermore, the forum is open to the whole scientific community, so young researchers from Spanish or foreign research centres can take part and present their projects.

With 240 people attending the 3rd IBEC Symposium on Bioengineering and Nanomedicine, attendance was 20% up on the previous year. A total of 79 young researchers presented posters, and 45 of them also gave oral presentations of their work.

- June
- 11 keynote speakers
- 240 people
- 79 posters

V Meeting ITREN-IBEC-UPC

A joint workshop to stimulate future collaborations and present the research carried out at the Institute of Tissue Regeneration Engineering (ITREN), Korea.

- July
- IBEC
- 40 people

Jornada "Teràpies avançades"

More than 60 researchers, medical professionals, company representatives and other interested participants from the health sector came to IBEC on 5 October for a CIBER-BBN conference, "Research and development of Advanced Therapies: an introduction to regulatory aspects".

- October
- IBEC
- 60 people

Complementary skills training

Courses in Leadership, Communication and Motivation, Scientific Writing in English and Conference Presentation Skills, organised by the Human Resources department.

- Throughout the year
- IBEC
- 70 people approximately

NeuroChem project meeting

Meeting of the project 'Biologically Inspired Computation for Chemical Sensing (NeuroChem)', which is funded by the European Commission under FP7 and coordinated by Artificial Olfaction group leader Santiago Marco.

- October
- IBEC
- 20 people

8th Meeting of the SEM Molecular Microbiology group

IBEC hosted the 8th meeting of the Molecular Microbiology group of the Sociedad Española de Microbiología (SEM). SEM is an interdisciplinary society with some 1,700 members, most of which are part of one of 11 specialist groups.

- November
- Facultat de Física, Universitat de Barcelona
- 150 people

Angioscaff annual meeting

2010's meeting of the European project AngioScaff (Angiogenesis-inducing Bioactive and Bioresponsive Scaffolds in Tissue Engineering) was organised by IBEC, home to two of the more than 30 specialist research groups that make up the consortium. IBEC director Josep Planell's Bio/non-bio Interactions for Regenerative Medicine group and Damien Lacroix's Biomechanics and Mechanobiology team are working on the design and development side of the project, focusing on bioactivity, cell-associated environmental responsiveness and controllable porosity.

- December
- Hotel H10 Marina Barcelona
- 80 people approximately

Communications

Press office

With all news still being published regularly on the IBEC web-site, stories that warrant a further push to the media include groundbreaking science stories published in high-ranking journals or news of EU funding for health projects.

Three press releases were issued by IBEC's Press Office at the end of the year:

12 November

Beating the regeneration blockers

IBEC researchers shed light on inhibitory molecules in neuroregeneration

(PI: José Antonio del Río)

3 December

The regeneration game

Tackling tissue morphogenesis in humans

(PIs: Damien Lacroix/Josep Planell)

21 December

MySpine: a virtual spine for a real problem

EU-funded project aims to improve treatment and prognosis of spinal diseases

(PI: Damien Lacroix)

Media coverage

January

EcoDiario, El Economista 26/01/2010
"Investigadores catalanes y franceses colaborarán para aplicar la nanotecnología al cáncer"
International workshop co-organized by IBEC on new applications for cancer diagnosis and treatment in Montpellier, France.

March

Debate section, La Vanguardia 13/03/2010
"El reto de la nanotecnología – Aportación minúscula, mejora grande"
Josep Samitier analyzes the challenges and contributions of nanotechnology.

El Periódico de Catalunya 14/03/2010
"Estamos desarrollando una nariz bioelectrónica que será capaz de diagnosticar enfermedades"
In an interview, Josep Samitier explains the scientific basis and the development of a bioelectronic device to detect diseases.

May

Magazine, La Vanguardia 15/05/2010
"Los nuevos dioses: Los avances de la ciencia permiten al ser humano alcanzar logros que parecen imposibles"
In an article about state-of-the-art scientific and medical developments for health improvement, some key Spanish researchers and doctors explain their contributions; one of them is Josep Samitier.

Europa Press 26/05/2010
"La UB presenta un macroproyecto de la salud para ser Campus de Excelencia Internacional 2010"
IBEC is one of the institutions and reseach centres that is included in the proposal for creating a large heath campus in Barcelona.

June

Global Talent 03/06/2010
Diario Médico 04/06/2010
Público 07/06/2010
Coverage of the 3rd IBEC Symposium on Bioengineering and Nanomedicine.

Science Careers 12/06/2010
"Designing a Career in Biomedical Engineering"
In an article about the 'pragmatic, problem-solving orientation and multidisciplinary exposure [of] biomedical engineers' Robotics group leader Alícia Casals is quoted as an example of a scientist whose work is at the intersection of several disciplines.

■ September

TV3 23/09/2010
IBEC Project manager Juan Fran Sangüesa was filmed as he gave a presentation about the BOND project and interviewed for the midday bulletin on TV3, the Catalan television channel.

El Far 29/09/2010
The Baix Llobregat-based weekly El Far mentions the signature of the agreement between IBEC and the Biopol'H consortium on 17 September.

■ October

El Pais 05/10/2010
"Cuestión de límites"
Article written by associate director Josep Samitier to accompany a feature by El Pais journalist Mónica López Ferrado, "Los 'nanoriesgos' no son tan diminutos" ("'Nanorisks' are not so small').

www.noticiascadadia.com 20/10/2010
"Oportunidades de crecimiento de los biomateriales en las tecnologías médicas"
An announcement about 20 October's Biocat-organised meeting on 'Biomateriales: de la biónica hacia la regeneración y las terapias avanzadas' at the Museo Colet in Barcelona. IBEC director Josep A. Planell gave the keynote speech.

Diari digital del Parc Científic Barcelona 29/10/2010
"Qui és...? María García-Parajo "La ciència és una passió""
An interview with group leader María appeared in the online newsletter of the PCB. As a result María was also interviewed by Ràdio 4's for their L'Observatori programme, on which Josep Samitier also featured during November.

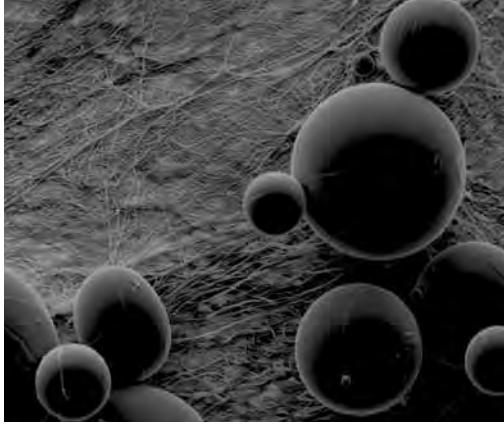
■ November

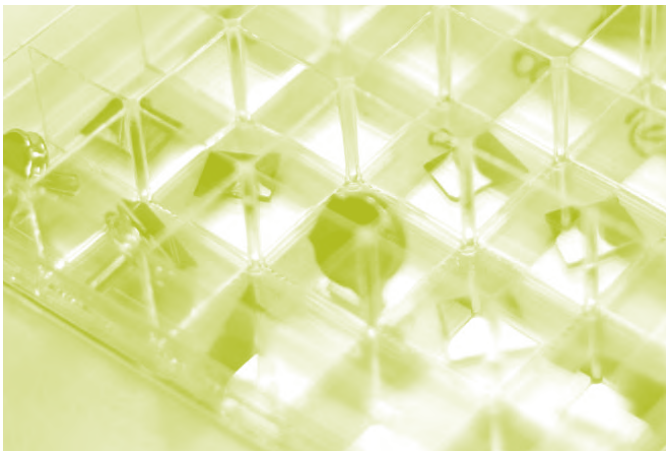
Various science and health websites
"Beating the regeneration blockers"
The 12 November press release about the Molecular and Cellular Neurobiotechnology group's research on inhibitory molecules in neuroregeneration was picked up by various online scientific and health news sites including www.sciencedaily.com, www.mstrust.org.uk, www.medicalnewstoday.com and Cell DNA.

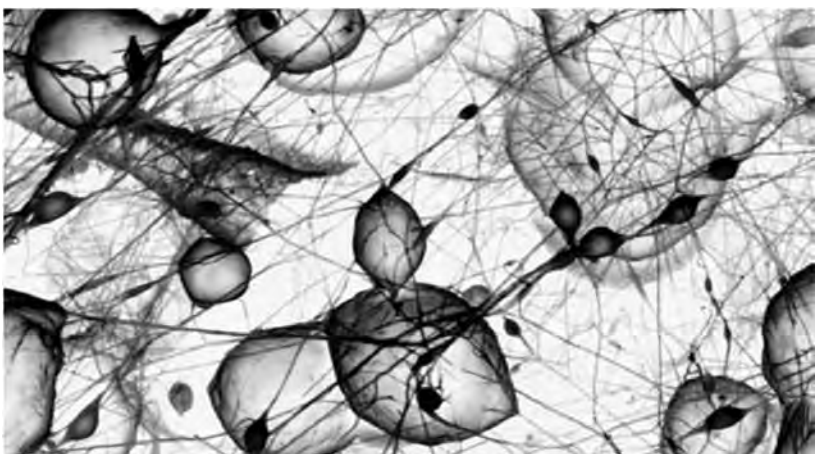
InsideIBEC

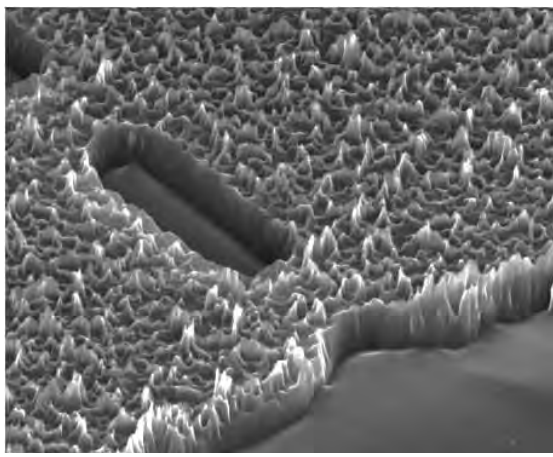
At the end of 2010 the first issue of IBEC's quarterly newsletter, InsideIBEC, was launched. The editions are available to view on the IBEC website and are also distributed to news and events subscribers and IBEC's alumni.









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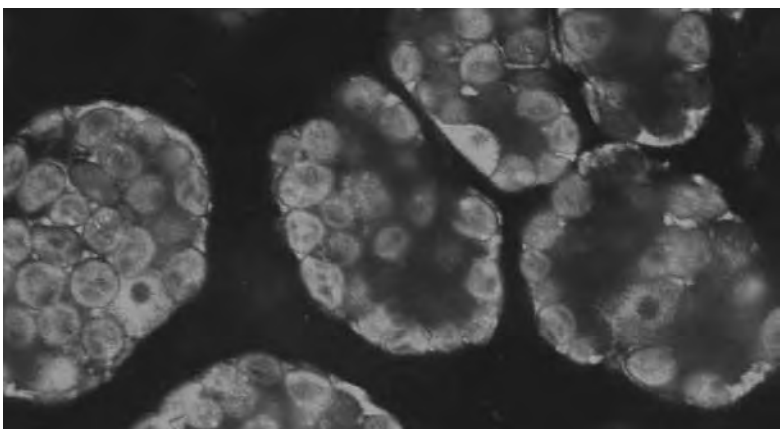

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