Annual Report 2016

IBEC

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Institute for Bioengineering of Catalonia

EXCELÈNCIA SEVERO OCHOA

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Welcome

In calendar terms, 2016 was the end of an era, being the ninth year of activity for IBEC as a research institution and a year spent full of excited anticipation for the coming tenth anniversary.

But in other ways, it also felt like a new beginning. With the generous buffer of 2015's Severo Ochoa award we were able to feel that we were finally able to put the country's financial crisis behind us. We boosted our global links by entering the EBICS International exchange program and attending their 1st International Workshop on Engineering Living Systems in Chicago, as well as with our continued involvement in EIT Health and the European Technological Platform on Nanomedicine. On a national level, we continued our management of the Spanish Nanomedicine Platform and became part of the new NEXTHEALTH RIS3CAT community of research innovation strategies for smart specialisation in Health.

The junior group leader who joined us in 2016, Javier Ramon, boosted our ERC count with a Starting Grant for his project 'Diabetes Approach by Multi-Organ-on-a-Chip'. While Javier was one of only six researchers in Catalonia to receive the Starting Grant in 2016, ICREA research professor Samuel Sánchez netted an ERC Proof of Concept grant for his Microcleaners project, which will tackle pollutants in water. Other awards in 2016 included two for junior group leader Pere Roca-Cusachs, who received the American Society for Cell Biology's Gibco Emerging Leader Prize as well as being accepted into the EMBO Young Investigator Programme. IBEC group leader and ICREA research professor Xavier Trepat came third in the *La Vanguardia* Science Award alongside the UPC's Marino Arroyo, and Samuel Sánchez received both the Círculo Ecuestre's Premio Joven Relevante and Catalonia's National Research Award for Young Talent – two more accolades to add to his growing collection.

During the year we celebrated six *Nature* group papers and a *Science* paper; 108 indexed journal papers in total, 86% of them in the first quartile; four new patents; and 17 PhD theses. Research highlights during the year included the resolution of a long-standing chemistry enigma when researchers at IBEC, the UB and two universities in Australia introduced in *Nature* a new way of catalysing chemical reactions. IBEC researchers also revealed how tissue rigidity activates cancer in a *Nature Cell Biology* study, and in *Science* they showed that several types of cells are attracted to the most rigid areas of tissues.

In regards to our relationships with industry, 2016 saw IBEC sign one collaboration agreement with Bioibérica S.A. and another with the pharmaceutical company Ferrer and bioinformatics company Mind the Byte. At MEDICA in Germany, GENOMICA presented a new in vitro diagnostics device for HPV testing developed by the IBEC-GENOMICA Joint Unit, a tangible success story in the institute's active pursuit of the establishment of research projects with industry partners who share its commitment to bringing high-quality health research and technologies to market and the patient. We also introduced our 3D bioprinting capabilities at the first IN(3D)USTRY event, reinforcing our role as the organisation that has made this technology available to researchers, clinicians and companies in Barcelona, Spain and the south of Europe.

Our link with hospitals and clinicians, another important part of this ongoing mission, was reinforced during 2016 when IBEC became part of a revolution in fetal surgery and the research of prenatal diseases thanks to support by the Obra Social "la Caixa" and Cellex foundations, which funded two major projects coordinated by Hospital Clínic and Hospital Sant Joan de Déu's Fetal Medicine Research Centre, Fetal i+D.

March saw the first applicants to IBEC's International PhD Programme compete for the programme's nine positions, and later in the year we launched the "La Caixa"-funded INPhINIT programme, another option for young scientists to begin their careers at IBEC. For more established researchers, the first Bioengineering Excellence Scientific Training (BEST) call for postdocs, co-funded by H2020 and our Severo Ochoa grant, took place.

With all this going on, 2016 was another great and memorable year in the consolidation of IBEC as a global reference in bioengineering – as well as a pioneer in work-life balance for its staff, winning an Alares Foundation prize for "Reconciliation of Working Life, Family and Personal and Social Responsibility" in the Universities, Business Schools and Research Organisations category.

We step into 2017 with gusto, ready to celebrate IBEC's first decade and our plans for many more to come.

Josep Samitier
Director of IBEC

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February

New non-invasive monitoring of COPD

A collaboration between IBEC's Biomedical Signal Processing and Interpretation group and two local hospitals resulted in a new non-invasive method of evaluating the efficiency of the respiratory muscles in patients with chronic obstructive pulmonary disease (COPD).

Published in the *European Respiratory Journal*, the study by Raimon Jane's group and his collaborators at the Hospital Germans Trias i Pujol and Hospital del Mar describes how they used respiratory muscle mechanomyogram (MMG) – a non-invasive way to measure vibrations related to the mechanical activation of muscles using accelerometers positioned on the skin – to assess respiratory muscle function in ten patients with severe-to-very severe COPD. The MMG is higher in more severe patients, even during quiet breathing, showing a lower efficiency of the respiratory muscles.

The researchers are confident that his contribution can be a very useful tool to evaluate COPD progression, and could provide valuable information on the effect of treatments.

L. Sarlabous et al (2015). Efficiency of mechanical activation of inspiratory muscles in COPD using sample entropy. Eur Respir J. *46(6):1808-11*

Micromotors use surface variations for docking and guiding

Researchers at IBEC, the Max-Planck Institute for Intelligent Systems and the University of Stuttgart have revealed in an article in *Nature Communications* that micromotors can be guided using tiny topographical patterns on the surfaces over which they swim.

Samuel Sánchez and Mykola Tasinkevych's 'microswimmers' are usually guided through fluids using specially engineered magnetic multilayer coatings, which combined with external magnetic fields, helps to control their trajectory.

This new study, the result of a collaboration between experimental research and theory, demonstrates that the particles can use the features of the surfaces over which they swim to change their direction of motion. "This finding opens up the possibility of guiding these particles along complex pathways using small changes in the surface," says Samuel. "This can have significant implications for the design of new artificial micromotors for many applications."

Simmchen, J. et al (2016). Topographical pathways guide chemical microswimmers. Nat. Commun*, 7, 10598*

Playing with molecular Lego

IBEC junior group leader Lorenzo Albertazzi and his former colleagues at the Eindhoven University of Technology, working together with industry partner Novartis, made a leap in drug delivery vectors by developing a new type of carrier with some groundbreaking improvements.

They focused on supramolecular polymers, an emerging family of nanosized structures with many potential uses in materials chemistry and medicine, to prepare them. Exploiting the unique modular approach of supramolecular chemistry, the researchers could co-assemble neutral and positively charged polymers known as BTAs and control the overall properties of the polymer by simple mixing of monomers – molecules that bind chemically (or supramolecularly) to others. "This unique modularity means that we essentially have a library of building blocks – a bit like a big bucket of Lego bricks in different colours – and we can combine them simply mixing the ones we like in a vial," explains Lorenzo. "This is possible because the bricks self-assemble, means they spontaneously get together to form a fiber."

Not only that, but supramolecular polymers also contain two compartments that can carry more than one type of drug. Small hydrophobic compounds can be encapsulated in the lipophilic core, while siRNA can be condensed on the outside via electrostatic interactions.

M.H. Bakker et al (2016). "Multicomponent Supramolecular Polymers as a Modular Platform for Intracellular Delivery". ACS Nano*, 10 (2), pp 1845–1852*

March

Scientists solve long-standing chemistry enigma

Researchers at IBEC, the University of Barcelona and two universities in Australia introduced a new way of catalysing chemical reactions by applying an electric field between the reacting molecules. This opens the door for the faster and cheaper fabrication of chemical compounds.

The reaction studied was a classical Diels-Alder reaction that was promoted by applying an oriented electric field between two nano-electrodes containing the reacting molecules.

"Theory suggested that many chemical reactions – and not just redox (electron transferring) reactions, as is often thought – might be catalysed by applying an electric field," says Ismael Díez-Pérez, senior researcher at IBEC and assistant professor at the UB, who led the *Nature* study. "We've provided experimental evidence for this for the first time."

Being able to catalyse chemical reactions is essential, as it speeds up the reaction and thus makes it more proliferate – and therefore cheaper to use – in its many applications. Electrostatic catalysis (the use of electric fields) is the least developed form of catalysis in synthetic chemistry, because electrostatic effects are strongly directional.

A.C. Aragonès et al (2016). Electrostatic catalysis of a Diels–Alder reaction. Nature, *531, 88–91*

Tiny microbots that can clean up water

IBEC researchers developed a self-propelled tiny 'microbot' that can remove lead from contaminated water. Working with colleagues in Stuttgart and Singapore, Samuel Sánchez's group used graphene oxide to make their microscale motors, which are able to adsorb lead from industrial wastewater from a level of 1000 parts-per-billion to down to below 50 parts-per-billion in just an hour.

The graphene outer shell of the microbot captures the lead, which can later be removed for recycling The inner layer of platinum works as the engine, decomposing hydrogen peroxide as fuel so that the bot can self-propel. Between the graphene oxide and platinum layers is a layer of nickel that allows researchers to control the movement and direction of the microbot magnetically from outside. A magnetic field can be used to collect them all from the water when they've finished, to be used again.

"We now plan to develop our microbots to be able to collect other contaminants, as well as reducing the cost of making them and being able to mass-produce them," says Samuel.

D. Vilela et al. "Graphene-Based Microbots for Toxic Heavy Metal Removal and Recovery from Water." Nano Letters, *10.1021/acs.nanolett.6b00768*

April

How tissue stiffness activates cancer

Researchers at IBEC revealed how tissue rigidity activates cancer, new knowledge that could potentially lead to new strategies to impair or even halt the growth of tumours.

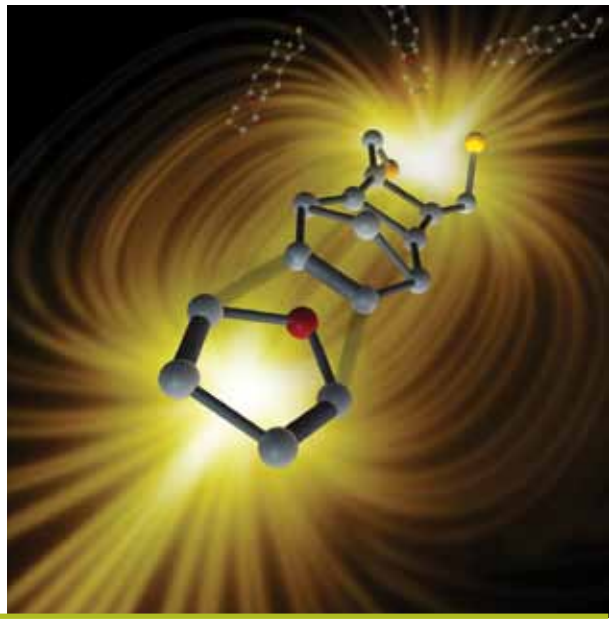
The scientists and their collaborators at the Georgia Institute of Technology identified the mechanism by which tissue stiffness activates a protein called YAP, a major oncogene. "Most solid tumours are stiffer than normal tissue; for example, breast cancer is usually screened by detecting hard lumps in the breast," explains group leader at IBEC and assistant professor at the University of Barcelona Pere Roca-Cusachs. "What's more, increasing or decreasing tissue stiffness can enhance or impair tumour progression respectively."

Cells must apply forces to their surroundings to detect stiffness. They do this through different molecules including integrins, which directly bind cells to their surrounding extracellular matrix, and talin, which connects integrins to the cell's cytoskeleton.

The researchers discovered that, when cells pull from those molecules while applying forces, if the substrate is stiff, the force unfolds talin, which exposes a binding domain to vinculin, which then binds and triggers the activation of YAP – one of the major players in tumour progression. If the substrate is soft, however, the force is applied slower, causing integrins to unbind from the tissue before talin can unfold, so YAP is not activated.

This is an important first step that opens the way towards the eventual development of a new strategy that could impair the growth of many types of cancer: breast, lung, prostate, skin, and many others.

A. Elosegui-Artola et al (2016). "Mechanical regulation of a molecular clutch defines force transmission and transduction in response to matrix rigidity." Nature Cell Biology, *DOI: 10.1038/ncb3336*



Scientists solve long-standing chemistry enigma: the first-ever catalysis of a chemical reaction using an electric field, which could revolutionise the way we produce chemicals for applications in daily life

May

Enzymes that help bacteria make themselves at home

IBEC researchers came a step closer to understanding how bacteria can cause chronic infections by identifying the key enzymes that allow them to create the right conditions for infection.

When *P. aeruginosa* bacteria cause chronic lung infections in patients with cystic fibrosis or chronic obstructive pulmonary disease (COPD), it means they have been able to form a mature biofilm in situ that lets them grow and adapt. This biofilm not only enhances cell-to-cell communication for the bacteria, thus allowing the infection to increase and thrive, but it also increases the chances of developing new antibiotic resistance.

The scientists modeled a *P. aeruginosa* biofilm as a set of layers with different RNR expression profiles. "We found that the bacteria had difficulties forming a biofilm when class II and III RNRs – the oxygen independent and oxygen sensitive ones – were missing," explains Anna Crespo. "Classes II and III are clearly essential for anaerobic growth, and without them, fully mature biofilms will not be able to establish themselves."

Their findings bring researchers a step closer to the understanding of this complex growth pattern and play an important role in understanding the virulence of bacterial biofilms, which will help towards the better design of specific antibacterial drugs.

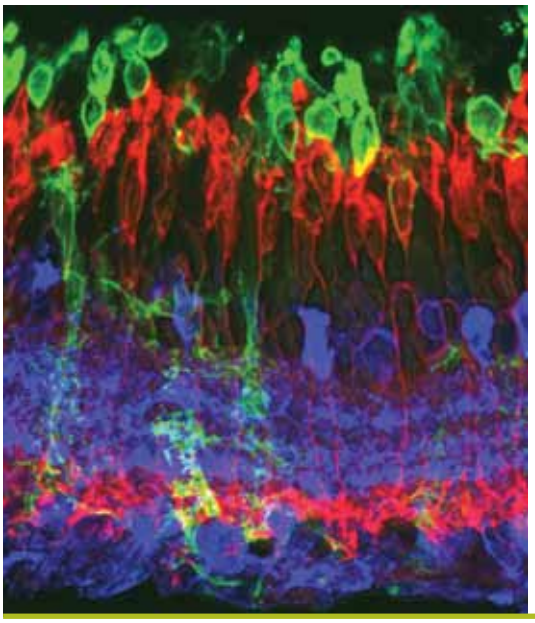
A. Crespo et al (2016). Pseudomonas aeruginosa *exhibits deficient biofilm formation in the absence of class II and III ribonucleotide reductases due to hindered anaerobic growth.* Frontiers in Microbiology *7:688*

Tracking bacterial virulence: global modulators as indicators

IBEC researchers and their collaborators defined new bacterial virulence markers that could help track and prevent outbreaks of *E. coli*.

In a paper published in *Scientific Reports*, the researchers at IBEC, the UB, the Universidade de Santiago de Compostela and Germany's Institute of Medical Microbiology and DZIF examined the correlation between the presence of certain genes and the virulence phenotype of highly pathogenic *E. coli* strains. The researchers found that the genomes of several intestinal pathogenic enteroaggregative *E. coli* strains harbour two variants of a gene that encodes a global modulator (the hha gene). These variants, termed hha2 and hha3, predominate in shiga toxin-producing isolates, such as the deadly O104:H4, as well as in the widely distributed and antibiotic resistant ST131 isolates, that cause extraintestinal infections.

"We show that tracking these proteins and their



Vision restoration by molecular prostheses: mouse rd10 with a fully degenerated retina which is able to "find" light

genes can be a new strategy to identify bacterial pathogenic serotypes," says Antonio Juárez, UB professor and associate researcher at IBEC, who led the study. "If we can amplify hha2 and hha3 as a virulence indicator in environmental and clinical *E. coli* isolates, this will help to easily track them and prevent outbreaks."

A. Prieto et al (2016). Tracking bacterial virulence: global modulators as indicators. Sci Rep *6, Article number: 25973*

Looking to the ocean for malaria solutions

Researchers found heparin-like molecules with reduced blood-thinning activity that can be used for therapeutic approaches against malaria – in sea cucumbers, red algae and marine sponges.

While heparin is able to block the cell adhesion of infected red blood cells to various host receptors and disrupt the growth of the pathogen, its downfall is its powerful anticoagulating activity: the quantities needed for malaria treatment would result in too much blood-thinning and bleeding. There's also the potential risk of infection, since polysaccharides such as heparin tend to be obtained from mammals.

The IBEC/ISGlobal joint Nanomalaria unit, together with their collaborators at IN2UB and the Universidade Federal do Rio de Janeiro, looked to the ocean for their solution to this problem. In heparin-like molecules from sea cucumbers, red algae and marine sponges, the researchers found that the anticoagulant properties were much reduced.

Their discovery means that heparin-related molecules can now be explored for new therapeutic approaches against malaria where polysaccharides with low anticoagulating activity could play a dual role as drugs and to encourage immune response.

J. Marques et al (2016). Marine organism sulfated polysaccharides exhibiting significant antimalarial activity and inhibition of red blood cell invasion by Plasmodium. Sci Rep *6, Article number: 24368*

Generating human heart grafts from hPSCs

Scientists from IBEC, in collaboration with the Hospital General Universitario Gregorio Marañón in Spain and two other groups in the USA, made a big leap in heart regeneration advances by achieving heart grafts from human pluripotent stem cells for the first time in less than one month.

The collaborators described how they decellularized human hearts, leaving the extracellular matrix intact. They then used genome-editing techniques on human pluripotent stem cells (hPSCs) to efficiently produce cardiomyocytes, or heart cells, which they then used to repopulate the extracellular matrices of the decellularized human ventricles. Pluripotent stem cells are crucial for this process, as the body is not able to generate new cardiomyocytes after heart attack or other damage.

The cells within decellularized human heart matrices showed a higher degree of physiological and molecular cardiac differentiation compared to those cultured on regular tissue culture plates, which has been the usual method up to now. It took just 24 days for these human cardiac grafts to exhibit the correct electrophysiological responses needed in cardiac function; in other words, beating.

This type of de- and recellularization of organs represents a promising strategy for the development of biofunctional organs for drug screening and personalized medicine.

E. Garreta et al (2016). Myocardial commitment from human pluripotent stem cells: Rapid production of human heart grafts. Biomaterials*, 98, 64-78*

June

Non-invasive activation of proteins in deep tissue

Researchers at IBEC and their collaborators at the Centre of Regenerative Medicine of Barcelona developed a revolutionary new technique based on photoactivation, by which cells in deep tissue can activated and tracked *in vivo* without causing any damage.

The method is based on a photoactivation system that uses an inactive encapsulated inductor (Cre-loxP) that penetrates deep inside the body but only becomes functional when activated by light. Once activated, the inductor is able to modify certain parts of the DNA of particular cells whose behaviour is being studied. In this way, protein expression is controlled and changes can be targeted to specific cell types by using an external stimulus as a trigger.

"This innovative technique is a solution to the dispersion problem and enables the activation of proteins found in the cells in deeper tissues *in vivo* without interfering with the life expectancy of the animal," says IBEC's Dobryna Zalvidea.

The genetic modification persists throughout the life of the cell and is transmitted to its descendants.

I. Tekeli et al (2016). Long-term in vivo single-cell lineage tracing of Deep structures using three-photon activation. Light: Science & applications*, 5, 1-7*

Using 3D printing for crucial research tools

With 3D printing set to revolutionise research, IBEC researchers have been exploring the possibilities of using the new technology to already improve their processes and methods.

In a collaboration with the UPF, the CINVESTAV-Monterrey in Mexico, and the University of Washington, the scientists developed a new way of producing microfluidic devices – systems in which low volumes of fluids are processed. These are crucial tools in many areas of biomedical research, such as DNA analysis, lab-on-a-chip technology, and as a system that allows cell biologists to control the complete cellular environment.

Using a different kind of resin, poly(ethylene glycol) diacrylate, or PEG-DA, and a method of 3D printing known as stereolithography, the researchers were able to construct a 3D-printed device that is highly transparent – as microfluidics systems need excellent visibility – on which cells can be cultured.

"With this new biocompatible resin and 3D printing process, we avoid the drawbacks of PDMS devices, which as well as being tedious to make, were prone to assembly failures and difficult to disseminate to research and clinical settings," explains IBEC director Josep Samitier, whose PhD student, Luis G. Rigat, did a research internship at the University of Washington to learn from researchers already working with 3D printing.

A.Urrios et al (2016). 3D Printing of Transparent Bio-Microfluidic Devices in PEG-DA. Lab Chip*, 16, 2287-2294*

Mycobacterium in olive oil for cancer treatment

Researchers at the Autonomous University of Barcelona and IBEC revealed a way to effectively deliver a mycobacterium needed for the treatment of bladder cancer – using a formulation based on olive oil.

They found a way to reduce the natural clumping that occurs when mycobacteria cells, which possess a high content of lipids in their walls, are introduced to the usual aqueous solutions that are used for intravesical instillation in bladder cancer patients. This clumping may interfere with the interaction of the mycobacteria-host cells and negatively influence their antitumor effects.

After announcing their discovery last year that *M. brumae* offers an improved alternative to existing bladder cancer treatments such as BCG, which can cause infections, the collaborators were looking for ways to improve its immunotherapeutic activity. To do this, they've been designing different emulsions that can increase the homogeneity and stability, and

therefore the efficacy, of the mycobacteria solutions when introduced into the body.

"Of the emulsions we tested, the one based on olive oil induce a prominent immune response in both *in vitro* and *in vivo* experiments. In addition, the characteristics of this emulsion, which preserves the viability of the mycobacteria and provided higher anti-clumping rates, indicates favourable conditions for reaching the bladder epithelium," says IBEC's Eduard Torrents, who contributed to the study.

E. Noguera-Ortega et al (2016). Mycobacteria emulsified in olive oil-in-water trigger a robust immune response in bladder cancer treatment. Scientific Reports, *6:27232*

July

Vision restoration by molecular prostheses

ICREA professor Pau Gorostiza's IBEC group, together with that of Amadeu Llebaria of IQAC-CSIC, developed molecules that can be applied as light-regulated molecular prostheses to help restore vision in cases of retinal degeneration.

Light-regulated drugs can be photoswitched remotely – that is to say, their biological activity can be turned on and off using light. Now, the collaborators have achieved proteins from the neurons involved in vision that respond similarly to when they are under normal physiological conditions – in other words, they trigger a response when light is received. In this way, they could act as prosthetic molecules and restore the photoresponse of degenerating retinas.

The molecules have been tested on the retinal tissues of blind mice, where they were observed to be activating the cells in the retina, which sent an electrical signal in response to receiving light. "Our TCPs might work in a variety of organisms, including human, for which limited (opto)genetic manipulation techniques are currently available. This prospect makes the results on retina photosensitization especially appealing," says Pau.

This type of treatment, though far in the future, could help restore sensitivity to light and darkness with a drug.

M. Izquierdo-Serra et al (2016). Optical control of endogenous receptors and cellular excitability using targeted covalent photoswitches. Nature Communications *7, 12221*

September

Cells move en masse towards rigid tissues

In a study published in *Science*, researchers at IBEC showed that several types of cells are attracted to the most rigid areas of tissues. They developed new techniques to create biomaterials with variations in stiffness, and used these to observe which cell groups preferentially moved to the more rigid areas. The larger the group, the more efficient the movement; and individual cells were unable to find their way to the most rigid areas.

The researchers developed a theory explaining the phenomenon, naming it collective durotaxis. "Each cell applies a force to its environment that allows it to measure the surrounding stiffness. But cells need to physically interact with each other to transmit this information collectively in order to move," says Pere Roca-Cusachs, IBEC researcher, professor at the University of Barcelona and co-leader of the study.

"It's an example of collective intelligence: a group can carry out a task that their isolated individuals are unable to perform," says Xavier Trepat, ICREA researcher at IBEC, and leader of the study. "Tumors are more rigid than their surroundings, so collective durotaxis can explain the mechanisms by which tumor cells move to initiate the metastatic process. Similarly, scars are also more rigid than their surrounding tissues. We believe that collective durotaxis is a key mechanism to explain how cells move to heal wounds, and that it could help us to work out how to control metastasis."

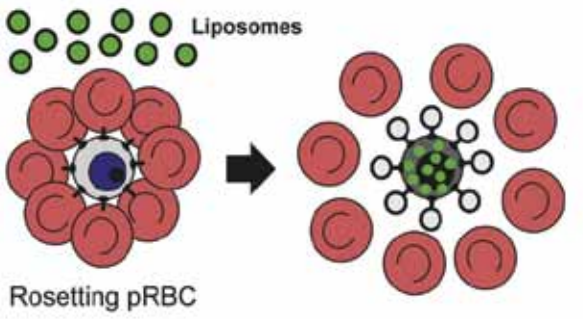
R. Sunyer et al (2016). Collective durotaxis cell emerges from long-range force intercellular transmission. Science, *353, 6304, 1157-1161*

October

Drug-loaded nanovectors covered with antibodies: a new approach for malaria

A new combination therapy – based on the use of nanovesicles coated with antibodies that target a parasite protein while loaded with an antimalarial drug – represents a promising alternative in the treatment of malaria, with the the advantage of delaying the development of resistance in the parasite.

Red blood cells infected by the malaria parasite express a protein at the cell surface (PfEMP1) that



Drug-loaded nanovectors covered with antibodies: a new approach to combat malaria

allows them to adhere to the cells lining the blood vessels and evade their clearance. In addition, PfEMP1 is one of the molecules responsible for the aggregation (or rosetting) of infected cells, which leads to clot formation and contributes to the fatal outcome of severe malaria.

In this study, the authors sought to inhibit erythrocyte resetting *in vitro* through the use of nanovesicles (liposomes) coated with anti-PfEMP1 antibodies and loaded with an antimalarial drug. They found that the immunoliposomes specifically targeted infected erythrocytes and physically disrupted rosette formation. In addition, they delivered the drug to the infected cells, thereby inhibiting parasite growth. "The chance that a parasite becomes resistant to two drugs with unrelated modes of action simultaneously is very low," explains Xavier Fernández-Busquets. "Combination therapies delay the evolution of resistance in the parasite and can therefore contribute to eradicating malaria."

Moles E, et al (2016). Development of drug-loaded immunoliposomes for the selective targeting and elimination of rosetting Plasmodium falciparum*-infected red blood cells.* J Control Release*, 241:57-67.*

Molecules activated by light to control glutamate receptors

Researchers at IBEC, IQAC-CSIC, the UAB, the Center for Biomedical Research (CIBER-BNN) and CNRS developed molecules that can modulate the activity of glutamate receptors in the central nervous system, with important applications in biomedicine.

Glutamate receptors are involved in synaptic transmission in the central nervous system. They are involved in many processes, such as pain perception, memory, and motor regulation. An alteration in their activity is associated with several diseases, so being able to control them is an important approach for drug development.

The scientists made a molecule that changes shape on receiving a violet light and attaches to glutamate receptors, which causes the latter to increase or decrease their activity. The controlled use of light allows for accurate and localized coupling.

The molecules could also be used for biological studies of the central nervous system or to assess new therapies. They can be thought of as controlled drugs that act in a certain area of the brain activated by 'micro-LEDs' implanted in the body. The use of such drugs could lead to precise control at the relevant site and controling the duration of their effects, in line with the new move towards precision medicine.

X.Rovira, et al (2016). OptoGluNAM4.1, a Photoswitchable Allosteric Antagonist for Real-Time Control of mGlu4 Receptor Activity. Cell Chemical Biology*, 23, 8, 929-934*

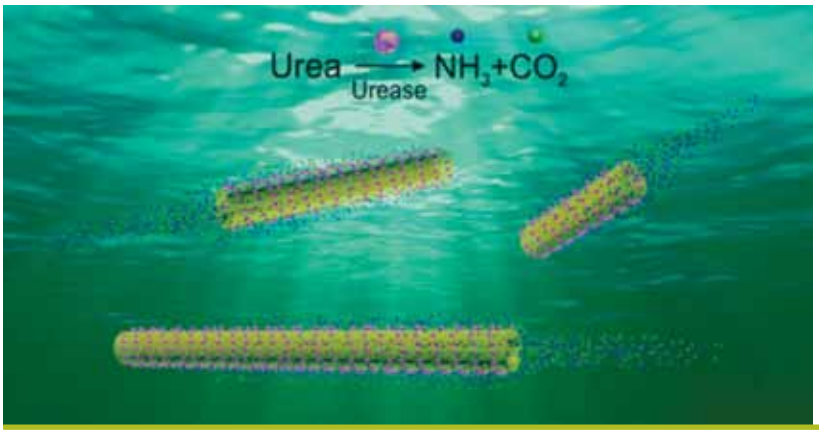
November

Record-breaking nanojets that use safe fuel

IBEC group leader and ICREA research professor Samuel Sanchez's nanojets set a new world record for the smallest man-made jet engine ever.

Samuel and his colleagues and collaborators at the Max-Planck Institute for Intelligent Systems, Germany, and the Harbin Institute of Technology, China, describe their bubble-free propelled tubular nanojets which, at 200nm, are a third of the size of their smallest jet engines so far, which were 600nm.

The record-breaking nanojets are powered by an enzyme-triggered biocatalytic reaction using urea, a naturally occurring compound, as a biocompatible



Record-breaking nanojets that use safe fuel

fuel. They're the first tubular nanojets that don't rely on bubble propulsion, which is the usual method used by such machines to self-propel, but whose toxicity – as the oxygen bubbles are formed by the catalytic decomposition of hydrogen peroxide – renders any biomedical applications impossible.

Moreover, their tubular shape means that they have the potential to reach their target in a more direct manner than previous urease-based micromotors, which up to now have been spherical in shape. The researchers' next steps will be to load these nanomachines with drugs of clinical interest and move towards *in vitro* and, later, *in vivo* tests.

Xing Ma et al (2016). Bubble-Free Propulsion of Ultrasmall Tubular Nanojets Powered by Biocatalytic Reactions. J. Am. Chem. Soc. *138 (42), 13782–13785*

December

Using EFM to probe endospore survival strategies

An IBEC group has demonstrated, for the first time, that the hydration properties of a single bacterial endospore in varying environmental relative humidity can be determined with high accuracy and reproducibility, and in a non-destructive way, shedding new light on endospore survival strategies.

Endospores are recognized as the hardiest form of life on Earth, and are produced by certain bacterial cells in response to a lack of nutrients. They can remain in a metabolically dormant state for decades in a variety of environments including air, soil or organic matter. Nevertheless, upon exposure to the appropriate conditions, they germinate back into vegetative bacterial cells within minutes, thus constituting an impressive survival strategy for living organisms.

The response of bacterial endospores to changes in environmental relative humidity (hygroscopicity) is among their more outstanding properties. Endospores are known to adsorb moisture from the environment, but their viability seems not to be compromised by doing so, which is believed to be related to the internal distribution of water in the endospores.

Gabriel Gomila's Nanoscale Bioelectrical Characterization group, working together with IBEC Associate Researcher and UB professor Antonio Juárez, used Electrostatic Force Microscopy, a form of Atomic Force Microscopy, to measure the internal hydration properties – moisture uptake and internal distribution of water – of endospores under high relative humidity conditions.

"It has been amazing to observe how the endospore structure is able to preserve its core, where DNA is located, under low hydration conditions, irrespective of the ambient relative humidity. This is certainly key in the endospore's extraordinary survival abilities," says Gabriel. "This same property is also at the basis of their extraordinary water responsive properties, which has led to research into energy-harvesting devices based on endospores that can generate electrical power from an evaporating body of water, as well as electromechanical tunnelling graphene quantum dot-spore devices."

The IBEC group's results also demonstrate the sensitivity and potential of their EFM technique to accurately address the hygroscopic properties of small scale objects.

M. Van Der Hofstadt et al (2016). Internal Hydration Properties of Single Bacterial Endospores Probed by Electrostatic Force Microscopy. ACS Nano, *10.1021/acsnano.6b06578*

News Highlights 2016

January

ERC funding to tackle pollutants in water

IBEC group leader and ICREA research professor Samuel Sánchez received an ERC Proof of Concept grant to explore the innovation potential of some of his research.

His project "Active microcleaners for water remediation" (Microcleaners) will tackle the huge rise in pollutants in water that has been the result of the massive growth in industrial, domestic and agricultural activities.

The tiny Microcleaners – based on the same technology Samuel uses for his self-propelled nanorobots that are designed for applications in nanomedicine, such as drug delivery – are active self-mixing and multifunctional systems capable of cleaning chemical and biological pollutants.

IBEC director is fellow of IEC

IBEC Director Josep Samitier was elected as fellow of the Institut d'Estudis Catalans.

An institution with much influence in society, IEC promotes and develops research and study into all elements of Catalan culture, and is best known for its work in standardizing the Catalan language.

It was founded in 1907 by Enric Prat de la Riba, then president of Barcelona County Council who would go on to be the first president of the Mancomunitat de Catalunya, and its members have included the likes of August Pi i Sunyer, Àngel Guimerà and Pompeu Fabra. IEC has been a member of the International Union of Academies since 1922.

February

Help for the homeless

IBEC Managing Director David Badia, on behalf of IBEC's employees, presented the €665 raised by the institute at 2015's Christmas Celebration to the Arrels Fundació, a charity for the homeless in Barcelona's Raval district.

Arrels director Ferran Busquets was delighted to receive the funds, which were raised by generous IBECers who bought tickets for the tombola on 17th December. The money will go towards helping the 400 Arrels volunteers reach out to more than 1600 homeless people per year with support by way of clothing, medicine, psychological aid and accommodation.

Samuel Sánchez inspires 255 promising students

IBEC group leader and ICREA professor Samuel Sánchez was the guest speaker at a ceremony held at Mon Sant Benet by the Fundació Catalunya-La Pedrera to celebrate their awarding of €1000 each to 255 students who obtained the best entry grades for university.

This year marks the 19th edition of the 'Ajuts Universitaris' programme, a unique initiative in Catalonia that supports students who are starting their university career. The event was presided over by the president of the foundation, Germán Ramón-Cortés, director general Marta Lacambra, and representatives of all the Catalan universities.

March

Moving in important circles

IBEC group leader and ICREA research professor Samuel Sánchez was the winner of this year's edition of the Círculo Ecuestre's Premio Joven Relevante.

Samuel received the honour at a gala dinner in March, where he was voted first of the three finalists by the members of the exclusive society. The prize recognizes and rewards an individual or team of people younger than 38 who has developed a project that brings significant change for the benefit of Catalan and Spanish society.

The Círculo Ecuestre was founded in 1856 by a group of middle-class Catalans united by a common interest – horse riding. It has since been a meeting point in Catalan society, and a place where current and past affairs are debated and culture, business

and leisure are brought together. The club currently has 1565 members, of which 400 are under the age of 40, from all walks of life: economics, politics, society and culture.

Xavier a runner-up in the *La Vanguardia* Science Award

IBEC group leader and ICREA research professor Xavier Trepat came third in the *La Vanguardia* Science Award.

Xavier was nominated, alongside the UPC's Marino Arroyo, for their groups' research into what happens at a cellular level when the body's tissues are broken – work that was published last year in *Nature Materials*. Xavier and Marino gained 15.3% of the votes in a readers' poll that was open throughout February to nominate the Spanish scientist or scientists that did the most important research during 2015.

First place went to Joan Seoane at VHIO for his work on lumbar puncture against cerebral tumours. Clara Soria-Valles and Fernando G. Osorio of the University of Oviedo came second for their work on the role of the NF-kB molecule in ageing.

"la Caixa" and Cellex to support research into fetal medicine

IBEC became part of a revolution in fetal surgery and the research of prenatal diseases thanks to support by the Obra Social "la Caixa" and Cellex foundations.

The two foundations funded two major projects coordinated by the Fetal Medicine Research Centre, Fetal i+D (Hospital Clínic and Hospital Sant Joan de Déu). A fetal surgery part of the project, promoted by the Cellex Foundation, will improve the interventions currently being carried out, as well as developing new surgery to treat problems that currently lack solutions.

GLAM support for leukemia research

The GLAM project, of which IBEC's Biomimetics for Systems for Cell Engineering group leader Elena Martínez is a partner, supported the 3rd Festa StandupPaddle (SUP) in aid of leukemia research in Barcelona on 24th April.

Via the crowdfunding platform "Mi grano de Arena" (My grain of sand), GLAM collected donations for the event, which involved stand up paddle boarding races, family activities and much more. All donations made on the website and 75% of the money collected on the day was forwarded to the Josep Carreras Foundation, a Barcelona-based organisation aiming to make leukaemia a 100% curable disease.

April

Cystic fibrosis – the fight continues

Representatives from the Associació Catalana de Fibrosi Quística (ACFQ) came to IBEC on 22nd March to meet researchers and discuss the focus of their continuing support of investigation into the disease.

The visit took place in the framework of some exploratory groundwork in preparation for a potential new initiative involving the Obra Social "La Caixa" to focus on support for rare disorders.

Eduard Torrent's Bacterial Infections: Antimicrobial Therapies group's projects researching the enzyme that promotes the growth of the bacteria linked to this disease, and possible therapeutic targets, has been supported by the ACFQ since 2009.

IBEC International PhD Programme interviews

22 hopeful candidates visited IBEC for their interviews for IBEC's International PhD Programme positions.

The candidates, who represented 12 countries, were selected from the more than 150 applicants who applied for the programme's nine positions, which are supported by Severo Ochoa and La Caixa. It's the first ever time that IBEC has held mass interviews of this type, as the PhD programme is new for this year and forms part of the institute's Strategy for 2014-2017 in the area of attracting the best talent from all over the world via a transparent, open and international selection process.

IBEC project among 44 funded by AXA

The AXA Research Fund, the international scientific philanthropy initiative of global insurer AXA, announced that it will devote €15.6m in 2016 to 44

IBEC International PhD Programme interviews: Mechanics of Development and Disease group leader Vito Conte grills a young hopeful

new research projects with leading academic institutions in 16 countries.

IBEC's two-year project, "Novel approaches for Pandemic Virus Targeting Using Adaptive Polymers", is led by new junior group leader Lorenzo Albertazzi and aims to harness nanotechnology to introduce a whole new class of tools to fight viruses. This and the 43 other new projects were announced at an event in Paris, bringing together AXA executives and experts, members of the AXA Research Fund scientific community and academic partners, and other stakeholders.

Focus on Cystic Fibrosis

To coincide with National Cystic Fibrosis Day 2016, IBEC and the Catalan Association of Cystic Fibrosis (ACFQ) organized an event, "The present and future of Cystic Fibrosis", on 27th April at the Barradas auditorium.

As part of IBEC's new 'Focus on…' series of outreach activities, which will highlight diseases for which the institute's researchers are working towards finding solutions, the day will raise awareness about and present research results and clinical advances relating to CF, which is one of the most common serious genetic diseases in Catalonia. IBEC's Bacterial Infections: Antimicrobial Therapies group's projects researching the enzyme that promotes the growth of the bacteria linked to this disease, and possible therapeutic targets, has been supported by the ACFQ since 2009.

IBEC signs agreement with Bioibérica

IBEC signed a collaboration agreement with Bioibérica S.A., a company specialised in the R&D, production and sale of biomolecules and new technologies for the pharmaceutical, veterinary and agrochemical industries. It's the latest success story in IBEC's active pursuit of the establishment of research projects with industry partners who share its commitment to bringing high-quality health research and technologies to market and the patient.

Together, IBEC – specifically its Nanomalaria joint unit with ISGlobal, led by Xavier Fernández-Busquets – and Bioibérica, which since its formation in 1975 has focused on the investigation and production of biomolecules extracted from animal tissue with significant biological and therapeutic properties, will explore ways of combining their expertise to achieve advances in future medicine.

May

Leica's European Tour comes to IBEC

IBEC scientists and other staff from the PCB enjoyed some special workshops given by Leica.

IBEC was the host institution in Spain of Leica's European Tour 2016, which allows researchers to get hands-on with some of the company's most cutting-edge microscopes and other equipment.

The technologies being presented and demonstrated at this week's workshops are the DMi8 inverted microscope with Fluorescence Recovery After Pho-

Xavier Trepat, ICREA professor and group leader at IBEC, was the guest star at the first anniversary celebration of Big Vang, La Vanguardia's online science section.

tobleaching (FRAP) module, their SP8 X Confocal Microscope with WLL and Hybrid Detectors, HyVolution confocal super-resolution imaging, and the Leica TCS SP8 with Digital LightSheet. Researchers are able to test their own samples in these pieces of equipment.

"Peru-sing" collaboration opportunities in South America

IBEC Director Josep Samitier visited Peru as part of a delegation of representatives from Severo Ochoa and Maria de Maeztu research centres in Spain.

The visit to Lima, organised by MINECO, which bestows the two types of Excellence awards, aimed to bring together the top Spanish institutions with those of the Pacific Alliance – Chile, Colombia, Mexico and Peru.

Each of the eight Spanish centres presented their research and international strategies, and they had the chance to hear about the same from Pacific Alliance centers, as well as identifying potential synergies.

June

In the presence of royalty

IBEC director Josep Samitier, along with other leading lights from Spain's Severo Ochoa and María de Maeztu centres, was received by Their Majesties the King and Queen.

Their Majesties received the directors and representatives of 33 institutions, including IBEC, that have been accredited with the highest institutional recognition of scientific research in Spain, at the Palacio de la Zarzuela.

Carmen Vela, Secretary of State for Research, Development and Innovation, highlighted the importance of the winning centers and units for the advancement of knowledge in Spain.

Three minutes of fame

IBEC PhD student Ana Solorzano was selected as one of the 10 finalists from 300 participants in a "Thesis in 3 Minutes" competition at the 2016 Jornadas de Cooperación CONACyT-Catalunya (JCCC).

Ana, who is doing her PhD in the Signal and Information Processing for Sensing Systems group of Santiago Marco, presented the condensed explanation of her work, entitled "Fuego, Sensores de Gas, Reconocimiento de Patrones, Intoxicación", at the finals of the competition on 13th June.

Xavier Trepat a guest star at Big Vang's first anniversary

Xavier Trepat, ICREA professor and group leader at IBEC, was the guest star at the first anniversary celebration of Big Vang, *La Vanguardia*'s online science section.

At the event on 7th June, where Xavier shared the stage with the director of IRB Joan Guinovart, the relationship between scientists and journalists was discussed – a relationship that can sometimes be a little illusive, as journalist Cristina Saez put it, refer-

ring to the disagreements that can arise between the two sides when explaining science to the public. Along with fellow journalist Núria Jar, she introduced questions to the invited guests.

Celebrating advances in spinal cord and brain research by Marató-funded projects

IBEC group leader and ICREA research professor Pau Gorostiza took part in the 17th Symposium of La Marató de TV3, which was devoted to the celebration of the 30 research projects awarded funding by the telethon in 2010.

The event at the Institut d'Estudis Catalans, which included a poster session open to the public, featured round tables of experts discussing the findings of the projects, which covered research into the understanding, treatment and prognosis acquired spinal cord and brain injuries.

IBEC at first ever international 3D printing congress

IBEC Director Josep Samitier and the Technology Transfer unit introduced IBEC's 3D bioprinting capabilities at the first IN(3D)USTRY event, which was held in Barcelona.

The first ever international meeting devoted to 3D printing, "IN(3D)USTRY: From Needs to Solutions" saw leading companies and other organisations showcase the innovations and opportunities that the new technology can offer to countless projects and processes.

The meeting, which was founded by Fira de Barcelona and HP, attracted professionals working in areas as diverse as cars and aeronautics, architecture and habitat, retail and consumer goods and, of course, healthcare.

July

IBEC a winner at the 10th National Alares Awards

At a ceremony held at the Caixa Forum in Madrid, IBEC's managing director David Badia received on behalf of IBEC the second prize for "Reconciliation of Working Life, Family and Personal and Social Responsibility" from the Alares Foundation.

IBEC, which was one of just 39 winners selected from 392 candidates, received the award for the practices implemented in its guide "Measures to reconcile work and family life", as well as for its actions towards social responsibility.

IBEC a key member of the new RIS3CAT communities

IBEC is a member of one of five 'communities' that will receive funding as part of the RIS3CAT initiative, which aims to enable and promote large projects in Catalonia that combine industry and research.

In the launch meeting at the headquarters of RIS3CAT coordinator ACCIO, the government's agency for competitiveness in business, Minister for Business and Enterprise Jordi Baiget, who chaired the event alongside Director General of Industry Nuria Betriu, declared RIS3CAT "the greatest ever effort for innovation in Catalonia".

IBEC is a member of NEXTHEALTH, one of two health-related RIS3CAT communities among the five, all of which bring together businesses, research organizations, hospitals, and other major players to form a critical mass to work in collaboration on large-scale projects to boost innovation.

September

Wikipedia entries for IBEC

IBEC now has Wikipedia entries in English, Spanish and Catalan.

Wikipedia is the seventh most-visited website in the world and the largest encyclopedia ever, with 5,200,000 entries in English alone. The fifteen year-old website has been described as the 'largest collaborative effort in the history of mankind'.

As with all Wikipedia entries, the IBEC page is a 'living' page, and will be expanded and improved over time as the institute's history progresses.

With these new entries, IBEC joins the category "Research institutes in Catalonia" of the free online encyclopedia, in which other centres in the Catalan research system are already present.

Ferrer, IBEC and Mind the Byte to study new molecules

against cancer metastasis

The pharmaceutical company Ferrer created a consortium with the IBEC and the bioinformatics company Mind the Byte to study the development of new therapeutic molecules against cancer metastasis.

The work will follow the research on cadherin interaction and its role in cells that cause metastasis conducted by Dr. Xavier Trepat, ICREA professor at IBEC and one of the few scientists to have won three grants from the European Research Council (ERC).

IBEC at B·Debate

Xavier Rubies, head of IBEC's Technology Transfer unit, took part in the B·Debate on "Fighting Blindness. Future Opportunities and Challenges for Visual Restoration" organized by the Barcelona Macula Foundation in collaboration with the Centre for Genomic Regulation (CRG) and LEITAT.

Xavier took part in the "From Bench to Bedside" round table, where he explained the process of bringing research results to market. The other speakers agreed with his position that in order to achieve effective results, it's necessary to start by looking at demand, and then to lead the transfer of projects according to the needs of the market.

This edition of B·Debate, an initiative of Biocat and Obra Social "la Caixa", aimed to explore the potential of new therapeutic approaches for retinal dystrophies, combining nanotechnology, regenerative medicine, stem cells, gene therapy, genomics, bioengineering, photonics and optogenetics.

New strategies to combat malaria: heparin and nanomedicine

IBEC, the Barcelona Institute for Global Health (ISGlobal) and the biotech firm Bioiberica signed a partnership agreement to study the development of new compounds derived from heparin to combat malaria.

The partnership, which was officially announced at the BioSpain meeting in Bilbao, is based on the research undertaken by Xavier Fernández-Busquets, head of IBEC and ISGlobal's joint Nanomalaria unit, engaged in developing specific antimalaria therapies, and the R&D project of Bioiberica, world leader in heparin production, to seek new applications of this molecule.

Every year malaria infects 200 million people worldwide and causes half a million deaths. For several decades it has been known that when the malaria parasite enters the bloodstream, it invades the liver cells to produce thousands of merozoites – a stage in the life cycle of the parasite – that enter into the circulation and infect red blood cells, managing to evade the immune system.

October

Strengthening links with Singapore

IBEC director Josep Samitier, group leaders Elisabeth Engel, Xavier Trepat and Pere Roca-Cusachs, and Ester Sánchez, representing the Strategic Initiatives Unit, were in Singapore to take part in the first IBEC-MBI Joint Symposium, which took place on 26th September.

The event, hosted by the Mechanobiology Institute (MBI), the National University of Singapore's dedicated centre focused on exploring this emerging field at the interface of cell biology, physics, engineering and computational biology, aimed to foster collaboration between the two institutions.

The programme included sessions on specific fields of research shared by the two centers, namely cell-matrix interactions, regenerative medicine, matrix to nucleus transduction, collective cell migration, and featured speakers from both sides.

ERC funding for new diabetes approach at IBEC

IBEC's Dr. Javier Ramón was one of just six researchers in Catalonia to have been awarded a 2016 Starting Grant by the European Research Council (ERC).

The senior researcher in the Biomimetic Systems for Cell Engineering group won funding for his project 'Diabetes Approach by Multi-Organ-on-a-Chip' (DAMOC) from Europe's most prestigious funding body.

With the support, which will last for up to five years, Javier will start a new line to design a innovative new tool to test drugs for diabetes. As well as improving drug testing approaches, the multi-organ-on-a-chip device will provide new therapies to prevent the loss of beta cell mass and defects in the glucose uptake in skeletal muscle associated with type 2 diabetes.

Pere Roca-Cusachs won the American Society for Cell Biology's Gibco Emerging Leader Prize and was accepted into the EMBO Young Investigator Programme during 2016

International prize for Pere as an emerging leader in science

IBEC junior group leader and UB assistant professor Pere Roca-Cusachs was one of ten finalists selected for the American Society for Cell Biology's Gibco Emerging Leader Prize.

Supported by Thermo Fisher, the international prize recognises emerging leaders in science who are non-tenured faculty holding independent positions in the early phase of their career. Pere was chosen as a finalist for his research uncovering the biophysical molecular mechanism by which cells sense tissue rigidity and transduce it into downstream signalling.

IBEC researcher wins international electrochemistry prize

Senior researcher Ismael Diez won an award from the International Society of Electrochemistry (ISE).

The Nanoprobes and Nanoswitches group member was this year's recipient of the Jaroslav Heyrovsky Prize for Molecular Electrochemistry, which is named after the Czech chemist, inventor and 1959 Nobel Prize winner.

"I'm really happy to have my work recognised by this award, because although I've won prizes from the ISE before, this one is for my independent contributions as a senior scientist," said Ismael, who's also an assistant professor at the University of Barcelona.

IBEC's first EMBO Young Investigator

IBEC junior group leader and UB assistant professor Pere Roca-Cusachs has been accepted into the prestigious EMBO Young Investigator Programme.

EMBO, the European Molecular Biology Organization, chooses some of the best young group leaders in Europe through a highly competitive annual selection. Pere presented his research plan for the next five years to an international panel in Heidelberg at the beginning of October.

"I'm really delighted to have been accepted," said Pere, who is the first ever IBEC researcher to be selected for the programme, and the only one from Spain this year.

IBEC a Centre of Excellence for health in EC report

IBEC has been designated one of just 28 European Centres of Excellence in a new report by the European Commission's Directorate-General for Research & Innovation.

In the report, IBEC appears alongside 27 other CoEs in Europe in nine H2020 areas: Nanotechnology,

Former IBEC PhD student Ariadna Bartra, winner of a Premi PIONER from CERCA, with Signal and Information Processing for Sensing Systems group leader Santiago Marco

Photonics, Advanced Manufacturing, ICT/Cyber Security, Health, Food/Agriculture/Forestry, Energy, Transport, and Climate/Resources. IBEC, which appears under Health, is the only institute in Spain to appear in the table.

November

New advanced therapies initiative in Catalonia

Last week saw the launch of the ADVANCECAT project, led by the University of Barcelona.

Part of the RIS3CAT community, ADVANCECAT aims to accelerate the development of advanced therapies – medicines based on cell therapy, gene therapy and tissue engineering – in Catalonia from basic research to clinical or industrial transfer.

Formed by 18 organizations in the field of health including two universities, twelve biomedical research institutes – including IBEC – and four companies and private foundations, ADVANCECAT, which is integrated in the NextHealth community and coordinated by Biocat, will bring together public and private sectors for better management of resources in order to get the most out of the Catalan health system.

INPhINIT programme opened for applications

A new PhD programme at IBEC funded by the Obra Social "La Caixa", INPhINIT, opened for applications in November.

INPhINIT aims to attract international early-stage researchers to the top Spanish research centres in the areas of the life and health sciences, physics, technology, engineering and maths.

In each call, INPhINIT recruits 57 candidates of any nationality, who enjoy a three-year employment contract at the participating research centre of their choice, all of which have been designated by the Spanish ministries as Severo Ochoa, Maria de Maeztu or Carlos III Centres or Units of Excellence.

IBEC and GENOMICA present NEDxA in Germany

IBEC's Technology Transfer Unit was in Germany to present a new product developed by the IBEC-GENOMICA Joint Unit that carries out analysis to detect Human Papillomavirus (HPV) in a cheap, quick and convenient desktop device.

Head of Technology Transfer Xavier Rubies, as well as representing IBEC as a research centre related to health, joined forces with representatives from GENOMICA S.A.U. to reveal NEDxA, a nano-electronic diagnostic array, at the MEDICA World Forum for Medicine in Düsseldorf on 14th-17th November.

EIT Health Summit taking place in Barcelona

Barcelona played host to EIT Health's very first Summit, the highlight of its first year of activities.

IBEC is a core partner in the €2.1 billion Knowledge and Innovation Community (KIC), one of the largest public funded initiatives for health worldwide, with IBEC director Josep Samitier on the Supervisory Board. Barcelona is one of EIT Health's co-location

centers, with the initiative's Spanish headquarters based at the PCB.

The EIT Health Summit, which took place on 23rd-24th November at CosmoCaixa, brought together up to 350 participants from among the initiative's partner organisations, education programmes and external stakeholders.

IBEC joins network that forges links with medical centres

IBEC became a partner in the Red de Innovación en Tecnologías Médicas y Sanitarias (ITEMAS), an innovation network for medical and health technologies.

ITEMAS, promoted by the Instituto de Salud Carlos III (ISCIII), brings 95 companies and organizations together with 66 medical centres in Spain to collaborate on R+D projects. The partners will also work together on outreach initiatives.

December

What can we do about sexism in science?

More than 50 people attended a special event organised by IBEC, "Advancing Gender Equality and Diversity in Science". The morning of talks and discussions aimed to raise awareness and reflect on how to balance gender equality, and particularly how institutions, as well as society in general, can address such issues via best practices or other strategies.

More IBEC success in CaixaImpulse

Two IBEC projects were granted funding as part of the 2016 CaixaImpulse programme, which is organized by the "la Caixa" Foundation and Caixa Capital Risc.

Cellular and molecular mechanobiology group leader Pere Roca-Cusachs' project, "Solid tumor therapy", and "ISCHEMSURG", led by Monica Mir, senior researcher in Josep Samitier's Nanobioengineering group, will each receive up to €70,000 through this year's programme, which aims to promote technology transfer in science.

IBEC researchers win EIT Health awards

IBEC group leaders Eduard Torrents and Elisabeth Engel both received awards at a EIT Health Spain event at the PCB.

Eduard's project, Novel Antimicrobial Therapy, won first prize in the 'PoC +' category of EIT Health Spain's Proof of Concept (PoC +) awards, and in the 'PoC' category, Elisabeth won a prize for Dermoglass, the smart dressing for the treatment of chronic wounds.

Samuel Sánchez wins National Research Award for Young Talent

IBEC group leader and ICREA researcher Samuel Sánchez was announced as the winner of this year's Premi Nacional de Recerca al Talent Jove (National Research Award for Young Talent) from the Generalitat de Catalunya and the Catalan Foundation for Research and Innovation (FCRI).

The prestigious honour and cash prize of €10,000 is awarded annually to the most accomplished young researcher in Catalonia.

PIONER award for IBEC student

Former IBEC PhD student Ariadna Bartra was awarded a Premi PIONER from CERCA.

The Signal and Information Processing for Sensing Systems group's student's thesis, 'Detecció d'estats inadequats per la conducció d'un vehicle a partir de la degradació del control dinàmic', was selected for its "direct applicability and market-minded approach, as well as its impact on improving road safety", according to the judging panel. Her research carried out in Santiago Marco's group was connected to the driver drowsiness alerter developed by IBEC and the company Ficosa.

Ariana received her award with the four other 2016 winners at a ceremony on 21st December.

About IBEC

IBEC Strategy 2014-2017

IBEC's Strategic Plan for the period 2014-2017 identifies the following four areas in which to concentrate our efforts:

- To expand the centre both in size and in results by recruiting new professionals and scientists, as well as renewing groups that perform at the highest standard in terms of both scientific quality, and transfer and innovation.
- To focus its scientific work on the areas where it can stand out most distinctively and compete internationally, with an orientation towards scientific and technological challenges with a high impact on people's health and quality of life.
- To forge alliances with organisations of recognised international standing to consolidate the institute's path of specialisation, differentiation and internationalisation.
- To improve the way the institute is managed by implementing tools such as an integrated management system and management by results, in order to make the best use of resources and align management with its strategy.

In this way, IBEC's Strategic Plan for 2014-2017 is structured in terms of four strategic goals:

- **SG1.** To consolidate top-class science which enables IBEC to strengthen its international position, by focusing its core activity on three areas of application: "Bioengineering for Regenerative Therapies", "Bioengineering for Future Medicine" and "Bioengineering for Active Ageing".
- **SG2.** To develop technology and applications thereof that help to improve business competitiveness and the quality of hospital services.
- **SG3.** To run a distinctive specialist training programme to attract international talent.
- **SG4.** To develop a culture of excellence in management, self-sustainability and management by objectives.

Each of these strategic goals is pursued in the following areas of action: Research, Technology transfer and translation, Training development, Human resources (see next page), Management, Alliances, and Communication.

HRS4R: Gender and Diversity Committee

Part of IBEC's Strategic Plan 2014-2017 has been the design and implementation of a new Human Resources Strategy for Researchers (HRS4R) according to the principles of the European Charter for Researchers and the Code of Conduct for the Recruitment of Researchers.

One of the first measures of the HRS4R's Action Plan was to set up a Gender and Diversity Committee in June 2014, which includes researchers at different career stages and support services staff. The committee has been meeting on a trimestral basis to work on the design, preparation and implementation of the 'IBEC Equal Opportunities and Diversity Management Plan' which includes 17 actions to be implemented in 2014-2016. 2016 saw the fulfilment of several of those actions.

- In October, four research groups at IBEC participated in a project on Gender Diversity Impact (GEDII) that is coordinated by a group of experts from the Open University of Catalonia (UOC) and is funded by the European Commission under H2020. The project examines the relationship between gender diversity in research teams and their research performance.
- In November 2016, the first "Equal Opportunity and Diversity Management Plan" was concluded, which has helped us to include a gender and diversity perspective in our decisions in a transversal way in our day-to-day life, from small gestures or actions to major decisions.

2016's "Advancing Gender Equality and Diversity in Science" event was the celebration and high point of the Gender and Diversity Plan

With the experience gained and the interest shown by many members of the IBEC community, we began to consolidate these issues. As proof of this, in 2016 we continued to publish articles regularly in the *InsideIBEC* newsletter. I-BOX, the staff participation tool for suggestions, completed its first year, receiving 26 ideas from which the best were voted for and awarded with prizes at Christmas. We were also presented with an Alares Foundation prize for "Reconciliation of Working Life, Family and Personal and Social Responsibility". The reward came as a result of a report presented by IBEC, which resulted in a runner-up prize in the Universities, Business Schools and Research Organisations category.

- Also in November, the 'Advancing Gender Equality and Diversity in Science' event was the celebration and high point of the Gender and Diversity Plan, with more than 50 people in attendance, from IBEC as well as other research institutions. The morning of talks and discussions aimed to address some of the problems of equality – or lack of it – that still exist well into the 21st century, in not just the scientific arena but also in society as a whole.

  The proceedings began with a look at gender and aging stereotypes in society and specifically in science and advertising by marketing and communications consultant Montse Montllau, followed by an examination by CRG Group Leader Dr. Mara Dierssen of more science-based issues such as bias in publishing papers, raising funds and recruitment procedures. Sociologist Dr. Jörg Müller from the Internet Interdisciplinary Institute (IN3) at the Open University of Catalonia (UOC) looked at EU-level policy on gender, and IBEC's HR Head Carol Marí presented IBEC's action plan to tackle gender and diversity issues at the institute for the period 2014-2016, highlighting the role of the internal committee. The event was closed by CERCA Director Dr. Lluís Rovira, who gave an overview of the organisational guidelines for best practices at the Catalan research centres and presented a video on how to combat unconscious bias in recruitment. Afterwards there was time dedicated to questions and answers which generated some interesting debates, and the participants and speakers had the opportunity to meet in person and to network.

As planned in the Human Resources Strategy for Researchers (HRS4R) according to the principles of the European Charter for Researchers and the Code of Conduct for the Recruitment of Researchers, now is the time for a new Plan. In the last months of the year a call was put out for volunteers to be members of the new Gender and Diversity Committee. The new committee has members from all research positions, as well as support staff, and works on the design, preparation and implementation of the 'Second IBEC Equal Opportunities and Diversity Management Plan' which includes an Action Plan to be implemented from 2017 to 2019 to progress towards respect, inclusion of all and equality at work.

Transparency

In compliance with Law 19/2014 (Transparency, public access to information and good governance), a section of the IBEC website provides all the information we are obliged to provide in order to adhere to the principles of this law.

The section (**www.ibecbarcelona.eu/about-us/transparency**) contains the following information and/or documents:

Organització

Estructura organitzativa i de funcionament

- Organs de govern i organigrames
- Acords de creació i funcionament d'entitats del sector públic
- Cartes i catàlegs de serveis
- Catàleg de procediments

Alts càrrecs i directius

- Relació d'alts càrrecs i directius
- Incompatibilitats
- Activitats, béns i interessos
- Retribucions, indemnitzacions i dietes
- Codi de bones pràctiques per als alts càrrecs de la Generalitat de Catalunya

Empleats públics

- Relació de llocs de treball del sector públic
- Personal adscrit per adjudicataris de contractes signats amb l'Administració
- Retribucions, indemnitzacions i dietes

Convocatòries: accés i resolució

- Convocatòries personal laboral, col·lectius específics i formació per promoció.

Representació sindical

- Nombre i cost d'alliberats sindicals

Procediments i actuacions jurídiques

Normativa

- Normativa sectorial
- Directives, instruccions i circulars
- Normativa en tràmit

Règim d'intervenció administrativa

- Actes amb incidència sobre el domini públic i sobre la gestió dels serveis públics

Revisió d'actes administratius

- Revisió d'actes administratius

Resolucions administratives i judicials amb rellevància pública

- Resolucions administratives i judicials amb rellevància pública

Dictàmens

- Respostes a consultes sobre interpretació i aplicació de la normativa

Línies d'actuació

Plans i programes generals i sectorials, auditories i informació estadística

- Plans i programes generals i sectorials, auditories i informació estadística

Econòmica i finances

Pressupostos

- Pressupostos aprovats
- Pressupostos executats
- Pressupostos liquidats
- Comptes anuals

Informes d'auditoria de comptes i fiscalització

- Informes d'auditoria de comptes i fiscalització

Patrimoni de la Generalitat

- Inventari de béns immobles
- Béns mobles de valor especial
- Gestió de patrimoni
- Contractació patrimonial

Subvencions i ajuts

- Subvencions i ajuts públics previstos
- Subvencions i ajuts públics atorgats
- Control financer de les subvencions i els ajuts

Contractació

Contractes

- Contractes

Convenis

- Registre de convenis de col·laboració Altres convenis
- Altres convenis

Territori

Plans territorials sectorials

- Plans territorials sectorials

Informació cartogràfica

- Informació cartogràfica

The IBEC Foundation

IBEC is a non-profit foundation established at the end of 2005 by the Generalitat de Catalunya (Autonomous Government of Catalonia), the University of Barcelona (UB) and the Technical University of Catalonia (UPC).

The main governing body of IBEC is its Board of Trustees with representatives from the Catalan ministries of Health and Research, the UB and UPC. The Board of Trustees meets twice a year to approve IBEC's annual budget and monitor its activity to ensure that it pursues scientific excellence with societal impact. For executive purposes, a Management Committee (chosen from the Board) monitors IBEC's activities through *ad hoc* meetings with the Director and Managing Director.

The Board's decisions are guided by an independent International Scientific Committee (ISC). This committee ensures practices and criteria are implemented in accordance with international standards of excellence in research.

IBEC's relationship with the universities

IBEC's forerunner, the Centre of Research for Bioengineering (CREB) of the Technical University of Catalonia (UPC), was founded in 1992 by six research groups from five different departments with the aim of collaborating in research and industrial projects in the broader area of bioengineering. IBEC's first director, Prof. Josep A. Planell, was director of CREB from 1997 and led the process that resulted in the creation in 2003 of the Catalan Reference Centre for Bioengineering (CREBEC), composed of different divisions from the above-mentioned CREB and the Research Centre on Bioelectronics and Nanobioscience (CBEN) of the University of Barcelona (UB). CREBEC, which aimed to coordinate the multidisciplinary research activities in biomedical engineering carried out in Catalonia, was transformed at the end of December 2005 into the Institute for Bioengineering of Catalonia (IBEC).

The research groups affiliated with the two universities which are seconded at IBEC are listed on page 123. IBEC's PhD students are able to follow their doctoral courses at the universities, which offer degrees in physics, chemistry, biology, materials science and engineering, among others, and masters courses related to bioengineering and nanomedicine, attracting students from all over the world. Several others of IBEC's research staff are also involved in the doctoral programmes, particularly in the joint Biomedical Engineering Programme. Moreover, being located on the same campus, the relationship with both universities and the access to their facilities – library, scientific services, etc – is very fruitful.

IBEC's current director, Josep Samitier, was Vice-Rector of Research and Innovation and Acting Rector of the University of Barcelona (UB) from 2005 to 2008. He remains Full Professor of Electronics in the university's Physics Faculty.

Board of Trustees (for most of 2016)

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Professor in Biomedical Signal and Data Processing Department of Biomedical Engineering, Politecnico di Milano, Italy

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Director Fraunhofer Institute for Biomedical Engineering, Germany

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Cecil and Ida Green Distinguished Professor of Biological and Mechanical Engineering Massachusetts Institute of Technology, Boston, MA, USA

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Professor / Deputy Head Department of Biomedical Engineering and Department of Mechanical Engineering, National University of Singapore, Singapore

Prof. Krishna Persaud
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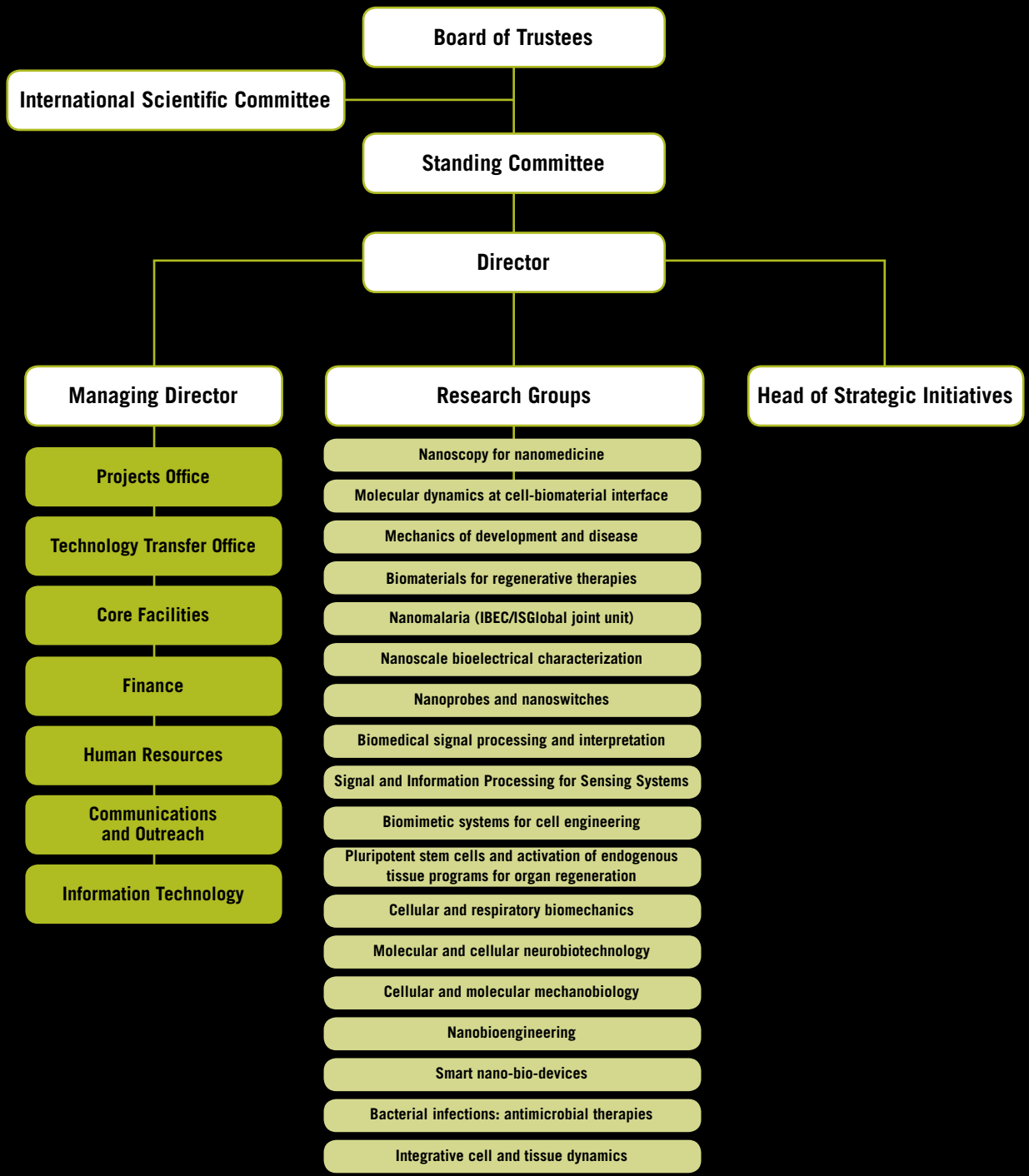
Prof. Bernat Soria
Director Departamento de Células Troncales, Centro Andaluz de Biología Molecular (CABIMER), Seville, Spain

Prof. Molly Stevens
Professor of Biomedical Materials and Regenerative Medicine / Research Director for Biomedical Material Sciences, Institute of Biomedical Engineering Imperial College, London, UK

Jocelyne Troccaz, PhD
Director de Recherche, CNRS Equipe Gestes Médico-Chirurgicaux Assistés par Ordinateur (GMCAO), Laboratoire TIMC-IMAG, Université Joseph Fourier-CNRS, France



Organisational chart

Support services

Head of Human Resources
Carolina Marí

Human Resources Technicians
Neus Vilalta
Núria Jané
Ciara Boter

Health and Safety Technician
Raquel Guillén

HUMAN RESOURCES

Head of Finance
Ana María González

Purchasing Technician
Mayte Muñoz

Accounting Assistant
Jessica Díaz

Accounting Technician
Victòria López

Director
Josep Samitier

FINANCE

IT Manager
Julio Bafaluy

IT Technician
Francisco Contreras

IT

COMMUNICATIONS AND OUTREACH

Coordinator of Events and Outreach
Pilar Jiménez

Head of Communications and Outreach
Vienna Leigh

Communications Assistant (from December 2016)
Pilar Rodríguez

Coordinator of Media Relations and Branding
Àngels López

Head of Projects Office
Javier Adrián

Project Managers
Rosa Miralles
Javier Selva
Guillermo Talavera
Ester Rodríguez

Funding Manager
Esther Gallardo

Assistant to the Projects Office
Judith Forné

PROJECTS OFFICE

Assistant to the Director
Ester Sánchez

Managing Director
David Badia

IMS Developer
Carles Ortega

DIRECTORATE

Head of Strategic Initiatives
Teresa Sanchis

Project Manager
Sergio González

STRATEGIC INITIATIVES

Head of Technology Transfer Office
Xavier Rúbies

Project Managers
Xavier Puñet
Diana Mª González

TECHNOLOGY TRANSFER

Not pictured:

Project Assistant
Esther Oriol

Communications Assistant
Carolina Llorente (until July 2016)
Accounting Technician
Francisco Buenestado (until November 2016)

Technology Transfer Project Manager
Marta Soler (until March 2016)
HR Technician
Ricard Rius (until April 2016)

For the Core Facilities staff list, see pages 116-121

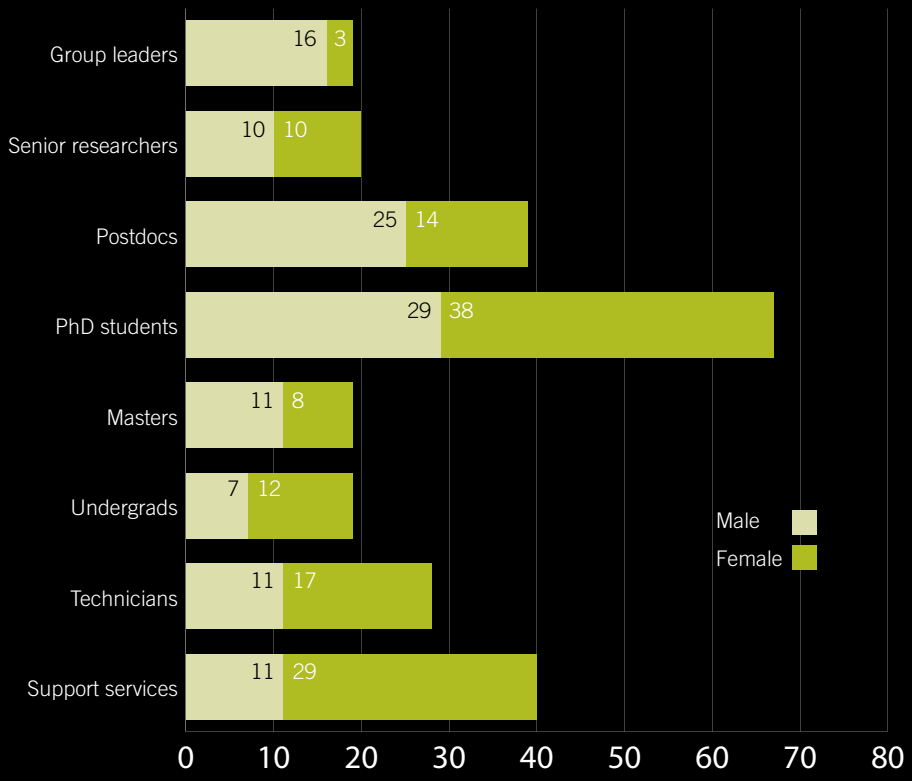
Statistics

In 2016 IBEC's total staff, including administration staff as well as researchers, students and technicians, numbered 251. Of this total, 148 are hired by IBEC, while the rest are seconded, affiliated, externals, visitors or other status.

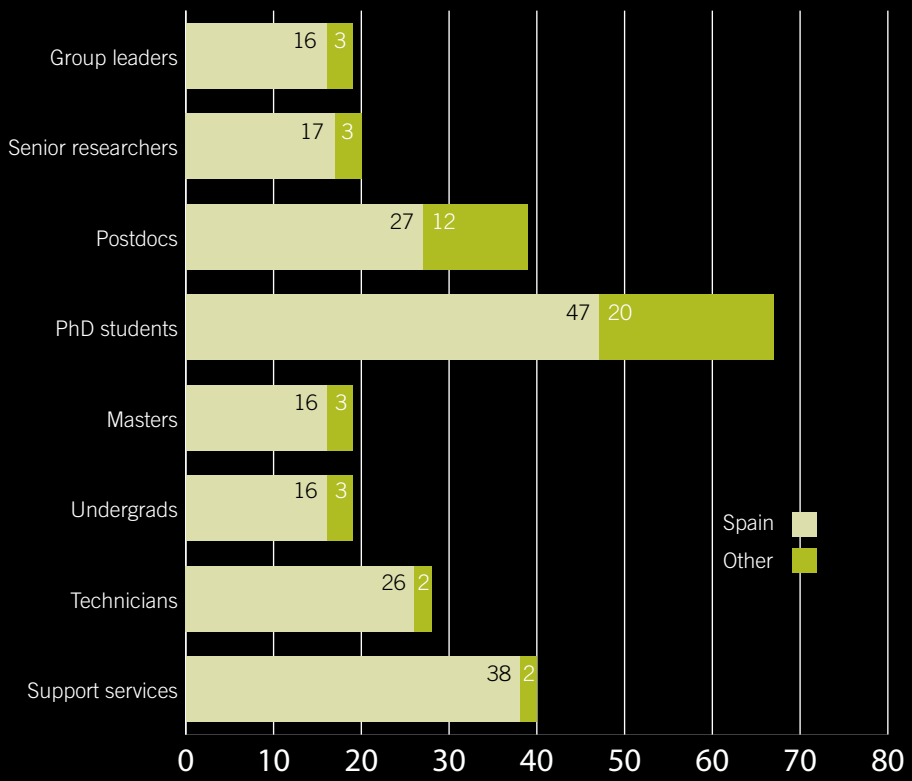
The following statistics reflect the state of affairs on 31st December 2016.

1. Age of all IBEC staff (researchers, technicians and administration)

2. Gender of all staff



3. All staff by gender and job category



4. All staff by nationality (Spain/other) and job category

5. All IBEC staff by nationality (map)

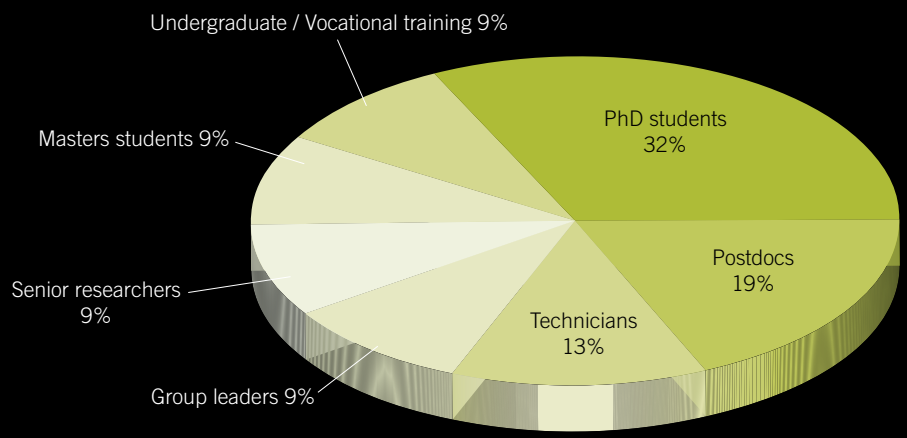
The 251 personnel at IBEC in 2016 (including administration staff) represented

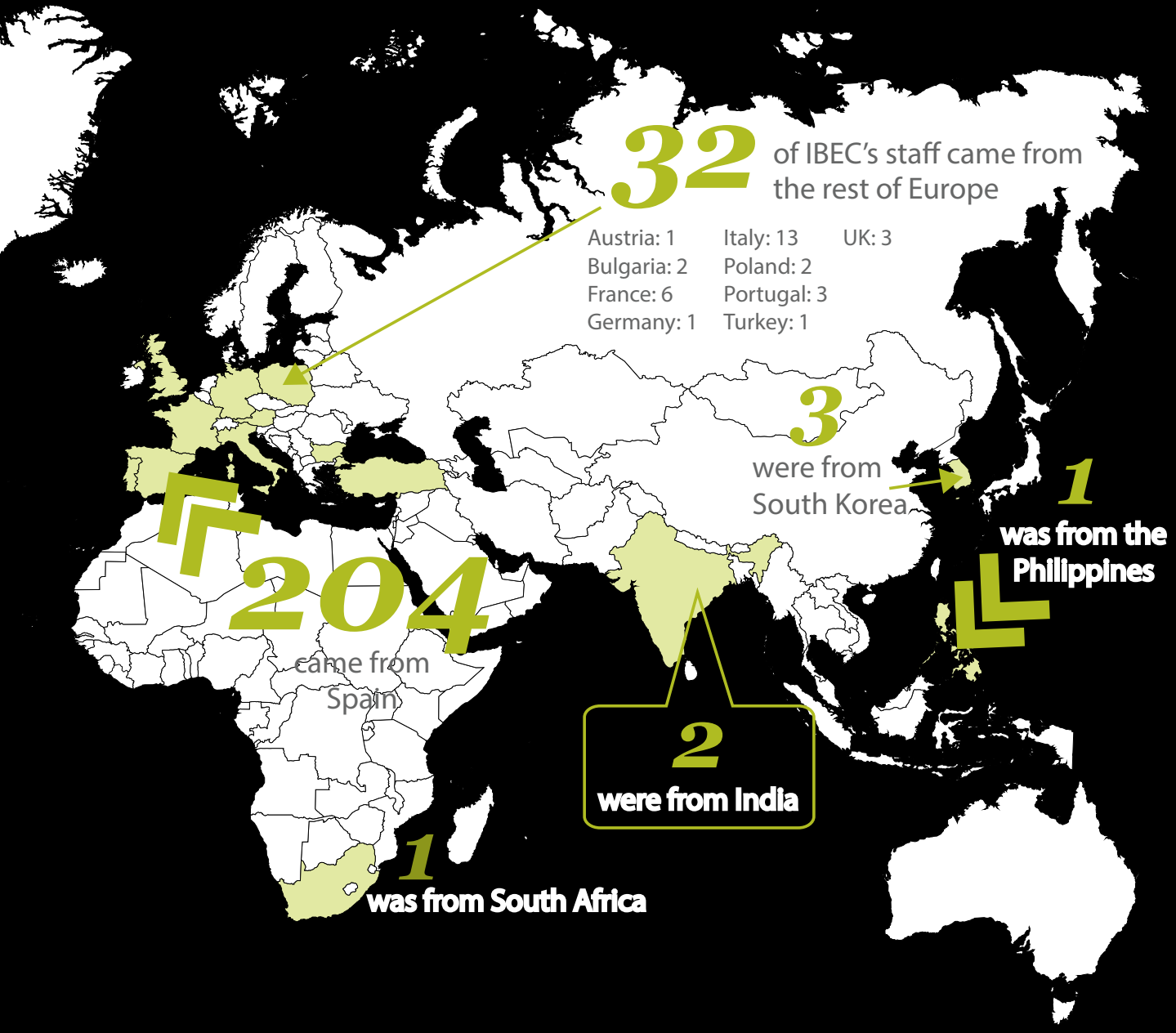
21 countries

Argentina: 2
Brazil: 1
Colombia: 1
Cuba: 1
Mexico: 1
Panama: 1
Uruguay: 1

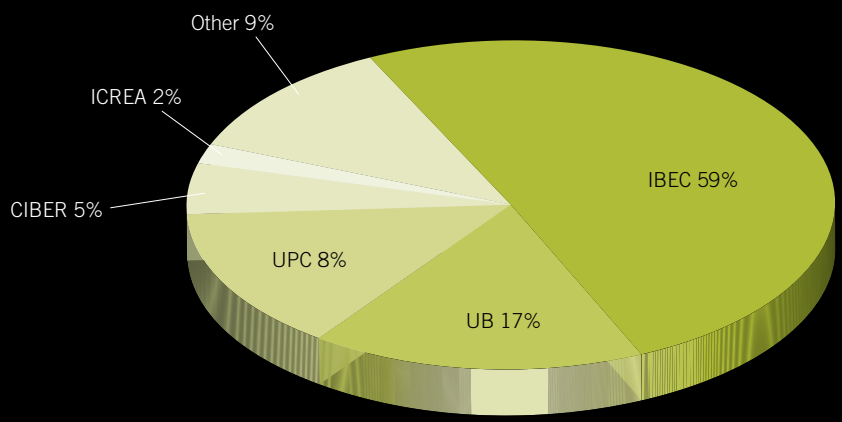
8 were from Latin America

6. IBEC researchers and technicians by job category





7. IBEC staff by contracting institution



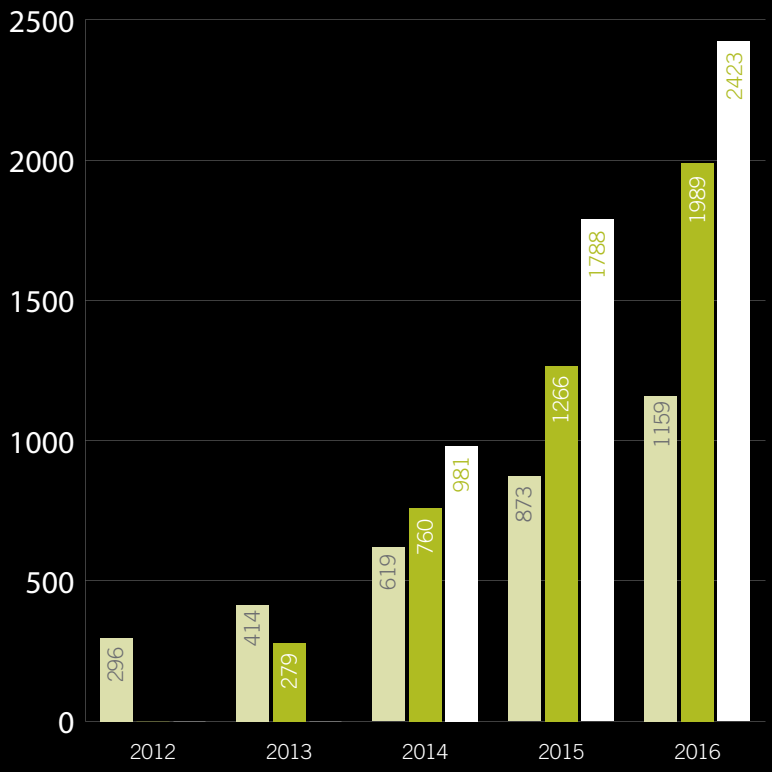
8. Mobility in 2016

7 went to other labs in Spain

16 went to labs in Europe

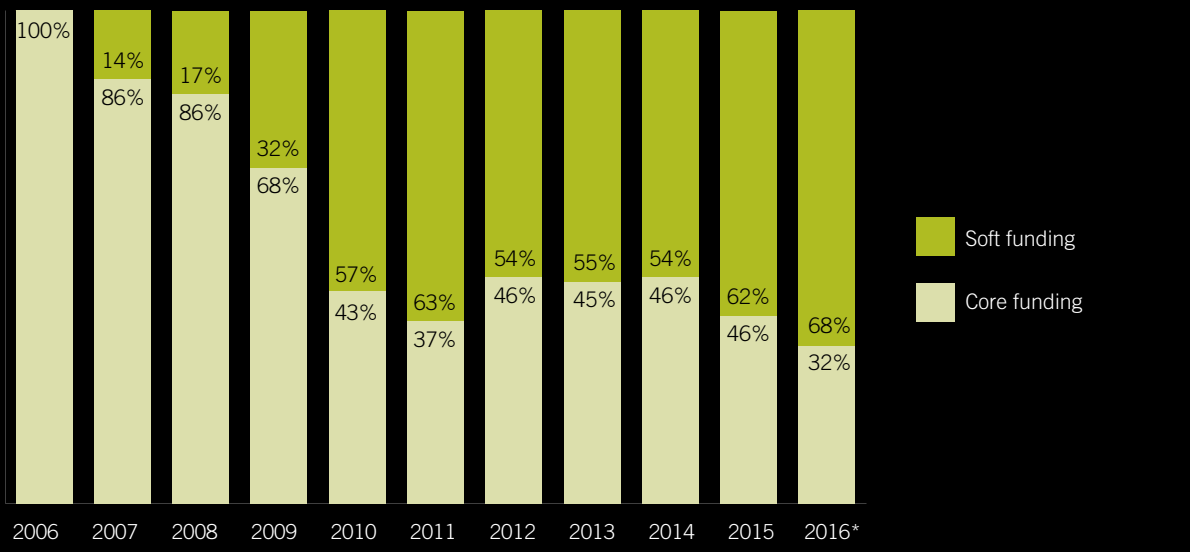
3 went to the rest of the world

Number of researchers who spent time elsewhere in 2016: **26**



9. Number of followers on social media 2012-2016

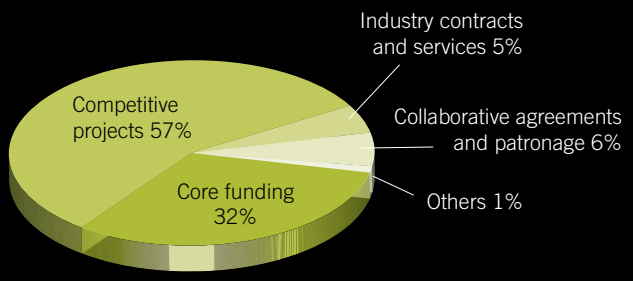
10. Funding sources in 2016



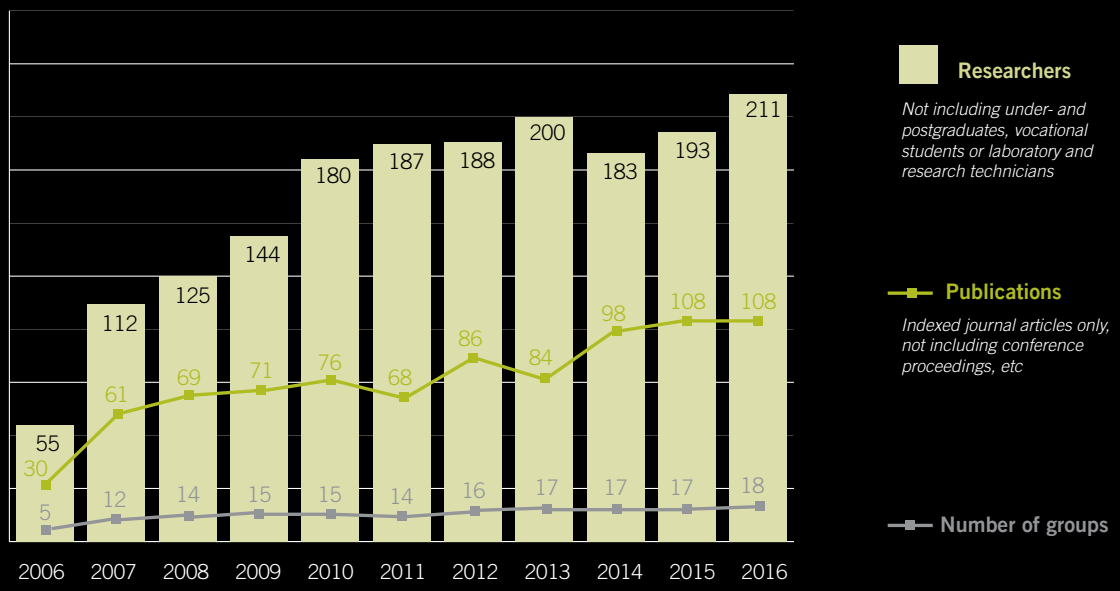
Graph: Percentage of funding from core v. competitive sources. Core funding is funding from trustees. Soft funding includes competitive projects (funded by sources such as the EU's H2020 programme, the Spanish Ministry of Science or the Catalan Ministry of Research), Industry contracts, funding from private institutions.

Pie chart: Different sources of funding in 2016, broken down into types.

** Figures for 2016 are provisional, pending audit*



11. Evolution of IBEC



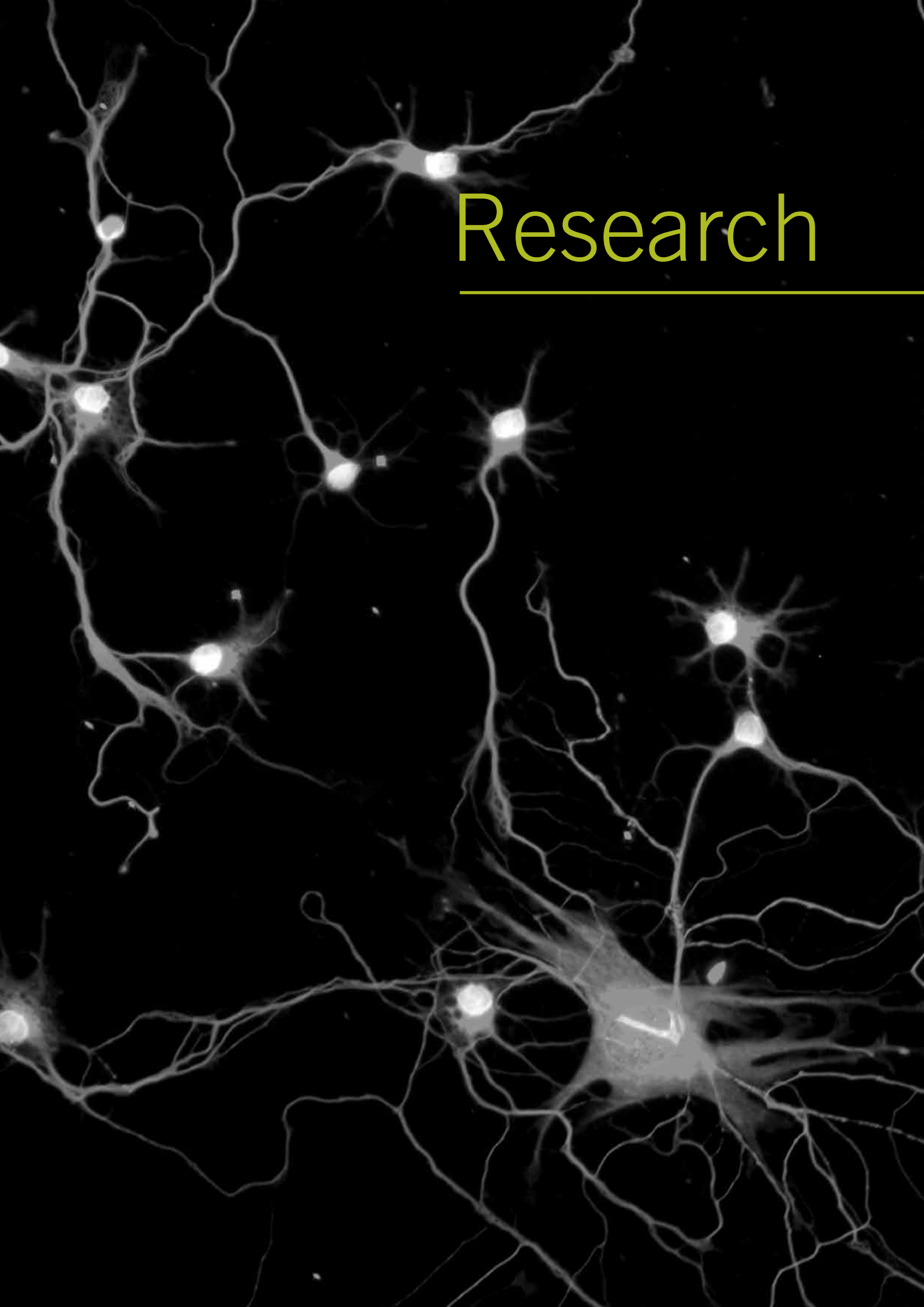
Researchers

Not including under- and postgraduates, vocational students or laboratory and research technicians

Publications

Indexed journal articles only, not including conference proceedings, etc

Number of groups



Research

Postdoctoral Researcher
Silvia Pujals

PhD Student
Natàlia Feiner

Junior Group Leader: Lorenzo Albertazzi

Nanoscopy for nanomedicine

The main goal of our group is to use Super Resolution Microscopy (nanoscopy) to visualize and track in living cells and tissues self-assembled nanomaterials with therapeutic potential (nanomedicine).

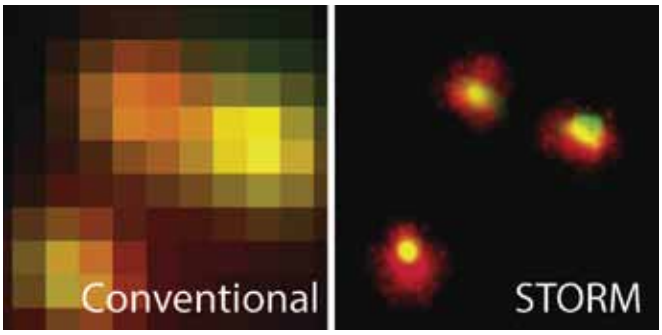
The understanding of materials-cell interactions is the key towards the development of novel nanotechnology-based therapies for treatment of cancer and infectious diseases.

Our group aims to use a multidisciplinary approach, at the interface of chemistry, physics and biology, to develop novel nanomaterials for the treatment of cancer and infectious diseases.

We aim at the development of novel nanocarriers for drug delivery based on self-assembly, i.e. able to build themselves. Molecular self-organization is ubiquitous in the biological world and represents for us a source of inspiration for the design of nanostructures with biomedical potential. In particular we focus on the development of self-assembled nanoparticles and nanofibers able to selectively target diseased cells and deliver locally therapeutic moieties such as drugs and genetic material (e.g. DNA, siRNA, mRNA).

A key point towards the development of novel nanotechnology-based therapies is the understanding of the behavior of nanomaterials in the complex biological environment. Here we use super resolution microscopy to track nanomaterials during their voyage in the biological environment and to visualize the interactions with blood components, immune system and target cells. We make use of a variety of super resolution techniques based on single molecule detection such a stochastic optical reconstruction microscopy (STORM), photoactivated localization microscopy (PALM), point accumulation for imaging in nanoscale topography (PAINT), and single particle tracking (SPT). These methods allow to achieve a resolution down to few nanometers and are therefore ideal to visualize nanosized synthetic objects in the biological environment. Super resolution microscopy provides a molecular picture of structure-activity relations and represent a guide towards the design of innovative materials for nanomedicine.

Nanoparticles interactions with blood components imaged with conventional optical microscopy (left) and super resolution STORM microscopy (right).



Masters Student
Roger Riera

Undergraduate Students
Adrià Terradellas
Sergi De la Cruz

Research projects

- **TARGETSTORM** Nanomateriales para terapias dirigidas contra el cáncer visualizados con microscopia de súper resolución STORM (2016-2019)
  PI: **Lorenzo Albertazzi**
  MINECO Retos investigación: Proyectos I+D
- Novel approaches for Pandemic Virus Targeting Using Adaptive Polymers (2015-2017)
  PI: **Lorenzo Albertazzi**
  AXA Research Fund

Collaborations with other research centres

Roey Amir, Tel Aviv University, Israel

Mika Linden, Ulm University, Germany

Ilja Voets, Eindhoven University of Technology, The Netherlands

Giovanni Pavan, SUPSI, Switzerland

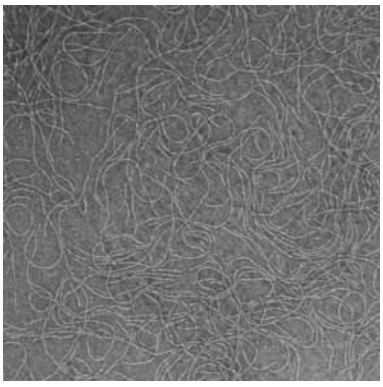
Bruno De Geest, University of Ghent, Belgium

Salvador Borros, IQS Barcelona

Scientific equipment and techniques

- Nikon NSTORM Super Resolution Microscope
- Super Resolution microscopy
- Single particles tracking
- TIRF fluorescence imaging

TEM image of novel self-assembled nanofibers synthesized in the group.



Publications

- Beun, L. H., Albertazzi, L., Van Der Zwaag, D. *et al* (2016). Unidirectional living growth of self-assembled protein nanofibrils revealed by super-resolution microscopy. *ACS Nano*, 10 (5): 4973-4980
- Bakker, M. H., Lee, C. C., Meijer, E. W. *et al* (2016). Multicomponent supramolecular polymers as a modular platform for intracellular delivery. *ACS Nano*, 10 (2): 1845-1852
- Garzoni, M., Baker, M. B., Leenders, C. M. A. *et al* (2016). Effect of H-bonding on order amplification in the growth of a supramolecular polymer in water. *Journal of the American Chemical Society*, 138 (42): 13985-13995
- Aloi, A., Vargas Jentzsch, A., Vilanova, N. *et al* (2016). Imaging nanostructures by single-molecule localization microscopy in organic solvents. *Journal of the American Chemical Society*, 138 (9): 2953-2956
- da Silva, R. M. P. *et al* (2016). Super-resolution microscopy reveals structural diversity in molecular exchange among peptide amphiphile nanofibres. *Nature Communications*, 7 11561
- De Koker, S. *et al* (2016). Engineering polymer hydrogel nanoparticles for lymph node-targeted delivery. *Angewandte Chemie - Int Ed*, 55 (4): 1334-1339
- van der Zwaag, D. *et al* (2016). Super resolution imaging of nanoparticles cellular uptake and trafficking. *ACS Applied Materials & Interfaces*, 8 (10): 6391-6399
- Li, H. *et al* (2016). Spontaneous protein adsorption on graphene oxide nanosheets allowing efficient intracellular vaccine protein delivery. *ACS Applied Materials & Interfaces*, 8 (2): 1147-1155 (2016).
- Beuwer, M. A., Knopper, M. F., Albertazzi, L. *et al* (2016). Mechanical properties of single supramolecular polymers from correlative AFM and fluorescence microscopy. *Polymer Chemistry*, 7 (47): 7260-7268

Postdoctoral Researcher
Salima Nedjari

PhD Student
Dencho Gugutkov

Group Leader / ICREA Research Professor: George Altankov

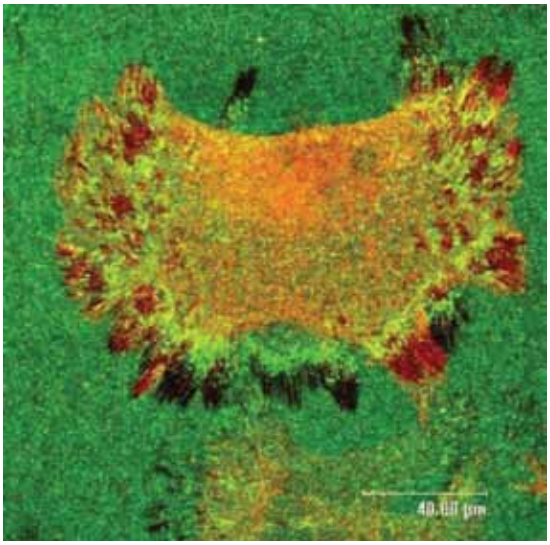
Molecular dynamics at cell-biomaterial interface

We are interested in cell–biomaterials interaction, and more specifically, on the dynamic formation of the provisional extracellular matrix (ECM) – the thin protein layer that cells recognize, produce, and remodel at the materials interface.

We aim to learn how this process affects the biocompatibility of materials, and if it can be controlled by engineering the surface properties of materials. For this purpose, we perform systematic studies in the following directions:

Remodelling of ECM proteins at cell-biomaterials interface

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



ECM organization at the biomaterial interface depends on the allowance of cells to rearrange adsorbed matrix proteins – a process strongly dependent on proper

Fig. 1: Dynamic behaviour of ECM proteins at cell-biomaterials interface: Fibroblast remodelling of adsorbed collagen IV (green) depend on α2 integrin (red) function. Colocalization is in orange. Dark zones represents the mechanical removal of adsorbed protein followed by fibri-like organization (arrow).

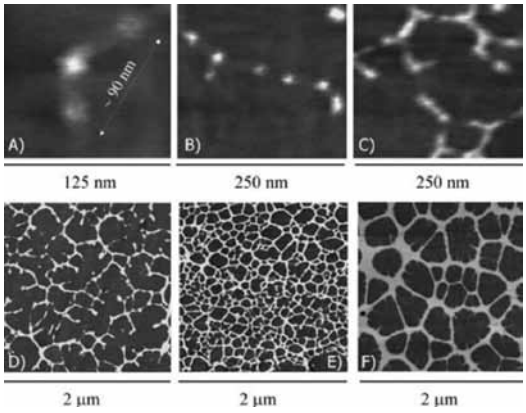


Fig. 2: Material driven fibronectin fibrilogenesis at nanoscale as observed with AFM (Gugutkov *et al*, 2009)

functioning of integrin receptors. We anticipate that materials that bind proteins loosely will support the arrangement of a provisional ECM, while stronger binding provokes its degradation.

Biomaterials surface-driven assembly of ECM proteins at the nanoscale

Upon adsorption at material interfaces, proteins may assemble spontaneously and this interaction has significant consequences for their biological response. Recently we have employed distinct silane-inspired chemistries and polymer compositions to create model substrates with tailored densities of -OH, -COOH, $-NH_2$ and $-CH_3$ groups, thus varying the chemistry, charge and hydrophilic/ hydrophobic balance. In a series of communications combining AFM and other nanoindentation techniques, we have described a novel phenomenon of substratum-driven protein assembly depicting the fate of various matrix proteins such as fibronectin, collagen IV, vitronectin and fibrinogen at the above model biomaterials interfaces.

Specifically, we show that by varying the density of chemical functions one can tailor both the assembly and degradation of proteins. Following those findings we aim to control ECM remodelling by engineering specific material properties. Understanding the behavior of ECM proteins on flat biomaterials interface further boosts an important bioengineering target – the biohybrid organ technologies based on two-dimensional protein layers that mimic the arrangement of the natural basement membrane.

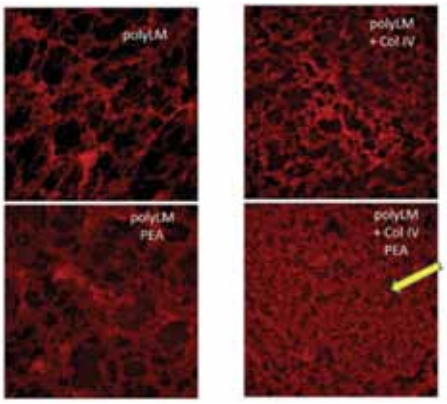


Fig. 3: Fluorescent confocal images of poly-laminin and poly-laminin/Col IV composite matrices showing the "condensation" effect of PEA surface resembling the physiological basement membrane

Development of artificial basement membrane

This project aims to develop a synthetic basement membrane (BM) to be used as a supportive lining for cellularized implants, with specific focus on the design of a bioengineered blood vessel. Taking advantage of the self-assembly properties of the two principal components of the BM, laminin and collagen IV, composite matrices of these molecules are produced by mixing them before or during the polymerization of laminin under acidic conditions.

Selected composites will be deposited on scaffolds produced using electronspun nanofibers preferentially made of polyethyl acrilate (PEA), which additionally favour networking of

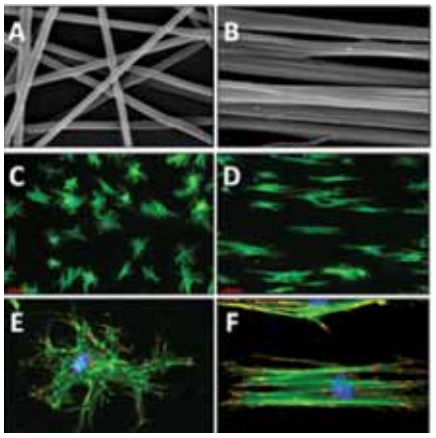


Fig. 4: Hybrid PLA/fibrinogen nanofibers deposited in random (A) and aligned (B) configurations. Human mesenchymal stem cells adhere to the fibers and acquire a stellate-like (C & E) or elongated (D & F) morphology, depending on the fiber orientations (staining: vinculin in red and actin in green).

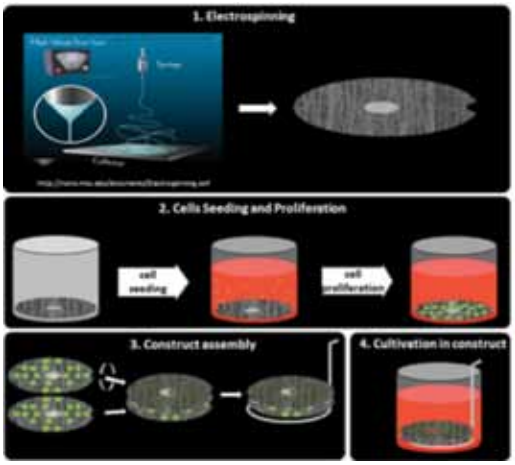


Fig. 5: Schematic illustration of the STRUCTGEL concept.

laminin and collagen IV. The resemblance to natural BM will be evaluated in terms of their morphological features and ability to properly induce the formation of biomimetic monolayers of endothelial cells. This project is driven involving joint efforts of Dr Coelho-Sampaio's Lab from the Federal University of Rio de Janeiro, Brazil.

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

In solution, proteins can form structures of various shapes, including fibers with a diameter of only a few nanometers and with lengths up to centimeters. A fascinating possibility to mimic similar ECM structures is to engineer protein-like or matrix protein-containing nanofibers via electrospinning technology. For this purpose we are developing electrospun nanofibers from natural (e.g., fibrinogen) and synthetic polymers (e.g. PLA, PEA) in order to direct the desired cellular response via spatially organized cues (e.g. fiber size and geometrical organization) as well as by tailoring their chemical and mechanical properties.

Nanofibers-based 3D constructs providing stem cells with spatially organized stimuli

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

Creating dynamic stem cell niches using stimuli-responsive biomaterials

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

Research projects

- **FIBROGELNET** Network for development of soft nanofibrous construct for cellular therapy of degenerative skeletal disorders (2013-2017)
  PI: **George Altankov** (coordinator)
  EU - FP7-PEOPLE-2012-IAPP

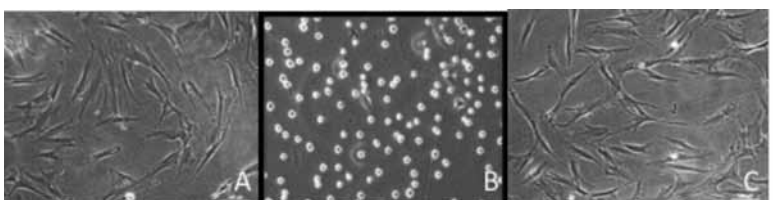


Fig. 6: Reversible attachment/detachment of human mesenchymal stem cells from thermo-responsible PNIPAM substrata: Cells were cultured at 37ºC for 5 h on PNIPAM (A) and left to detach at room temperature for 2 hours (B), then switched again to 37ºC overnight (C).

- **MYOHEAL** Muscle regeneration after injury. Engineered biodegradable ion–loaded scaffolds to promote muscle regeneration (2015-2017)
  PI: **George Altankov**
  MINECO, MAT 2015 – 69315 –C3
- **MYOREM** Remodelación por mioblastos de la matriz extracelular en la interfaz celula-biomaterial (2016-2018)
  PI: **George Altankov**
  MINECO, Retos investigación: Proyectos I+D

Collaborations with other research centres

Center for Biomaterials, Technical University of Valencia, Spain

Institute of Pharmacy, Martin Luther University, Halle, Germany

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

Institute for Biophysics and Biomedical Engineering, Bulgarian Academy of Sciences, Sofia, Bulgaria

Institute of Solid State Physics, Bulgarian Academy of Sciences, Sofia, Bulgaria

Division of Biomedical Engineering, School of Engineering, University of Glasgow, United Kingdom

Industrial collaborations:

Bio-Elpida, France

BulGen, Bulgaria

Scientific equipment and techniques

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

Publications

- Zhao, M., Altankov, G., Grabiec, U., Bennett, M., Salmeron-Sanchez, M., Dehghani, F. and Groth, T. (2016). Molecular composition of GAG-collagen I multilayers affects remodeling of terminal layers and osteogenic differentiation of adipose-derived stem cells. *Acta Biomaterialia*, 41 86-99
- Forget, J., Awaja, F., Gugutkov, D., Gustavsson, J., Gallego Ferrer, G., Coelho-Sampaio, T., Hochman-Mendez, C., Salmeron-Sánchez, M. and Altankov, G. (2016). Differentiation of human mesenchymal stem cells toward quality cartilage using fibrinogen-based nanofibers. *Macromolecular Bioscience*, 16 (9): 1348-1359

Book Sections

- Coelho, N. M., Llopis-Hernández, V., Salmerón-Sánchez, M. and Altankov, G. (2016). Dynamic reorganization and enzymatic remodeling of type IV collagen at cell–biomaterial interface. In: *Advances in Protein Chemistry and Structural Biology* (ed. Christo, Z. C.). San Diego, USA, Academic Press. 105: 81-104

Junior Group Leader: Vito Conte

Mechanics of development and disease

In the group we advance cross-disciplinary research at the interface between engineering, biology and physics. We are interested in deciphering the physical mechanisms of development and disease in biological organisms.

We do so by studying how cell and tissue mechanics determine structure and function in these organisms. To that end, we are developing new biophysical tools to compute cell and tissue forces in arbitrary 3D environments that have realistic geometries and material properties, such as anisotropy, heterogeneity, poroelasticity, and non-linear viscoelasticity. We utilise these tools to carry out *in vivo* and *in vitro* mechanical measurements, which we integrate into 2D and 3D physical models of the biological organisms under study. The *in silico* models we build allow us to make predictive biomechanical analyses of these organisms by studying the necessary and sufficient conditions for their development and disease under conditions very close to the real ones.

The group currently has two main fields of research inside IBEC's Bioengineering for Future Medicine pillar.

Biomechanical regulation of cancer progression

Our research in this field moves from growing evidence that cancer progression alters mechanical properties of cells and tissues affected by the disease. However, we ignore whether these alterations feed back into the cancer progression and, for that reason, may represent potential means to hinder or arrest the disease biomechanically. We want to understand the interplay between mechanics and malignancy of tissues to help identify new biomechanical markers or physical mechanisms of cancer progression that are clinically targetable for the prevention and treatment of the disease.

Embryo morphogenesis

In 2016 we started to explore how cell and tissue mechanics in the early embryo are associated to and regulated by a concerted programme of gene expression. This programme transforms the embryo from a simple unstructured organism into a healthy complex organism. Specifically, we're interested in quantifying the forces defining the physical mechanisms that morph the fruit fly blastula into the gastrula. Gastrulation is a key stage in the healthy development of the embryo of most animals: if anything goes awry during this process a diseased or abnormal phenotype is produced if the embryo survives at all.

Research projects

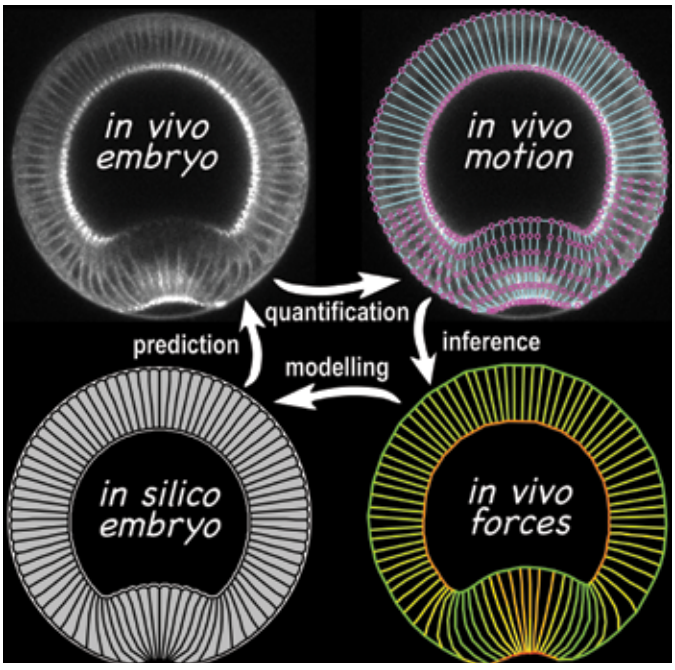
- **CancerMechReg** Regulacion biomecanica de la progresion del cancer (2016-2019)
  PI: **Vito Conte**
  MINECO, Proyectos I+D Excelencia

Collaborations with other research centres

José Muñoz, Polytechnic University of Catalonia (UPC)

Scientific equipment and techniques

- Mechanical quantification *in vitro* and *in vivo*
- Experimental physical modelling *in silico*



In vivo biomechanical quantification of ventral furrow invagination in the *Drosophila melanogaster* embryo.

Publications

- Sunyer, R., Conte, V., Escribano, J., Elosegui-Artola, A., Labernadie, A., Valon, L., Navajas, D., García-Aznar, J. M., Muñoz, J. J., Roca-Cusachs, P. & Trepat, X. (2016). Collective cell durotaxis emerges from long-range intercellular force transmission. *Science*, 353 (6304): 1157-1161

Senior Researchers
Soledad Pérez
Oscar Castaño
Miguel Angel Mateos

Masters Students
Alejandro Martínez
Elena Aguinaco
Sergi Rey
Andrea Martin
Kevin Weisse
Albert Martí
Elise Bouillot

Group Leader: Elisabeth Engel

Biomaterials for regenerative therapies

Research in the Biomaterials for Regenerative Therapies group is devoted to the development and knowledge transfer to industry of innovative biomaterials and scaffolds for tissue regeneration.

We design, fabricate and characterize bioactive and biodegradable materials and investigate their interactions with biological entities, both in terms of their fundamental aspects and with specific applications for tissue engineering purposes in mind. The aim is the repair and functional restoration of tissues or organs by means of 3D scaffolds, cells and signals.

Different research areas are being developed in the group:

The production of polymeric biomaterials using different fabrication techniques: by using a polymer nanoprecipitation technique, the group produced nanoparticles for antibiotic drug delivery that effectively treated persistent bacterial infections. The use of a jet break-up polymer precipitation technique together with protein/peptide functionalization allowed the group to produce micro particles for effective cell delivery.

The production of structured bioactive nanocomposites that can enhance vascularization, bone and skin regeneration, either by electrospinning, rapid prototyping or micro-particles production. In 2016 we were awarded by a CAIXAIM-PULSE first edition project to bring our “Dermoglass” project to a closer commercialization stage. Thus, within the IBEC-LaCaixa Joint program we are developing new nanoparticles that have an antimicrobial effect to add this property to the dressing. This project also obtained an award by EIT Health to enhance IP protection and scalability for further commercialization.

Recent advances describe a novel hybrid material which faithfully mimics the structure of bone’s extracellular matrix, recreating the molecular architecture and biochemical environment to surround cells with the proper stimuli to spread and grow (Sachot N *et al.*, 2016, *J Mater Chem B*). Other biomaterials developed in the group such as hybrid fibrous mats with different contents of calcium-releasing nanoparticles are able to induce angiogenesis in *in vivo* models (Oliveira H. *et al.*, 2016, *Acta Biomaterialia*).

In collaboration with the group of Prof. Rodriguez-Cabello from the University of Valladolid, the group developed microstructured biomimetic hydrogels using new crosslink methods that induce bone formation *in vivo*. These biomaterials have also been combined with 3D printed hydroxyapatite scaffolds to enhance bone formation in collaboration with

Biomaterials for regenerative therapies

PhD Students
Claudia Navarro
Jesús Ordoño
Joan Martí
Irene Cano

Laboratory Technician
Belén González

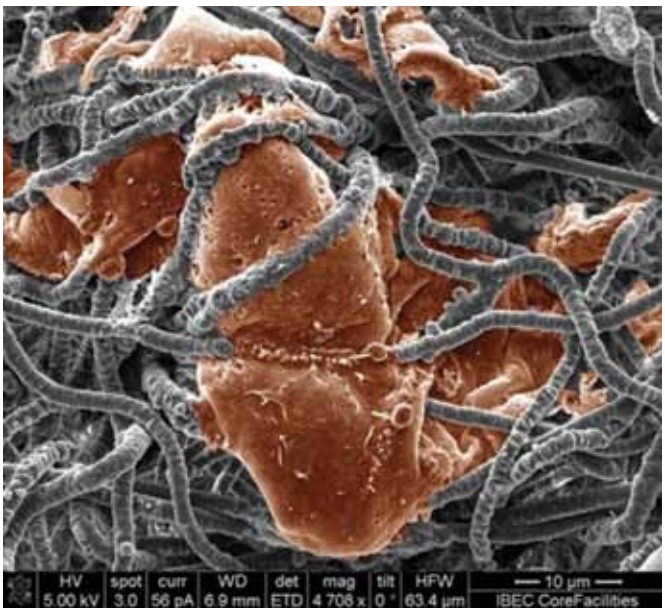
Undergraduate Student
Maximilian Jergitsch

Research Assistant
Gerard Rubí

Prof. Vallet and Prof. Bujan (Vila *et al. Acta Biomaterialia* 2016).

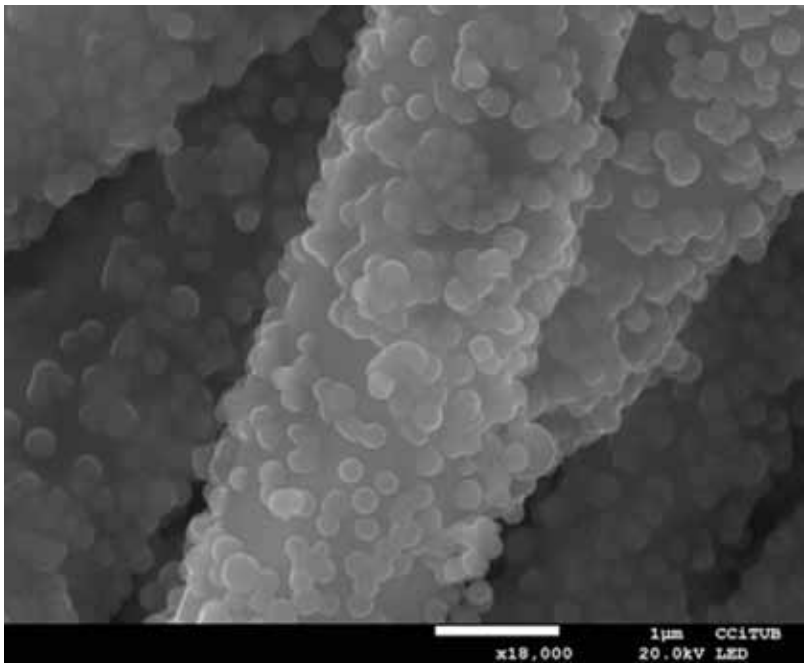
In collaboration with Prof. del Rio and Prof. Trepat at IBEC and Prof. Kevin Healy at Berkeley, fabrication of customized biomaterials and/or microfluidics based platforms for the fundamental study of biological systems related to angiogenesis processes and neural regeneration have been developed. We have used signalling gradients of concentration to address progenitor cells to the desired target.

A new project awarded by MINECO has started. We have been working on microparticles to produce new bioinks to print organs such as bone and produce microtissues as systems to model pathologies like cancer. This microtissues can be created inside a bioreactor and use this bioreactor to decellularize and recellularize with the appropriate cells and can be controlled by means of bioluminescence.



Cardiac fibroblasts integrate within the PLA fibers ECM-like matrix (Jesús Ordoño)

Finally, we have started a project to develop instructive matrices to activate cardiac cells to promote cardiac regeneration.



PLA nanofibers coated with Silicon nanoparticles (Joan Martí)

Filed patents

- Patent Number: Ep16162079. **Patent in the field of biomaterials in ophthalmology.** Assignees: Centro de Investigación Biomédica en Red (CIBER), IBEC, Universitat Politécnic de Catalunya (UPC), Universidad de Valladolid (Instituto Universitario de Oftalmobiología Aplicada) (UV-LOBA). Authors: Miguel Angel Mateos, Riccardo Levato, Josep A. Planell, Elisabeth Engel, Xavier Puñet, Margarita Calonge, Teresa Nieto, Marina López, Sara Galindo De La Rosa

Research projects

- **THE GRAIL** Tissue in Host Engineering Guided Regeneration of Arterial Intimal Layer (2012-2016)
  PI: **Elisabeth Engel, Soledad Pérez** (scientific coordinator)
  EU - Cooperation - HEALTH
- **INSBIOMAT** Biomateriales instructivos para regeneración cardíaca *in vivo* (2015-2016)
  PI: **Elisabeth Engel**
  MINECO Acciones Dinamización "Europa Excelencia"
- **MatriCell** Desarrollo de partículas poliméricas para generar matrices extracelulares *in vitro* (2016-2018)
  PI: **Elisabeth Engel**
  MINECO Retos investigación: Proyectos I+D
- **DERMOGLASS** Smart dressing for the treatment of chronic wounds (2016-2017)
  PI: **Elisabeth Engel**
  Caixaimpluse / EIT Health / Obra Social La Caixa Mecenatge/donacions
- Andamios diseñados para promover una vascularización eficiente para fracturas óseas no consolidadas (2012-2016)
  PI: **Oscar Castaño**
  MINECO MAT2011-29778-C02-01

- Diseño y desarrollo de Biomateriales bioactivos para la regeneración de la piel basada en la señalización controlada de liberación de iones (2013-2016)
  PI: **Elisabeth Engel**
  MINECO MAT2012-38793

Collaborations with other research centres

Dr. Ernest Mendoza Applied Nanomaterials Laboratory, Research Centre in Nanoengineering, Technical University of Catalonia (UPC, BarcelonaTech), Spain

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

Dr. José María Mora Servei de cirurgia ortopédica i traumatológica, Consorci Hospital de Terrassa, Spain

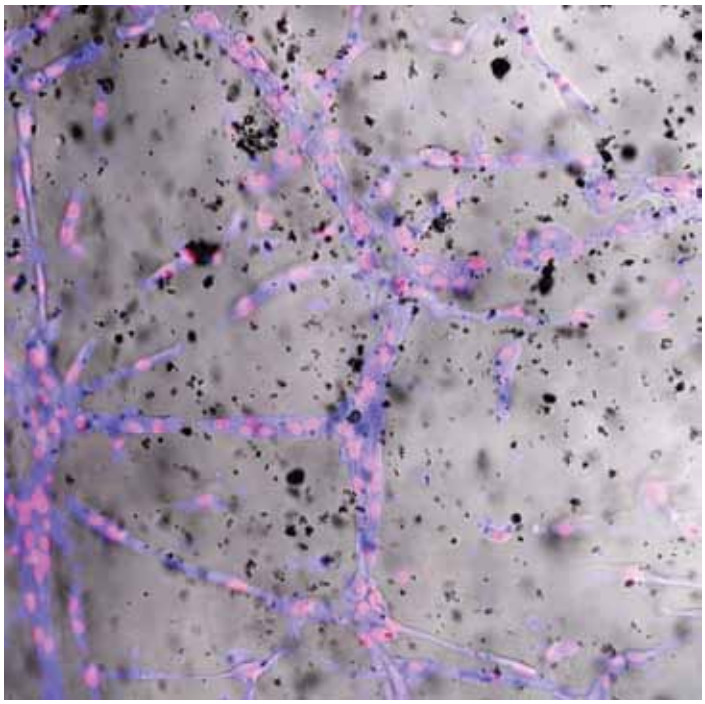
Dr. Mercè Alsina Servicio de Dermatología, Hospital Clínic de Barcelona, Spain

Prof. Didier Letourneur Laboratoire de Bioingénierie Cardiovasculaire, INSERM, University Denis Diderot-Paris 7, Paris, France

Prof. Dirk Grijpma, Department of Biomaterials Science and Technology, University of Twente, Twente, the Netherlands

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

Human Mesenchymal Stem cells forming networks within a functionalized Polyethylene Glycol Hydrogel containing calcium-phosphate particles. (Claudia Navarro)



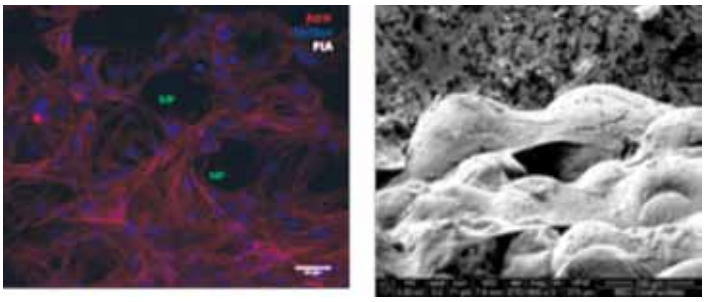
Publications

- Álvarez, Z., Hyroššová, P., Perales, J. C. and Alcántara, S. (2016). Neuronal progenitor maintenance requires lactate metabolism and PEPCK-M-directed cataplerosis. *Cerebral Cortex*, 26 (3): 1046-1058
- Vila, M., García, A., Girotti, A., Alonso, M., Rodríguez-Cabello, J. C., González-Vázquez, A., Planell, J. A., Engel, E., Buján, J., Garcíaa-Honduvilla, N. and Vallet-Regí, M. (2016). 3D silicon doped hydroxyapatite scaffolds decorated with Elastin-like Recombinamers for bone regenerative medicine. *Acta Biomaterialia*, 45 349-356
- Oliveira, H., Catros, S., Boiziau, C., Siadous, R., Marti-Munoz, J., Bareille, R., Rey, S., Castano, O., Planell, J., Amédée, J. and Engel, E. (2016). The proangiogenic potential of a novel calcium releasing biomaterial: Impact on cell recruitment. *Acta Biomaterialia*, 29 435-445
- Sachot, N., Castaño, O., Oliveira, H., Martí-Muñoz, J., Roguska, A., Amedee, J., Lewandowska, M., Planell, J. A. and Engel, E. (2016). A novel hybrid nanofibrous strategy to target progenitor cells for cost-effective: In situ angiogenesis. *Journal of Materials Chemistry B*, 4 (43): 6967-6978
- Vila, O. F., Garrido, C., Cano, I., Guerra-Rebollo, M., Navarro, M., Meca-Cortés, O., Ma, S. P., Engel, E., Rubio, N. and Blanco, J. (2016). Real-time bioluminescence imaging of cell distribution, growth, and differentiation in a three-dimensional scaffold under interstitial perfusion for tissue engineering. *Tissue Engineering Part C: Methods*, 22 (9): 864-872

Conference Papers

- Torrents, E., Baelo, A., Levato, R., Julián, E., Crespo, A., Astola, J., Gavaldà, J., Engel, E. and Mateos-Timoneda, M. A. (2016). Mejora en la administración antibiotic para el tratamiento de infecciones en forma de biofilm con el uso de

nanopartículas que disgregan la matriz extracellular. *XX Congreso de la Sociedad Española de Enfermedades Infecciosas y Microbiología Clínica (SEIMC)*, Barcelona, Spain. Published by Elsevier



Microtiusses formed with rMSC cells on polylactic acid microparticle scaffolds. (Irene Cano)

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

Dr. Joelle Amedee INSERM, University of Bordeaux Segolen, Bordeaux, France

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

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

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

Prof. Kevin Healy Biomaterials & Tissue Engineering Laboratory, University of California at Berkeley, USA

Prof. Jaume Veciana NANOMOL, Institut de Ciència de Materials de Barcelona (ICMAB-CSIC), Spain

Dr. Diego Gutiérrez de la Iglesia (MD) Pediatric orthopaedic surgery, San Juan de Dios Hospital, Spain

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

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

Prof. Mateo Santin Brighton Studies in Tissue Mimicry and Aided Regeneration (BrightSTAR) Research Group, University of Brighton, UK

Prof. Wouter J.A. Dhert & Dr. Jos Malda Department of Orthopaedics, University Medical Center Utrecht, The Netherlands

Prof. Andrés J. García, F.B.S.E. Petit Institute for Bioengineering and Bioscience, Georgia Institute of Technology, Atlanta, GA

Dr. Luigi Ambrosio Institute of Polymers, Composites & Biomaterials National Research Council, Naples, Italy

Prof. Carlos Semino Grupo de Insuficiencia Cardíaca y Regeneración Cardíaca (ICREC), IQS School of Engineering, Universitat Ramon Llull

Scientific equipment and techniques

- Surface characterization equipment (contact angle, Z potential, nanoindenter)
- Cell culture facilities
- Molecular Biology equipment: protein and DNA electrophoresis
- Thermocycler (PCR)
- Rapid prototyping tool
- Peptide synthetiser
- Combustion furnace
- Electrospinning device
- Spin-coater
- Vibrational viscosimeter
- ElectroForce® BioDynamic® test instrument

Group Leader: Xavier Fernàndez-Busquets

Nanomalaria

(joint unit IBEC/ISGlobal)

The current activity of the Nanomalaria group is focused on the development of nanomedicine-based systems to be applied to malaria prophylaxis, diagnosis and therapy.

Malaria is arguably one of the main medical concerns worldwide because of the numbers of people affected, the severity of the disease and the complexity of the life cycle of its causative agent, the protist *Plasmodium spp*. The clinical, social and economic burden of malaria has led for the last 100 years to several waves of serious efforts to reach its control and eventual eradication, without success to this day. With the advent of nanoscience, renewed hopes have appeared of finally obtaining the long sought-after magic bullet against malaria in the form of a nanovector for the targeted delivery of antimalarial drugs exclusively to *Plasmodium*-infected cells. Nanotechnology can also be applied to the discovery of new antimalarials through single-molecule manipulation approaches for the identification of novel drugs targeting essential molecular components of the parasite. Finally, methods for the diagnosis of malaria can benefit from nanotools applied to the design of microfluidic-based devices for the accurate identification of the parasite's strain, its precise infective load, and the relative content of the different stages of its life cycle, whose knowledge is essential for the administration of adequate therapies. The benefits and drawbacks of these nanosystems have to be considered in different possible scenarios, including economy-related issues that are hampering the progress of nanotechnology-based medicines against malaria with the dubious argument that they are too expensive to be used in developing areas. Unfortunately, it is true that the application of nanoscience to infectious disease has been traditionally neglected, with most research resources overwhelmingly biased towards other pathologies more prominent in the developed world. Thus, extra ingenuity is demanded from us: malaria-oriented nanomedicines not only need to work spotlessly, they have to do so in a cost-efficient way because they will be deployed in low-income regions.

The driving force of the Nanomalaria group is our personal commitment to applying nanomedicine to infectious diseases of poverty though several research lines: (i) Exploration of different types of encapsulating structure (liposomes, synthetic and natural polymers), targeting molecule (protein, polysaccharide, nucleic acid), and antimalarial compound (e.g. new structures derived from marine organisms and antimicrobial peptides) for the assembly of nanovectors capable of delivering their drug cargo with complete specificity to diseased cells. (ii) Study of metabolic pathways present in *Plasmodium* but absent in humans, with the aim of identifying specific enzymes as therapeutic targets. (iii) Use of glycosaminoglycans for innovative antimalarial strategies. (iv) Design of new methods

Postdoctoral Researcher
Ernest Moles

PhD Student
Elena Lantero
Arnau Biosca
Elisabet Martí

Graduate Student
Albert Manzano

for the targeted drug delivery to *Plasmodium* stages in the mosquito vector. (v) Investigation of novel drugs against insect-borne diseases working through radically new mechanisms. (vi) Extension of our activities to new pathologies (leishmaniasis).

Research projects

- **NANOMISSION** Engineering of nanovectors for the delivery of antimalarial drugs to *Plasmodium* transmission forms (2015-2017)
  PI: **Xavier Fernàndez-Busquets**
  Biotechnology Programme, MINECO, Spain (BIO2014-52872-R)
- Amphoteric polyamidoamines as innovative tools to selectively direct antimalarial drugs towards *Plasmodium*-infected red blood cells (2014-2016)
  PI: **Xavier Fernàndez-Busquets**
  Fondazione CARIPLO (2013-0584)
- Research agreement for the study of heparin-related molecules in new antimalarial strategies (2016-2018).
  PI: **Xavier Fernàndez-Busquets**
  BIOIBERICA
- Group for the study of self-aggregating proteins (2014-2016).
  Coordinator: Salvador Ventura Zamora
  MICINN, I+D-Investigación fundamental no orientada. Consolidated Research Group certified by the Generalitat de Catalunya, Spain (2014-SGR-938)

Collaborations with other research centres

Prof. Dario Anselmetti Universität Bielefeld, Germany

Prof. Maria Antònia Busquets University of Barcelona, Spain

Prof. Elisabetta Ranucci Università degli Studi di Milano, Italy

Prof. José Manuel Bautista Universidad Complutense de Madrid, Spain

Dr. Matthias Rottmann Swiss Tropical and Public Health Institute, Basel, Switzerland

Prof. Robert Sinden Imperial College London, UK

Dr. Israel Molina Hospital Universitari Vall d'Hebron, Barcelona

Publications

- Moles, E., Moll, K., Ch'ng, J. H., Parini, P., Wahlgren, M. and Fernàndez-Busquets, X. (2016). Development of drug-loaded immunoliposomes for the selective targeting and elimination of rosetting *Plasmodium falciparum*-infected red blood cells. *Journal of Controlled Release*, 241 57-67
- Guivernau, B., Bonet, J., Valls-Comamala, V., Bosch-Morató, M., Godoy, J. A., Inestrosa, N. C., Perálvarez-Marín, A., Fernàndez-Busquets, X., Andreu, D., Oliva, B. and Muñoz, F. J. (2016). Amyloid-β peptide nitrotyrosination stabilizes oligomers and enhances NMDAR-mediated toxicity. *Journal of Neuroscience*, 36 (46): 11693-11703
- Marques, J., Vilanova, E., Mourão, P. A. S. and Fernàndez-Busquets, X. (2016). Marine organism sulfated polysaccharides exhibiting significant antimalarial activity and inhibition of red blood cell invasion by *Plasmodium*. *Scientific Reports*, 6 24368
- Ch'ng, J.-H., Moll, K., Quintana, M. d. P., Chan, S. C. L., Masters, E., Moles, E., Liu, J., Eriksson, A. B. and Wahlgren, M. (2016). Rosette-disrupting effect of an anti-plasmodial compound for the potential treatment of *Plasmodium falciparum* malaria complications. *Scientific Reports*, 6 29317
- Fernàndez-Busquets, X. (2016). Novel strategies for *Plasmodium*-targeted drug delivery. *Expert Opinion on Drug Delivery*, 13 (7): 919-922
- Vilanova, E., Santos, G. R. C., Aquino, R. S., Valle-Delgado, J. J., Anselmetti, D., Fernàndez-Busquets, X. and Mourão, P. A. S. (2016). Carbohydrate-carbohydrate interactions mediated by sulfate esters and calcium provide the cell adhesion required for the emergence of early metazoans. *Journal of Biological Chemistry*, 291 (18): 9425-9437

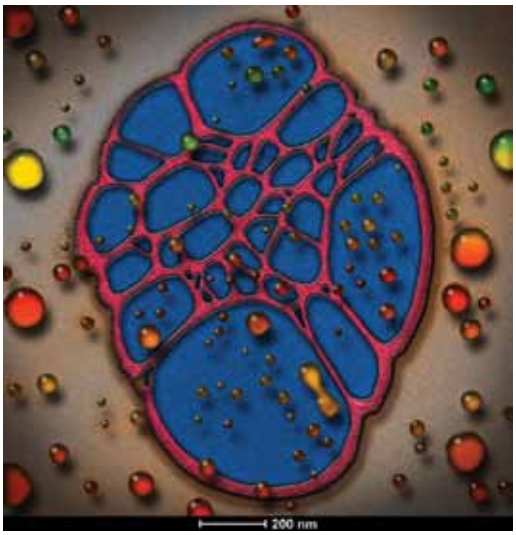


Figure 1. Cryo-transmission electron microscope image of liposomes being assayed for the encapsulation of drugs specifically targeted to red blood cells infected by the malaria parasite *Plasmodium falciparum*. CryoTEM image artistic editing by Marc Cirera, www.marccirera.com.

Prof. José Luis Serrano Instituto de Nanociencia de Aragón, Zaragoza

Prof. Johan Engbersen University of Twente, The Netherlands

Dr. Santiago Imperial University of Barcelona, Spain

Dr. Eduardo Prata Vilanova Universidade Federal do Rio de Janeiro, Brazil

Dr. Maria Manconi Università di Cagliari, Sardinia, Italy

Dr. Krijn Paaijmans ISGlobal, Barcelona, Spain

Dr. Ellen Faszewski Wheelock College, Boston, USA

Prof. Bernard Degnan University of Brisbane, Australia

Dr. Francisco J. Muñoz Universitat Pompeu Fabra, Barcelona, Spain

Prof. Salvador Ventura Universitat Autònoma de Barcelona, Bellaterra, Spain

Dr. Juan José Valle-Delgado Aalto University, Helsinki, Finland

Prof. Mats Wahlgren Karolinska Institutet, Stockholm, Sweden

Dr. Fatima Nogueira Instituto de Higiene e Medicina Tropical, Lisboa, Portugal

Dr. Christian Grandfils University of Liège, Belgium

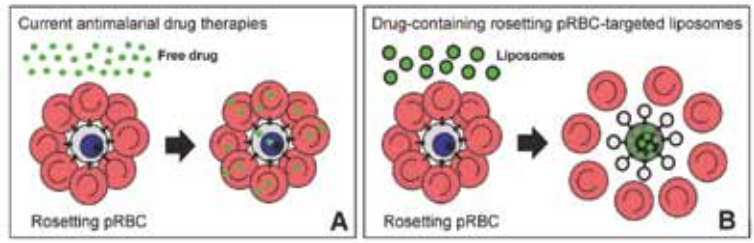


Figure 2. Development of drug-loaded immunoliposomes for the selective targeting and elimination of rosetting *Plasmodium falciparum*-infected red blood cells.

Scientific equipment and techniques

- Zeiss Primostar microscope
- Shake 'N' Stack (Thermo Hybaid) hybridization oven
- Rotatory evaporator RS 3000-V (Selecta)
- *Plasmodium falciparum* cell cultures

- Caddeo, C., Nacher, A., Vassallo, A., Armentano, M. F., Pons, R., Fernàndez-Busquets, X., Carbone, C., Valenti, D., Fadda, A. M. and Manconi, M. (2016). Effect of quercetin and resveratrol co-incorporated in liposomes against inflammatory/oxidative response associated with skin cancer. *International Journal of Pharmaceutics*, 513 (1-2): 153-163
- Credi, C., De Marco, C., Molena, E., Pla Roca, M., Samitier, J., Marques, J., Fernàndez-Busquets, X., Levi, M. and Turri, S. (2016). Heparin micropatterning onto fouling-release perfluoropolyether-based polymers via photobiotin activation. *Colloids and Surfaces B: Biointerfaces*, 146 250-259
- Valle-Delgado, J. J. and Fernàndez-Busquets, X. (2016). Rapid diagnostic tests for malaria: Past, present and future. *Future Microbiology*, 11 (11): 1379-1382

Group Leader: Gabriel Gomila

Nanoscale bioelectrical characterization

The main goal of the Nanoscale Bioelectrical Characterization group is to develop new experimental setups based on atomic force microscopy and theoretical frameworks enabling the access to the electrical properties of biological systems at the nanoscale (including biomembranes, single viruses, single bacteria cells and eukaryotic cells).

Our main objective is to contribute to develop new label-free biological nanoscale characterization methods and new electronic biosensors.

During 2016 we have determined, for the first time, the electromagnetic properties of single bacteria cells in the high frequency range (> GHz) with the use of the Scanning Microwave Microscope and of specific 3D numerical simulation models. We showed that with this approach one can detect the presence of small-scale nanostructures inside microorganisms, providing endless applications in the label-free imaging of single bacterial cells at high spatial resolution. On the other side, we have probed the internal hydration properties of single bacterial endospores by means of Electrostatic Force Microscopy. Endospores are recognized as the hardiest form of life on Earth, and one of the reasons for this, is that they handle changes in environmental relative humidity in a very smart way. We have shown in a label-free way that the endospores are able to preserve their core, where DNA is located, under low hydration conditions, what is key to understand the endospore's extraordinary survival abilities. On the methodological aspects, we have continued our efforts towards providing a simple interpretation to Electrostatic Force Microscopy and Scanning Microwave Microscopy images of highly non-planar samples, such as single bacterial or eukaryotic cells, for which we have developed a method to remove topographic cross-talk effects from the images. Finally, we have also optimized sample preparation and imaging methods to image and study electrically excitable cells with the Atomic Force Microscope, such as neurons.

Postdoctoral Researcher
Lázaro René Izquierdo

PhD Student
Helena Lozano
Martí Checa

Senior Technician
Rubén Millán

Research projects

- **NANOMICROWAVE** Microwave Nanotechnologies for Semiconductor and Life Sciences. (2013-2016)
  PI: **Gabriel Gomila**
  European FP7-PEOPLE-ITN project
- **SPM2.0** Scanning probe microscopies for nanoscale fast, tomographic and composition imaging. (2017-2020)
  Coordinator: **Gabriel Gomila**
  European H2020-MSCA-ITN project
- **NANOELECTOMOGRAPHY** Electrical nanotomography based on scanning probe microscopy for nanomaterials and biological samples (2014-2016)
  PI: **Gabriel Gomila**
  MINECO (TEC2013-48344-C2-1-P)
- **NANOELECTROPHYS** Scanning Electric Force Microscope for Electrophysological Recordings at the Nanoscale (2016-2019)
  PI: **Gabriel Gomila**
  MINECO (TEC2016-79156-P)
- **V-SMMART Nano** Volumetric Scanning Microwave Microscopy Analytical and Research Tool for Nanotechnology (2012-2016)
  PI: **Gabriel Gomila**
  European FP7-NMP-SME project
- ICREA Academia Award (2015-2019)
  PI: **Gabriel Gomila**
  Catalan Institution for Research and Advanced Studies (ICREA) / Generalitat de Catalunya

Collaborations with other research centres

Dr. Laura Fumagalli, University of Manchester, United Kingdom

Dr. Ferry Kienberger, Keysight Technologies Austria, Linz, Austria

Prof. Marco Sampietro, Politecnico di Milano, Italy

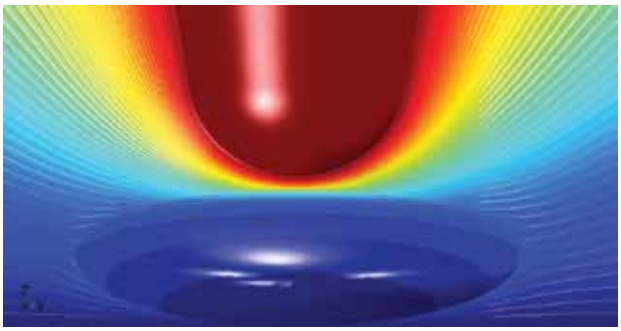
Dr. Jordi Borrell, University of Barcelona, Spain

Prof. Antonio Juárez, University of Barcelona, Spain

Dr. Manel Puig, University of Barcelona, Spain

Publications

- Biagi, M. C., Fabregas, R., Gramse, G., Van Der Hofstadt, M., Juárez, A., Kienberger, F., Fumagalli, L. & Gomila, G. (2016). Nanoscale electric permittivity of single bacterial cells at gigahertz frequencies by scanning microwave microscopy. *ACS Nano*, 10 (1): 280-288
- Van Der Hofstadt, M., Fabregas, R., Biagi, M. C., Fumagalli, L. & Gomila, G. (2016). Nanoscale dielectric microscopy of non-planar samples by lift-mode electrostatic force microscopy. *Nanotechnology*, 27 (40): 405706
- Van Der Hofstadt, M., Fabregas, R., Millan-Solsona, R., Juarez, A., Fumagalli, L. & Gomila, G. (2016). Internal hydration properties of single bacterial endospores probed by electrostatic force microscopy. *ACS Nano*, 10 (12): 11327–11336

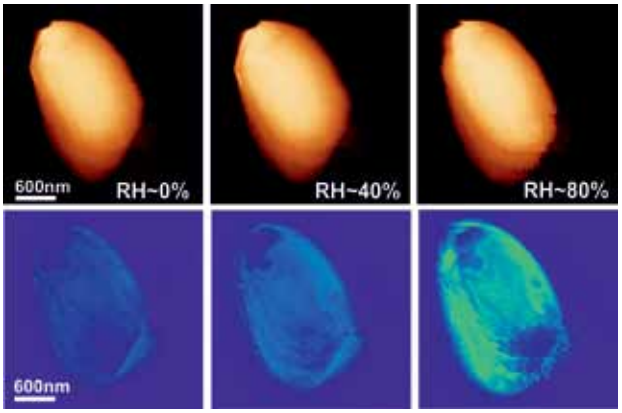


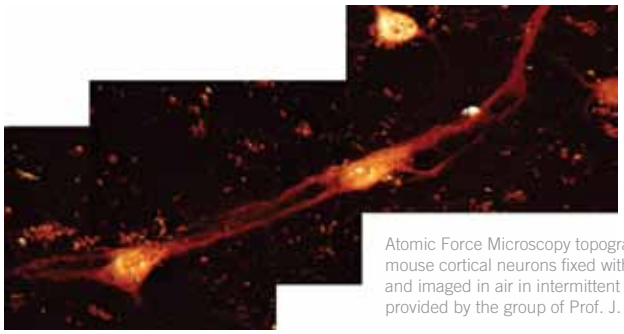
Electrical potential distribution corresponding to the electric interaction between a voltage biased sharp conducting tip of radius 250 nm and a single bacterial cell. The bacterial cell is represented as a 3D ellipsoid structure with uniform electric polarization. From the calculated electric potential distribution the tip-bacteria capacitance can be calculated and compared to experimental measurements obtained with the Scanning Microwave Microscope, in order to determine the electric permittivity of a single bacteria cell at GHz frequencies.

Scientific equipment and techniques

- Cypher Atomic Force Microscope (Asylum Research)
- Nanowizard 4 Bio-Atomic Force Microscope (JPK)
- Cervantes Atomic Force Microscope (Nanotec Electronica)
- Easy Scan 2 Atomic Force Microscope (Nanosurf)
- AxioImager A1m Reflection Optical Microscope (Zeiss) equipped with a AxioCam ERc5s (Zeiss)

Top Raw: Topographic images of a single bacterial endospore measured by Atomic Force Microscopy at different environmental relative humidity conditions. Bottom Row: Dielectric images of the same bacterial endospore measured by Electrostatic Force Microscopy under the same relative humidity conditions. While the topography of the bacterial endospore remains almost unaltered when modifying the environmental relative humidity, the dielectric response changes dramatically. From these type of measurements, the internal hydration properties of a single endospore can be obtained.





Atomic Force Microscopy topographic image of embryonic mouse cortical neurons fixed with paraformaldehyde and imaged in air in intermittent contact mode (sample provided by the group of Prof. J. A. del Rio, pages 88-91).

- CompactStat portable electrochemical interface and impedance analyzer (Ivium Technologies)
- 2 eLockIn204 4-phase Lock-In amplifiers (Anfatec)
- Keithley 6430 sub-femtoAmp remote sourcemeter (Keithley)

Group Leader / ICREA Research Professor: Pau Gorostiza

Nanoprobes and nanoswitches

The group's research focuses on developing nanoscale tools to study biological systems. These tools include instrumentation based on proximity probes, such as electrochemical tunnelling microscopy and spectroscopy, that we apply to investigate electron transfer in metal oxides and individual redox proteins.

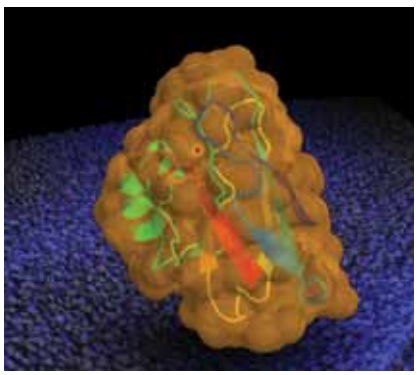
These studies are relevant to the development of biosensors and molecular electronics devices. In particular, based on our development of nanoscale field-effect transistors using individual redox protein, we have recently published a method to measure conductance switching in single redox proteins "wired" between two electrodes.

Another set of nanotools that we are developing is based on molecular actuators that can be switched with light, such as azobenzene, which can be chemically attached to biomolecules in order to optically control their activity. We have demonstrated for the first time two-photon stimulation of neurons and astrocytes with azobenzene-based photoswitches. We have also developed several bioactive compounds that have been engineered to be regulated by light. These "optopharmacological" compounds include peptide inhibitors of protein-protein interactions involved in clathrin-mediated endocytosis, and two ligands of G protein-coupled receptors (adenosine and metabotropic glutamate receptors), which are important therapeutic targets.

Research projects

- **NANOPROSTHETICS** Prótesis moleculares para restablecer la visión basadas en fotoconmutadores covalentes dirigidos (2016-2019)
  PI: **Pau Gorostiza**
  MINECO, Retos investigación: Proyectos I+D
- **MODULIGHTOR** Moduladores fotoconmutables sintéticos para manipular remotamente proteínas endógenas: fotocontrol *in vivo* de canales iónicos pentaméricos (2015-2018)
  PI: **Pau Gorostiza**
  MINECO Nacional /Acciones de Programación Conjunta Internacional

- Inhibición fotoselectiva de interacciones proteína-proteína para el estudio de redes interactómicas y el desarrollo de nuevas terapias (2015-2018)
  PI: **Pau Gorostiza**
  Fundación Ramon Areces
- **OPTOPHARMACOLOGY** Therapeutic applications of optopharmacology (2014-2016)
  PI: **Pau Gorostiza**
  MINECO (CTQ2013-43892-R)
- **Single-BioET** Single-molecule junction capabilities to map the electron pathways in redox bio-molecular architectures (2012-2016)
  PIs: **Ismael Díez** and **Pau Gorostiza**
  Marie Curie FP7-PEOPLE-IRG (International Re-integration Grants)
- Grup de recerca consolidat (2014-2016)
  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 2014)



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

- **WaveScalES** Human Brain Project Specific Grant Agreement 1 (2016-2018)
  PI: **Pau Gorostiza**
  European Commission, FET FLAGSHIPS, Tackling grand interdisciplinary science and technology challenges
- **OPTOFRAX** Optopharmacological brain mapping of autism mouse (2015-2017)
  PI: **Miquel Bosch**
  European Commission, MARIE CURIE - IF
- Milk fat globule membrane and periphera proteins: lipid-protein interactions (2016-2017)
  PI: **Fausto Sanz**
  INRA
- **nanoET-leukemia** Nanoconductance of electron transfer proteins of the respiratory chain. Direct measurement at the single molecular level and therapeutic regulation in cancer stem cells (2015-2018)
  PIs: Anna Lagunas (pages 96-101)/**Marina Inés Giannotti**
  MINECO, Proyectos RETOS 2015 / CIBER

Collaborations with other research centres

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

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

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

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

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

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

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

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

Prof. Carles Solsona Pathology and Experimental Therapeutics Dept, UB

Prof. Francisco Ciruela ICREA / Universitat de Barcelona, Spain

Prof. Jesús Giraldo & **Dr. Jordi Hernando** Universitat Autònoma de Barcelona, Spain

Group Leader (alongside Pau Gorostiza)
Fausto Sanz

Senior Researchers
Marina Inés Giannotti
Mireia Oliva
Ismael Díez

Senior Technician
Núria Camarero

Postdoctoral Researchers
Gertrudis Perea
Carlo Matera
Xavier Rovira
Silvia Pittolo
Miquel Bosch

PhD Students
Albert Cortijos
Marta Pozuelo
Berta Gumí
Hyojung Lee
Rosalba Sortino
Fabio Riefolo
Alexandre Gomila
Davia Prischich
Aida Garrido
Montserrat López

Masters Student
Adrián Crespo
Pablo Calvé

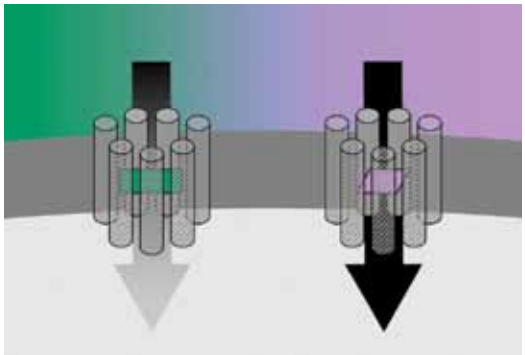
Research Assistant
Manuel López

Undergraduate Student
Sthefany Ortiz

Scientific equipment and techniques

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

Schematic representation of a light-regulated drug bound to a 7-transmembrane receptor. Under violet illumination, the drug is inactivated and the receptor produces normal intracellular signaling. In the dark or under green light, the drug inhibits the receptor and interferes with signaling in a reversible way. (Pittolo, S. *et al*, 2014).



Publications

- Aragonès, A. C., Haworth, N. L., Darwish, N. et al (2016). Electrostatic catalysis of a Diels–Alder reaction. *Nature*, 531 (7592): 88-91
- Aragonès, A. C., Aravena, D., Cerdá, J. I. et al (2016). Large conductance switching in a single-molecule device through room temperature spin-dependent transport. *Nano Letters*, 16 (1): 218-226
- Izquierdo-Serra, M., Bautista-Barrufet, A., Trapero, A., Garrido-Charles, A., Diaz-Tahoces, A. et al (2016). Optical control of endogenous receptors and cellular excitability using targeted covalent photoswitches. *Nature Communications*, 7 12221
- Giannotti, M. I., Abasolo, I., Oliva, M., Andrade, F., García-Aranda, N. et al (2016). Highly versatile polyelectrolyte complexes for improving the enzyme replacement therapy of lysosomal storage disorders. *ACS Applied Materials & Interfaces*, 8 (39): 25741–25752
- Noori, M., Aragonès, A. C., Di Palma, G., Darwish, N. et al (2016). Tuning the electrical conductance of metalloporphyrin supramolecular wires. *Scientific Reports*, 6 37352
- A. R. Dalton, J., Lans, I., Rovira, X., Malhaire, F. et al (2016). Shining light on an mGlu5 photoswitchable NAM: A theoretical perspective. *Current Neuropharmacology*, 14 (5): 441-454
- Rovira, X., Trapero, A., Pittolo, S., Zussy, C., Faucherre, A., Jopling, C., Giraldo, J., Pin, J.-P., Gorostiza, P., Goudet, C. and Llebaria, A. (2016). OptoGluNAM4.1, a Photoswitchable allosteric antagonist for real-time control of mGlu4 receptor activity. *Cell Chemical Biology*, 23 (8): 929-934
- Gumí-Audenis, B., Costa, L., Carlá, F., Comin, F., Sanz, F. and Giannotti, M. (2016). Structure and nanomechanics of model membranes by atomic force microscopy and spectroscopy: Insights into the role of cholesterol and sphingolipids. *Membranes*, 6 (4): 58

Senior Researchers
José Antonio Fiz
Beatriz Giraldo
Jordi Solà
Abel Torres

Group Leader: Raimon Jané

Biomedical signal processing and interpretation

The group's research addresses the design and development of advanced signal processing techniques and the interpretation of biomedical signals to improve non-invasive monitoring, diagnosis, disease prevention and pathology treatment.

Our main objective is to improve diagnosis capability through the characterization of physiological phenomena and to enhance early detection of major cardiac and respiratory diseases and sleep disorders. We propose and design new signal processing algorithms and develop new biosignal databases, with the collaboration of our hospital partners. To validate the clinical information of new surface signals, we have developed specific invasive/non-invasive protocols and animal models. The group focuses its research in a translational way to promote the transfer of our scientific and technological contributions. Currently, our prototypes are used in hospitals for research purposes and for future industrial developments.

Highlights in 2016:

Obstructive Sleep Apnea and Sleep Disorders

- A novel method to analyse cardiorespiratory synchronization in OSA patients during sleep (IEEE-EMBC 2016, 4280-4283) and characterize snores (CASEIB 2016, 531-536), with the Hospital Germans Trias i Pujol, Badalona.

Chronic Obstructive Pulmonary Disease and Asthma

- Automatic detection of continuous adventitious respiratory sounds in asthmatic patients using ensemble empirical mode decomposition and instantaneous frequency (*J Biomed Health Inf* 2016, 20 (2): 486-497) and Hilbert-Huang transform (*Signal Processing* 2016, 120:99-116), with the Hospital Germans Trias i Pujol, Badalona (PhD thesis, M. Lozano).
- Non-invasive estimation of neural respiratory drive from diaphragm electromyographic signals using fixed sample entropy (*J Biomed Health Inf* 2016, 20 (2): 476-485); (PhD thesis, L. Estrada).
- Novel methods to estimate the respiratory muscle activity using wireless sensor platform (IEEE-EMBC 2016, 5769-5772, CASEIB 2016, 244-247 and CASEIB 2016, 556-559).
- Time-frequency representation of the sternocleidomastoid muscle activity during respiratory activity by

Postdoctoral Researchers
Manuel Lozano
Leonardo Sarlabous

Research Assistant
Yolanda Castillo

PhD Students
Javier Rodríguez
Dolores Blanco
Luis Estrada
Oiane Urra

Research Assistant
Miguel Ángel Cámara

Masters Students
Josep Estévez
Magdalena Ràfols

electromyography recorded with concentric ring electrodes (IEEE-EMBC 2016, 3785-3788), with the Universidad Politécnica de Valencia.

Cardiac and cardiorespiratory diseases and ageing

- Evaluation of Periodic Breathing in Respiratory Flow Signal of Elderly Patients using SVM and Linear Discriminant Analysis (IEEE-EMBC 2016, 4276-4279).
- Estimation of blood pressure in patients with different ventricular ejection fraction using linear and non-linear methods (IEEE-EMBC 2016, 2700-2703) and characterization of patients with cardiovascular risk using Poincaré Plots (CASEIB 2016, 396-399), with Hospital Germans Trias i Pujol, Badalona and University of Jena, Germany.
- Analysis of ECG signal to risk stratification in patients with Parkinson disease (CASEIB 2016, 531-534).

Neurorehabilitation and Biofeedback

- Novel methods for analysis of the interlimb similarity of motor patterns for improving stroke assessment and neurorehabilitation (PhD thesis, O. Urra).

Research projects

- **M-Bio4Health** Multimodal physiological biomarkers for non-invasive monitoring and home healthcare of COPD patients with comorbidities (2016-2018)
  PI: **Raimon Jané**
  MINECO, Retos investigación: Proyectos I+D
- Novel m-Health tools for unobtrusive sensing and management improving of Obstructive Sleep Apnea patients at home (2016-2017)
  PI: **Raimon Jané**
  Obra Social La Caixa
- Study on software comparison of audio recordings and correlation to SAHS events (2015-2016)
  PI: **Raimon Jané**
  R+D contract with Audiodontics in the framework of a SBIR project "System for Monitoring Dental Device Compliance and Efficacy in Treatment of Obstructive Sleep Apnea", funded by the NIH (USA)

- Grup de recerca consolidat (2014-2016)
  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 2014)

Collaborations with other research centres

Dr. J. Mark Ansermino Department of Anesthesiology, Pharmacology and Therapeutics, University of British Columbia, Vancouver, Canada

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

Dr. Salvador Benito Hospital de la Santa Creu i Sant Pau, Barcelona

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

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

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

Prof. Guy Dumont Department of Electrical and Computer Engineering, University of British Columbia, Vancouver, Canada

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

Dr. Javier García-Casado Instituto Interuniversitario de Investigación en Bioingeniería y Tecnología Orientada al Ser Humano, Universidad Politécnica de Valencia

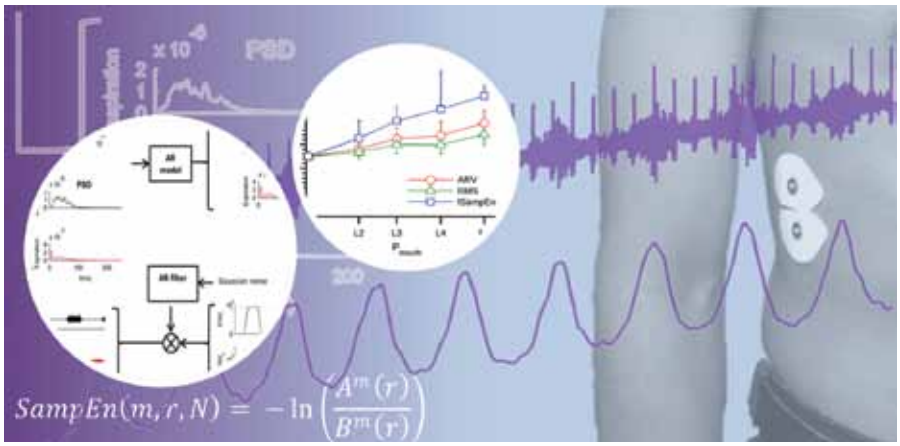
Dr. Joaquim Gea Servei Pneumologia, Hospital del Mar-IMIM, Barcelona

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

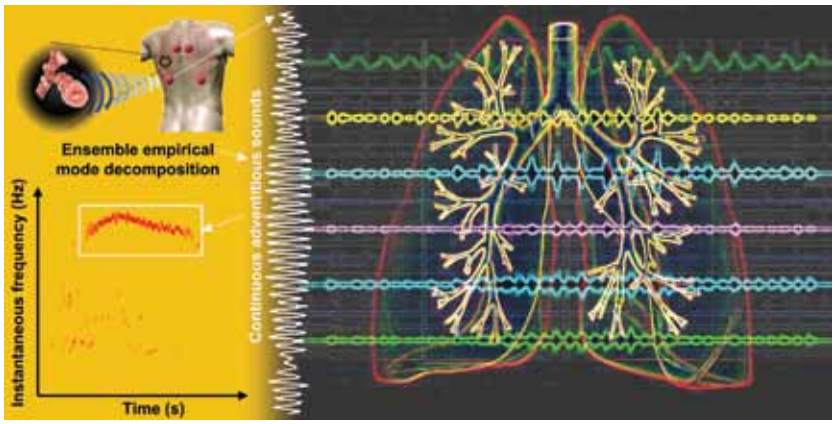
Dr. Eric Laciar Departamento de Electrónica y Automática, Universidad Nacional de San Juan, Argentina

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

Dr. Barry Mersky Audiodontics, LLC, Bethesda, Maryland, USA



Improvement in Neural Respiratory Drive Estimation from Diaphragm Electromyographic Signals using Sample Entropy of non-invasive EMG signals (Estrada *et al.*, 2016, *IEEE Journal of Biomedical and Health Informatics*).



Novel method for differentiating normal from adventitious respiratory sounds (RS) to improve the diagnosis of pulmonary diseases. Particularly, continuous adventitious sounds (CAS) are of clinical interest because they reflect the severity of certain diseases. The new method is based on the multi-scale analysis of instantaneous frequency (IF) and envelope (IE) calculated after ensemble empirical mode decomposition (EEMD) of respiratory sounds. (Lozano *et al.*, 2016, *IEEE Journal of Biomedical and Health Informatics*)

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

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

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

Dr. Juan Ruiz Servei de Pneumología de l'Hospital Germans Trias i Pujol de Badalona

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

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

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

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

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

Dr. Pierluigi Casale Laboratory for advanced research in microelectronics (IMEC), Eindhoven, The Netherlands

Dr. Francky Catthoor Laboratory for advanced research in microelectronics (IMEC), Leuven, Belgium

Dr. Miquel Domenech Dep. of Social Psychology, Universitat Autònoma de Barcelona

Dr. Caroline Jolley / Dr. John Moxham King's College London, UK

Publications

- Lozano, M., Fiz, J. A. and Jané, R. (2016). Performance evaluation of the Hilbert–Huang transform for respiratory sound analysis and its application to continuous adventitious sound characterization. *Signal Processing*, 120 99-116
- Lozano, M., Fiz, J. A. and Jané, R. (2016). Automatic differentiation of normal and continuous adventitious respiratory sounds using ensemble empirical mode decomposition and instantaneous frequency. *IEEE Journal of Biomedical and Health Informatics*, 20 (2): 486-497
- Estrada, L., Torres, A., Sarlabous, L. and Jané, R. (2016). Improvement in neural respiratory drive estimation from diaphragm electromyographic signals using fixed sample entropy. *IEEE Journal of Biomedical and Health Informatics*, 20 (2): 476-485

Conference Papers

- Arcentales, A., Rivera, P., Caminal, P., Voss, A., Bayés-Genís, A. and Giraldo, B. F. (2016). Analysis of blood pressure signal in patients with different ventricular ejection fraction using linear and non-linear methods. *38th Annual International Conference of the IEEE, Orlando, USA. Engineering in Medicine and Biology Society (EMBC), 2700-2703. Published by IEEE*
- Argerich, S., Herrera, S., Benito, S. and Giraldo, J. (2016). Evaluation of periodic breathing in respiratory flow signal of elderly patients using SVM and linear discriminant analysis. *38th Annual International Conference of the IEEE, Orlando, USA. Engineering in Medicine and Biology Society (EMBC), 4276-4279. Published by IEEE*
- Estrada, L., Torres, A., Garcia-Casado, J., Sarlabous, L., Prats-Boluda, G. and Jané, R. (2016). Time-frequency representations of the sternocleidomastoid muscle electromyographic signal

recorded with concentric ring electrodes. *38th Annual International Conference of the IEEE, Orlando, USA. Engineering in Medicine and Biology Society (EMBC), 3785-3788. Published by IEEE*

- Estrada, L., Torres, A., Sarlabous, L. and Jané, R. (2016). Evaluating respiratory muscle activity using a wireless sensor platform. *38th Annual International Conference of the IEEE, Orlando, USA. Engineering in Medicine and Biology Society (EMBC), 5769-5772. Published by IEEE*
- Solà-Soler, J., Giraldo, B. F., Fiz, J. A. and Jané, R. (2016). Study of phase estimation methods to analyse cardiorespiratory synchronization in OSA patients. *38th Annual International Conference of the IEEE, Orlando, USA. Engineering in Medicine and Biology Society (EMBC), 4280-4283. Published by IEEE*
- Castillo, Y., Blanco, D., Cámara, M. A. and Jané, R. (2016). Study of time-frequency characteristics of single snores: extracting new information for sleep apnea diagnosis. *XXXIV Congreso Anual de la Sociedad Española de Ingeniería Biomédica (CASEIB 2016), Valencia, Spain. CASEIB Proceedings, 105-108. Published by Sociedad Española de Ingeniería Biomédica*
- Estévez-Piorno, J., Ràfols-de-Urquía, M., Torres, A., Estrada, L. and Jané, R. (2016). Evaluación del registro y transmisión de señales electromiográficas mediante un dispostivo inalámbrico. *XXXIV Congreso Anual de la Sociedad Española de Ingeniería Biomédica (CASEIB 2016), Valencia, Spain.* CASEIB Proceedings, 556-559. *Published by Sociedad Española de Ingeniería Biomédica*
- Julian, S., Callicó, F., Giraldo, B. F., Juanola, A., López, D. and Rodiera, J. (2016). Segmentación del nodo vesical a partir del plano transversal de imágenes ecográficas de la región

Scientific equipment and techniques

- Research laboratory with full equipment for acquisition and processing of biomedical signal to test new sensors and to define clinical protocols (preliminary tests and control subjects)
- Non-invasive Vital Signs Monitor for small lab animals (mice and rats) (Mouse-Ox Plus)
- BIOPAC system for multichannel cardiac and respiratory biomedical signal acquisition
- Databases of biomedical signals from hospitals and animal laboratories
- Snoring analyzer equipment (SNORYZER)
- Sensors, electrodes and microphones to obtain cardiac, respiratory, neural, muscular and sleep biomedical signals
- Polisomnographic equipment available in the Sleep Laboratory of collaborator hospital
- Beat to beat arterial blood pressure and haemodynamic monitor equipment
- Computing server for high performance biomedical signals
- Threshold™ IMT (Inspiratory Muscle Trainner) for respiratory muscle training (Phillips™)
- Robust wearable wireless sensor device Shimmer3 (Shimmer Research Ltd., Dublin, Ireland).

suprapúbica. *XXXIV Congreso Anual de la Sociedad Española de Ingeniería Biomédica (CASEIB 2016), Valencia, Spain. CASEIB Proceedings, 278-281. Published by Sociedad Española de Ingeniería Biomédica*

- Ràfols-de-Urquía, M., Estévez-Piorno, J., Torres, A., Estrada, L. and Jané, R. (2016). Evaluación de un dispositivo inalámbrico para el registro de la actividad electromiográfica del músculo diafragma. *XXXIV Congreso Anual de la Sociedad Española de Ingeniería Biomédica (CASEIB 2016), Valencia, Spain. CASEIB Proceedings, 244-247. Published by Sociedad Española de Ingeniería Biomédica*
- Ramón Valencia, J. L., García-Sánchez, A., Roca-Dorda, J. and Giraldo, B. F. (2016). Análisis de la señal ECG en pacientes con enfermedad de Párkinson. *XXXIV Congreso Anual de la Sociedad Española de Ingeniería Biomédica (CASEIB 2016), Valencia, Spain. CASEIB Proceedings, 552-555. Published by Sociedad Española de Ingeniería Biomédica*
- Rodriguez, J., Voss, A., Caminal, P., Bayés-Genís, A. and Giraldo, B. F. (2016). Caracterización de pacientes con diferentes niveles de riesgo cardiovascular mediante diagramas de Poincaré. *XXXIV Congreso Anual de la Sociedad Española de Ingeniería Biomédica (CASEIB 2016), Valencia, Spain. CASEIB Proceedings, 396-399. Published by Sociedad Española de Ingeniería Biomédica*

Undergraduate Students
Nuemí Hernandiz
Marta Pérez

Group Leader: Santiago Marco

Signal and information processing for sensing systems

Current smart instrumentation using multi-sensors and/or spectrometers provides a wealth of data that requires sophisticated signal and data processing approaches in order to extract the hidden information.

In this context, we are interested in intelligent chemical instruments for the detection of volatile compounds and smells.

These systems can be based on an array of nonspecific chemical sensors with a pattern recognition system , taking inspiration from the olfactory system. Some spectrometries, e.g. Ion Mobility Spectrometry, are capable of very fast analysis with good detection limits but poor selectivity. These technologies have been proposed for the fast determination of the volatolome (volatile fraction of the metabolome), instead of the reference technique of gas chromatography – mass spectrometry.

Our group develops algorithmic solutions for the automatic processing of Gas Sensor Array, Ion Mobility Spectrometry (IMS) and Gas Chromatography – Mass Spectrometry (GC-MS) data for metabolomics and food samples.

In a parallel activity, our group is working on the detection of drowsiness in drivers using vehicle dynamic measures.

Our research in 2016 included the following:

Signal and Data Processing for smart chemical Instrumentation:

1. We have studied calibration transfer methods among chemical sensor arrays to reduce calibration costs.

2. We have studied how to reduce the cross-sensitivity to humidity in chemical sensors

3. We have designed methodologies to estimate the limit of detection in chemical sensors inspired in the IUPAC recommendations.

4. We have been working in the detection of toxic emissions from fires to improve building occupant's safety.

5. In collaboration with Universitat de Lleida (Dr. J. Palacin) and University of Örebro (Prof. A. Lilienthal) we are testing chemical source localization algorithms with autonomous robots.

PhD Students
Javier Burgués
Ana Maria Solórzano

Laboratory Technicians
Silvia Mas
Lluís Fernández

Senior Researcher
Agustín Gutiérrez

Postdoctoral Researcher
Jordi Fonollosa

Research projects

- **SIGVOL** Mejora de la señal para instrumentación química: aplicaciones en metabolómica de volátiles y en olfacción (2015-2017)
  PI: **Santiago Marco**
  MINECO
- Analisis de tapones de corcho por espectroscopia de movilidad de iones (2015-2016)
  PI: **Santiago Marco**
  Industrial Project with M3C INDUSTRIAL AUTOMATION & VISION, S.L., Spain
- BSH-Sensor test for indoor air quality and safety applications (2015-2016)
  PI: **Santiago Marco**
  Industrial Project with BSH Electrodomesticos España S.A.
- Preparació i realització d'un curs de processat de senyal per sensors químics de dos dies a BSH Zaragoza (2016-2017)
  PI: **Santiago Marco**
  Industrial Project with BSH Electrodomesticos España S.A.
- **SENSIBLE** Sensores inteligentes para edificios más seguros (2014-2016)
  PI: **Santiago Marco**
  MINECO, Acciones de Programación Conjunta Internacional
- **SMART-IMS** Procesado de Señal para Espectroscopia de Movilidad de Iones: Análisis de Fluidos Biomédicos y Detección de Sustancias Tóxicas (2012-2015)
  PI: **Santiago Marco**
  MINECO, I+D-Investigación fundamental no orientada
- Grup de recerca consolidat (2014-2016)
  PI: **Santiago Marco**
  AGAUR, Convocatòria d'ajuts per donar suport a les activitats dels grups de recerca de Catalunya
- **SAFESENS** Sensor Technologies for Enhanced Safety and Security of Buildings and its Occupants (2014-2017)
  PI: **Santiago Marco**
  ENIAC project (European project with a mix of public-private funding)

Publications

- Fonollosa, J., Fernández, L., Gutiérrez-Gálvez, A., Huerta, R. and Marco, S. (2016). Calibration transfer and drift counteraction in chemical sensor arrays using Direct Standardization. *Sensors and Actuators B: Chemical*, 236 1044-1053
- Fernandez, L., Guney, S., Gutierrez-Galvez, A. and Marco, S. (2016). Calibration transfer in temperature modulated gas sensor arrays. *Sensors and Actuators B: Chemical*, 231 276-284
- Huerta, R., Mosqueiro, T., Fonollosa, J., Rulkov, N. F. and Rodríguez-Lujan, I. (2016). Online decorrelation of humidity and temperature in chemical sensors for continuous monitoring. *Chemometrics and Intelligent Laboratory Systems*, 157 169-176
- Martínez, D., Moreno, J., Tresanchez, M., Clotet, E., Jiménez-Soto, J. M., Magrans, R., Pardo, A., Marco, S. and Palacín, J. (2016). Measuring gas concentration and wind intensity in a turbulent wind tunnel with a mobile robot. *Journal of Sensors*, Article ID 7184980

System to test chemical sensors for malodour detection

Collaborations with other research centres

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

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

Prof. Ramon Huerta
Biocircuits Lab, University of California in San Diego, USA

Prof. J. W. Gardner
Microsensors and Bioelectronics Lab, Dept. of Electric and Electronic Engineering, University of Warwick, UK

Prof. Achim Lilienthal
Mobile Robotics and Olfaction Lab, University of Örebro, Sweden

Dr. Ivan Montoliu
Nestlé Institute of Health Sciences, Laussane, Switzerland

Dr. Jordi Palacín
Robotics Lab, Universitat de Lleida, Spain

Dr. Cristina Castro
Sensors Technology, BSH-Zaragoza, Spain

Scientific equipment and techniques

- Gas chromatograph/mass spectrometer (Thermoscientific) with robotic head-space sampler

System to test chemical sensor arrays for diversity and redundancy

- 2 Infusion pumps K-systems
- 6 channel vapor generator plus humidity control (Owlstone, UK)
- Ion Mobility Spectrometer: Gas Detector Array (Airsense Analytics GmbH)
- Computing and General Purpose Electronic Instrumentation
- Field Asymmetric Ion Mobility Spectrometer (Owlstone, UK)
- Corona Discharge Ion Mobility Spectrometer (3QBD, Israel)
- Ultraviolet Ion Mobility Spectrometer (Gas Dortmund, Germany)

The SAFESENS project aims to produce personal health monitors for emergency personnel including toxic hazards detection

PhD Students
Jae Yoon Lee
Enara Larrañaga
Anna Vila
Gizem Altay

Senior Postdoctoral Researcher
Jordi Comelles

Senior Researchers
Vanesa Fernández
Javier Ramón

Junior Group Leader: Elena Martínez

Biomimetic systems for cell engineering

In vitro assay platforms involving human cells are increasingly important to study tissue development, tissue regeneration, construct models of disease or develop systems for therapeutic screening that predict the human *in vivo* context.

The main conceptual problem of the standard *in vitro* cell-based assays is that they rely on two dimensional monolayer cellular cultures, which fail to replicate the complexity of living systems. There is an urgent need to create technological platforms with complex cell culture systems that mimic better the tissue-like cellular microenvironment.

Our lab is interested in the development of new biomimetic systems for cell-based assays that account for the structural, physiological and biochemical features of the *in vivo* cellular microenvironment. Specifically, we develop systems that mimic the heterogeneity of the tissue extracellular matrix for cell engineering. Advanced designs include the structural anisotropy intrinsic to tissues such as heart muscle or bone, the binding of specific ligands and the capability of generating gradients of regulatory signals. These biomimetic systems will provide the interface between biological questions and engineering tools to (i) develop new insights into environmental regulation of cells, (ii) investigate diseases, and (iii) develop new therapies for regenerative medicine.

Research projects

- **MINAHE5** (Bio)funcionalización de Micro- y NanoHerramientas en Suspensión para Aplicaciones en Células Vivas (2015-2017)
  PI: **Maria Lluïsa Pérez**
  MINECO, Retos investigación: Proyectos I+D
- **COMIET** Engineering Complex Intestinal Epithelial Tissue Models (2015-2020)
  PI: **Elena Martínez**
  ERC Consolidator Grant

- **GLAM** Glass-Laser Multiplexed Biosensor (2015-2019)
  PI: **Elena Martínez**
  European Commission (H2020) – PHC-10-2015

Collaborations with other research centres

Prof. Josep Samitier IBEC (pages 96-101)

Prof. Ángel Raya / Dr. Samuel Ojosnegros Center of Regenerative Medicine in Barcelona (CMRB), Barcelona

Dr. Núria Montserrat IBEC (pages 82-85)

Dr. Daniel Riveline ISIS/IGBMC, Strasbourg (France)

Dr. Matthew Dalby University of Glasgow (UK)

Prof. Eduard Batlle Institut de Recerca Biomédica (IRB), Barcelona

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

Prof. Jordi Martorell Institut de Ciències Fotòniques (ICFO), Castelldefels (Spain)

Prof. Pablo Loza Institut de Ciències Fotòniques (ICFO), Castelldefels (Spain)

Prof. Martí Gich Institut de Ciència de Materials de Barcelona (ICMAB), Bellaterra (Spain)

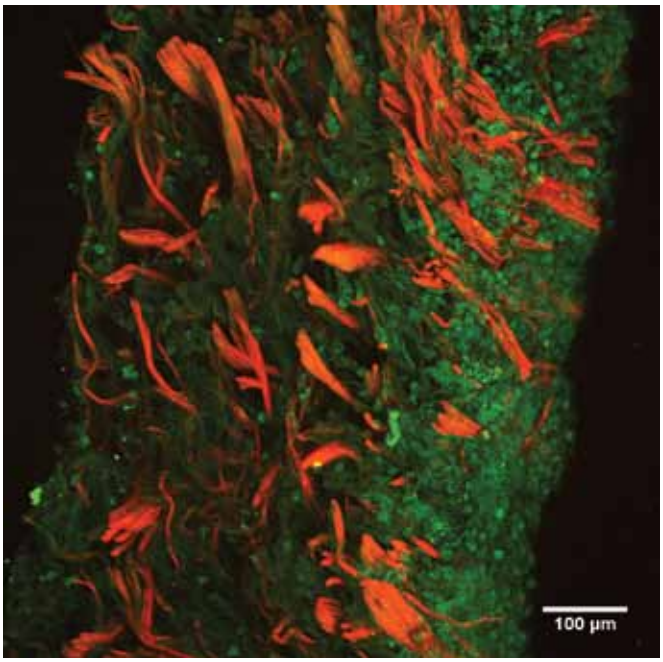
Prof. Rosa Villa CNM-SCIC, Bellaterra (Spain)

Scientific equipment and techniques

- Micro and nanofabrication techniques:
  - Biomolecule gradients produced by microfluidics
  - Large-area nanostructured polymer surfaces produced by diblock copolymers

Publications

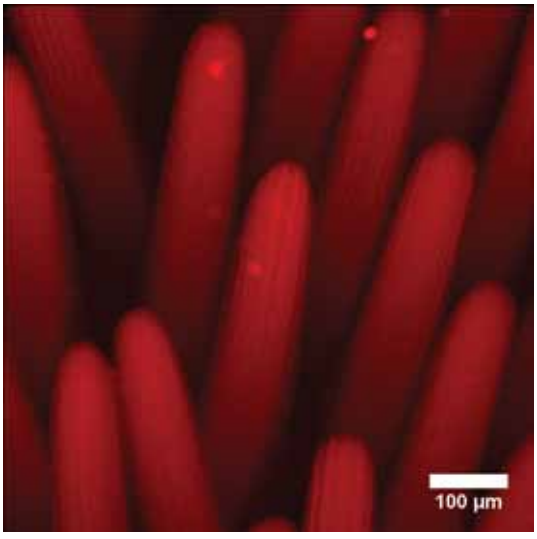
- Garreta, E., de Oñate, L., Fernández-Santos, M. E., Oria, R., Tarantino, C., Climent, A. M., Marco, A., Samitier, M., Martínez, E., Valls-Margarit, M., Matesanz, R., Taylor, D. A., Fernández-Avilés, F., Izpisua Belmonte, J. C. and Montserrat, N. (2016). Myocardial commitment from human pluripotent stem cells: Rapid production of human heart grafts. *Biomaterials*, 98 64-78
- Lagunas, A., Sasso, B., Tesson, N., Cantos, C., Martinez, E. and Samitier, J. (2016). Synthesis of a polymethyl(methacrylate)-polystyrene-based diblock copolymer containing biotin for selective protein nanopatterning. *Polymer Chemistry*, 7 212-218



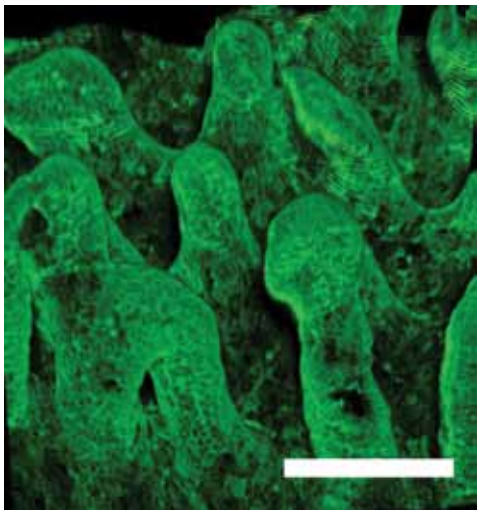
Cross-section of a cardiac tissue construct cultured in a perfusion bioreactor with electrical stimulation. A primary culture of neonatal rat cardiomyocytes was seeded in a 3D collagen-elastin matrix. Collagen fibers (orange) were imaged using two-photon second harmonic generation (SHG), and elastin fibers (green) using autofluorescence. As cells have a high degree of autofluorescence they are also shown in green, densely packed in the right part of the image.

- 3D microstructures on hydrogel materials
- Mini-bioreactor for 3D cell culture

- Characterization techniques:
  - Surface Plasmon Resonance (SPR) measurements on polymer materials



Hydrogel microstructures mimicking villi of the small intestinal tissue. They have been fabricated of PEGDA polymer and functionalized with labelled protein (in red).



3D rendering of villi-like microstructures fabricated of an hydrogel and seeded with Caco-2 cells. Scale bar = 200 µm.

- Atomic Force Microscope (AFM) expertise
- Optical Microscopes (white light/epifluorescence)
- Focused Ion Beam (FIB) / Scanning Electron Microscopy (SEM) of biological specimens

- Equipment:
  - Biological safety cabinet (class II)
  - High precision syringe pumps
  - Peristaltic pumps
  - Access to the Nanotechnology Platform (IBEC Core Facilities): equipment for hot embossing lithography, polymer processing and photolithography, chemical wet etching, e-beam evaporation and surface characterization (TOF-SIMS)
  - Access to the Scientific and Technological Centers (University of Barcelona): equipment for surface analysis (XPS, AFM, XRD) and microscopy techniques (SEM, TEM, confocal)

Junior Group Leader: Nuria Montserrat

iPSCs & activation of endogenous tissue programs for organ regeneration

The generation of induced pluripotent stem cells (iPSCs), especially the generation of patient-derived pluripotent stem cells suitable for disease modelling *in vitro*, opens the door for the potential translation of stem-cell related studies into the clinic.

Successful replacement, or augmentation, of the function of damaged cells by patient derived differentiated stem cells would provide a novel cell-based therapy for diseases. Since iPSCs resemble human embryonic stem cells (hESCs) in their ability to generate cells of three germ layers, patient-specific iPSCs offer definitive solutions for the ethical and histo-incompatibility issues related to hESCs. Indeed human iPSC (hiPSC)-based autologous transplantation is heralded as the future of regenerative medicine.

One of our aims is to generate and correct disease-specific hiPSCs for disease modelling and drug screening. The combination of gene-editing based methodologies together with the development of novel protocols for cell differentiation into relevant tissues/organs, provides a unique scenario for modelling disease progression, and the identification of molecular and cellular mechanisms leading to organ regeneration (Figure 2). In this regard we are particularly interested in generation of transgene-free and disease free patient derived hiPSCs for disease modelling and the discovery of novel therapeutic targets.

We believe that the recovery of tissue function should not be restricted to the development of cell replacement therapies. In this regard, in our laboratory we take advantage of organisms that possess the ability to regenerate such as zebrafish, in order to understand which molecular and cellular pathways lead to organ regeneration. Surprisingly, studies in neonatal mice have demonstrated that soon after birth this organism posses the capability to regenerate its heart. Taking advantage of such preliminary observations we are translating such analysis in order to understand if the mammalian neonatal kidney still posses the capability to regenerate, and more importantly, if we are able to dissect the epigenetic and cellular mechanisms leading to those responses.

Lastly, and in an effort to fully develop *in vitro* and *ex vivo* platforms for organ regeneration, in our lab we are focused

iPSCs & activation of endogenous tissue programs for organ regeneration

Senior Researchers
Elena Garreta
Federico González

Senior Technician
Carolina Tarantino

Postdoctoral Researcher
Mario Mancino

PhD Student
Andrés Marco

Laboratory Assistants
Patricia Katherine Prado
Mireia Samitier

in the development of reporter cell lines for different transcription factors essential for tissue-specific commitment and differentiation (i.e: renal and cardiac lineages). The possibility to combine pluripotent stem cell lines together with decellularized matrices, functionalized biomaterials and *ex vivo* organoids offers and unprecedented opportunity for the immediate generation of patient-specific *in vitro* and *ex vivo* platforms for disease modelling and organ regeneration (Figure 3).

Research projects

- **TRATENFREN** Desarrollo de nuevas estrategias para el tratamiento de la enfermedad renal (2015-2017)
  PI: **Núria Montserrat**
  MINECO, Retos investigación: Proyectos I+D
- Regenerative medicine for Fanconi anemia: generation of disease-free patient-specific iPS (2013-2016)
  PI: **Núria Montserrat**
  Fundació La Marató de TV3
- **REGMAMKID** How to regenerate the mammalian kidney (2015-2020)
  PI: **Núria Montserrat**
  ERC Starting Grant

Collaborations with other research centres

Juan Carlos Izpisua Belmonte Salk Institute for Biological Studies

Dr. Josep Maria Campistol Plana Experimental Laboratory of Nephrology and Transplantation, Hospital Clínic, Barcelona

Peter Hohestein The Roslin Institute, University of Edinburgh

Dr. Pere Gascón Vilaplana Head of Oncology Service/Molecular and Translational Oncology Laboratory, IDIBAPS

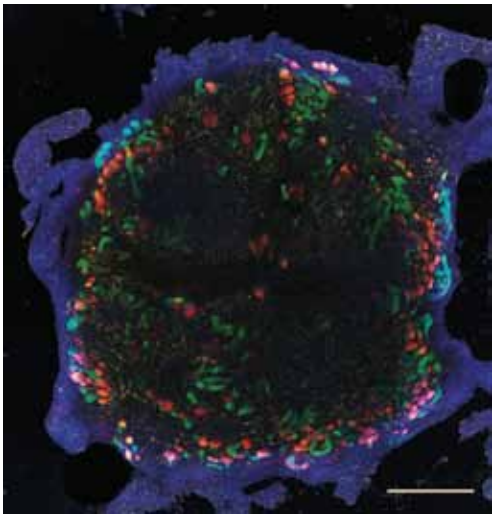
Gloria Calderon President, Embryotools SL

Pura Muñoz Cánovas Departament de Ciències Experimentals i de la Salut, Universitat Pompeu Fabra

Dr. Pedro Guillén Director Clínica Cemtro, Madrid

Publications

- Garreta, E., de Oñate, L., Fernández-Santos, M. E., Oria, R., Tarantino, C., Climent, A. M., Marco, A., Samitier, M., Martínez, E., Valls-Margarit, M., Matesanz, R., Taylor, D. A., Fernández-Avilés, F., Izpisua Belmonte, J. C. and Montserrat, N. (2016). Myocardial commitment from human pluripotent stem cells: Rapid production of human heart grafts. *Biomaterials*, 98 64-78
- Eguizabal, C., Herrera, L., De Oñate, L., Montserrat, N., Hajkova, P. and Izpisua Belmonte, J. C. (2016). Characterization of the epigenetic changes during human gonadal primordial germ cells reprogramming. *Stem Cells*, 34 (9): 2418-2428
- Montserrat, N., Garreta, E. and Izpisua Belmonte, J. C. (2016). Regenerative strategies for kidney engineering. *FEBS Journal*, 283 (18): 3303-3324
- Vélez, E. J., Lutfi, E., Azizi, S., Montserrat, N., Riera-Codina, M., Capilla, E., Navarro, I. and Gutiérrez, J. (2016). Contribution of in vitro myocytes studies to understanding fish muscle physiology. *Comparative Biochemistry and Physiology, Part - B: Biochemistry and Molecular Biology*, 199 67-73
- Garreta, E., Marco, A., Izpisua Belmonte, J. C. and Montserrat, N. (2016). Genome editing in human pluripotent stem cells: a systematic approach unrevealing pancreas development and disease. *Stem Cell Investigation*, 4 (11): 1-4



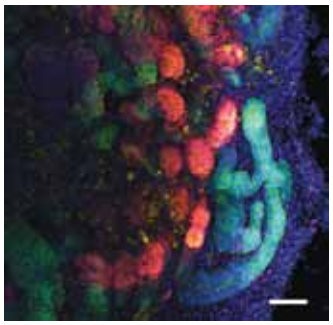


Figure 1: A. Representative immuno-fluorescence image of an organoid at day 25 of differentiation stained for the expression of ECADHERIN (green), WT1 (red) and PODOCALYXIN (yellow). Scale bar, 500 µm. B. Higher magnification showing ECAD+ renal tubular structures and WT1+PODLX+ glomeruli-like structures. Scale bar, 50 µm.

Dr. Francisco Fernández Avilés Head of Cardiology Service, Hospital General Universitario Gregorio Marañón, Madrid

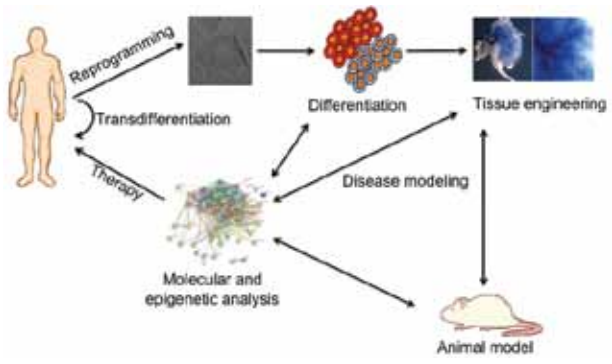
Dr María Eugenia Fernández Unit of Cell Production, Hospital Gregorio Marañón, Madrid

Joaquin Gutiérrez Fruitós University of Barcelona

Dr. Elena Martínez Biomimetic Systems for Cell Engineering, IBEC (pages 78-81)

Dr. Cristina Eguizabal Argaiz Centro Vasco de Transfusion y Tejidos Humanos (CVTTH), Bizkaia

Figure 2: Patient induced pluripotent stem cells (iPSCs) represent an unprecedented tool for the generation of *in vitro* platforms for disease modelling and the definition of protocols for pluripotent stem cells differentiation. Transdifferentiation also offers the possibility to generate auto-compatible cells with no need to undergo to pluripotent stage. In these scenarios the correction of the genetic defect(s) leading to disease may help to understand the molecular and cellular mechanisms driving disease gestation and progression, and more importantly, to identify novel mechanisms leading to organ regeneration. The combination of gene editing methodologies with defined protocols for tissue differentiation helps us to generate *in vitro* systems for drug screening and disease modelling.



Scientific equipment and techniques

- Real Time QuantStudio 5
- SimpliAmp thermocycler
- Eppendorf 5415D centrifuge
- Allegra X-15 R centrifuge
- Gyrozen 1248 centrifuge
- BioUltra 6 Telstar culture Hood 2x
- AH-100 Telstar primary culture Hood
- Binder CB 60 incubators 2x
- Controltecnica ASTEC SCA 165 incubator
- Controltecnica ZC 180 incubator
- Bioruptor Pico sonicator
- Thermomixer C thermal block
- Leica DMS1000 and DMIL Led microscopes
- Leica DMi1 microscope
- Leica MZ 10F magnifying glass
- Safe Imager 2.0 transilluminator

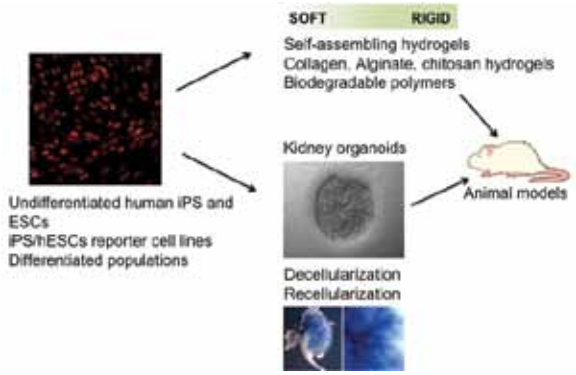


Figure 3: Induced pluripotent stem cells (iPSCs) resemble human embryonic stem cells (hESCs) in their ability to generate cells of the three germ layers of the embryo. This capacity can help us to understand the molecular and cellular cues driving cell fate. Our aim is to generate reporter cell lines from patient iPSCs in order to develop robust protocols for pluripotent stem cells differentiation. Moreover, the combination of patient differentiated populations together with functionalized biomaterials, *ex vivo* approaches (i.e: organoids), and decellularized tissue matrices, offers and unprecedented strategy for organ regeneration.

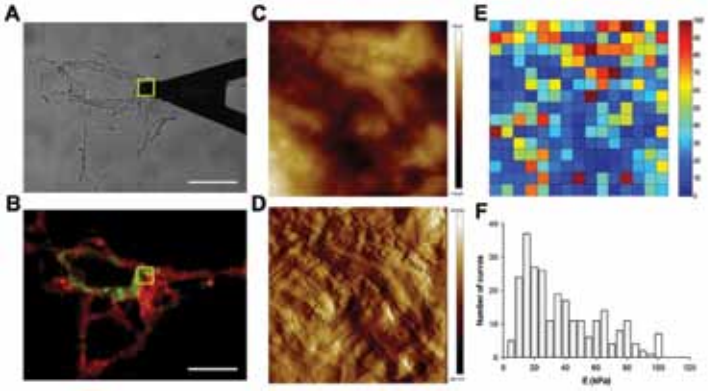
Group Leader: Daniel Navajas

Cellular and respiratory biomechanics

The goal of our research is to gain a deeper understanding of cellular and respiratory biomechanics to improve the diagnosis and treatment of respiratory diseases.

The work is organized in two interrelated areas, focused on respiratory mechanics at both the systemic and the cellular level. We use basic and translational approaches in a multidisciplinary framework involving close cooperation with clinical groups.

Our current research interest is focused on the study of cell-matrix mechanical cross-talk for tissue engineering and regenerative medicine. Cells sense and actively respond to the biophysical features of their microenvironment. Mechanical properties of the extracellular matrix regulate critical cell processes such as contraction, migration, proliferation, gene expression and differentiation. We use atomic force microscopy and other cutting-edge biophysical techniques to study the mechanical properties of the extracellular matrix and their impact in cell behavior. We have implemented protocols to decellularize different soft tissues. This innovative approach allowed us to reveal the local mechanical properties of the lung and heart extracellular matrix. By seeding cells in these scaffolds we study the impact of the mechanical features of the microenvironment on stem cell engraftment and differentiation onto lung and heart phenotypes. We produce lab-on-chip devices mimicking the native cell microenvironment to investigate mechanical signaling driving stem cell differentiation under precisely controlled conditions. Using 3D bioprinters we integrate stem cells into synthetic and extracellular matrix hydrogels to fabricate tissue patches as an innovative approach to regenerate ventricular scars resulting from heart infarct. Organ biofabrication reengineered from decellularized tissue scaffolds offers a promising alternative for transplantation. We develop improved bioreactors mimicking breathing and blood perfusion to biofabricate lungs by seeding stem cells into acellular lung scaffolds.



Mechanical mapping and imaging of the extracellular matrix of a slice of decellularized mouse lung obtained by the combination of bright field (A), immunofluorescence microscopy (B), and atomic force microscopy (C – F).

Postdoctoral Researchers
Jordi Otero
Noelia Campillo

PhD Student
Ignasi Jorba
Paula Nonaka
Bryan Falcones

Technician
Maeba Polo

Research projects

- Precondicionamento biofísico de células madre mesenquimales para el tratamiento de la lesión pulmonar aguda provocada por sobreventilación en modelo animal (2015-2017)
  PI: **Daniel Navajas**
  Fondo de Investigación Sanitaria (FIS), MINECO (PI14/00280)
- Bench test on performance of portable automatic CPAP devices (2016-2017).
  PI: Ramon Farré (UB).
  RESMED (FBG2016A)

Collaborations with other research centres

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

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

Prof. Antoni Bayés-Genis Institut del Cor dels Germans Trias I Pujol, Badalona

Prof. Daniel Weiss Department of Medicine, University of Vermont

Prof. A. Artigas Intensive Care Service, Hospital Parc Taulí, Sabadell

Mauricio Rojas Scientific Director of the Simmons Center for Interstitial Lung Diseases, University of Pittsburgh

David Gozal Chair of the Department of Pediatrics, University of Chicago Medical Center. Chicago

Scientific equipment and techniques

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

Publications

- Wolfenson, H. et al (2016). Tropomyosin controls sarcomere-like contractions for rigidity sensing and suppressing growth on soft matrices. *Nature Cell Biology*, 18, 33-42
- Campillo, N. et al (2016). A novel chip for cyclic stretch and intermittent hypoxia cell exposures mimicking obstructive sleep apnea. *Frontiers in Physiology*, 7 Article 319
- Nonaka, P. N. et al (2016). Lung bioengineering: physical stimuli and stem/progenitor cell biology interplay towards biofabricating a functional organ. *Respiratory Research*, 17 (1): 161
- Farré, R. and Navajas, D. (2016).Forced oscillation: A poorly exploited tool for simply assessing respiratory function in children. *Respirology*, 21 (6): 982-983
- Uriarte, J. J. et al (2016). Early impairment of lung mechanics in a murine model of marfan syndrome. *PLoS ONE*, 11 (3): e0152124
- Isetta, V. et al (2016). Novel approach to simulate sleep apnea patients for evaluating positive pressure therapy devices. *PLoS ONE*, 11 (3): e0151530
- Valero, C. et al (2016). Finite element simulation for the mechanical characterization of soft biological materials by atomic force microscopy. *Journal of the Mechanical Behavior of Biomedical Materials*, 62 222-235
- da Palma, R. K. et al (2016). Behavior of vascular resistance undergoing various pressure insufflation and perfusion on decellularized lungs. *Journal of Biomechanics*, 49 (7): 1230-1232
- Farré, R. et al (2016). Technology for noninvasive mechanical ventilation: Looking into the black box. *ERS Monograph*, 2 (1): 00004

Postdoctoral Researchers
Vanessa Gil
Arnau Hervera

Laboratory Technician
Miriam Segura

Senior Researcher
Rosalina Gavín

PhD Students
Laia Lidón
Laura Urrea
Andreu Matamoros
Agata Mata

Molecular and cellular neurobiotechnology

Our research interests are focused on three main aspects of developmental neurobiology and regeneration:

1) Reelin and neurodegeneration

Reelin is an extracellular glycoprotein involved in key cellular processes in developing and adult nervous system, including regulation of neuronal migration, synapse formation and plasticity. Most of these roles are mediated by the intracellular phosphorylation of Dab1, an intracellular adaptor molecule, in turn mediated by binding Reelin to its receptors. Altered expression and glycosylation patterns of Reelin in cerebrospinal and cortical extracts have been reported in Alzheimer's disease. However, putative changes in Reelin are not described in natural prionopathies or experimental models of prion infection or toxicity. With this is mind, in the study we determined that Reelin protein and mRNA levels increased in CJD human samples and in mouse models of human prion disease in contrast to murine models of prion infection. However, changes in Reelin expression appeared only at late terminal stages of the disease, which prevents their use as an efficient diagnostic biomarker. In addition, increased Reelin in CJD and in *in vitro* models does not correlate with Dab1 phosphorylation, indicating failure in its intracellular signaling. Overall, these findings widen our understanding of the putative changes of Reelin in neurodegeneration.

2) New in vitro models for neurodegeneration

The cellular prion protein, encoded by the gene *PRNP*, has been reported as receptor of b-amyloid. Their interaction is mandatory for neurotoxic effects of b-amyloid oligomers. In the study we aimed to explore whether the cellular prion protein participates in the spreading of a-synuclein. For this we developed cell to cell transport using microfluidic devices. Results demonstrate that *PRNP* expression is not mandatory for a-synuclein spreading. However, although the pathological spreading of a-synuclein can take place in the absence of *PRNP*, a-synuclein fibrils bind strongly on *PRNP* expressing cells, suggesting a role modulating the effect of a-synuclein fibrils.

3) Development of new lab on a chip devices for neurobiological research

We recently developed a new device able to reproduce axon lesioning *in vitro* in a single chip. Current experiments of our group in collaboration with groups of IBEC and CIBER-BBN aimed at developing new lab on chip devices to mimics and modulate particular neurobiological processes. For example: cortico-spinal chips to develop genetic studies; molecular gradient generation for migrating neurons and *in silico* 3D modeling for neurodegenerative diseases (Alzheimer chip).

Masters Students
Francina Mesquida

Undergraduate Student
Marta Sánchez

Group Leader: José Antonio Del Río

Research projects

- **NEURODEV** Nuevas funciones de PlexinD1/Sema3E, PrP^{c} y las proteínas asociadas a la mielina durante el desarrollo de la corteza cerebral de roedores y en neurodegeneración (2013-2016)
  PI: **José Antonio del Río**
  MINECO, I+D-Investigación fundamental no orientada, BFU2012-32617
- Role of the cellular prion protein as "cross-talk" protein between α-syn/ LRRK2 and p-Tau in sporadic and familiar Parkinson's disease (2015-2018)
  PI: **José Antonio del Río**
  Fundació La Marató de TV3
- Red Nacional de Priones (2015-2017)
  PI: **José Antonio del Río**
  MINECO, Acciones Dinamización "Redes Excelencia"
- **ANGIODEVSNC** Funciones de genes implicados en angiogénesis y remodelación vascular durante el desarrollo cortical y en neurodegeneración
  PI: **José Antonio del Río**
  MINECO, Retos investigación: Proyectos I+D
- Monitoring neurocognitive deficits in Alzheimer's and Parkinson's diseases using saliva or blood-derived biomarkers and a multiplexed approach (2016-2018)
  Project coordinator: Josep Samitier (pages 96-101)/J**osé A. del Río**
  Obra Social La Caixa
- Grup de Recerca Consolidat
  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 (SGR 2014-2016)
- Mecanismos epigenéticos implicados en la etiología y progresión de las demencias neurodegenerativas rápidamente progresivas (2015-2016)
  Scientist in charge, UB-IBEC: **José Antonio del Río** (Scientific Coordinator: Miguel Calero)
  MINECO

Publications

- Garcia-Calero, E., Botella-Lopez, A., Bahamonde, O., Perez-Balaguer, A. and Martinez, S. (2016). FoxP2 protein levels regulate cell morphology changes and migration patterns in the vertebrate developing telencephalon. *Brain Structure and Function*, 221 (6): 2905-2917
- Vilches, S., Vergara, C., Nicolás, O., Mata, A., Del Río, J. A. and Gavín, R. (2016). Domain-specific activation of death-associated intracellular signalling cascades by the cellular prion protein in neuroblastoma cells. *Molecular Neurobiology*, 53 (7): 4438–4448
- Ansoleaga, B., Garcia-Esparcia, P., Llorens, F., Hernández-Ortega, K., Carmona Tech, M., Antonio del Rio, J., Zerr, I. and Ferrer, I. (2016). Altered mitochondria, protein synthesis machinery, and purine metabolism are molecular contributors to the pathogenesis of Creutzfeldt–Jakob disease. *Journal of Neuropathology & Experimental Neurology*, 75 (8): 755-769
- Tomas-Roig, J., Piscitelli, F., Gil, V., del Río, J. A., Moore, T. P., Agbemenyah, H., Salinas-Riester, G., Pommerenke, C., Lorenzen, S., Beißbarth, T., Hoyer-Fender, S., Di Marzo, V. and Havemann-Reinecke, U. (2016). Social defeat leads to changes in the endocannabinoid system: An overexpression of calreticulin and motor impairment in mice. *Behavioural Brain Research*, 303 34-43
- Requena, J. R., Kristensson, K., Korth, C., Zurzolo, C., Simmons, M., Aguilar-Calvo, P., Aguzzi, A., Andreoletti, O., Benestad, S. L., Böhm, R., Brown, K., Calgua, B., del Río, J. A., Espinosa, J. C., Girones, R., Godsave, S., Hoelzle, L. E., Knittler, M. R., Kuhn, F., Legname, G., Laeven, P., Mabbott, N., Mitrova, E., Müller-Schiffmann, A., Nuvolone, M., Peters, P. J., Raeber, A., Roth, K., Schmitz, M., Schroeder, B., Sonati, T., Stitz, L., Taraboulos, A., Torres, J. M., Yan, Z. X. and

Collaborations with other research centres

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

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

Dr. Jokin Castilla CiC Biogune, Bilbao, Spain

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

Prof. Jose Manuel García Aznar Nanotechnology Institute, Zaragoza, Spain

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

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

Dr. Elisabeth Engel (pages 50-55), **Prof. Josep Samitier** (pages 96-101), **Prof. Xavier Trepat** (pages 112-115)

Prof. Ángel Raya Center of Regenerative Medicine in Barcelona (CMRB), Barcelona

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

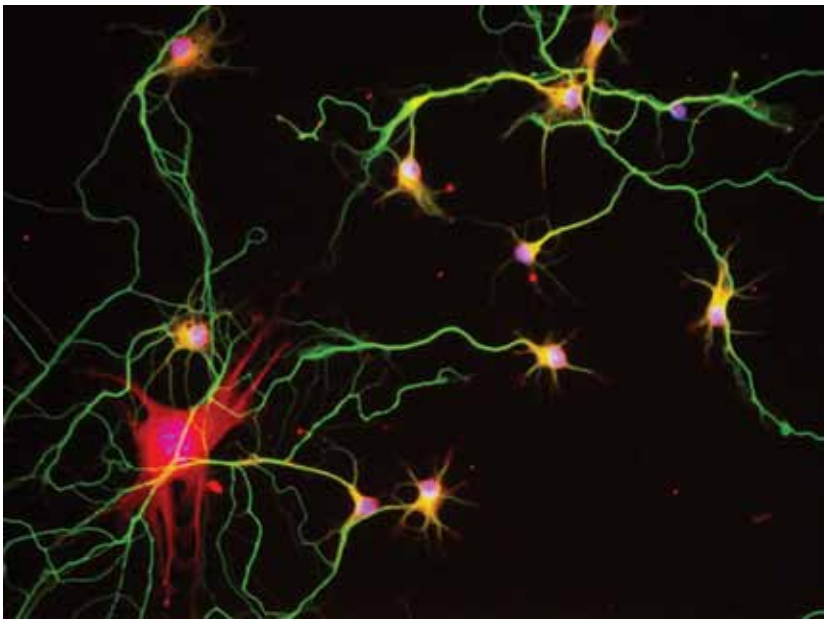
Prof. Isidro Ferrer Institut d'Investigació Biomèdica de Bellvitge, University of Barcelona, Spain

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

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

Prof. Masato Hagesawa Faculty of Medicine, Tokyo

Primary neuronal culture. Neurons (green) and astrocytes (red) derived from a E16.5 eGFP transgenic mouse embryo after 15 days *in vitro*



Scientific equipment and techniques

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

Zerr, I. (2016). The Priority position paper: Protecting Europe's food chain from prions. *Prion*, 10 (3): 165-181

- del Río, J. A. and Gavín, R. (2016). Functions of the cellular prion protein, the end of Moore's law, and Ockham's razor theory. *Prion*, 10 (1): 25-40

Conference Papers

- Ferrer, I., Llorens, F., Frau-Mendez, L., Fernandez-Vega, I., Thune, K., del Río, J. A., Schmizt, M., Ansoleaga, B., Gotzmann, N., Cramm, M., Zerr, I. and Zarranz, J. J. (2016). Identification of new molecular alterations in Fatal Familial Insomnia. *PRION 2016*, Tokyo, Japan. Published by Taylor & Francis

Group Leader: Pere Roca-Cusachs

Cellular and molecular mechanobiology

Every time we blink, move a hand, draw a breath, or walk, cells in our body exert, transmit, withstand, and detect forces. This mechanical interaction with the environment determines how cells proliferate, differentiate, and move, and regulates development, tumorigenesis or wound healing.

Just like biochemical stimuli initiate signaling cascades, mechanical forces affect the links and conformation of a network of molecules connecting cells to the extracellular matrix. Our research aims precisely at unraveling the mechanisms that these molecules use to detect and respond to mechanical stimuli like forces or tissue rigidity, triggering downstream cell responses. To this end, we combine biophysical techniques like magnetic tweezers, Atomic Force Microscopy, traction microscopy, and microfabricated force sensors with molecular biology, advanced optical microscopy, and theoretical modelling.

Sensing rigidity: Using this multi-disciplinary approach, we have recently unveiled a molecular mechanism that cells employ to detect and respond to the rigidity of their environment, which could be crucial in breast tissue and breast cancer (Elosegui-Artola *et al.*, 2016, *Nat. Cell Biol.*, and Elosegui-Artola *et al.,* 2014, *Nature Mater.*). This mechanism is mediated by what is known as a "molecular clutch": in a surprising analogy with a car engine, cells can be understood as a molecular network that can engage and disengage from its environment, just as the clutch of a car.

Sensing the environment: We are currently expanding on the idea of the molecular clutch, to explore how cell molecular engines sense not only mechanical rigidity, but other important parameters from their environment: for instance, the composition and distribution of ligands in the extracellular matrix, or other cells. In this regard, we recently uncovered that cell-cell force transmission, mediated by a molecular clutch, is essential for cells to sense gradients in stiffness (Sunyer *et al.*, 2016, *Science* in collaboration with the group of Xavier Trepat).

The membrane as a mechanosensor: Due to its mechanical properties, the plasma membrane itself can respond to forces and act as a mechanosensor. Recently, we have shown that cell membranes can use purely physical principles to adapt their shape in response to mechanical forces (Kosmalska *et al.*, 2015, *Nat. Commun.*). We are currently studying how cells harness this physical membrane behavior to respond to signals from their environment.

Ultimately, when we determine the molecular mechanisms that communicate cells with their environment, we will understand how forces determine development when things go right, and tumor formation when they go wrong.

Senior Postdoctoral Researcher
Alberto Elosegui

Postdoctoral Researcher
Anabel-Lise Le Roux

PhD Students
Víctor González
Roger Oria
Anita Joanna Kosmalska

Undergraduate Student
Cristian Moreno

Research Assistant
Xarxa Quiroga

Filed patents

- Patent Number: Ep16382121.8. **Patent in the field of inhibitors of solid tumors.**
  Assignees: IBEC, University of Barcelona.
  Authors: Pere Roca-Cusachs, Alberto Elósegui-Artola

Research projects

- Grup de recerca consolidat (2014-2017)
  PI: **Pere Roca-Cusachs**
  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
- **IMREG** El sistema acoplado entre integrinas y proteínas adaptadoras como regulador mecánico del comportamiento celular (2016-2019)
  PI: **Pere Roca-Cusachs**
  MINECO, Proyectos I+D Excelencia
- Red de excelencia en mecanobiologia (2014-2016)
  PI: **Pere Roca-Cusachs**
  MINECO, Subprograma Estatal de Generación de Conocimiento "REDES DE EXCELENCIA"
- Stromal stiffness in tumor progression (2014-2017)
  PI: **Pere Roca-Cusachs**
  Fundació la Marató de TV3

Collaborations with other research centres

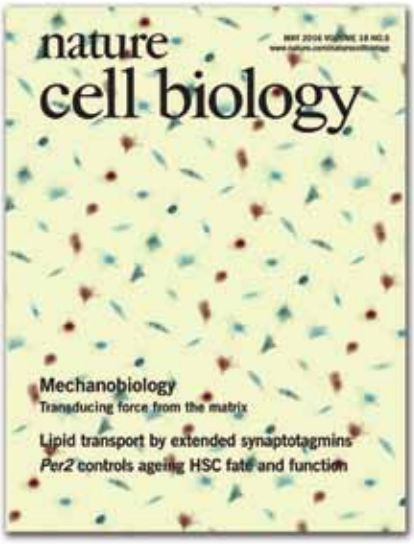
Dr. Nils Gauthier, Mechanobiology Institute, Singapore

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

Prof. Marino Arroyo, UPC, Barcelona

Publications

- Sunyer, R., Conte, V., Escribano, J., Elosegui-Artola, A., Labernadie, A., Valon, L., Navajas, D., García-Aznar, J. M., Muñoz, J. J., Roca-Cusachs, P. and Trepat, X. (2016). Collective cell durotaxis emerges from long-range intercellular force transmission. *Science*, 353 (6304): 1157-1161
- Elosegui, A., Oria, R., Chen, Y., Kosmalska, A., Perez-Gonzalez, C., Castro, N., Zhu, C., Trepat, X. and Roca-Cusachs, P. (2016). Mechanical regulation of a molecular clutch defines force transmission and transduction in response to matrix rigidity. *Nature Cell Biology*, 18 (5): 540-548
- Meacci, G., Wolfenson, H., Liu, S., Stachowiak, M. R., Iskratsch, T., Mathur, A., Ghassemi, S., Gauthier, N., Tabdanov, E., Lohner, J., Gondarenko, A., Chander, A. C., Roca-Cusachs, P., O'Shaughnessy, B., Hone, J. and Sheetz, M. P. (2016). α-Actinin links extracellular matrix rigidity-sensing contractile units with periodic cell-edge retractions. *Molecular Biology of the Cell*, 27 (22): 3471-3479



Our *Nature Cell Biology* cover in 2016 (Elosegui, A.*et al.)*

Prof. Ada Cavalcanti, U. of Heidelberg, Germany

Satyajit Mayor, National Centre for Biological Sciences, Bangalore, India

Sergi Garcia-manyes, King's College, London, UK

Cheng Zhu, Georgia Tech, Atlanta, USA

Louise Jones, Barts Cancer Institute, London, UK

Scientific equipment and techniques

- Confocal Microcopy
- Traction Microscopy
- Live cell fluorescence microscopy
- Cell stretching
- Cell culture
- Magnetic Tweezers
- Atomic Force Microscopy
- Surface Micro/Nano-patterning
- Optical tweezers

PhD Students
Roberto Paoli
Nomaphelo Ntshongontshi
Maider Badiola

Postdoctoral Researchers
Romén Rodríguez
Maria José López

Senior Researchers
David Caballero
Anna Lagunas
Mònica Mir

Group Leader: Josep Samitier

Nanobioengineering

The Nanobioengineering group is a multidisciplinary team working together in applying nanotechnology for the development of new biomedical systems and devices.

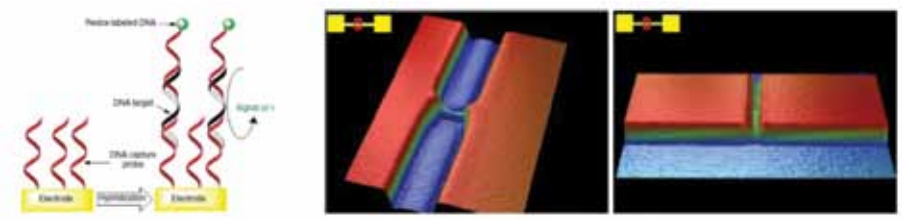
The main output are diagnostic and point-of-care systems and integrated microfluidic Organ-on-Chip devices for the study of organ physiology, disease etiology, or drug screening.

The main research activities of the group include the engineering and biochemical functionalization of biomaterials integrated with microfluidics systems. The bioengineered microdevices are used to study cell responses to biomolecular compounds applied to Organ-on-Chip devices, or for the development of new lab-on-a-chip based biosensors.

The goal is to fabricate microsystems containing living cells that recapitulate tissue and organ level functions *in vitro* and new portable diagnosis devices that can be used as Point-of-Care systems. The projects carried out by the group are focused on clinical and industrial problems and are related to three convergent research lines:

1. Biosensors and Lab-on-a-Chip devices for clinical diagnosis and food safety applications

- DNA sensors and platform arrays for cancer biomarker detection.
- Antibody-based sensors for pathogenic microorganisms' detection and neurodegenerative early detection
- Sensor array for *in vivo* hypoxia and ischemia monitoring.
- Sensors to mimic the chemical detection of plant roots for robotic applications.
- Microfluidic chip for reagent handling in POC diagnosis devices.



Nano-gap DNA sensors.

Undergraduate Students
Mar De Pablo
Elisenda Ferró
David Pijoan
Andrea Esteban
Jaume Bartolí

Research Assistants
Ignasi Casanellas
Andrea García

Research Technician
Samuel Dulay

Laboratory Technicians
David Izquierdo
Miriam Funes
Judit Pérez

Masters Students
Marina Llenas
Alfonso Flores

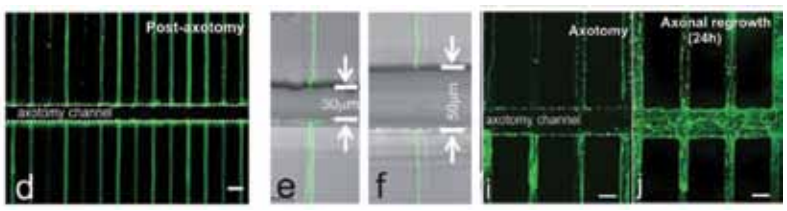
- Microfluidic chip using hydrodynamic forces for cell counting and sorting. Application for detection of circulating tumors cells (CTC).

2. Nanotechnology applied to biomolecule interaction studies and micro/nano-environments for regenerative medicine applications

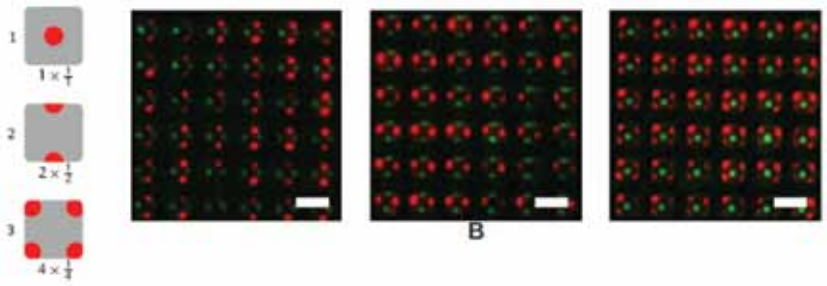
- Development of bioengineered 2D and 3D micro/nanoenvironments with a topography and chemical composition controlled at the nanoscale for cell behavior studies (adhesion, proliferation, differentiation).
- Biophysical description of cellular phenomena (cell migration, differentiation) using micro/nanotechnologies, cell biology tools and soft matter physics.
- Study of magnetite nanoparticles - Amyloid-Beta interaction in Alzheimer disease.

3. Microfluidic systems for biological studies and Organ-on-Chip devices

- Microfluidic chip for blood/plasma filtering.
- Spleen-on-a-chip development.
- Nanoporous-based systems for kidney-on–a-chip developments.



Proximal segments of axons showing regeneration formation in compartmentalized microfluidic devices



Fluorescence images of multi patterns fabricated with pyramidal PDMS stamp.

- Engineering microfluidic platforms for neurobiological studies.
- Development of 3D neuromuscular tissue models for soft robotics and clinical applications.

Research projects

- Desarrollar un sistema de asistencia robótica para medicina y cirugía fetal (2016-2019)
  PI: **Josep Samitier**
  CELLEX
- **MINDS** Plataforma MIcrofluídica 3D de cultivo Neuronal compartimentada para el estuDio de enfermedades neurológicaS (2016-2018)
  PI: **Josep Samitier**
  MINECO, Proyectos I+D Excelencia
- Joint Programme - Healthy Ageing (2016)
  PI: **Josep Samitier**
  Obra Social La Caixa
- **ELECTRA-G** (2014-2016)
  PI: **Josep Samitier**
  Conveni GENOMICA S.A.U.
- Desarrollo de una nueva tecnología lab-on-a-chip para la detección y cuantificación de secuencias de ADN/ARN (2014-2016) (Joint Unit IBEC-Genomica)
  PI: **Josep Samitier**
  Genómica S.A.U
- **BIOBOT** Engineered biological soft robots based on neuro-muscular junction control (2015-2018)
  PI: **Josep Samitier**
  MINECO, Proyectos EXPLORA Ciencia / Tecnología 2015
- **nanoET-leukemia** Nanoconductance of electron transfer proteins of the respiratory chain. Direct measurement at the single molecular level and therapeutic regulation in cancer stem cells (2015-2018)
  PIs: Anna Lagunas (pages 96-101)/Marina Inés Giannotti (pages 64-67)
  MINECO, Proyectos RETOS 2015 / CIBER
- Monitoring neurocognitive deficits in Alzheimer's and Parkinson's diseases using saliva or blood-derived biomarkers and a multiplexed approach (2016-2018)
  Project coordinator: **Josep Samitier**/José A. del Río (pages 88-91)
  Obra Social La Caixa
- **ISCHEMSURG** Miniaturized electrochemical sensor for monitoring of free flap ischemia in post-surgery (2017-2018)
  Project coordinator: **Mònica Mir**
  CaixaImpulse

Collaborations with other research centres

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

Dr. José Antonio Andrades, Universidad de Málaga, Spain

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

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

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

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

Prof. Josep Maria Canals University of Barcelona, Spain

Dr. Matthew Dalby University of Glasgow, UK

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

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

Prof. E. Faszewski Wheelock College, Boston, USA

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

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

Dr. Nicole Jaffrezic Université Claude Bernard Lyon 1, France

Dr. Graham Johnson Uniscan Instruments Ltd, Buxton, UK

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

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

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

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

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

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

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

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

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

Prof. M. Sampietro Politecnico di Milano, Italy

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

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

Industry partners:

Biokit S.A. (Werfen group); Genomica S.A.U. (Zeltia group); Tallers Fiestas S.L.; Enantia S.L.; Microfluidic ChipShop GmbH

Publications

- Torras, N., Agusil, J. P., Vázquez, P., Duch, M., Hernández-Pinto, A. M., Samitier, J., de la Rosa, E. J., Esteve, J., Suárez, T., Pérez-García, L. and Plaza, J. A. (2016). Suspended planar-array chips for molecular multiplexing at the microscale. *Advanced Materials*, 28 (7): 1449–1454
- Parra-Cabrera, C., Samitier, J. and Homs-Corbera, A. (2016). Multiple biomarkers biosensor with just-in-time functionalization: Application to prostate cancer detection. *Biosensors and Bioelectronics*, 77 1192-1200
- Urrios, A., Parra-Cabrera, C., Bhattacharjee, N., Gonzalez-Suarez, A. M., Rigat-Brugarolas, L. G., Nallapatti, U., Samitier, J., Deforest, C. A., Posas, F., Garcia-Cordero, J. L. and Folch, A. (2016). 3D-printing of transparent bio-microfluidic devices in PEG-DA. *Lab on a Chip*, 16 (12): 2287-2294
- Caballero, D., Katuri, J., Samitier, J. and Sánchez, S. (2016). Motion in microfluidic ratchets. *Lab on a Chip*, 16 (23): 4477-4481
- Lagunas, A., Sasso, B., Tesson, N., Cantos, C., Martinez, E. and Samitier, J. (2016). Synthesis of a polymethyl(methacrylate)-polystyrene-based diblock copolymer containing biotin for selective protein nanopatterning. *Polymer Chemistry*, 7 212-218
- Sanmartí-Espinal, M., Galve, R., Iavicoli, P., Persuy, M. A., Pajot-Augy, E., Marco, M. P. and Samitier, J. (2016). Immunochemical strategy for quantification of G-coupled olfactory receptor proteins on natural nanovesicles. *Colloids and Surfaces B: Biointerfaces*, 139 269-276
- Credi, C., De Marco, C., Molena, E., Pla Roca, M., Samitier, J., Marques, J., Fernàndez-Busquets, X., Levi, M. and Turri, S. (2016). Heparin micropatterning onto fouling-release perfluoropolyether-based polymers via photobiotin activation. *Colloids and Surfaces B: Biointerfaces*, 146 250-259

- Tahirbegi, I. B., Pardo, W. A., Alvira, M., Mir, M. and Samitier, J. (2016). Amyloid Aβ 42, a promoter of magnetite nanoparticle formation in Alzheimer's disease. *Nanotechnology*, 27 (46): 465102
- Silva, N., Muñoz, C., Diaz-Marcos, J., Samitier, J., Yutronic, N., Kogan, M. J. and Jara, P. (2016). In situ visualization of the local photothermal effect produced on α-cyclodextrin inclusion compound associated with gold nanoparticles. *Nanoscale Research Letters*, 11 180
- Pla-Roca, M., Altay, G., Giralt, X., Casals, A. and Samitier, J. (2016). Design and development of a microarray processing station (MPS) for automated miniaturized immunoassays. *Biomedical Microdevices*, 18 (4)
- Páez-Avilés, C., Juanola-Feliu, E., Punter-Villagrasa, J., Del Moral Zamora, B., Homs-Corbera, A., Colomer-Farrarons, J., Miribel-Català, P. L. and Samitier, J. (2016). Combined dielectrophoresis and impedance systems for bacteria analysis in microfluidic on-chip platforms. *Sensors*, 16 (9): 1514
- Botaya, L., Coromina, X., Samitier, J., Puig-Vidal, M. and Otero, J. (2016). Visualized multiprobe electrical impedance measurements with STM tips using shear force feedback control. *Sensors*, 16 (6): 757
- Paoli, R. and Samitier, J. (2016). Mimicking the kidney: A key role in organ-on-chip development. *Micromachines*, 7 (7): 126

Book Sections

- Lagunas, A., Caballero, D. and Samitier, J. (2016). Influence of controlled micro- and nanoengineered environments on stem cell. In: *Advanced Surfaces for Stem Cell Research* (ed. Tiwari, A., Garipcan, B. and Uzun, L.). Wiley, San Francisco, USA, p85-140

Scientific equipment and techniques

- Nanofabrication and nanomanipulation
  - Automatized microcontact printing system (custom-made)
  - 3D Printing system for microfluidic devices.
- Characterization
  - Surface Plasmon Resonance (SPR)
  - Potentiostates
  - Optical Waveguide Lightmode Spectroscope (OWLS)
  - Atomic Force Microscope (AFM)
  - Optical Microscopes (white light/epifluorescence)
  - Electrical Impedance spectroscopy (EIS)
  - Multi-frequency Lock-in Amplifier
  - Sub-femtoamp Remote SourceMeter Instrument
- Molecular/cell biology
  - Biological safety cabinet (class II)
  - Microwell plate readers
  - Protein and DNA electrophoresis systems
  - Microincubator Okolab
  - Nanodrop spectrophotometer
  - CO2 incubator for cells
  - Cell culture cabin:
- Microfluidics
  - High precision syringe pumps
  - Peristaltic pumps

Postdoctoral Researchers
Tania Patiño
Agostino Romeo
Nerea Murillo

Laboratory Technicians
Angel Blanco
Ariadna Pérez (lab manager)

Smart nano-bio-devices

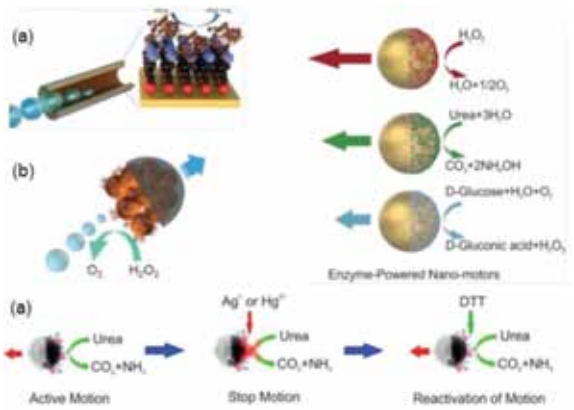
Chemically powered micro- and nanomotors are small devices that are self-propelled by catalytic reactions in fluids. These synthetic systems form a relatively new class of active matter, natural examples of which include flocks of birds, collection of cells and suspensions of bacteria.

A number of promising applications have been envisioned for these micro-nano motors, such as targeted drug delivery, environmental remediation and as pick-up and delivery agents in lab-on-a-chip devices. These applications rely on the basic functionalities of self-propelled motors: directional motion, sensing of the local environment, and the ability to respond to external signals. Our group works on the design and study of new types of synthetic motors towards these applications and develops proof-of-concept studies to demonstrate their viability. Below are some of the projects that we are currently working on.

Enzyme powered motors towards biomedical applications

Conventional micro-nano motors have been powered by the catalytic decomposition of hydrogen peroxide on a Pt surface. This method falls short when it comes to bio-medical applications due to the toxicity of peroxide. To move toward more biocompatible propulsion sources, there has been a recent effort to integrate enzymes in the nanomotors. Enzymes trigger biocatalytic reactions, which can convert chemical energy into kinetic motion for bioprocesses, for example, intracellular protein transport. Different types of enzymes including urea and D-glucose have been coupled with the nanomotor structures to achieve a non-toxic propulsion mechanism. We have also developed method to achieve direction and velocity control in these types of motors.

Several enzymes can be coupled with synthetic nanomotor architectures to derive a bio-compatible propulsion mechanism.



Active matter near interfaces

We study colloidal suspensions of Pt-coated silica particles as a model system of synthetic active matter. These systems have mostly been studied in homogeneous environments until now. Our interest lies in observing these

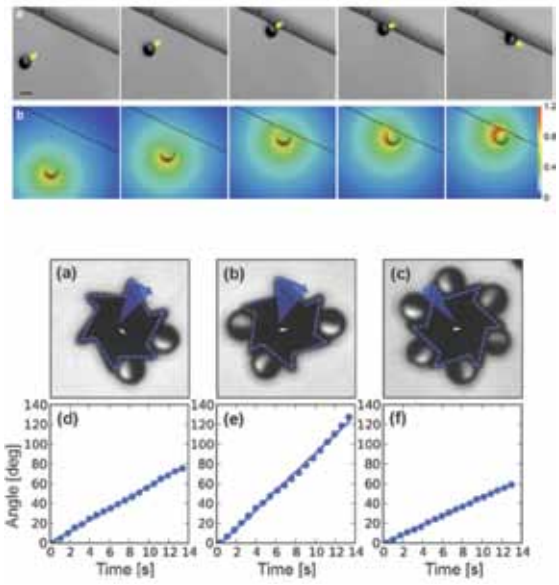
PhD Students
Lucas Santiago Palacios
Jaideep Katuri
Ana Candida Lopes
Jemish Parmar
Rafael Mestre

Masters Students
Xavier Arqué
Tania Gonçalves
Albert Miguel López
Silvia Vicente Rizo

Undergraduate Student
María Telleria
Natàlia Salvat

Group Leader / ICREA Research Professor: Samuel Sánchez

systems in more complex settings, such as near interfaces. Since the self-propelled particles generate chemical and hydrodynamic fields around them, they interact in complex ways with nearby surfaces that often leads to interesting behaviour. We could find, for instance that close to solid surfaces they achieve a stable 'gliding' state which could be exploited to develop a system for guiding micro-nano motors using topographical features. The same effect could also be used to self-assemble micro-motors around passive structures to form micro-gears.



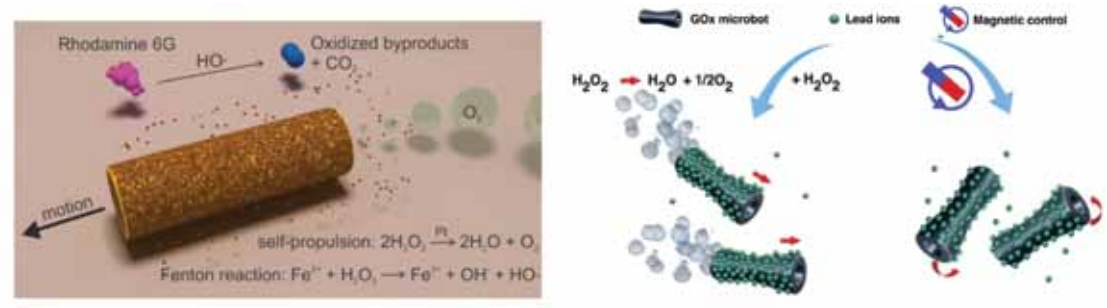
Phoretic and hydrodynamic interactions with nearby surfaces can be exploited to create a guidance mechanism for self-propelled particles and to self-assemble micro-gears.

Environmental applications of micro-nano motors

Artificial microjets, based on microtubular geometries self-propel by the ejection of a jet of bubbles. Recent studies have demonstrated that the bubbles released from the microjets can mix solutions and enhance chemical reactions. We have designed 'roll-up' microjets that use up hydrogen peroxide as a fuel and generate and actively transport free radicals in the solution in a 3D manner, boosting the degradation of organic dyes via Fenton-like reactions. Long-term activity lasting upto 24 hrs has been recorded for these systems. Electrodeposited microjets that are much smaller than their 'roll-up' counterparts, containing graphene-oxide on the outside have been developed as 'heavy metal scrubbers'. Lead is captured by these graphene-modified microjets and cleaned out from contaminated solutions. The metal can thereafter be desorbed, and the microjets can be reused again.

Bio-hybrid micro-nano motors

Bio-hybrid motors focus on the interaction of a motile cell with artificial materials to create a mobile system that is powered by cellular actuation. Bio-hybrids are not powered by toxic chemical fuels but by biological fluids, making them ideal for biomedical applications. They are responsive to their local environment (pH, temperature, and chemical gradients) and are capable of performing complex tasks that synthetic-only motors would not be capable of. We

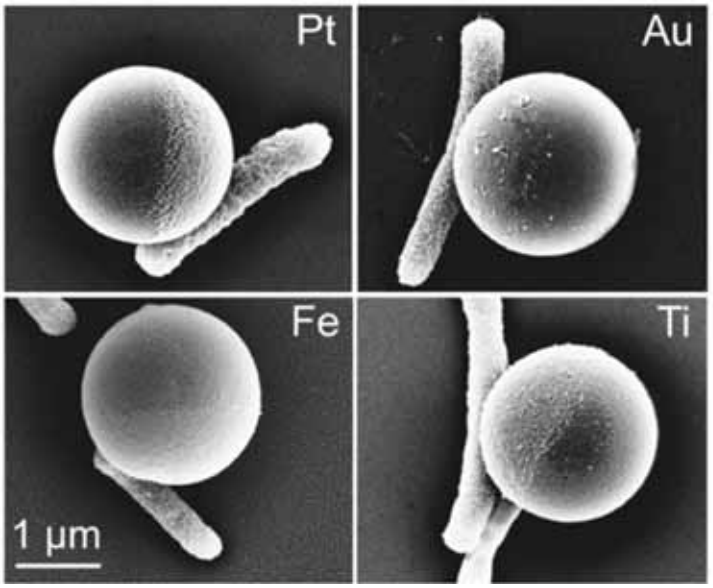


Fe and Gox based micromotors can be used to remove organic and heavy metal contaminants from water.

have coupled *E. coli* bacteria with metal capped 'Janus' colloids to create a multi-flagellated bio-hybrid system. *E. coli* adheres selectively to the metal cap of the Janus particle and the polystyrene side of the Janus particle can be used for localized drug attachment.

Flexible sensors and soft robotics

Soft materials and architectures that conform to and create an intimate matching with soft and non-planar body surfaces offer intriguing opportunities in biomedicine. A recent line of research in our group is to investigates soft and flexible systems oriented towards hydrid bio-robotics and wearable electronics for biosensing. On the one hand, we are interested in the fabrication of soft hybrid bio-bots based on 2D bio-fabrication and 3D bio-printing techniques. Here, artificial components (hydrogels, polymers, nanoparticles etc.) and biological cells are integrated to produce different types of controlled actuation, paving the way for complex hybrid systems. On the other hand, we develop flexible biosensors for non-invasive, cost-effective and personalized monitoring of bio-analytes in biological fluids. Such devices could play a key role in reducing the costs associated with clinical and biomedical diagnostic procedures. We focus on sensors based on electrochemical and colorimetric detection, as they are particularly suited for low-cost, portable and user-friendly medical diagnostics.



Bacteria can be selectively adhered to metal caps of 'Janus' colloids to create multi-flagellated bio hybrid systems.

Research projects

- **LT-NRBS** Lab-in-a-tube and Nanorobotic biosensors (2013-2017)
  PI: **Samuel Sánchez**
  European Research Council (ERC-StG)
- Mesoporous Silica Micro/Nano-motors as Active Drug Delivery Vehicles (2014-2016)
  PI: Ma Xing (hosted by **Samuel Sánchez** at MPI-IS)
  Alexander von Humboldt Foundation
- LOC-Systems based on Nano/Micromachines for Food Safety Applications (2014-2016)
  PI: Diana Vilela (hosted by **Samuel Sánchez** at MPI-IS)
  Alexander von Humboldt Foundation
- **MicroDia** Sistemas Lab-on-a-chip basados en micro-nanomotores para el diagnóstico de enfermedades (2016-2018)PI: **Samuel Sánchez**
  MINECO, Retos investigación: Proyectos I+D
- **MICROCLEANERS** Active microcleaners for water remediation (2016-2018)
  PI: **Samuel Sánchez**
  European Research Council (ERC-PoC)

Collaborations with other research centres

Prof. D.P. Kim National Center of Applied Microfluidic Chemistry, Department of Chemical Engineering, POSTECH (Pohang University of Science and Technology), Korea

Prof. D.S. Kim Department of Mechanical Engineering, POSTECH, Pohang, Korea

Prof. M. Rümmeli Sungkyunkwan (SKKU) University, Seoul, Korea / IFW Dresden, Germany

Prof. P. Fischer Molecular, Micro- and Nano- machines, Max-Planck Institute for Intelligent Systems, Stuttgart, Germany

Prof. S. Dietrich, Dr. M. Popescu, M. Tasinkevych, Dr. W. Uspal Theory of Soft Condensed Matter, MPI for Intelligent Systems, Stuttgart, Germany

Prof. M. Sitti Physical Intelligence department, MPI for Intelligent Systems

Prof. C. Bechinger Faculty 2 of Physics, University of Stuttgart, Germany

Prof. I. Pagonabarraga University of Barcelona, Spain

Dr. L. Ionov Leibniz Institute for Polymer Research, Dresden, Germany (now at Georgia University, USA)

Prof. O.G. Schmidt, Dr. A-K. Meyer, Mrs.V. Magdanz Institute for Integrative Nanosciences, Leibnitz Institute for Solid State and Materials Research, Dresden, Germany

Dr. A-K. Meyer Division of Neurodegenerative Diseases and Center for Regenerative Therapies Dresden (CRTD) Technische Universität Dresden, Germany

Prof. A. Richter Institut für Halbleiter- und Mikrosystemtechnik, Technische Universität Dresden, Germany

Dr. B. Friedrich Max Planck Institute for the Physics of Complex Systems, Dresden, Germany

Prof. J. Spatz, Dr. J-H. Dirks Biomaterials Department, MPI for Intelligent Systems

Prof. D. H. Gracias The John Hopkins Universtity, Baltimore, USA

Publications

- Vilela, D., Parmar, J., Zeng, Y., Zhao, Y. and Sánchez, S. (2016). Graphene based microbots for toxic heavy metal removal and recovery from water. *Nano Letters*, 16 (4): 2860-2866
- Ma, X., Hortelão, A. C., Patiño, T. and Sánchez, S. (2016). Enzyme catalysis to power micro/nanomachines. *ACS Nano*, 10 (10): 9111–9122
- Ma, X., Jang, S., Popescu, M. N., Uspal, W. E., Miguel-López, A., Hahn, K., Kiam, D.-P. and Sánchez, S. (2016). Reversed Janus micro/nanomotors with internal chemical engine. *ACS Nano*, 10 (9): 8751-8759
- Ma, X., Wang, X., Hahn, K. and Sánchez, S. (2016). Motion control of urea powered biocompatible hollow microcapsules. *ACS Nano*, 10 (3): 3597-3605
- Ma, X., Hortelao, A. C., Miguel-López, A. and Sánchez, S. (2016). Bubble-free propulsion of ultrasmall tubular nanojets powered by biocatalytic reactions. *Journal of the American Chemical Society*, 138 (42): 13782–13785
- Simmchen, J., Katuri, J., Uspal, W. E., Popescu, M. N., Tasinkevych, M. and Sánchez, S. (2016). Topographical pathways guide chemical microswimmers. *Nature Communications*, 7 10598
- Parmar, J., Vilela, D., Pellicer, E., Esqué-de los Ojos, D., Sort, J. and Sánchez, S. (2016). Reusable and long-lasting active microcleaners for heterogeneous water remediation. *Advanced Functional Materials*, 26 (23): 4152-4161
- Maggi, C., Simmchen, J., Saglimbeni, F., Katuri, J., Dipalo, M., De Angelis, F., Sánchez, S. and Di Leonardo, R. (2016). Self-assembly of micromachining systems powered by Janus micromotors. *Small*, 12 (4): 446-451

- Vilela, D., Romeo, A. and Sánchez, S. (2016). Flexible sensors for biomedical technology. *Lab on a Chip*, 16 (3): 402-408
- Safdar, M., Janis, J. and Sánchez, S. (2016). Microfluidic fuel cells for energy generation. *Lab on a Chip*, 16 (15): 2754-2758
- Romeo, A., Leung, T. S. and Sánchez, S. (2016). Smart biosensors for multiplexed and fully integrated point-of-care diagnostics. *Lab on a Chip*, 16 (11): 1957-1961
- Patino, T., Mestre, R. and Sánchez, S. (2016). Miniaturized soft bio-hybrid robotics: a step forward into healthcare applications. *Lab on a Chip*, 16 (19): 3626-3630
- Katuri, J., Seo, K. D., Kim, D. S. and Sánchez, S. (2016). Artificial micro-swimmers in simulated natural environments. *Lab on a Chip*, 16 (7): 1101-1105
- Caballero, D., Katuri, J., Samitier, J. and Sánchez, S. (2016). Motion in microfluidic ratchets. *Lab on a Chip*, 16 (23): 4477-4481
- Stanton, M. M., Simmchen, J., Ma, X., Miguel-López, A. and Sánchez, S. (2016). Biohybrid Janus motors driven by *Escherichia coli*. *Advanced Materials Interfaces*, 3 (2): 1500505

Scientific equipment and techniques

- Autolab Galvostat/potentiostat (Metrohm)
- Dynamic light scattering (Wyatt)
- Langmuir Blodgett (KSV NIMA)
- Inverted Fluorescent microscope with cell incubator, galvo stage for 3D tracking (Leica DMi8); Upright microscope (Leica)
- Video camera (1000+ fps) (Hamamatsu)
- High speed camera (10000+ fps) (Vision Research)
- CCD video camera (100fps) (Thorlabs)
- Centrifuge (Eppendorf)

- 3D BioPrinter Inkredible+ (CELLINK)
- UV- Visible spectrometer (Analytik Jena)
- 3D printer (Formlabs)
- Wave form source; Voltage amplifier (Tabor Electronics)
- DC power supply (Hameg)
- Oscilloscope (Rigol)
- Testtube heater; Eppendorf tube Shaker (Hach)
- Oxygen Plasma cleaner (Deiner Electronics)
- TOC Analyser (Analytik Jena)
- Spin coater (Laurell)
- High vacuum film deposition system (Leica Microsystems)
- UV irradiation system (Vilber Lourmat)
- Portable potentiostat-galvanostat and multiplexer (PalmSens)
- Sonicator (Branson)

Postdoctoral Researcher
Maria del Mar Cendra

PhD Students
Anna Crespo
Núria Blanco
Lucas Pedraz
Aida Baelo

Bacterial infections: antimicrobial therapies

Infectious diseases constitute a tenacious and major public health problem all over the world. The emergence and increasing prevalence of bacterial strains that are resistant to available antibiotics demand the discovery of new therapeutic approaches.

In addition, there is an urgent need for reliable and rapid detection of infecting bacteria and its pattern of resistance to antibiotics.

Bacterial DNA synthesis open new horizons in the discovery of new antibacterial targets due to remarkably differences to the eukaryotic system. The enzyme ribonucleotide reductase (RNR) catalyzes the reduction of ribonucleotides to the corresponding deoxyribonucleotides (dNTP) and thereby provides the building blocks for DNA synthesis and repair. The balance of the different dNTPs has to be carefully regulated and the RNR enzymes as well as its expression play important roles. In the bacterial world it is not known which transcriptional regulators are required to control the expression of the different RNR genes, their role in virulence and during bacterial biofilm formation. RNRs could be considered a good antimicrobial target candidate to inhibit bacterial growth because they present substantial differences relative to their eukaryote counterparts. The discoveries of new molecules against the activity of this system is crucial to be explored.

Our lab aims to investigate new antimicrobial therapies to combat bacterial infections with different objectives:

- First, to establish the molecular basis for the regulation of RNR genes, their importance in virulence and biofilm formation;
- Second, the identification and screening of new molecules for the highly selective inhibition of bacterial RNR;
- Third, by using nanomedicine techniques the development of novel and specific nanoparticles to deliver existing antibiotics or new identify antimicrobial drugs, especially when the bacteria are growing in biofilm, close to the physiological conditions of the disease and where the current chemotherapy fails;
- Fourth, we are studying new methodologies to threat bacterial chronic infections in patients suffering cystic fibrosis;

Masters Student
Kevin Ibeas

Undergraduate Students
Zoe Downer
Megan Hickland
Laia Abelló

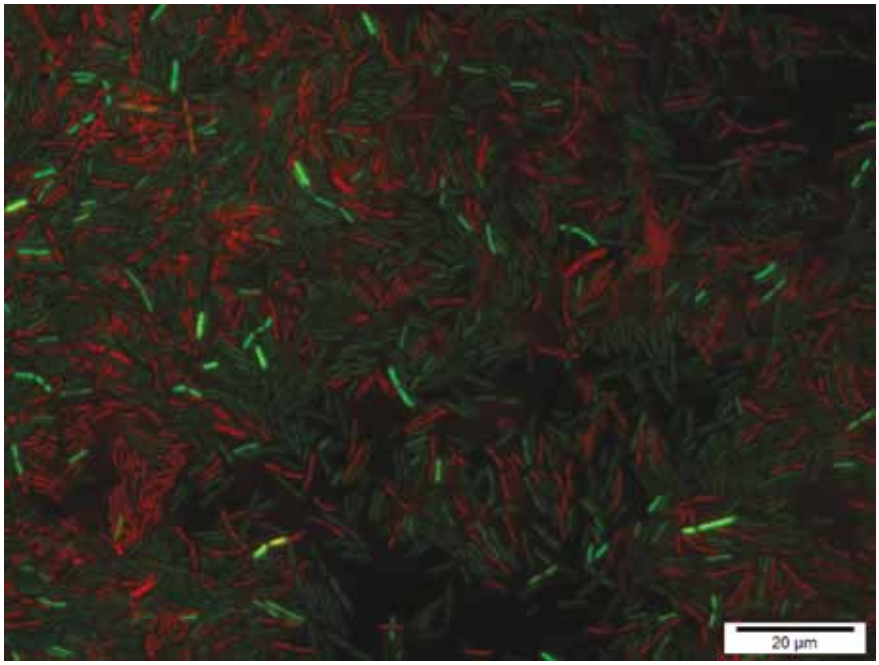
Research Technician
Pep Astola

Group Leader: Eduard Torrents

- Finally, we will use lab-on-a-chip technology to deeply elucidate mechanisms to combat bacterial forming biofilm as well as new approaches to identify multiresistant bacteria to different antibiotics.

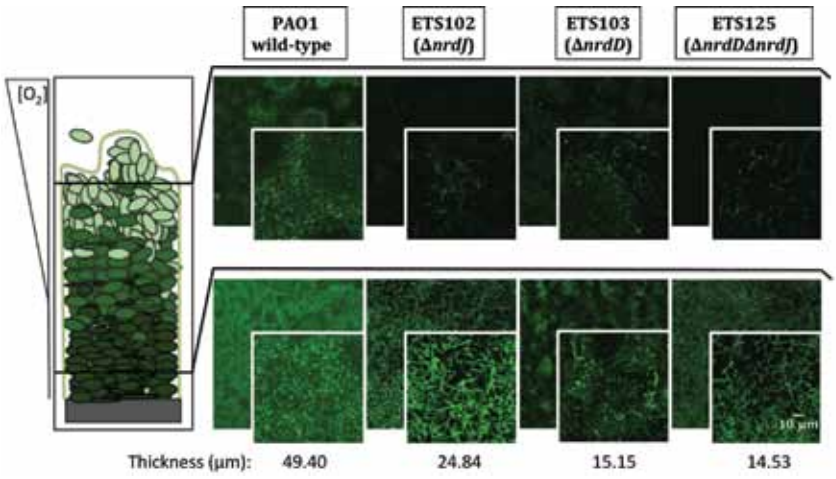
We believe these projects will be beneficial to society since we explore the use of different bioengineering approaches to elucidate ways to diagnose and eradicate multi-drug resistant bacteria.

Pseudomonas aeruginosa cells treated with the antibiotic carbenicillin



Publications

- Noguera-Ortega, E., Blanco-Cabra, N., Rabanal, R. M., Sanchez-Chardi, A., Roldán, M., Torrents, E., Luquin, M. and Julián, E. (2016). Mycobacteria emulsified in olive oil-in-water trigger a robust immune response in bladder cancer treatment. *Scientific Reports*, 6 27232
- Basas, J., Morer, A., Ratia, C., Martín, M. T., del Pozo, J. L., Gomis, X., Rojo-Molinero, E., Torrents, E., Almirante, B. and Gavaldà, J. (2016). Efficacy of anidulafungin in the treatment of experimental *Candida parapsolosis* catheter infection. *Journal of Antimicrobial Chemotherapy*, 71 (10): 2895-2901
- Noguera-Ortega, E., Rabanal, R. M., Secanella-Fandos, S., Torrents, E., Luquin, M. and Julián, E. (2016). Gamma-irradiated mycobacteria enhance survival in bladder tumor bearing mice although less efficaciously than live mycobacteria. *Journal of Urology*, 195 (1): 198-205
- Crespo, A., Pedraz, L., Astola, J. and Torrents, E. (2016). *Pseudomonas aeruginosa* exhibits deficient biofilm formation in the absence of class II and III ribonucleotide reductases due to hindered anaerobic growth. *Frontiers in Microbiology,* 7 Article 688
- D'Auria, G., Torrents, E., Luquin, M., Comas, I. and Julián, E. (2016). Draft genome sequence of *Mycobacterium brumae* ATCC 51384. *Genome Announcements*, 4 (2): e00237-16
- Noguera-Ortega, E., Secanella-Fandos, S., Eraña, H., Gasión, J., Rabanal, R. M., Luquin, M., Torrents, E. and Julián, E. (2016). Nonpathogenic *Mycobacterium brumae* inhibits bladder cancer growth *in vitro, ex vivo*, and *in vivo*. *European Urology Focus*, 2 (1): 67-76



Detailed microscopy observations of structured biofilms from *Pseudomonas aeruginosa* PAO1 wild-type and different ribonucleotide reductase mutants. On the left side, a scheme of the longitudinal structure of *P. aeruginosa* biofilm is represented, labeled with indications of the oxygen concentration along the biofilm. On the right side, confocal laser scanning microscopy images are shown, which were taken from the aerobic region of the biofilm (top part, superficial biofilm) and from the anaerobic region (bottom part, deeper in the biofilm structure). The corresponding average thickness of each strain is representative of three independent experiments.

Filed patents

- Patent number: P 62/302,316. **Patent in the field of antimicrobial resistant infections.**
  Assignees: Vall d'Hebron Research Institute (VHIR), IBEC, Institució Catalana de Recerca i Estudis Avançats (ICREA), Institut Català de Nanociència i Nanotecnologia (ICN2). Authors: Joan Gavaldà, Eduard Torrents, Víctor Puntes
- Patent number: P 62/301,946. **Patent in the field of antimicrobial resistant infections.**
  Assignees: Vall d'Hebron Research Institute (VHIR), IBEC, Institució Catalana de Recerca i Estudis Avançats (ICREA), Institut Català de Nanociència i Nanotecnologia (ICN2). Authors: Joan Gavaldà, Víctor Puntes, Eduard Torrents

Research projects

- **inhibitRNR** Las ribonucleotido reductasas como una nueva diana terapéutica frente a patógenos bacterianos (2016-2018)
  PI: **Eduard Torrents**
  MINECO, Retos investigación: Proyectos I+D
- **RNRbiotic** A new strategy to combat bacterial infections. (2015-2017).
  PI: **Eduard Torrents**
  Obra Social La Caixa "CAIXAIMPULSE"
- Novel strategies to combat bacterial chronic infections by the development of micro-fluidics platforms to analyse and treat bacterial growing in biofilms (2016)
  PI: **Eduard Torrents**
  Obra Social La Caixa

- **BACTSHOT** Novel antimicrobial therapy. (2016-2017)
  PI: Eduard Torrents.
  EIT Health Head Start – Proof of Concept
- Ribonucleotide reductasas: una nueva diana terapéutica contra organismos patógenos en enfermos de fibrosis quística (2010-2017)
  PI: **Eduard Torrents**
  Asociación Española Fibrosis Quística/PABLO MOTOS Becas de Investigación "Pablo Motos"

Collaborations with other research centres

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

Dr. Elisabeth Engel IBEC (pages 50-55)

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

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

Dr. Joan Gavaldà Infectious diseases, Vall d'Hebrón Hospital and Research Institute, Barcelona, Spain

Prof. Víctor Puntes Inorganic nanoparticles group, Institut Català de Nanociència i Nanotecnología, Barcelona, Spain

Prof. Josep Samitier IBEC (pages 96-101)

Prof. Santiago Vazquez Laboratori de química farmacèutica, Pharmacy Faculty, Barcelona University.

Scientific equipment and techniques

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

Conference Papers

- Baelo, A., Julián, E. and Torrents, E. (2016). Methylhydroxylamine specifically inhibits ribonucleotide reductase activity in pathogenic bacteria. Biotech Annual Congress (BAC 2016), Salamanca, Spain. Published by Elsevier
- Pedraz, L., Crespo, A. and Torrents, E. (2016). A single transcription factor behind all bacterial dNTP synthesis revealed as a novel antimicrobial target. Biotech Annual Congress (BAC 2016), Salamanca, Spain. Published by Elsevier
- Julián, E., Rabanal, R. M., Secanella-Fandos, S., Torrents, E., Luquin, M. and Noguera-Ortega, E. (2016). Eficacia de micobacterias Gamma-irradiadas en el tratamiento de cancer vesical no-músculo invasivo. *XX Congreso de la Sociedad Española de Enfermedades Infecciosas y Microbiología Clínica (SEIMC 2016)*, Barcelona, Spain. Published by Elsevier
- Torrents, E., Baelo, A., Levato, R., Julián, E., Crespo, A., Astola, J., Gavaldà, J., Engel, E. and Mateos-Timoneda, M. A. (2016). Mejora en la administración antibiotic para el tratamiento de infecciones en forma de biofilm con el uso de nanopartículas que disgregan la matriz extracellular. *XX Congreso de la Sociedad Española de Enfermedades Infecciosas y Microbiología Clínica (SEIMC 2016)*, Barcelona, Spain. Published by Elsevier

Group Leader / ICREA Research Professor: Xavier Trepat

Integrative cell and tissue dynamics

We aim at understanding how physical forces and molecular control modules cooperate to drive biological function.

We develop new technologies to map and perturb the main physical properties that determine how cells and tissues grow, move, invade and remodel. By combining this physical information with systematic molecular perturbations and computational models we explore the principles that govern the interplay between chemical and physical cues in living tissues.

We study how these principles are regulated in physiology and development, and how they are derailed in cancer and aging.

Making cellular forces visible

To study cell and tissue dynamics we develop new technologies to measure physical forces at the cell-cell and cell-matrix interface. By combining these technologies with computational analysis of cell shape and velocity we obtain a full experimental characterization of epithelial dynamics during tissue growth, wound healing and cancer cell invasion.

Collective durotaxis: a mechanism for cellular guidance by mechanical cues

Directed cell migration is one of the earliest observations in cell biology, dating back to the late XIX century. Also known as taxis, directed cell migration has been commonly associated with chemotaxis, i.e. the ability of a broad variety of cell types to migrate following gradients of chemical factors. We recently demonstrated a new mode of collective cell guidance by mechanical cues, called collective durotaxis. This new migration mode emerges only in cell collectives and, strikingly, does not require isolated cells to exhibit gradient sensing. To study the mechanisms behind this phenomenon, we developed new tools to measure the forces that propel cells during durotaxis at the cell-matrix and cell-cell levels. Upon combining this new experimental technique with biochemical approaches and theoretical modelling, we concluded that collective durotaxis originates from long-range transmission of contractile intercellular forces. This mechanism is unique in that the very same machinery that senses the attractant -the actomyosin cytoskeleton- is responsible for propulsion towards it. As such, collective durotaxis appears to be the simplest and perhaps most primitive mechanism by which a collective system responds to a gradient.

Integrative cell and tissue dynamics

Senior Researcher
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Léo Florent Alexandre Valon
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Marina Uroz

Masters Student
Ariadna Marin

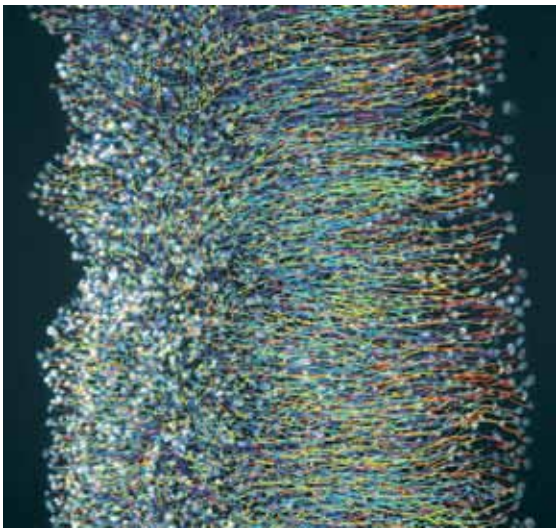
Laboratory Technician
Natalia Castro

Microfabrication and wound healing

Using microfabrication technologies, we designed new ways to decipher the mechanisms of wound healing. By doing so we uncovered a new understanding of how cells move and work together to close a gap in a tissue. We showed that a new mechanism applies in which cells assemble supracellular contractile arcs that compress the tissue under the wound. By combining experiments and computational modeling, we showed that contractions arising from these arcs make the wound heal in a quicker and more robust way.

Fracking epithelial layers

Epithelial sheets must be malleable enough to adopt functional shapes during morphogenesis and to quickly self-repair after damage. Yet, they must be resilient enough to ensure organ compartmentalization and to protect organisms against environmental pathogens. To study the mechanisms that regulate this fine balance between malleability and integrity we develop tools to map epithelial tension during tissue stretching. By combining these tools with computational modeling we determined the mechanisms of epithelial fracture. Intriguingly, one of such mechanisms is hydraulic fracturing or “fracking”.



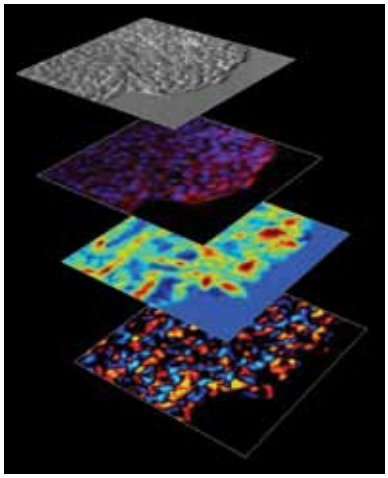
A group of human mammary epithelial cells expands asymmetrically on a surface of increasing rigidity (towards the right of the image). Colored lines correspond to the tracks followed by each cell (gray dots) for 10h.

Publications

- Sunyer, R., Conte, V., Escribano, J., Elosegui-Artola, A., Labernadie, A., Valon, L., Navajas, D., García-Aznar, J. M., Muñoz, J. J., Roca-Cusachs, P. and Trepat, X. (2016). Collective cell durotaxis emerges from long-range intercellular force transmission. *Science*, 353 (6304): 1157-1161
- Tekeli, I., Aujard, I., Trepat, X., Jullien, L., Raya, A. and Zalvidea, D. (2016). Long-term in vivo single-cell lineage tracing of deep structures using three-photon activation. *Light: Science and Applications*, 5 (6): e16084
- Ladoux, B., Mège, R. M. and Trepat, X. (2016). Front-rear polarization by mechanical cues: From single cells to tissues. *Trends in Cell Biology*, 26 (6): 420-433
- Plutoni, C., Bazellieres, E. et al (2016). P-cadherin promotes collective cell migration via a Cdc42-mediated increase in mechanical forces. *Journal of Cell Biology*, 212 (2): 199-217
- Asadipour, N., Trepat, X. and Muñoz, J. J. (2016). Porous-based rheological model for tissue fluidisation. *Journal of the Mechanics and Physics of Solids*, 96 535-549
- Alencar, A. M., Ferraz, M. S. A., Park, C. Y., Millet, E., Trepat, X., Fredberg, J. J. and Butler, J. P. (2016). Non-equilibrium cytoquake dynamics in cytoskeletal remodeling and stabilization. *Soft Matter*, 12 (41): 8506-8511
- Przybyla, L., Lakins, J. N., Sunyer, R., Trepat, X. and Weaver, V. M. (2016). Monitoring developmental force distributions in reconstituted embryonic epithelia. *Methods*, 94 101-113
- Blanchard, R. et al (2016). Patient-specific fracture risk assessment of vertebrae: A multiscale approach coupling X-ray physics and continuum micromechanics. *International Journal for Numerical Methods in Biomedical Engineering*, 32 (9): e02760

Research projects

- Grup de recerca consolidat (2014-2016)
  PI: **Xavier Trepat**
  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
- Joint Programme - Healthy Ageing (2016)
  PI: **Xavier Trepat**
  Obra Social La Caixa
- **DUROTAXIS** Mecanobiología de la durotaxis: de las células aisladas a los tejidos (2016-2018)
  PI: Xavier Trepat
  MINECO, Proyectos I+D Excelencia
- Mechanics of Monolayer Migration (2011-2016)
  Co-Investigator: **Xavier Trepat** (PI: Jeffrey Fredberg, Harvard School of Public Health)
  National Institutes of Health, USA
- **CAMVAS** Coordination and migration of cells during 3D Vasculogenesis (2014-2017)
  PI: **Xavier Trepat**
  MARIE CURIE - IOF
- **TENSIONCONTROL** Multiscale regulation of epithelial tension (2015-2019)
  PI: **Xavier Trepat**
  European Research Council - CoG



Our lab has developed techniques to simultaneously map cell velocities, cytoskeletal structure, intercellular stresses, and cell-substrate tractions (from top to bottom).

Collaborations with other research centres

Julien Colombelli / Eduard Batlle Institute for Research in Biomedicine (IRB) Barcelona

Marino Arroyo Universitat Politècnica de Catalunya, Barcelona

Guillaume Charras / Roberto Mayor University College London, UK

Erik Sahai Cancer Research, UK

Benoit Ladoux Université Paris 7, France

Jim Butler / Jeff Fredberg Harvard University, Boston

Scientific equipment and techniques

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

Core Facilities

IBEC provides its researchers with extensive research facilities and a scientific–technical infrastructure distributed over interdisciplinary open lab spaces. It is designed and managed to facilitate research and promote the interaction and exchange of knowledge between IBEC scientists from different fields of expertise.

In this way, researchers share not only the space itself but also the equipment, bench space, and qualified technical staff, thereby helping to reduce research costs.

Apart from routine laboratory equipment, the Core Facilities provide additional sophisticated, state-of-the-art equipment to support the groups' research. They are organized into two different categories: in-house equipment which includes a new common space, BioSpace, only for internal users, and the Nanotechnology Platform, which is open to external users.

In-House Equipment

Routine Laboratory Equipment

- Chromatography System Biologic LP – Bio-Rad
- Spectrophotometer – Nanodrop
- Multimode microplate reader Infinite M200 Pro – Tecan
- Spectrophotometer UV-Visible – Shimadzu
- Microplate Reader Benchmark Plus – Bio-Rad
- StepOnePlus Real Time PCR System – Applied Biosystems
- DNA Engine Thermal Cycler – Bio-Rad
- T100 Thermal Cycler – Bio-Rad
- GeneAmp PCR System 9700
- ImageQuant LAS 4000 mini – GE Healthcare
- GelDoc XR+ System – Bio-Rad

BioSpace

Launched in 2016, IBEC's BioSpace is a shared space dedicated to work with primary and cell lines cultures. It is equipped with several Class-II biosafety cabinets, CO_2 incubators and routine equipment for cell culture, as well as an inverted microscope and a stereomicroscope, both with fluorescence option. In the first year of operation, almost 100 IBEC researchers from 10 groups took part in the introductory sessions in order to work in this space.

Considering the strategic plan of IBEC in the areas of regenerative medicine and tissue engineering, in

BioSpace, our new shared cell culture room at IBEC

In-house equipment

Left: Detail of the 3D bioprinter located in the BioSpace, which is equipped with three extruders for multimaterial printing

Below: A multimaterial 3D construct made of two types of hydrogels generated using IBEC's 3D bioprinter

2016, the institute has made a firm commitment to 3D bioprinting with the acquisition of the first state-of-the-art 3D bioprinter (3DDiscovery from RegenHU) in Spain.

The 3D bioprinter allows the printing of different types of biomaterials (polymers, abrasive viscous substances, hydrogels loaded with cells and solutions) in a coordinated way, generating complex multi-material 3D scaffolds which are therefore closer to biological tissues. The applications of these constructs range from 3D cellular models for drug screening (i.e. dermis), scaffolds for regenerative medicine or, at a more advanced stage, organ printing.

At present, the 3D bioprinting system is set up in the BioSpace, and 35 IBEC researchers from 8 groups have received training to work with the printer. The two-day training consists of theoretical and practical sessions. Core Facilities have been giving support to the IBEC Technology Transfer Unit in organizing and performing demonstrations of the 3D bioprinter's capabilities, and multiple companies and institutions have shown interest. We expect that some collaborative projects will arise from these interactions.

Nanotechnology Platform

IBEC's Nanotechnology Platform is an accessible and versatile research facility featuring 100m^2 of class 10,000 cleanroom space offering state-of-the-art equipment for the fabrication and characterization of micro- and nanodevices and structures for biomedical applications.

Our aim is to facilitate advanced research support by providing services in the fields of micro and nanofabrication for all academic and industrial researchers. Some of the areas of application include bioengineering, BioMEMS, materials science, tissue engineering, optic and biomaterials and microfluidics.

The Nanotechnology Platform offers scientific and technological support that includes the design, development and analysis of devices, materials, and processes, so that academic researchers and companies alike may use the platform to develop their innovative ideas.

Services

- Access to 10,000 class cleanroom.
- Training on and self-use of the following equipment: interferometer, profilometer, optical microscope, spin-coater, plasma cleaner and mask aligner (photolithography).
- Training on microfluidic chips design, fabrication and interfacing with pumping systems.
- *Fabrication*:
  - Design and fabrication of customized microfluidic chips using photolithography and replica molding (rapid prototyping in PDMS silicone).
  - E-beam lithography technique for the manufacture of micro- and nano-structures.
  - Replication of micro-nanostructures in thermoplastic polymers by nanoimprint lithography
  - Fabrication of Cr photomasks for photolithographic processes
  - Thin layer deposition of materials (Au, Al, Ti, Cr, SiO2, Al2O3, etc.)
  - Microelectrodes
  - Fabrication of SU-8 molds for microcontact printing and micromolding in capillaries
  - Medium density microarrays (proteins and DNA)

Head of Core Facilities: Isabel Oliveira

Nanotech Platform Coordinator
Mateu Pla

Nanotech Platform Technicians
Marina Cazorla
Judit Linacero

Laboratory Technicians
Laura Gómez
Ramona Bravo
Jenifer González
Miriam Funes

Laboratory Assistants
Alícia Nadal
Tania Bordoy

Core facilities members' publications 2016

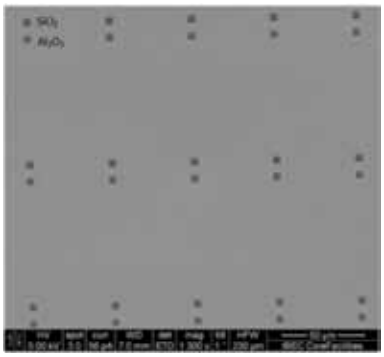
- Pla-Roca, M., Altay, G., Giralt, X., Casals, A., Samitier, J., (2016). Design and development of a microarray processing station (MPS) for automated miniaturized immunoassays Biomedical Microdevices 18, 4,
- Credi, C., De Marco, C., Molena, E., Pla-Roca, M., Samitier, J., Marques, J., Fernàndez-Busquets, X., Levi, M., Turri, S., (2016). Heparin micropatterning onto fouling-release perfluoropolyether-based polymers via photobiotin activation Colloids and Surfaces B: Biointerfaces 146, 250-259

Users' publications

- Temiño, I., Del Pozo, F.G., Ajayakumar, M.R., Galindo, S., Puigdollers, J., Mas-Torrent, M. (2016). A rapid, low-cost, and scalable technique for printing state-of-the-art organic field-effect transistor. Adv. Mater. Technol. 1, 1600090.
- Carretero, E., Alonso, R., Marco, J.M. (2015). Oxygen diffusion at high temperatures within the SnO2/Sst interlayer in sputtered thin films. Applied Surface Science, Vol 359, pags 669-675.

Users

- Seat, S.A.
- GP-Pharm, S.A.
- Bio-model
- Infinitec Activos S.L.
- ViaFactor BV
- Advanced Nanotechnologies, S.L.
- BSH Electrodomésticos España, S.A.
- Cosingo - Image Optic Spain, S.L.
- Technoform Bautec Iberica, S.L.
- BCN Peptides, S.A.
- Fundació CTM Centre Tecnològic
- Institut Químic de Sarrià
- Universidad Politécnica de Madrid
- Universidad de Zaragoza

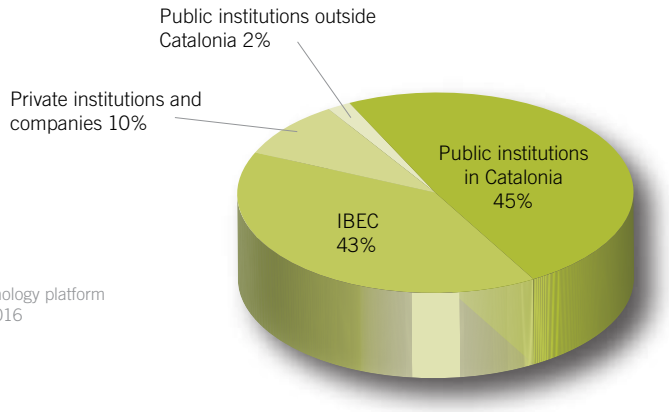


SEM image showing multimaterial thinlayer structures (5µm X 5µm) fabricated on a a gold surface obtained with sequential DWL photyolithography, thin-layer deposition and liftoff processes (with the permission of the Nanoscale bioelectrical characterization group).

- *Characterization*:
  - ❒ Sample characterization using ToF-SIMS:
  - Complete mass spectra of surfaces of organic and inorganic materials
  - Chemical mapping of elements and molecular distribution
  - Depth profile, implantation profiles and interface analysis.
  - ❒ SEM morphological and topographical characterization
  - ❒ Surface topographic analysis by using optical interferometry and mechanical profilometry.
  - ❒ Optical characterization of samples with bright and dark field.
  - ❒ Contact angle measurements of wettability properties of surfaces

Equipment

- Time-of-Flight Ion Mass Spectroscopy (ToF-SIMS)
- Ultra-High Resolution Field Emission Scanning Electron Microscopy (SEM)
- E-beam Lithography (EBL)
- UV-Photolithography Mask-aligner
- Direct Write Laser
- Thermal and E-beam metal evaporator
- Interferometer
- Profilometer
- Chemical Bath
- Spin-coaters (2 units)
- Plasma Cleaner
- Optical microscope
- UV lamp
- Contact angle
- Microarrayer



Nanotechnology platform users in 2016

Some data related to Nanotechnology Platform users

During our four years of operation, 106 researchers from ten IBEC groups, 111 researchers from 25 other public institutions, and 24 from 14 private companies have become users of the Nanotechnology Platform. In 2016 the average of users and services performed by the platform was 31 and 209 per month, respectively.

The Nanotechnology Platform is listed on BioCores@BCN, an online tool launched by the CRG which is part of the pan-European initiative Core for Life, which aims to help scientists and other customers find the local scientific service, technique or equipment they need for their biomedical or life sciences research.

The platform is also an active member of the ICTS (Infraestructuras Científicas y Técnicas Singulares) map as part of NANOBIOSIS (Infraestructuras Integradas de Producción y Caracterización de Nanomateriales, Biomateriales y Sistemas en Biomedicina), an integrated platform for research-oriented medical applications.

Activities during 2016

- Two talks related to ToF-SIMS, “Applications of Secondary In Mass Spectrometry”, were given to the masters students of Applied Materials Chemistry (Faculty of Chemistry, University of Barcelona).
- A talk titled “Photolithography: From 2D designs to 3D structures” was given as part of the degree programme in biotechnology at the University of Vic.
- The 3D bioprinter was presented in an IBEC Seminar, “What can we do with our 3D bioprinter?”, in March.
- Collaboration with Leica Microsystems on the organization of a two days’ workshop, “Nuevas Aplicaciones & Nuevas Tecnologías”.
- Organizing the workshop “Good practices in a multi-disciplinary laboratory”, aimed at young scientists and students working at IBEC. The objective is to acquire the good practices necessary in a laboratory to ensure the highest quality of results (page 155).
- Invited speaker in the Mondragon University’s Jornada en Salud 3D, with a talk entitled “3D Bioprinting: Engineering Complex Tissues and Soft Materials”.
- Participation in the “Joves i Ciencia 2016” programme, enabling a student to perform some microfluidics device assembling and fabricating some 3D bioprinted constructs.
- The 3D bioprinter’s capabilities were presented to several companies and hospitals giving support to IBEC’s Technology Transfer Unit.
- Participated in two documentaries about 3D printing, giving support to the IBEC Communications and Outreach Unit.

- Universidad de Valladolid
- Universidad Miguel Hernandez
- University of Barcelona (UB)
- Technical University of Catalonia (UPC)
- Centre de Recerca en Enginyeria Biomèdica (CREB)
- Fundació Institut de Recerca en Energia de Catalunya (IREC)
- Instituto de Investigación Sanitaria - Fundación Jimenez Diaz
- Institut de Recerca Biomedica (IRB)
- Institut de Ciéncies Fotòniques (ICFO)
- Fundació Centre de Regulació Genòmica (CRG)
- Institut de Microelectronica de Barcelona (CNM)
- D+T Microelectrónica, A.I.E.
- Centre de investigación en nanociencia i nanotecnologia (CIN-2)
- Institut Català de Nanociència i Nanotecnologia (ICN2)
- Institut de Ciència de Materials de Barcelona (ICMAB)
- Institut de Biologia Molecular de Barcelona (IBMB-CSIC)
- Universitat Autónoma de Barcelona (UAB)
- Institute of Environmental Assessment and Water Research (IDAEA-CSIC)
- Institut de Quimica Avançada de Catalunya (IQAC-CSIC)
- Fundació IGTP - Ciencies de la Salut Germans Trias i Pujol

New external users (2016)

- Stat-Diagnostica and Innovation S.L.
- Centre Internacional de Mètodes Numèrics en Enginyeria (CIMNE)
- Max Planck Institute for Brain Research

Networking

Core partnerships

The model implemented in the creation of IBEC as result of research groups of the University of Barcelona and the Polytechnic University of Catalonia collaborating together and being affiliated to IBEC to conduct their research through our institute has been reinforced over the years with our policy on core partnerships, in which collaborative research is the main aim.

Besides the affiliated staff at the universities, IBEC has a remarkable number of group leaders – four out of eighteen – that are also ICREA research professors, as well as many research staff members affiliated with CIBER.

Affiliated groups

UNIVERSITAT DE BARCELONA

- Nanoscale Bioelectrical Characterization, led by Gabriel Gomila (pages 60-63)
- Nanoprobes and Nanoswitches, Pau Gorostiza/Fausto Sanz (pages 64-67)
- Signal and Information Processing for Sensing Systems, Santiago Marco (pages 74-77)
- Cellular and Respiratory Biomechanics, Daniel Navajas (pages 86-87)
- Molecular and Cellular Neurobiotechnology, José Antonio Del Río (pages 88-91)
- Nanobioengineering, Josep Samitier (pages 96-101)

UNIVERSITAT POLITÈCNICA DE CATALUNYA

- Biomaterials for Regenerative Therapies, Elisabeth Engel (pages 50-55)
- Biomedical Signal Processing and Interpretation, Raimon Jané (pages 68-73)

ICREA

ICREA

The Catalan Institution for Research and Advanced Studies (ICREA) is supported by the Catalan Government 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. 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 2016, four of IBEC's group leaders were ICREA research professors:

- George Altankov, Molecular Dynamics at Cell-Biomaterial Interface (pages 44-47)
- Xavier Trepat, Integrative Cell and Tissue Dynamics (pages 112-115)
- Pau Gorostiza, Nanoprobes and Nanoswitches (pages 64-67)
- Samuel Sánchez, Smart Nano-bio-devices (pages 102-107)

Two of IBEC's group leaders were ICREA Academia:

- Gabriel Gomila, Nanoscale Bioelectrical Characterization (pages 60-63)
- Maria Pau Ginebra, Associated Researcher (see next page)

Associated researchers

Associated researchers are university professors seconded to IBEC with an agreement signed between their university and the institute who are based in the university premises and working on topics that are of interest or complementary to our research areas. They participate in IBEC's scientific strategy, academic activities and support initiatives, and have the option to submit project proposals and papers with IBEC affiliation.

Recruitment is carried out according to several criteria such as scientific excellence and alignment with IBEC's institutional strategy. Associated researchers are approved by the International Scientific Committee, which evaluates their performance on a regular basis.

Polytechnic University of Catalonia (UPC)

- Prof. Alícia Casals
- Prof. Maria Pau Ginebra

University of Barcelona (UB)

- Prof. Antonio Juárez

Universitat Pompeu Fabra (UPF)

- Prof. Ralph G. Andrzejak

IBEC-affiliated publications in 2016 by associated researchers

Pla-Roca, M., Altay, G., Giralt, X., **Casals, A.** & Samitier, J. (2016). Design and development of a microarray processing station (MPS) for automated miniaturized immunoassays. *Biomedical Microdevices*, 18 (4)

Muñoz, L. M. & **Casals, A.** (2016). Improving the performance of input interfaces through scaling and human motor models. *Human-Computer Interaction*, 31 (5): 385-419

Aviles, A. I., Alsaleh, S., Montseny, E., Sobrevilla, P. & **Casals, A.** (2016). A Deep-Neuro-Fuzzy approach for estimating the interaction forces in Robotic surgery. IEEE International Conference on Fuzzy Systems, Vancouver, Canada (2016). FUZZ-IEEE, 1113-1119. Published by IEEE

Fraioli, R., Dashnyam, K., Kim, J. H., Perez, R. A., Kim, H. W., Gil, J., **Ginebra, M. P.**, Manero, J. M. & Mas-Moruno, C. (2016). Surface guidance of stem cell behavior: Chemically tailored co-presentation of integrin-binding peptides stimulates osteogenic differentiation in vitro and bone formation *in vivo*. *Acta Biomaterialia*, 43: 269-281

Labay, C., Buxadera-Palomero, J., Avilés, M., Canal, C. & **Ginebra, M. P.** (2016). Modulation of release kinetics by plasma polymerization of ampicillin-loaded β-TCP ceramics. *Journal of Physics D: Applied Physics*, 49 (30): 304004

Van Der Hofstadt, M., Fabregas, R., Millan, R., **Juárez, A.**, Fumagalli, L. & Gomila, G. (2016). Internal hydration properties of single bacterial endospores probed by electrostatic force microscopy. *ACS Nano*, 10 (12): 11327–11336

Biagi, M. C., Fabregas, R., Gramse, G., Van Der Hofstadt, M., **Juárez, A.**, Kienberger, F., Fumagalli, L. & Gomila, G. (2016). Nanoscale electric permittivity of single bacterial cells at gigahertz frequencies by scanning microwave microscopy. *ACS Nano*, 10 (1): 280-288

Gibert, M., Paytubi, S., Beltrán, S., **Juárez, A.**, Balsalobre, C. & Madrid, C. (2016). Growth phase-dependent control of R27 conjugation is mediated by the interplay between the plasmid-encoded regulatory circuit TrhR/TrhY-HtdA and the cAMP regulon. *Environmental Microbiology*, 18 (12): 5277-5287

Prieto, A., Urcola, I., Blanco, J., Dahbi, G., Muniesa, M., Quiros, P., Falgenhauer, L., Chakraborty, T., Hüttener, M. & **Juárez, A.** (2016). Tracking bacterial virulence: Global modulators as indicators. *Scientific Reports*, 6: 25973

Tassinari, E., Aznar, S., Urcola, I., Prieto, A., Hüttener, M. & **Juárez, A.** (2016). The incC sequence is required for R27 plasmid stability. *Frontiers in Microbiology*, 7 (6): Article 629

Solano-Collado, V., Hüttener, M., Espinosa, M., **Juárez, A.** & Bravo, A. (2016). MgaSpn and H-NS: Two unrelated global regulators with similar DNA-binding properties. *Frontiers in Molecular Biosciences*, 3: Article 60

Joint units and other partnerships

Barcelona Global Health Institute (ISGLOBAL)

IBEC and the Barcelona Global Health Institute (ISGLOBAL) signed an official agreement in 2010 to facilitate collaboration in certain areas of common interest. This led to the establishment of a joint unit where both institutions contribute with resources (researchers, spaces, etc) to develop diagnostic and therapeutic nanomedicine-based systems to be applied to malaria (Nanomalaria joint unit, pages 56-59).

Due to the fruitful collaboration, the agreement has been extended up to May 2017 with new objectives for the next two years.

Hospital Universitari Germans Trias i Pujol (IGTP)

A joint research Unit between IBEC and the Hospital Universitari Germans Trias i Pujol (IGTP) is coordinated by Raimon Jané, head of IBEC's Biomedical Signal Processing and Interpretation group (pages 68-73), and the hospital's Miquel Àngel Gasull.

Their results in 2016 included a paper in the *IEEE Journal of Biomedical Health Informatics* in March presenting a new way of automatically differentiating normal respiratory sounds from continuous adventitious ones, which can reflect the severity of certain diseases. The researchers and clinicians used a dataset of 870 inspiratory cycles recorded from 30 patients with asthma to test their sound classifier, which is based on the multiscale analysis of instantaneous frequency sequences, which markedly decrease when continuous additional sounds appear in respiratory cycles.

Centro de Investigación Biomédica en Red (CIBER)

Spain's Centro de Investigación Biomédica en Red (CIBER), a legal entity financed by the Instituto de Salud Carlos III, creates large multidisciplinary and multi-institutional networks of research centres that will integrate basic and clinical research.

Eleven IBEC group leaders aggregated in six research groups work in programmes within CIBER, such as CIBER-BBN, which covers bioengineering, biomaterials and nanomedicine. Research is focused on disease prevention, diagnostics systems and technologies for specific therapies, such as regenerative medicine and nanotherapies. Xavier Trepat's group (pages 112-115) was officially accepted by the CIBER Board as a new CIBER-BBN group in 2015 and started its activity in 2016.

Another programme within CIBER, CIBERES – Centro de investigación en red de enfermedades respiratorias – involves Cellular and Respiratory Biomechanics group leader Daniel Navajas (pages 86-87) and addresses respiratory illnesses.

Ongoing CIBERBBN projects during 2016

- **NANOMEDIAG** Nanobioanalytical platforms for improved medical diagnosis of infections caused by pathogen microorganisms.
  PI: **Josep Samitier**
- **OLIGOCODES** Universal Diagnostic Platforms Based On Oligonucleotide Codified Nanoparticles and DNA Microarray Sensor Devices.
  PI: **Josep Samitier**
- **CHONDRONANONET** Nanopatterned Cell Carriers for Improved Architectural Communication Networks in Chondrogenesis towards Osteoarthritic Joint Repair
  PI: **Josep Samitier** (coordinator); **Pau Gorostiza**; **Anna Lagunas**
- **E-LEUKEMIA** The nanoconductance of redox proteins of the respiratory chain and its physiopathological implication in leukemia
  PI: **Pau Gorostiza** (coordinator); **Josep Samitier**; **Anna Lagunas**
- **AMEND** Early Diagnosis of Alzheimer in a Multiplexed approach based on New blood biomarkers (2016-2018)
  PI: **Mònica Mir** (coordinator)
- **NANOXEN++** *Xenopus tropicalis* as an optogenetic and optopharmacological platform
  PI: **Pau Gorostiza** (coordinator)
- **NANO3B** Novel nanocarriers as delivery systems across the Blood-Brain barrier
  PI: **Fausto Sanz**
- **NANOLYSO** Nanomedicine-based enzyme replacement therapy for the treatment of lysosomal storage disorders
  PI: **Fausto Sanz**
- **CHONDREG** Identification of the epigenetic mechanisms preventing chondrocyte de-differentiation: generation of novel therapeutic strategies for the treatment of cartilage chronic osteochondral lesions
  PI: **Nuria Montserrat** (with Clinica CEMTRO (Madrid))
- **BIOSURFACES** Biofunctionalization of titanium implant surfaces
  PI: **George Altankov**
- **Bioproterial** Biological activity of matrix proteins at the cell-material interface.
  PI: **George Altankov**
- **M-OLDOSA** Multimodal analysis and m-Health tools for diagnostic and monitoring improving of obstructive lung disease and obstructive sleep apnea patients.
  PI: **Raimon Jané** (coordinator); **Daniel Navajas**
- **MultiTools2Heart** Multiscale computational tools to improve diagnosis, risk assessment and treatment in prevalent heart diseases
  PI: **Beatriz Giraldo; Raimon Jané**

Centro de Investigación Biomédica en Red Enfermedades Neurodegenerativas (CIBERNED)

CIBERNED, which covers neurodegenerative diseases, maintains its own legal personality as it is managed by Fundación CIEN. It is composed of 63 research groups working on basic and clinical research. José Antonio del Río (pages 88-91), who works on projects within CIBERNED, puts IBEC's number of group leaders working within CIBER programmes at 12.

Ongoing CIBERNED projects during 2016

- Spanish Network of Neurodegenerative Diseases of the Ministry of Heath (FIS) (P1-L14) (2009-2017)
  PI: **José Antonio del Río**
- Epigenetic factors in Rapid Dementias
  PIs: Miguel Calero (ISCIII), Pasqual Sánchez-Juan (Hospital Valdecilla), Isidre ferrer (UB), **José A. del Río** (IBEC)

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.

International alliances

EBICS

EBICS' mission is to create a new scientific discipline for building living, multi-cellular machines that solve real world problems in health, security, and the environment. Participating Institutions are Massachusetts Institute of Technology, Georgia Institute of Technology, University of Illinois at Urbana-Champaign, City College of New York, Morehouse College, University of California-Merced, Boston University, Gladstone Institutes, Princeton University, Tufts University and the University of Georgia.

The EBICS International exchange program allows US students to spend time at IBEC while provide exceptional training and the opportunity to network with students and faculty from diverse scientific and engineering backgrounds.

In August 2016 IBEC took part in the EBICS-organized 1st International Workshop on Engineering Living Systems in Illinois, which had the primary goal of exploring the ethical and research implications that arise from EBICS' mission.

EIT Health

IBEC is a core partner in the €2.1 billion Knowledge and Innovation Community (KIC), one of the largest public funded initiatives for health worldwide, with IBEC director Josep Samitier on the Supervisory Board. Barcelona is one of EIT Health's co-location centers, with the initiative's Spanish node headquarters based at the PCB. IBEC's participation represents a recognition of the relevance of the institute in the international arena in health research and innovation, as well as a unique opportunity for its further internationalization.

In the framework of EIT Health, IBEC will be able to lead and participate in multidisciplinary projects to promote healthy living, to support active ageing and to improve healthcare. EIT Health is aiming to create 70 start-ups per year and to have 1m students participating in online educational programmes per year.

At a Spanish level, IBEC coordinates a Network of Excellence funded by the Ministry of Economy and Competitiveness to reinforce the functioning and the strategic importance of the Spanish co-location centre via specific actions related to (a) active participation in international EIT Health activities, (b) organization of national EIT Health activities, (c) EIT Health project development, (d) dissemination activities of EIT Health objectives and results.

Elisabeth Engel and Eduard Torrents received awards at the EIT Health Spain event held at the PCB to close its first year of activity in December

IBEC's activity in 2016 within the framework of EIT Health was focused on:

- Participation in EIT Health's very first Summit on 23rd-24th November at CosmoCaixa, the highlight of its first year of activities. The event brought together up to 350 participants from among the initiative's partner organisations, education programmes and external stakeholders, and represented a unique opportunity to tell the world about EIT Health's activities carried out so far, while also presenting its ambitions and goals for the future. The Summit's programme included the presentation of the successful projects that were awarded EIT Health funding in 2016 and the launch of the 2017 strategy and portfolio, as well as round table discussions, an exhibition, and the kick-off session of CityNet, EIT Health's citizen science activity programme.
- IBEC group leaders Eduard Torrents and Elisabeth Engel both received awards at an EIT Health Spain event held at the PCB to close its first year of activity in December. Eduard's project, Novel Antimicrobial Therapy, won first prize in the 'PoC +' category of EIT Health Spain's Proof of Concept (PoC +) awards, and in the 'PoC' category, Elisabeth won a prize for Dermoglass, the smart dressing for the treatment of chronic wounds. EIT Health Spain's 'Proof of Concept (PoC +)' awards recognize research projects that are participating in acceleration programs in health in the initiative, which is one of the largest healthcare consortia worldwide, and business ideas that are in stages prior to the creation of a company. The awards are part of the financing initiatives of the EIT Health accelerator, and have been organized by the Spanish node during 2016.

Human Brain Project

The Human Brain Project (HBP)'s Ramp-Up Phase finished in March 2016, with the next phase (SGA) starting in April. ICREA Professor Pau Gorostiza (pages 64-67) participates in the Systems and Cognitive Neuroscience of the HBP, one of two Future and Emerging Technology (FET) Flagships funded by the European Commission to address the big scientific and technological challenges of the age through long-term, multidisciplinary efforts.

The HBP project involving Pau, Wave Scaling Experiments and Simulations (WaveScalES), is coordinated by Pier Stanislao Paolucci at the Instituto Nazionale di Fisica in Rome and will study the neuronal networks underling sleep and wakefulness under normal conditions and in disease.

The HBP aims to put in place a cutting-edge, ICT-based scientific Research Infrastructure for brain research, cognitive neuroscience and brain-inspired computing. The project, which started a promotes collaboration across the globe, and is committed to driving forward European industry.

Nano World Cancer Day 2016 was organised by NanomedSpain and, at a European level, the European Technology Platform on Nanomedicine

The European Technological Platform on Nanomedicine (ETPN)

IBEC has been a voting member of the European Technological Platform on Nanomedicine (ETPN) since 2008.

During 2016, the Spanish Nanomedicine Platform (NanomedSpain), which is coordinated by IBEC Director Josep Samitier, organised the Spain-based event of the pan-European initiative Nano World Cancer Day on February 2nd. More than 50 people, including students, scientists and journalists, attended the event that took place at the Faculty of Medicine of the University of Barcelona. Speakers represented the research and clinical points of view on nanomedicine and its range of applications against cancer, as well as organisations such as the Asociación Española Contra el Cáncer (AECC) and companies (Genomica S.A.U.).

Nano World Cancer Day 2016 was a pan-European event organized in the framework of World Cancer Day (February 4th 2016) that aimed to amplify awareness about nanomedicine and its ability to introduce new opportunities and game changers in the fight against cancer. At a European level is it was organized by the European Technology Platform on Nanomedicine together with the European Project ENATRANS (Enabling NAnomedicine TRANSlation). For this third edition, twelve simultaneous conferences took place in Austria, France, Germany, Greece, Ireland, Italy, Portugal, Netherlands, Spain, Switzerland, Turkey and the United Kingdom.

National alliances

Spanish Nanomedicine Platform (NanoMed Spain)

The Spanish Nanomedicine Platform (NanoMed Spain) is a forum managed by IBEC that brings together public research centres, hospitals, companies and government representatives to unite public and private interests in the development of common strategies. NanoMed Spain represents the interests of its stakeholders in the burgeoning and multidisciplinary area of nanomedicine, and is supported by the Spanish Ministry of Economy and Competitiveness (MINECO), through the Spanish Programme for R+D+I oriented to Societal Challenges.

The activity of NanoMed Spain in 2016 was focused on:

- The continued co-organization of the Annual Conference of the Biomedical Research Technology Platforms

(15th-16th March), together with the Spanish platforms for Innovative Medicines, Biotechnology, and Health Technology, with over 200 participants. At the meeting, held at Barcelona's Hotel Crowne Plaza, the keynote speaker invited by NanoMed Spain was Sylvia Bove, CEO of EIT Health. In addition, the Platform organised a parallel session on innovation in nanomedicine, in which various projects funded by the European programme H2020 were presented. These success stories includes IBEC's Elena Martinez's (pages 78-81) ERC Consolidator grant to use biomimetic systems to study intestinal epithelium related diseases, as well as the SME Neos Surgery, which has received funding to complete the development of a new device for spine surgery.

- Co-hosting an event as part of Nano World Cancer Day 2016 on Tuesday 2nd February, a global initiative organized for World Cancer Day (see above). At the conference, which took place in the Aula Magna of the University of Barcelona, the latest innovations in nanomedicine for cancer were presented and discussed, with topics ranging from early diagnosis and the controlled release of drugs to radiation therapy using nano-particles.
- Organising a Public Procurement of Innovative Technology (Compra Pública de Tecnología Innovadora, CPTI) event in April to promote innovation oriented towards the development of new markets from demand through to public procurement in Barcelona. Representatives for regional and state policies were present at the event, which dealt with the perspective of companies and hospitals from a national and European point of view, success stories, and new opportunities.
- The Platform also organized and/or participated in several initiatives to promote collaboration between the public and private sector throughout 2016, for example in the Graphene Interplatforms Group (GRAFIP), created in February of 2016 in the framework of the Foro Transfiere in Málaga and coordinated by MATER-PLAT. GRAFIP aims to promote R&D and industrial activities around graphene, involving all stakeholders such as R&D agents, Technological Platforms, companies, facilitators and market agents. Additionally, an important role is planned within GRAFIP to promote activities related to graphene by Spanish consortia internationally.

Fundació "La Caixa

Since 2011 IBEC has had an alliance with Fundació "La Caixa", which until 2014 funded IBEC's institutional valorization and technology transfer programme "Diagnosis and therapy systems based on the integration of novel nano-bio-info-cogno-technologies". This spelled the beginning of an on-going collaboration on various other projects.

Since 2015, IBEC and La Caixa have run a joint programme in Healthy Ageing Research. Projects are expected to contribute to the development of one of IBEC's focus programmes, Bioengineering for Healthy Ageing, have a translational approach, and be the seed for innovations to be further translated through EIT Health.

Four projects are being developed in 2016-2017:

- Monitoring neurocognitive deficits in Alzheimer's and Parkinson's diseases using saliva or blood-derived biomarkers and multiplexed approach (PI: José Antonio del Rio, pages 88-91)
- Novel m-Health tools for unobtrusive sensing and management improving of Obstructive Sleep Apnea patients at home (PI: Raimon Jané, pages 68-73)
- Dermoglass: Advanced wound healing dressings (PI: Elisabeth Engel, pages 50-55)
- Novel strategies to combat bacterial chronic infections by the development of microfluidics platforms to analyse and treat bacterial growing in biofilms (PI: Eduard Torrents, pages 108-111)

At the end of 2016 Eduard Torrent's Bacterial Infections: Antimicrobial Therapies group's (pages 108-111) project with the Associació Catalana de Fibrosi Quística (ACFQ) was awarded funding by the Obra Social "La Caixa". Eduard's work about developing new strategies to combat bacterial infections and possible therapeutic targets is strongly linked to cystic fibrosis (CF) and has been supported by the ACFQ since 2009. Now, the work

has received a generous boost for three more years thanks to a new funding initiative from the foundation.

In 2016, the Obra Social "la Caixa" and Cellex foundations funded two major projects coordinated by the Fetal Medicine Research Centre, Fetal i+D (Hospital Clínic and Hospital Sant Joan de Déu). The projects – comprising four sub-projects, one of which, Robotics and Electronic Biosensors, is to be coordinated at IBEC – will revolutionise fetal surgery and the research of prenatal diseases. IBEC's involvement is a forward step in fulfilling its mission to forge links with clinicians and bring its health-related research results closer to patients.

In November 2016 a new PhD programme at IBEC funded by the Obra Social "La Caixa", INPhINIT, opened for applications. INPhINIT aims to attract international early-stage researchers to the top Spanish research centres in the areas of the life and health sciences, physics, technology, engineering and maths. In each call, INPhINIT recruits 57 candidates of any nationality, who enjoy a three-year employment contract at the participating research centre of their choice, all of which have been designated by the Spanish ministries as Severo Ochoa, Maria de Maeztu or Carlos III Centres or Units of Excellence.

In 2016 two further IBEC projects were granted funding as part of the 2016 CaixaImpulse programme, which is organized by the "la Caixa" Foundation and Caixa Capital Risc. Cellular and molecular mechanobiology group leader Pere Roca-Cusachs' (pages 92-95) project, "Solid tumor therapy", and "ISCHEMSURG", led by Monica Mir, senior researcher in Josep Samitier's Nanobioengineering group (pages 96-101), will each receive up to €70,000 through the programme, which aims to promote technology transfer in science.

RIS3CAT/NextHealth: the ADVANCECAT project

Part of the RIS3CAT community, the ADVANCECAT project, led by the University of Barcelona, aims to accelerate the development of advanced therapies – medicines based on cell therapy, gene therapy and tissue engineering – in Catalonia from basic research to clinical or industrial transfer.

Formed by 18 organizations in the field of health including two universities, twelve biomedical research institutes – including IBEC – and four companies and private foundations, ADVANCECAT, which is integrated in the NextHealth community and coordinated by Biocat, will bring together public and private sectors for better management of resources in order to get the most out of the Catalan health system.

Red de Innovación en Tecnologías Médicas y Sanitarias

In 2016 IBEC became a partner in the Red de Innovación en Tecnologías Médicas y Sanitarias (ITEMAS), an innovation network for medical and health technologies.

ITEMAS, promoted by the Instituto de Salud Carlos III (ISCIII), brings 95 companies and organizations together with 66 medical centres in Spain to collaborate on R+D projects. The partners will also work together on outreach initiatives.

HealthTech Cluster

Since 2014, IBEC has been a member of a new alliance aimed at promoting and contributing to the competitiveness of the health technology sector in Catalonia. The HealthTech Cluster brings together research organisations, companies, hospitals and other bodies to compete globally by promoting innovation and internationalization of partners and improving conditions within the sector.

Two projects of Monica Mir and Pere Roca-Cusachs were awarded funding by the CaixaImpulse programme in 2016

The cluster is an initiative of ACCIÓ, the Generalitat's Agency of Competitiveness for Companies in Catalonia. This network will focus particularly on partners that are working on developing technologies for healthcare, rather than basic research. The other members include the Universitat Politècnica de Catalunya (UPC) on the research side, Barcelona's Hospital Clínic among the healthcare bodies, and companies such as Telstar and the Sibel Group.

In February 2016 the HealthTech Cluster outlined its plans at its General Assembly at the UPC's Campus Nord. The meeting approved HealthTech Cluster's strategic plan for 2016, with some of the main working groups focused on will be innovation, internationalisation and networking. The programme of presentations included IBEC Associated Researcher Alicia Casals, who gave a talk entitled "Robòtica Intel·ligent i Sistemes Assistencials", and there was also a visit to her laboratory afterwards.

Bioinformatics Barcelona (BIB)

Bioinformatics Barcelona (BIB), a network of 25 members including universities, research centres, hospitals, major scientific facilities, and pharmaceutical, technology and bioinformatics companies, aims to respond to the challenges posed by the growth of big data and position Barcelona as a world leader in bioinformatics.

IBEC participated in the development of the platform, which is supported by the Government of Catalonia and the Obra Social "la Caixa", and which aims to involve all Barcelona organizations working in the field of health and food. BIB will act as a catalyst for initiatives in advanced research and knowledge and technology transfer between research groups, hospitals and the business sector, as well as the development of training programmes in bioinformatics.

In 2016 BIB officially launched its website, which details the bioinformatic activities of 40 partners – including IBEC – and over 80 research groups. IBEC's Biomedical Signal Processing and Interpretation (pages 68-73), Mechanics of Development and Disease (pages 48-49) and Signal and Information Processing for Sensing Systems groups (pages 74-77) are featured on the site, as they carry out bioinformatics-related activities such as algorithmics, biomedical informatics, biostatistics, or bioinformatics of disease and treatment.

EIP on AHA

Since 2013, under the umbrella of the HUBc, several research activities at IBEC have been accepted as 'commitments' by the European Commission's European Innovation Partnership on Active and Healthy Ageing (EIP

Director Josep Samitier presented IBEC in three minutes at 2016's CERCA Conference

on AHA). This policy-influencing initiative alongside H2020 brings together public and private stakeholders to develop new innovations which can improve the quality of life of older people while creating market opportunities for business. Stakeholders work together along six Action Groups on Adherence to medical plan, Falls prevention, Prevention of functional decline and frailty, Integrated care, ICT solutions for independent living and Age-friendly environments.

IBEC participates in two Action Groups (Functional decline and frailty; Integrated care) and has actively contributed to place Catalonia as an EIP-AHA reference site, which labels it as an inspirational ecosystem, delivering creative and workable solutions that improve the lives and health of older people.

BIOCAT

BIOCAT coordinates, develops and promotes the biotechnology, biomedicine and medical technology sectors in Catalonia, to make the region an international reference in terms of high quality research, competitive networks and an increasingly dynamic knowledge transfer system. IBEC has worked closely with BIOCAT on such projects as BioNanoMed Catalunya, an alliance of research centres, hospitals and companies launched in 2011 to share know-how and resources and facilitate new developments in nanomedicine.

One of BIOCAT strategic initiatives is B·Debate, which aims to drive top-notch international scientific events to foster debate, collaboration and open exchange of knowledge among experts of renowned national and international prestige in order to tackle complex challenges of high interest in the life sciences. The debates foster the integration of various disciplines of science. During 2015, IBEC organized a B·Debate workshop on "Future Tools for Biomedical Research. *In vitro, in silico* and *in vivo* Disease Modeling".

In 2016 Xavier Rubies, head of IBEC's Technology Transfer unit, took part in a B·Debate conference on "Fighting Blindness. Future Opportunities and Challenges for Visual Restoration", organized by the Barcelona Macula Foundation in collaboration with the Centre for Genomic Regulation (CRG) and LEITAT. Xavier took part in the "From Bench to Bedside" round table, where he explained the process of bringing research results to market. The other speakers agreed with his position that in order to achieve effective results, it's necessary to start by looking at demand, and then to lead the transfer of projects according to the needs of the market.

Other strategic alliances

During 2016 IBEC continued to be a member or partner of the following organisations or initiatives:

- Associació Catalana d'Entitats de Recerca (ACER), of which IBEC Director Josep Samitier is the president. Established in 2003 by the Catalan government's department of Universities, Investigation and Information Society, ACER is an independent association of more than 40 institutions in Catalonia which conduct research as their principal mission. The association's goal is to help establish the region as an international benchmark in scientific and technological research by representing its associated centres, encouraging collaboration and the coordinated exchange of information, promoting synergies with similar agencies related to local, national or international research, and contributing to the improvement of scientific understanding in society.
- CERCA Institute (the Government of Catalonia's means of supervising, supporting and facilitating the activities of Catalan research centres). IBEC Director Josep Samitier had three minutes to present IBEC at this year's CERCA Conference 2016, the association's annual get-together which invites representatives from all of its research centre members in Catalonia. Held at Barcelona's CCCB on 8th June, the event was dedicated to highlighting the potential for collaboration between CERCA centres, with the aim of improving the impact and management of research. Forty-one centers presented dynamic three-minute presentations to highlight their own collaboration opportunities.

Memoranda of Understanding

IBEC pursues opportunities to collaborate on a long-term basis with other world-class national or international research institutes, organisation or other bodies with a collaborative agreement or Memorandum of Understanding (MoU).

These formalise the participation of IBEC and the partner institute in cooperative scientific projects, promote the exchange of researchers, aid dissemination of information, the sharing of resources and the organization of joint events and activities.

In 2016, IBEC had MoUs in place with the following organisations:

International

- EIT Health (page 128)
- Interuniversitair Micro-electronica Centrum, Leuven, Belgium
- National Institute for Materials Science (NIMS), Tsukuba, Japan
- Institute of Tissue Regeneration Engineering (ITREN), Dankook University, Korea
- University of Warwick's Centre for Cognitive and Neural Systems, UK
- Interstaatliche Hochschule für Technick Buchs (NTB), Switzerland
- Università degli Studi di Brescia, Italy
- The European Synchroton Radiation Facility (ESFR), France
- Max Planck Institute for Intelligent Systems (MPI-IS), Germany

Local and national

- Hospital de la Santa Creu i Sant Pau, Barcelona
- Plataforma de Colaboración en Tecnologías Médicas y Sanitarias (ITEMAS, page 132)
- Universidad CEU San Pablo, Madrid
- Institute of Functional Genomics, Universitat de Vic
- Pompeu Fabra University, Barcelona
- Fundació Clínic/Hospital Clínic, Barcelona
- Bellvitge Institute for Biomedical Research (IDIBELL), Barcelona
- Vall d'Hebron Research Institute (VHIR), Barcelona
- Fundació Joan Costa Roma (JCRF), Terrassa
- Centre de Medicina Regenerativa de Barcelona (CMRB), Barcelona
- Institut De Recerca I Tecnologia Agroalimentaries (IRTA), Barcelona
- The Barcelona Global Health Institute (ISGLOBAL), the Center for Research in Environmental Epidemiology (CREAL) and the Instituto de Diagnóstico Ambiental y Estudios del Agua (IDAEA-CSIC) to study DDT concentration detection in treated surfaces to tackle malaria
- CIBER (pages 125-127); under a special agreement, IBEC's Nanotechnology Platform (see pages 116-121)

An audience of nearly a hundred enjoyed a special public seminar by IBEC group leader and ICREA research professor Samuel Sánchez, one of this year's Setmana de la Ciència events

is considered an integrated service platform within the CIBERBBN programme, thus facilitating access to all researchers within the network

- The Open University of Catalonia (UOC)
- Escuela Superior de Ingenieros de Caminos, Canales y Puertos de la Universidad de Madrid
- Barcelona Macula Foundation
- University of Barcelona (UB), Barcelona through its Cell Therapy Programme (TCUB) and also the Doctoral Programmes
- Polytechnic University of Catalonia (UPC), Barcelona
- Banc de Sang i Teixits (BST), Barcelona
- Federación de Asociación de Retinosis Pigmentaria (FARPE)
- Fundación de Lucha contra la Ceguera (FUNDALUCE)

Outreach activities and other joint initiatives

- Fundació Catalunya-La Pedrera (for the "Joves i Ciència" and "Professors i Ciència" programmes).
- Barcelona Science Park (PCB) (hosting students under the "Passa l'estiu al parc" initiative and participating in the annual Fira Recerca en Directe).
- Fundació Catalana per la Recerca i la Innovació (FCRI) (for participation in the "Espai Ciència" of the annual Saló de l'ensenyament at Barcelona's Fira and the city's "Setmana de la Ciència" festival).
- The council of Sant Feliu de Guíxols (having worked together on a museum exhibit "Curar-se en salut").
- The Barcelona city council (for ESCOLAB and the Festa de la Ciència).
- BIOcomuniCA'T (for Nit Europea de la Recerca Barcelona).
- In 2016 IBEC participated in the thirtieth edition of the seminar series "Aspectes generals i d'investigació bàsica en càncer de mama" organized by the multidisciplinary group for the study of breast cancer at the Autonomous University of Barcelona (UAB). Josep Samitier (pages 96-101) gave a talk on nanotechnology and nanopharma applied to this variant of cancer, while Pau Gorostiza (pages 64-67) spoke about the development of light-regulated drugs for the remote control of biological activity and their application in breast cancer.

Technology transfer and industrial collaborations

Innovation can only happen if research discoveries leave the lab and reach the market and users. Effective translation of discoveries into marketable products requires market-driven projects, effective liaison with industry, and intellectual property protection.

The technologies that meet our criteria for commercialization are developed into products and therapies through collaborations and alliances with other research organizations, companies and clinicians, and by the creation of new start-ups. IBEC researchers are supported by the Technology Transfer Unit along the tech transfer and valorization processes, and take the lead in the commercialization process.

IBEC signs a contract research agreement with Bioibérica

In April IBEC signed a collaboration agreement with Bioibérica S.A., a company specialising in the R&D, production and sale of biomolecules and new technologies for the pharmaceutical, veterinary and agrochemical industries. It was an important success story in IBEC's active pursuit of the establishment of research projects with industry partners who share its commitment to bringing high-quality health research and technologies to market and the patient.

Together, IBEC – specifically its Nanomalaria joint unit with ISGlobal, led by Xavier Fernández-Busquets (pages 56-59) – and Bioibérica, which since its formation in 1975 has focused on the investigation and production of biomolecules extracted from animal tissue with significant biological and therapeutic properties, will explore ways of combining their expertise to achieve advances in future medicine. The partnership was officially announced at the BioSpain meeting in Bilbao.

GENOMICA presents NEDxA at MEDICA, first fruit of their collaboration with IBEC

IBEC's Technology Transfer Unit attended MEDICA in Germany in November, where GENOMICA presented a new *in vitro* diagnostics device for Human Papillomavirus (HPV) testing, a new product developed by the IBEC-GENOMICA Joint Unit that carries out analysis to detect HPV in a cheap, quick and convenient desktop device. This is a milestone in the history of GENOMICA that transcends for the first time from its well-established CLART technology to present a revolutionary molecular diagnostics device. IBEC and GENOMICA will continue this fruitful collaboration to bring more new products in the market.

Ferrer, IBEC and Mind the Byte join forces to study new molecules against cancer metastasis

IBEC, pharmaceutical company Ferrer and the bioinformatics company Mind the Byte created a consortium to study the development of new therapeutic molecules against cancer metastasis. The work will follow the research on cadherin interaction and its role in cells that cause metastasis conducted by Xavier Trepat (pages 112-115). Both Dr. Andrés G. Fernández, director of Ferrer Advanced Biotherapeutics, and Dr. Alfons Nonell-Canals, a specialist in computer-aided drug design and CEO of the bioinformatics company Mind the Byte, agree that this is a case of technology transfer between a public research centre and two private companies "in which each will contribute with their knowledge and expertise."

Ferrer lidera un consorcio para investigar metástasis tumorales

El grupo se alía con el Institut de Bioenginyeria y la biotec Mind the Byte

ROSA SALVADOR

Barcelona

El grupo Ferrer ha constituido un consorcio con el Institut de Bioenginyeria de Cataluña (IBEC) y la start-up tecnológica Mind the Byte para desarrollar nuevas moléculas para el tratamiento de las metástasis tumorales. El consorcio forma parte de la estrategia de "innovación abierta" que Ferrer puso en marcha en 2013, para centrar la I+D farmacéutica en el codesarrollo de medicamentos con empresas líderes, frente a la estrategia tradicional de la industria farmacéutica de tener equipos investigadores internos.

El IBEC y Mind the Byte son dos organizaciones con sede en el Parc Científic de Barcelona. El consorcio se basa en desarrollar las investigaciones de Xavier Trepat, uno de los científicos líderes del IBEC, sobre la interacción de las células con la matriz extracelular que rigen las células entre ellas) y su implicación en las células que causan las metástasis.

Alfons Nonell-Canals, Xavier Trepat y Andrés G. Fernández liderarán el consorcio

Ferrer invierte cerca de 30 millones al año en I+D, el 20% de

proceso que con la tecnología tradicional se alarga mucho más. Andrés G. Fernández, director de Ferrer Advanced Biotherapeutics (FAB), la división de Ferrer que dirige la I+D en terapias

conjunto de 30 millones de euros, de los que cerca del 20% corresponde a FAB, que gestiona los proyectos más rupturistas, aunque efectivamente con menores posibilidades de llegar al

IBEC, pharmaceutical company Ferrer and the bioinformatics company Mind the Byte created a consortium to study the development of new therapeutic molecules against cancer metastasis

IBEC, the hot spot in 3D bioprinting, present at the first edition of IN(3D)USTRY

IBEC Director Josep Samitier and the Technology Transfer Unit introduced IBEC's 3D bioprinting capabilities at the first IN(3D)USTRY event, which was held in Barcelona in June. IBEC's 3D bioprinter is the only one offering the level of precision and characteristics requred for regenerative medicine purposes in southern Europe. It puts IBEC at the forefront of a new revolution in regenerative medicine by allowing researchers to add biological properties to implanted tissues such as bone, and may eventually be able to manufacture entire organs for transplantation.

IN(3D)USTRY is a new international event focusing on the current state and future of Additive and Advanced Manufacturing, more popularly known as 3D printing. This event is a "global hub" bringing together all components of the Additive Manufacturing ecosystem to showcase the latest technology and innovation. Participants included firms from four user sectors – Health, Automative & Aerospace, Architecture and Retail & Consumer Goods – seeking innovative solutions to their future challenges and presenting these challenges to 3D printing experts who will, in turn, showcase their success stories and illustrate how the technology can be applied successfully in these sectors.

Supporting Cystic Fibrosis patients

The Cystic Fibrosis Association of Catalonia (Asociación Catalana de Fibrosis Quística) provides active support to the research conducted by Eduard Torrents, head of IBEC's Bacterial infections: antimicrobial therapies group (pages 108-111), into the enzyme that promotes the growth of the bacteria linked to this disease. Cystic fibrosis is an inherited genetic disease which mainly affects the lungs and digestive system. It is a serious, degenerative disorder with a limited life expectancy, and for which there is no cure as yet. In Spain, cystic fibrosis affects one out of every 2,500 newborn babies. The scientific work carried out by Eduard and his team may lead, within a reasonable period of time, to the discovery of a mechanism that stops the development of the bacteria and, when used in conjunction with antibiotics, eliminates it completely. In the case of a person already infected, the use of a drug that acts on *Pseudomonas* could eliminate the enzyme altogether.

Xavier Rubies, head of IBEC's Technology Transfer unit, took part in September's B · Debate conference on "Fighting Blindness. Future Opportunities and Challenges for Visual Restoration"

Pancreatic cancer and surgery medical device: more IBEC success in CaixaImpulse

Two IBEC projects were granted funding as part of the 2016 CaixaImpulse programme, which is organized by the "la Caixa" Foundation and Caixa Capital Risc. One of the projects is led by Cellular and Molecular Mechanobiology group leader Pere Roca-Cusachs (pages 92-95) and is focused in the development of new compounds indicated in solid tumor therapy. Preliminary results brought promising data on one of the molecules developed and tested, and a new patent and a second round of molecules is under development. The second project is led by Monica Mir, senior researcher in Josep Samitier's Nanobioengineering group (pages 96-101), and is focused on the development of a new sensor technology capable to detect ischemia situations after surgery interventions like free-flap. The technology is under development and a definitive prototype and potential license is expected at the end of 2017 or the beginning of 2018.

Market-minded PhD thesis: PIONER award for IBEC student

Former IBEC PhD student Ariadna Bartra was awarded a Premi PIONER from CERCA. The Signal and Information Processing for Sensing Systems group's student's thesis, 'Detecció d'estats inadequats per la conducció d'un vehicle a partir de la degradació del control dinàmic', was selected for its "direct applicability and market-minded approach, as well as its impact on improving road safety", according to the judging panel. Her research carried out in Santiago Marco's group (pages 74-77) was connected to the driver drowsiness alerter developed by IBEC and the company Ficosa.

IBEC an active member of the Health Tech Cluster

The Technology Transfer Unit at IBEC is an active member of to the Innovation Committee of the HealthTech Cluster, an initiative promoted by the Government of Catalonia to foster the competitiveness of the health technology sector. IBEC is a transversal research and technology player for the medical device industry and hospitals, bringing technologies and solutions for unmet needs. This sector is defined by companies from the medical device and eHealth industries that provide technological solutions to improve health and wellness and the sustainability of healthcare systems. The HealthTech Cluster is led by private companies but includes most

agents from the value chain, such as hospitals, universities, research and technological centres and public organizations.

Increasing support to industry

IBEC's researchers are significantly increasing the number of contract research and fee for service contracts with industry. The knowledge developed by our researchers allow us to collaborate in fields as diverse as driving, medical devices, cork quality control for the wine industry, therapeutic molecules, or sensors for washing machines. The medical device market and the beyond-the-pill strategy of many pharma companies are two of the more promising business areas for the coming years. In this landscape IBEC, in conjunction with hospitals and its joint units, is increasingly an ideal partner for companies to develop new solutions.

IBEC's Market Driven Technology Transfer at B·Debate

Xavier Rubies, head of IBEC's Technology Transfer Unit, took part in September's B·Debate conference on "Fighting Blindness. Future Opportunities and Challenges for Visual Restoration", organized by the Barcelona Macula Foundation in collaboration with the Centre for Genomic Regulation (CRG) and LEITAT.

Xavier took part in the "From Bench to Bedside" round table, where he explained the process of bringing research results to market, defined as Market-Driven Technology Transfer at IBEC. The other speakers agreed with his position that in order to achieve effective results, it's necessary to start by looking at demand, and then to lead the transfer of projects according to the needs of the market.

This B·Debate conference, an initiative of Biocat and Obra Social "la Caixa", aimed to explore the potential of new therapeutic approaches for retinal dystrophies, combining nanotechnology, regenerative medicine, stem cells, gene therapy, genomics, bioengineering, photonics and optogenetics.

A gathering of the industrial biotech sector in Catalonia

More than 250 companies and public organizations met at March's Nit de CataloniaBio 2016, the annual forum for the sector, which this year had a special focus on the 10th anniversary of organiser CataloniaBio. CataloniaBio is an association of biotech and pharma companies, but the most relevant public institutions and research centers were invited, and IBEC was represented by director Josep Samitier and Xavier Rúbies and Diana Gonzalez from the Technology Transfer Unit. Also present at the event was the conseller of Health, Antoni Comín, the conseller of Business and Knowledge, Jordi Baiget, CataloniaBio president and Reig Jofre CEO Ignasi Biosca, and CataloniaBio vice-president and Kern Pharma's Director of Strategy and Development Clara Campàs.

Clinical and translational collaborations

IBEC counts on the collaboration of medical doctors to provide input on the clinical aspects of its research, so that results are easily extended to clinical practice.

In this way, IBEC benefits from its privileged position as technological counterpart of the major hospitals in the Barcelona area, four of which (Hospital Clínic, Sant Pau, HSCSP and Bellvitge) are recognized as Biomedical Research Institutes of Excellence by the Spanish government. IBEC's framework agreements and collaborations with these nearby hospitals allow easy access to clinical samples and patients.

Clinical collaborations can be at the research level, with academic publications as the result; translatory, to develop products aimed at reaching the market; or with a spin-off company in mind.

Joint unit with the Hospital Universitari Germans Trias i Pujol

A joint research Unit between IBEC and Hospital Universitari Germans Trias i Pujol (IGTP), coordinated by Raimon Jané, head of IBEC's Biomedical Signal Processing and Interpretation group (pages 68-73) and the hospital's Manel Puig Domingo, is developing a collaborative project in respiratory sound analysis.

During 2016 IBEC's the joint unit had a paper in the IEEE Journal of Biomedical Health Informatics. The work presents a new way of automatically differentiating normal respiratory sounds from continuous adventitious ones, which can reflect the severity of certain diseases. The researchers and clinicians used a dataset of 870 inspiratory cycles recorded from 30 patients with asthma to test their sound classifier, which is based on the multiscale analysis of instantaneous frequency sequences, which markedly decrease when continuous additional sounds appear in respiratory cycles.

VHIR-IBEC alliance on infectious diseases

With Dr. Joan Gavaldà at the Infectious Disease department of the Vall d'Hebron Research Institute (VHIR), Eduard Torrents' Bacterial Infections and Antimicrobial Therapies group (pages 108-111) signed a close collaboration agreement to form a collaborative alliance during 2015. Their complementary research areas are expected to bridge the gap between fundamental microbiological knowledge and making new therapies available to patients.

During 2016, they published a paper in the *Journal of Antimicrobial Chemotherapy* describing the efficacy of anidulafungin in the treatment of experimental *Candida parapsolosis* catheter infection, as well as filing two patents, one about a thermotherapy method to treat antimicrobial resistant infection, and the other concerning a method to treat antimicrobial resistant infection using electric current.

Creating a 3D *in vitro* model of the human intestine

During 2016 Elena Martinez's Biomimetic Systems for Cell Engineering group (pages 78-81) signed a collaborative alliance with Barcelona's Vall d'Hebron Research Institute (VHIR) to evaluation and characterize the intestinal barrier in a 3D *in vitro* model of the human intestine. The collaboration, specifically with VHIR's unit focused on the Physiology and Pathophysiology of the Digestive Tract, will validate the model as an *in vitro* representation of functional intestinal disorders.

Sant Joan de Déu y el Clínic impulsan un ambicioso programa de medicina fetal

Más pequeño todavía

IBEC is part of a collaboration on fetal surgery coordinated by the Fetal Medicine Research Centre, Fetal i+D (Hospital Clínic and Hospital Sant Joan de Déu)

Kidney and iPS collaborations with Hospital Clinic

IBEC signed a collaboration agreement with Barcelona's Hospital Clinic during 2016 for Nuria Montserrat's Pluripotent Stem Cells and Activation of Endogenous Tissue Programs for Organ Regeneration group (pages 82-85) to work with Dr. Eduard Gratacós, Head of BCNatal (Hospital Clinic/Hospital Sant Joan de Déu) and Professor at the University of Barcelona with embryonal kidney samples to study the molecular mechanisms of kidney diseases.

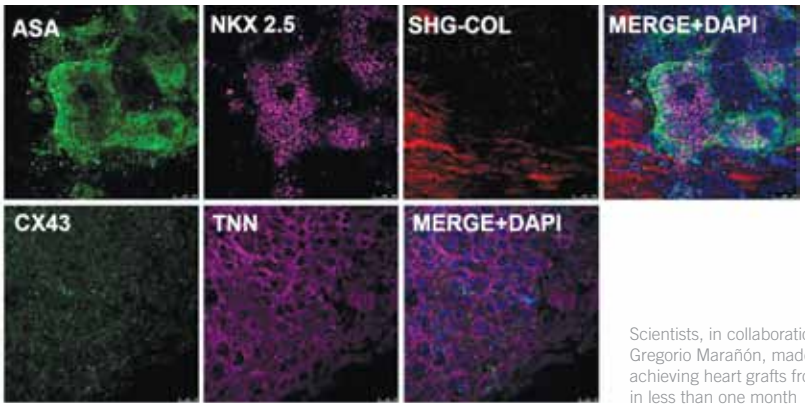
The alliance follows on from a similar research agreement reached in 2015 to facilitate the same IBEC group to work with Dr. Josep M. Campistol, CEO and nephrologist in Hospital Clínic and researcher in IDIBAPS, on using pluripotent stem cells to the identify transcription factors and epigenetic modifiers responsible for aging.

Fetal surgery collaboration with two hospitals

IBEC is to be part of a revolution in fetal surgery and the research of prenatal diseases as the Cellex Foundation and the "la Caixa" Banking Foundation become the main promoters of Catalan research in fetal medicine. The two foundations are funding two major projects coordinated by the Fetal Medicine Research Centre, Fetal i+D (Hospital Clínic and Hospital Sant Joan de Déu). A fetal surgery part of the project, promoted by the Cellex Foundation, will improve the interventions currently being carried out, as well as developing new surgery to treat problems that currently lack solutions, and a prenatal diseases part, "Imatge fetal robòtica", stems from the support that the "la Caixa" Banking Foundation has given the Fetal i+D centre since 2010 to search for new clinical biomarkers to identify the neurological and cardiovascular impact that fetal diseases have on adulthood, and the evaluation of therapies in experimental models to reduce this impact.

The projects – comprising four sub-projects, one of which, Robotics and Electronic Biosensors, is coordinated at IBEC – will develop a system of sealing and fixing membranes through the use of new materials; an optical biosensor system; a robotic assistance system; and a surgical planning and navigation system for fetal surgery. IBEC's Nanobioengineering group will contribute by developing biosensors specifically designed to be applied in the field of fetal medicine, and will seek to develop and apply them in cases where possible infectious diseases in the fetus, tissue ischemia during interventions, or metabolic activity need to be evaluated, while the group of Associated Researcher Alícia Casals (page 124) will develop a guidance system support for prenatal surgery.

IBEC's involvement is a forward step in fulfilling its mission to forge links with clinicians and bring its health-related research results closer to patients.



Scientists, in collaboration with the Hospital General Universitario Gregorio Marañón, made a big leap in heart regeneration advances by achieving heart grafts from human pluripotent stem cells for the first time in less than one month

Generating human heart grafts from hPSCs

During 2016 scientists from IBEC, in collaboration with the Hospital General Universitario Gregorio Marañón in Spain and two other groups in the USA, made a big leap in heart regeneration advances by achieving heart grafts from human pluripotent stem cells for the first time in less than one month.

The collaborators - including Nuria Montserrat's Pluripotent Stem Cells and Activation of Endogenous Tissue Programs for Organ Regeneration group (pages 82-85) described how they decellularized human hearts, leaving the extracellular matrix intact. They then used genome-editing techniques on human pluripotent stem cells (hPSCs) to efficiently produce cardiomyocytes, or heart cells, which they then used to repopulate the extracellular matrices of the decellularized human ventricles. Pluripotent stem cells are crucial for this process, as the body is not able to generate new cardiomyocytes after heart attack or other damage.

The cells within decellularized human heart matrices showed a higher degree of physiological and molecular cardiac differentiation compared to those cultured on regular tissue culture plates, which has been the usual method up to now. It took just 24 days for these human cardiac grafts to exhibit the correct electrophysiological responses needed in cardiac function; in other words, beating.

This type of de- and recellularization of organs represents a promising strategy for the development of biofunctional organs for drug screening and personalized medicine.

Clinica CEMTRO collaboration on cartilage lesions

In 2016 Nuria Montserrat's Pluripotent Stem Cells and Activation of Endogenous Tissue Programs for Organ Regeneration group (pages 82-85) started a collaboration within the framework of the CIBER project "CHONDREG: Identification of the epigenetic mechanisms preventing chondrocyte de-differentiation: generation of novel therapeutic strategies for the treatment of cartilage chronic osteochondral lesions" with Clinica CEMTRO in Madrid.

A potential therapeutic target for MS

Towards the end of 2016, IBEC's Molecular and Cellular Neurobiotechnology group (pages 88-91) published findings on a possible new approach to fight multiple sclerosis. Working with their collaborators at the Vall d'Hebron Institut de Recerca (VHIR), the group examined the role of the immune semarphorin sema7A – a guidance molecule with dual functions in both the immune system and the central nervous system – in neuroinflammation. In an *in vitro* model of neuroinflammation, they saw that demyelination or cell death – the hallmarks of MS – were not affected in sema7A-deficient brain tissues when a lipopolysaccharide (LPS) endotoxin

– an antigen that illicits a strong immue response – was added. Normal brain tissue, however, showed changes in demyelination and cell death when the endotoxin was introduced. When they tested this *in vivo*, mice lacking Sema7A showed lower demyelinization than wild type mice. In addition, a histopathological analysis of the brain indicated a decrease in the neuroinflammatory responses.

"Altogether, these results indicate that sema7A is involved in peripheral immunity and central nervous system inflammation in MS," says José Antonio del Río, head of the IBEC group. "Indeed, these data suggest that sema7A might be a potential therapeutic target to treat MS and other autoimmune conditions."

Working with Bellvitge on CJD

Together with the Institute of Neuropathology of the Hospital Universitari de Bellvitge and other collaborators, IBEC's Molecular and Cellular Neurobiotechnology group (pages 88-91) published a study during 2016 concerning sporadic Creutzfeldt-Jakob disease (sCJD), an incurable neurodegenerative disease that is often called the human form of mad cow disease. The researchers looked at the neuron loss, synaptic decline, and spongiform change that are the hallmarks of sCJD to see if they might be related to deficiencies in mitochondria, energy metabolism and protein synthesis, using frontal cortex samples from fifteen cases of sCJD alongside healthy controls of the same ages. Their findings, published in the *Journal of Neuropathology & Experimental Neurology*, point to altered mRNA and protein expression of components of mitochondria, protein synthesis machinery, and purine metabolism as components of the pathogenesis of CJD.

Studying sleep apnea with Hospital Clinic

Daniel Navajas' Cellular and Respiratory Biomechanics group (pages 86-87) published two papers on sleep apnea during 2016, both in collaboration with the Sleep Laboratory of the Pneumology Department of Hospital Clinic, Barcelona. A study published in *PLOS ONE* in March looked at a new approach to test positive pressure therapy devices using a 'model' of a sleep apnea patient, while in July, some work published in *Frontiers in Physiology* described the design, fabrication and testing of a versatile chip for the study of cellular responses to cyclical hypoxia and stretch.

GLAM project working with Radboud UMC

As part of the H2020-funded GLAM project (Glass-Laser Multiplexed Biosensor), which aims to develop an innovative device for personalized diagnosis and therapy monitoring for genitourinary cancers, the Biomimetic Systems for Cell Engineering group (pages 78-81) began working in collaboration with the Department of Urology at the Radboud University Medical Center in Nijmegen, The Netherlands during 2016. As the clinical partner, Radboud will provide patient samples to be used in testing biomarkers in genito-urinary oncology, particularly bladder cancer.

GLAM is coordinated by Leitat and, as well as those from Spain and the Netherlands, involves partners from Israel, Belgium, Serbia and the UK.

Co-operation triangle of researchers, clinicians and patients' association

At the end of 2016 Eduard Torrent's Bacterial Infections: Antimicrobial Therapies group's (pages 108-111) project with the Associació Catalana de Fibrosi Quística (ACFQ) was awarded funding by the Obra Social "La Caixa". Eduard's work about developing new strategies to combat bacterial infections and possible therapeutic targets is strongly linked to cystic fibrosis (CF) and has been supported by the ACFQ since 2009. Now, the work has received a generous boost over three years thanks to a new funding initiative from the foundation.

CF affects 1 in 2000-3000 newborns in Europe per year, according to the WHO. It causes the formation and accumulation of thick mucus in the lungs, intestines, pancreas and liver, and patients suffer respiratory failure due to chronic bacterial colonization – biofilms – in the lungs. Eduard's research is taking new approaches to

IBEC and the Catalan Association of Cystic Fibrosis (ACFQ) organized an event, "The present and future of Cystic Fibrosis", on 27th April 2016

overcome this problem, such as developing testing systems that closely resemble what is found in a CF patient's lungs, as well as introducing several nanomedicine strategies to combat these infections. The co-operation triangle of researchers, clinicians and the patients' association, with the support of the Obra Social "La Caixa", has the potential to make huge advances in the fight against this inherited condition.

Mycobacterium in olive oil for cancer treatment

Eduard Torrents' Bacterial Infections and Antimicrobial Therapies group at IBEC (pages 108-111) has an on-going collaboration with Dr. Esther Julián from the Department of Genetics and Microbiology at the Universitat Autònoma de Barcelona on new treatments for bladder cancer using mycobacterium. During 2016, they revealed a way to effectively deliver a mycobacterium needed for the treatment of bladder cancer in humans – using a formulation based on olive oil.

After announcing their discovery in 2015 that *Mycobacterium brumae* offers an improved alternative to existing bladder cancer treatments such as BCG, which can cause infections, the collaborators – which included the Department of Animal Medicine and Surgery of the UAB's Veterinary School, as well as its Microbiology Service – had been looking for ways to improve the immunotherapeutic activity of *M. brumae*. To do this, they designed different emulsions that can increase the homogeneity and stability, and therefore the efficacy, of the mycobacteria solutions when introduced into the body. Of the emulsions tested, the one based on olive oil induce a prominent immune response in both *in vitro* and *in vivo* experiments. In addition, the characteristics of this emulsion, which preserves the viability of the mycobacteria and provided higher anti-clumping rates, indicates favourable conditions for reaching the bladder epithelium.

PoC tool for respiratory diseases with Hospital Clinic

IBEC's Nanobioengineering group headed by director Josep Samitier is working together with clinicians at Barcelona's Hospital Clinic to develop a point-of-care platform for respiratory diseases. Aimed at primary care providers, the diagnostic and monitoring tool will help to detect and track the progress of diseases such as chronic obstructive pulmonary disease (COPD).

IBEC group as TERCEL node

In 2016 Nuria Montserrat's Pluripotent Stem Cells and Activation of Endogenous Tissue Programs for Organ Regeneration group (pages 82-85) was selected as a node group in the Red de Terapia Celular (TerCel) network, a a collaborative project launched by the Instituto de Salud Carlos III in 2003 to promote research in cell therapy

and transfer scientific advances to Spain's national health system. Based on a multidisciplinary approach and on interaction and cooperation between its 33 groups, which work in both basic and clinical research, TerCel's main objective is to discover and describe the mechanisms of the beneficial actions of cellular therapy in disease by developing experimental approaches.

In this framework, the IBEC group is now a partner in the network's CardioCel programme, which is oriented towards the research, development, production and application of cell therapy drugs in cardiovascular disease. The group will aim to develop strategies for heart healing using different regenerative approaches, from the use of pluripotent stem cells to 3D bioprinting.

IBEC group leader a member of the HFA

Nuria Montserrat (pages 82-85) has been selected as a member of the Cardiorenal Dysfunction Group of the European Society of Cardiology's Heart Failure Association (HFA). The Committees and Study Groups are the heart of the association, producing papers, workshops, events and supporting the HFA Board in accomplishing their mission. To be nominated for a Committee or Study Group, a researcher must be an HFA Silver or Gold member or Fellow of the HFA.

Events and communications

Meetings and scientific events in 2016

Throughout the year

Institutional and scientific projects

Throughout the year, IBEC hosts meetings for the consortia of its ongoing institutional and scientific projects. Consortia hosted in 2016 included Nanomicrowave (Nanoscale Bioelectrical Characterization group, pages 60-63), The Grail (Biomaterials for Regenerative Therapies, pages 50-55), PrionetSpain (Molecular and Cellular Neurobiotechnology, pages 88-91), Safesens (Signal and Information Processing for Sensing Systems, pages 74-77) and Modulightor (Nanoprobes and Nanswitches, pages 64-67).

February

■ 2 February

NanoMed Spain organises Nano World Cancer Day 2016

The Spanish Nanomedicine Platform (NanoMed Spain, pages 130-131) organised the Spain-based event of the pan-European initiative Nano World Cancer Day on February 2nd.

More than 50 people, including students, scientists and journalists, attended the event at the Faculty of Medicine of the University of Barcelona. Speakers represented the research and clinical points of view on nanomedicine and its range of applications against cancer, as well as organisations such as the Asociación Española Contra el Cáncer (AECC) and companies (Genomica S.A.U.).

Nano World Cancer Day 2016 is a pan-European event organized in the framework of World Cancer Day (February 4th 2016). It amplifies awareness about nanomedicine and its ability to introduce new opportunities and game changers in the fight against cancer. At a European level it was organized by the European Technology Platform on Nanomedicine (page 130) together with the European Project ENATRANS (Enabling NAnomedicine TRANSlation). For this third edition, twelve simultaneous conferences took place in Austria, France, Germany, Greece, Ireland, Italy, Portugal, Netherlands, Spain, Switzerland, Turkey and the United Kingdom.

April

■ 11 April

IBEC International PhD Programme interviews

22 hopeful candidates visited IBEC in April for their interviews for IBEC's International PhD Programme positions.

The candidates, who represented 12 countries, had been selected from the more than 150 applicants who applied for the programme's nine positions, which are supported by Severo Ochoa and La Caixa. It was the first ever time that IBEC had held mass interviews of this type, as the PhD programme is new for this year and forms part of the institute's Strategy for 2014-2017 in the area of attracting the best talent from all over the world via a transparent, open and international selection process.

■ 14 April

Jornada Compra Publica Innovadora

On April 14 NanoMed Spain (pages 130-131) organised a Public Procurement of Innovative Technology (Compra Pública de Tecnología Innovadora, CPTI) event to promote innovation oriented towards the development of new markets from demand through to public procurement in Barcelona.

Representatives for regional and state policies were present at the event, which dealt with the perspective of companies and hospitals from a national and European point of view, success stories, and new opportunities.

■ 26 April

First microbiology conference of the Societat Catalana de Biologia

Bacterial Infections: Antimicrobial therapies group leader Eduard Torrents (pages 108-111) was the co-organizer, along with AGAUR Director Jordi Mas-Catallà, of the first Jornada de Microbiology of the Societat Catalana de Biologia.

Held at the l'Institut d'Estudis Catalans on 26th April, the event aimed in its first edition to connect all groups and researchers working in microbiology and infectious diseases in Catalonia, and to integrate their different areas of knowledge.

■ 27 April

Focus on Cystic Fibrosis

To coincide with National Cystic Fibrosis Day 2016, IBEC and the Catalan Association of Cystic Fibrosis (ACFQ) organized an event, "The present and future of Cystic Fibrosis", on 27th April at the Barradas auditorium in L'Hospitalet de Llobregat.

As part of IBEC's new 'Focus on…' series of out-reach activities, which will highlight diseases for which the institute's researchers are working towards finding solutions, the day raised awareness about and present research results and clinical advances relating to CF, which is one of the most common serious genetic diseases in Catalonia.

IBEC's Bacterial Infections: Antimicrobial Therapies group's (pages 108-111) projects researching the enzyme that promotes the growth of the bacteria linked to this disease, and possible therapeutic targets, has been supported by the ACFQ since 2009.

May

■ 4 May

Feria de empresas (UB)

This careers fair, organized by the University of Barcelona's physics and chemistry faculties, helps undergraduate and master students of these subjects to find out more about potential employers or furthering their studies, as well as improving the university's relations with the business sector. IBEC attended the fair to offer university students advice and information about continuing their career at the institute as graduate, masters or PhD students.

■ 5 May

(re)Search4Talent

The second edition of IBEC's Open Day for students, "(re)Search4Talent", took place in May, and was attended by 84 visitors. The objective of the day was to attract talented students who are at a key moment of their career when they have to decide about their professional future. If they are interested in a research career, the day offers the chance to talk to real researchers and ask questions about day-to-day work in the lab, career paths, work-life balance, mobility and more.

Following the success of 2015's edition and with the feedback received from the participants, both the IBEC members as well as the students, a few improvements were introduced in the organization of the day. Instead of a guided visit to all the IBEC facilities, a small fair was held where the participants were able to find out about all the research groups and, if they were interested in one particular group, they were able to visit that group's facilities.

June

■ 29 June

9th IBEC Symposium

IBEC celebrated its 9th annual IBEC Symposium at Barcelona's AXA Auditorium in June. This year the theme was 'Bioengineering for Active Ageing, which is one of the institute's three main areas of application.

The speakers were Josep Samitier (pages 96-101), Eduard Torrents (pages 108-111) and Raimon Jané (pages 68-73) from IBEC, Paul Verschure from the Universitat Pompeu Fabra, Antoni Bayés-Genís from the Institut del Cor del Germans Trias i Pujol, and International Scientific Committee member Sergio Cerutti from the Politecnico di Milano.

As usual, participants were invited to submit posters, and some were selected to give a flash presentation of their work. The winners of this year's poster and flash prizes were Patricia Prado Peralta from the iP-SCs and Activation of Endogenous Tissue Programs for Organ Regeneration group and Oiane Urra from Biomedical Signal Processing and Interpretation

Martí Checa and Lázaro René Izquierdo of the Nanoscale Bioelectrical Characterization group (pages 60-63) offer advice to students at May's '(re) Search4Talent' open day

respectively.

The symposium was kindly supported by Leica, BioLab, Lasing and Isaza Scientific, who also gave a talk.

Next year's symposium, the tenth, will celebrate the end of IBEC's first decade of operation, looking back at ten years of scientific impact and discoveries.

■ 30 June-1 July

ISC Meeting

June saw the arrival of IBEC's International Scientific Committee for their annual two-day meeting with the directorate. Among other things, the panel of experts from research and industry positively evaluated the first four Junior Group Leaders in IBEC's Tenure Track scheme, with all of them becoming consolidated as Group Leaders at the beginning of 2017.

October

■ 6-7 October

Mechanobiology Across Networks

Mechanobiology Across Networks, the joint meeting of the Spanish Network of Excellence in Mechanobiology and the European Innovative Training Network BIOPOL, was hosted by IBEC in October. IBEC's Pere Roca-Cusachs was co-organiser alongside Miguel Ángel del Pozo of CNIC and Kai Erdmann of the University of Sheffield.

By factoring the role not only of biochemical but also of mechanical signals, the emerging discipline of mechanobiology is reshaping our understanding of molecules, cells, and tissues. The meeting brought together two networks dedicated to this emerging topic.

The meeting featured talks and poster presentations from both senior and junior members of both networks, and addressed fundamental and applied questions in mechanobiology from the perspectives of physics, biology, and engineering. The meeting was also open for attendance to anyone interested in the topic.

■ 27-28 October

Frailty Workshop

On October 27-28, 2016 the School of Telecommunications Engineering at the Technological University of Madrid (ETSIT) hosted the workshop "Frailty: A Societal Challenge in Need of Integrated Solutions" in Madrid. The event was organized by the ETSIT and Abbott Laboratories with the support of EIT Health Spain (page 128), IBEC, and the Spanish Ministry of Economy and Innovation.

More than 80 people, including, engineers, students, geriatricians and other health care professionals attended the meeting, which was intended to deepen the understanding of frailty.

Having fun at the 2016 Christmas celebration

November

■ 11 November

Mecenatge i finançament de la recerca

As director of IBEC and president of ACER (page 135), Josep Samitier took part in the Jornada de mecenatge i finançament de la recerca at the Parlament de Catalunya in November.

■ 22-24 November

NanoBio&Med 2016

NanoBio&Med2016 presented the most recent international developments in the field of Nanobiotechnology and Nanomedicine and provided a platform for multidisciplinary communication, new cooperations and projects to participants from both science and industry. Emerging and future trends of the converging fields of Nanotechnology, Biotechnology and Medicine were discussed among industry, academia, governmental and non-governmental institutions.

NanoBio&Med2016 offered a complete overview into the state of the art in those fields and also to learn about the research carried out and the latest results. The discussion in recent advances, difficulties and breakthroughs will be at his higher level. An industrial forum will be organized to promote constructive dialogue between business and public leaders and put specific emphasis on the technologies and applications in the nanoBioMed sector.

■ 30 November

Advancing Gender Equality and Diversity in Science"

More than 50 people attended a special event organised by IBEC, "Advancing Gender Equality and Diversity in Science". The morning of talks and discussions aimed to raise awareness and reflect on how to balance gender equality, and particularly how institutions, as well as society in general, can address such issues via best practices or other strategies.

The proceedings began with a look at gender and aging stereotypes in society and specifically in science and advertising by marketing and communications consultant Montse Montllau, followed by an examination by CRG Group Leader Dr. Mara Dierssen of more science-based issues such as bias in publishing papers, raising funds and recruitment procedures.

December

■ 20 December

Christmas celebration

Most of the IBEC community attended IBEC's internal Christmas party, which featured an activity organised by the PhD Committee, "Engineering BioChristmas", a tombola and some surprises. In total, the party goers raised €1040 for local cancer charity AFANOC.

Courses and training in 2016

Throughout the year

English classes

English classes at IBEC have two different levels (intermediate and advanced) with an integrated methodology of oral and written expression and grammar. All teachers are native speakers. At the beginning of every trimester (in October, January and April) level test are performed with all new participants who wish to begin with English classes.

English classes are offered for all staff and scientists with an IBEC labour contract, and to all PhD students regardless of contracting institution.

Yoga classes

Yoga classes take place at lunchtimes at IBEC and are open to all the IBEC community. In the classes, participants practice breathing techniques to calm down get positivity back. The postures are devoted to increase the overall strength and flexibility of the body.

Risk prevention

Regular courses focused on job requirements in the laboratory and offices, safety courses and health promotion workshops.

Welcome and Intranet training

Throughout the year, information sessions take place covering key aspects of IBEC and its internal functioning, from the organizational chart, finance, training and events, to where to look or whom to approach for information. These sessions aim to offer newcomers information so that their incorporation into IBEC is as fast and smooth as possible. Likewise, regular training sessions are carried out on the use of the intranet, such as purchases and budget.

February

■ 23 February

How to Write a Competitive Proposal for Horizon 2020

A packed room of project managers, scientists and other professionals from the various entities of the PCB enjoyed Dr. Sean McCarthy's course organized by IBEC and IRB Barcelona, "How to Write a Competitive Proposal for Horizon 2020", on 23rd February. Dr. McCarthy has been involved in all aspects of European Research since 1980 as a researcher, research manager, group leader and company director.

After explaining the context of Horizon 2020 and the process by which EU policies become projects, Dr. McCarthy delivered a comprehensive and exhaustive list of tips and pointers to help scientists and project managers alike ensure that their proposals stand the best chance to be selected. Some sound advice included writing proposals backwards (abstract last), familiarising oneself with the evaluators' checklist before starting to write, becoming an evaulator oneself, and making sure the 'impact' part is written by the actual users. Participants learned to 'sell, not tell' their ideas and to imagine themselves in the evaulators' shoes; with a pile of proposals reaching to the ceiling, how can they ensure that theirs is not one that is immediately cast aside?

Dr. McCarthy also had some sterling advice for scientists going through the ERC selection process. The interview panel will want the answers to five blunt questions: Why bother? Why you? Why now? Will your project establish Europe as an international leader? and Is the knowledge already available?

May

■ 11 May

Leica's European Tour comes to IBEC

IBEC scientists and other staff from the PCB enjoyed some special workshops given by Leica in May. The institute was the host in Spain of Leica's European Tour 2016, which allows researchers to get hands-on with some of the company's most cutting-edge microscopes and other equipment.

The technologies being presented and demonstrated at the workshops were the DMi8 inverted microscope with Fluorescence Recovery After Photobleaching (FRAP) module, their SP8 X Confocal Microscope with WLL and Hybrid Detectors, HyVolution confocal super-resolution imaging, and the Leica TCS SP8 with Digital LightSheet. Researchers were able to test their own samples in these pieces of equipment.

June

■ 6-8 June

Oral Skills in English – Say it so it Stays

A workshop in oral presentation skills for 12 PhD and masters students by Dr. Elinor Thomson, which aimed to improve their effectiveness and confidence when presenting their science to their peers.

The course contents included: what makes a science presentation really effective; realise the importance of the audience; understand the key steps in preparation; clarify the importance of message and purpose; find story techniques to enhance engagement; develop and use visual aids appropriately; performance skills, identify strengths and weaknesses; strengthen critical awareness of features of successful presentations.

July

■ 13 July

Image J and Video Processing

With the support of the PhD Committee, HR organized a Workshop in Basic concepts in Image J for image analysis and quantification. The course aimed to help PhD students, master students and postdocs to achieve basic skills in the analysis and quantification of microscopy images using ImageJ.

Contents of the Workshop included understanding image properties; transformation (cropping, removing background, filters, etc); quantification (intensity profiles, types of measurements); opening image sequences; transformation (drift, slice selection, background, walking average) and quantification (kymographs, tracking, montage) of videos and generating them for publication; and plugins.

Pere Roca-Cusachs (pages 92-95), Cellular and Molecular Mechanobiology group leader at IBEC, taught the course. Pere's expertise in ImageJ comes mostly from his time as postdoctoral researcher at the lab of Michael Sheetz, Columbia University, where he used the software for day-to-day image analysis and data processing.

September

■ 14-15 September

Workshop on Grant Writing

This two-day workshop was focused on applying for competitive grants. The main objective was to significantly increase participants' chances of obtaining research funding. The 12 participants – group leaders, senior researchers, senior postdocs and project managers – acquired a set of practical tools and methods to facilitate the grant writing process, giving them a competitive advantage.

Topics covered included, among others, how to take into account the evaluators view; how to match your proposal to the call; how to structure: the why, what and how of proposal writing; time management, and finding the right partners.

■ 20 September

Statistical concepts for research

The aim of this workshop was to introduce statistical techniques to study, analyze and interpret data to the 17 PhD, master student and postdoc participants. It covered different statistical techniques to analyze the datasets that result from experiments, and was taught by Beatriz Giraldo, senior researcher in IBEC's Biomedical Signal Processing and Interpretation group (pages 68-73).

Dr. Sean McCarthy's course organized by IBEC and IRB Barcelona, "How to Write a Competitive Proposal for Horizon 2020", attracted project managers, scientists and other professionals

■ 28 September

Data visualization

This workshop's aim was to provide participants with an accessible and comprehensive introduction to data visualisation – the visual analysis and communication of data. The course provided the 22 PhD student and postdoc attendees with an accessible and comprehensive introduction to data visualisation and infographic design.

The workshop's content covered challenging existing thinking about creating and consuming visualisation design; what make 'good' design; the range of analytical and design options such as chart types, annotation, colour applications, and composition; a foundation of design principles and practical guidelines; ideas to broaden visual vocabulary; and a road map for developing data visualisation capabilities.

Trainer Andy Kirk is a leading data visualization specialist. His teaching activities extend to visiting lecturers positions at the Maryland Institute College of Art (MICA, USA) and at Imperial College (UK), delivering data visualization modules on Masters programmes in both cases. Andy is the author of two books, with his most recent published by SAGE in June 2016 and titled "Visualising Data : A Handbook for Data Driven Design".

October

■ 6 and 13 October

Becoming a scientific writer: putting 'why' before 'how'

The aim of this workshop was to help publishing scientists (11 PhDs, postdocs and senior researchers) develop a more impartial, analytical view of their own writing behaviour and of their readers' perception of the finished product; to ask 'why should I write it like this'? and to try to understand and connect with the readers' minds. Trainer Dr. Gavin Lucas is a scientist with over 14 years of experience in biomedical research and publishing, and seven years of experience as a freelance editor, translator and consultant.

■ 26 October

Good practices in a multi-disciplinary lab

This workshop trained 21 young scientists and students in the good practices necessary in a multi-disciplinary laboratory to ensure the highest quality of research results. It was taught by IBEC's risk prevention representatives who followed the process of performing an experiment, from previous planning until the moment of leaving the bench.

Sessions were organized into two parts. The

In October's "Good practices in a multi-disciplinary lab", young scientists and students learnt the practices necessary in a multidisciplinary laboratory to ensure the highest quality of research results

first covered good practices from the moment a researcher arrives to the bench and starts working until the end of the experiment. In the second part, participants had to deal with different daily lab situations in a simulated bench. This part was highly interactive, including games and discussions.

November

■ 2, 4, 8 and 10 November

Learning to write clearly: the 'how' of good scientific writing

Converting large amounts of complex information into clear, well- structured text is a major challenge in scientific writing. The aim of this workshop was to help participants improve their writing skills through awareness of the elements of clear writing. This workshop provided a nuts and bolts approach to effective communication through writing to 13 PhDs and postdocs. It combined basic theoretical knowledge with practical, step-by-step exercises. Emphasis was placed on how to arrange words, sentences and paragraphs into coherent units of thought.

Trainer Carolyn Newey is an editor, trainer and consultant who has been editing biomedical texts in close collaboration with scientists and physicians in Barcelona for over 20 years.

IBEC Seminars and PhD Discussions

Throughout the year, 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.

In addition, the PhD Discussions Sessions 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 2016, ten PhD students presented their work in these sessions. Additionally, in order to help IBEC students in their career development and provide them with additional skills, invited speakers gave lectures on 'Scientists and popularisers: challenge and responsibility', 'Technology Transfer: how to bring science to the market' and 'Career progression in science - options beyond the bench' (jointly with PCB and IRB).

■ 26 January

Michael Schmuker
School of Engineering and Informatics, University of Sussex, Falmer, Brighton, United Kingdom
Neural computation in odour space

■ 28 January

Josep Roca
University of Barcelona
From Systems Understanding to Personalized Medicine: Lessons and Recommendations based on a multi-disciplinary and translational analysis of COPD

■ 5 February

Josef A. Käs
Principal Investigator & Head of the Soft Matter Physics Division, Leipzig University
Why do rigid tumours contain soft cancer cells?

■ 11 March

Samuel Ojosnegros
Centre de Medicina Regenerativa de Barcelona
Imaging Eph/ephrin cell-cell communication through Enhanced Number and Brightness: a novel method for the study of protein aggregation

■ 18 March

Mateu Pla
Coordinator of the Nanotechnology Platform (pages 116-121), IBEC
What can we do with our 3D Bioprinter?

■ 6 April

Nick Brown
Dept of Physiology, Development and Neuroscience University of Cambridge
Linking cell adhesion receptors with the cytoskeleton in morphogenesis

■ 15 April

Jaume Veciana
Institut de Ciència de Materials de Barcelona (CSIC) and Networking Research Center on Bioengineering, Biomaterials and Nanomedicine (CIBER-BBN)
Multifunctional molecular nanovesicles. A new challenge for drug delivery

■ 26 April

Wieteke de Boer
Departments of Biological Sciences and Neuroscience, Columbia University, New York
Optical activation of neurons through low power two-photon IR excitation of gold nanoparticles

■ 19 May

Gabriel Gomila
Group Leader, Nanoscale Bioelectrical Characterization group (pages 60-63), IBEC
The new IBEC Bio-AFM system: system's

Coordinator of the Nanotechnology Platform (pages 116-121) Mateu Pla outlines the capabilities of IBEC's 3D bioprinter

performance, applications and user's guide

■ 20 May

Xavier Fernández-Busquets
Head of the Nanomalaria Joint Unit (IBEC/Barcelona Institute for Global Health) (pages 56-59)
A Short (Hi)story of Malaria

■ 26 May

Isaac Gállego
Georgia Institute of Technology, Georgia, USA
DNA Nanotechnology: from its Applications to the Self-Assembly in Alternative Solvents

■ 12 July

Shulamit Levenberg
Faculty of Biomedical Engineering, Technion, Haifa, Israel
Engineering Vascularized Tissue Constructs

■ 10 October

Alexia-Ileana Zaromytidou
Chief Editor, Nature Cell Biology/Nature Research
Publishing in the Nature journals

■ 13 October

David Lagares
Harvard Medical School
Targeting fibroblast durotaxis as anti-fibrotic therapy

■ 13 October

Maria Lluch Senar
Staff Scientist, Centre for Genomic Regulation
Scaling up in Systems Biology: from a minimal cell to microbiomes

■ 16 November

Silvia Muro
Fischell Department of Bioengineering and Institute for Bioscience and Biotechnology Research, University of Maryland
Nanobio-technology for drug delivery: fundamental aspects and translational applications

■ 18 November

Alvaro Mata
Director of the Institute of Bioengineering at Queen Mary University of London
Enabling technologies for biofabrication of functional materials and biomimetic environments

■ 22 November

Herbert Levine
Director, Center for Theoretical Biological Physics (CTBP)
Models of individual and collective cell motility

Outreach activities in 2016

Throughout the year

Group visits

Throughout the year, 17 groups of students from high schools in Barcelona and Catalonia visited IBEC, with a total number of 380 participants. Some of these visits were part of the ESCOLAB programme, an initiative of the City Council of Barcelona, which introduces groups high school students into the city's research laboratories to encourage scientific vocation.

In addition, visits to IBEC included a group of students from Cambridge University, American biomaterials students from the University of Perpignan, another group from the University of Texas, and twelve students from the UPC's biomedical engineering department.

These visits couldn't happen without the volunteer researchers from IBEC that generously offer their time to host the guests.

Entrevistas de Bachillerato

An initiative at IBEC to help nurture the scientific minds of the future, the Entrevistas de Bachillerato, pairs high school students with IBEC PhD students to talk about subjects such as nanotechnology for the pupils' final baccalaureate work. Five such one-to-one encounters took place throughout 2016, with IBEC's young researchers resolving questions and doubts and sharing new ideas to help with the school projects.

Research placements for students

This scheme offers high school students the opportunity to have their research projects be assessed by a tutor and to gain hands-on experience in a laboratory. IBEC volunteers looked after a total of 17 students in 2016.

Some of these students came to IBEC as part of the PCB's Recerca a Secundària initiative, addressed to 16-year-olds who are about to begin their research projects at school, and in the framework of Fundació Catalunya-La Pedrera Joves i Ciencia programme, a high school student did his research project at IBEC with Coordinator of the Nanotechnology Platform Mateu Pla (pages 116-121). Other students came as part of the ACER Premi Extraordinari Batxillerat or Passa l'estiu al Parc.

Happy Lab

In February, May and October, there were visits from 127 primary school age students of 10 and 11 years old as part of a new scheme for younger visitors, Happy Lab.

Participation in IBEC's outreach blog

Several researchers contributed interviews to IBEC's outreach blog, http://divulga.ibecbarcelona.eu, which had 85 posts during 2016.

January

■ 15 January

Els divendres de Biologia i Geologia al CESIRE

In a new initiative for teachers organised with CESIRE, the Generalitat's education department, group leader Nuria Montserrat gave a talk to a 51-strong audience, "Desenvolupant estratègies per a la regeneració d'òrgans: A quina distància estem de la realitat?".

February

■ 10 February

"Envelliment humà, on estan els límits?"

IBEC Director Josep Samitier was a speaker at a free public lecture organised by the Secció de Ciència i

Tecnologia de l'Ateneu Barcelonès as part of the association's "+Humans: el futur de la nostra espècie" cycle. He and Joan Guàrdia of the Institut de Recerca Cervell, Cognició i Conducta and psychology professor at the University of Barcelona shared their views on human ageing.

■ 20 February

Ajuts Universitaris

IBEC group leader and ICREA professor Samuel Sánchez was the guest speaker with a talk on "Nanorrobots inteligentes" at a ceremony held at Mon Sant Benet by the Fundació Catalunya-La Pedrera to celebrate their awarding of €1000 each to 255 students who obtained the best entry grades for university.

March

■ 5 March

"Biomaterials: ajudem al nostre organisme a regenerar-se"

Senior researcher Miguel Angel Mateos gave a talk and a workshop in Sant Feliu de Guíxols, "Biomaterials: ajudem al nostre organisme a regenerar-se", one Saturday in March as part of IBEC's ongoing collaboration with the village's council, which began in 2014 with the museum exhibit "Curar-se en salut".

■ 7 March

"Nanorobots de la mà de Samuel Sánchez"

IBEC group leader and ICREA research professor Samuel Sánchez paid a visit to CMU Penyafort-Montserrat college in March to give a talk about nanorobots and their medical applications, including their potential to fight cancer. The school's conference room was filled to overflowing and there was half an hour of questions afterwards, with some students asking to collaborate in Samuel's research or carry out placements in his laboratory.

■ 9 March

Saló de l'Ensenyament

IBEC participated in the Espai Ciència at March's Saló de l'Ensenyament education fair with an activity entitled "El futur de les aplicacions mèdiques: la bioenginyeria".

The Saló de l'Ensenyament is held every year in Barcelona to guide thousands of young people who are on the point of choosing a career. In the Espai Ciència, visitors can participate in workshops and activities to experience live, interactive science demonstrations. The space is an initiative organized by the Catalan Foundation for Research and Innovation (FCRI) with the collaboration of the Fira de Barcelona, where it is held.

April

■ 6 April

Festival de la Nanotecnología

The Smart nano-bio-devices, Nanoprobes and Nanoswitches and Nanomalaria groups all contributed to the first Festival de la Nanotecnología, an initiative jointly organised by the Centres Científics i Tecnològics of the UB (CCiTUB) and held from 4 to 8 April in various parts of Spain (Zaragoza, Donostia / San Sebastián, Barcelona and the Bellaterra Campus of the UAB).

■ 6-9 April

Fira Recerca en Directe

The 'Live Research' fair at Barcelona's CosmoCaixa is organized by the Parc Científic de Barcelona (PCB) with the support of the Obra Social CatalunyaCaixa. It aims to present research to the general public, with researchers demonstrating and explaining their methods and goals in an accessible way. This year volunteers from the Biomaterials for Regenerative Therapies, Cellular and Respiratory Biomechanics, Cellular and Molecular Mechanobiology and Nanomalaria groups all helped out.

■ 8 April

Doctoral ceremony at UAB

IBEC group leader and ICREA research professor Samuel Sánchez was a special guest at the first doc-

The first Festival de la Nanotecnología, an initiative jointly organised by the Centres Científics i Tecnològics of the UB, was held from 4 to 8 April in various parts of Spain

toral and special awards ceremony of the Universitat Autonoma de Barcelona held on 8 April at the Hotel Campus UAB. He gave a talk, 'L'experiència d'un viatge al·lucinant', to the more than 400 audience members in attendance.

■ 27 April

"The present and future of Cystic Fibrosis"

To coincide with National Cystic Fibrosis Day 2016, IBEC and the Catalan Association of Cystic Fibrosis (ACFQ) organized an event on 27th April. As part of IBEC's new 'Focus on…' series of outreach activities, which will highlight specific diseases, the day raised awareness about and presented results and clinical advances relating to CF. Anna Crespo from the Bacterial Infections: Antimicrobial Therapies group (pages 108-111) gave a talk for high school students, and group leader Eduard Torrents participated in the round table.

May

■ 5 May

(re)Search4Talent

The second edition of IBEC's Open Day for students, "(re)Search4Talent", took place in May and attracted more than 50 undergraduate students eager to learn more about work opportunities at IBEC. Additionally, as part of the (re)Search4Talent scheme, university groups visited at other times of the year and enjoyed talks by Smart nano-bio-devices, Mechanics of Development and Disease and Biomaterials for Regenerative Therapies group researchers.

■ 20 May

Pint of Science

Group leader Pere Roca-Cusachs took part in a global science outreach event taking place simultaneously in 9 countries and 50 cities all over the world. The Pint of Science festival aimed to deliver interesting, fun and relevant pub talks on the latest scientific research by the people who carry it out. Pere gave his talk at a packed Sant Antoni bar.

Pint of Science, which was established by a community of postgraduate and postdoctoral researchers at Imperial College in 2012, takes place annually over three days simultaneously in pubs in the UK, Ireland, France, Italy, the US, Australia, Germany and Spain.

June

■ 1, 3 and 8 June

Professors i Ciència

The first two weeks of June saw Vanessa Gil and

BIYSC students getting hands-on experience in the lab

Àgata Mata of the Molecular and Cellular Neurobiotechnology group (pages 88-91) lend a hand at the Fundació Catalunya-La Pedrera's Professors i Ciència course for teachers with the activity "Una finestra al desenvolupament embrionari del sistema nervios".

■ 13 June

Thesis in 3 Minutes

Ana Solorzano from the Signal and Information Processing for Sensing Systems group (pages 74-77) was one of the 10 finalists from 300 participants in the "Thesis in 3 Minutes" competition at the 2016 Jornadas de Cooperación CONACyT-Catalunya.

■ 19 June

Festa de la Ciència

Elena Lantero of the Nanomalaria joint unit (pages 56-59) gave a talk, "Nanotecnologia, una nova arma contra la malària", as part of Barcelona's Festa de la Ciència.

■ 19 & 22 June

RoboCat winners

The eight young winners of the RoboCat competition of the Fundació Princesa de Girona (FPdGi) came to visit IBEC. This competition, which took place at the end of May, required participants to build their own robots with different materials and use any platform to program them. Samuel Sánchez, winner of the FPdGi Award for Scientific Research in 2015, hosted the visitors.

July

■ 11-22 July

Barcelona International Youth Science Challenge (BIYSC)

This year IBEC took part in the Barcelona International Youth Science Challenge (BIYSC 2016), which aims to stimulate scientific talent among young people from all over the world. A hundred undergraduate students aged between 16 and 19 participated in this first edition, which was organised by the Catalunya-La Pedrera Foundation.

IBEC's researchers contributed via the institute's BIYSC project, "Instructive Biomaterials for Regenerative Medicine", coordinated by Biomaterials for Regenerative Therapies group senior researcher Soledad Pérez. IBEC's project was one of ten being offered by research centres in the area within the framework of BIYSC, and one of four that was fully subscribed.

As well as the lectures from leading scientists, BIYSC offered debates and discussions with the directors of international research centres, including IBEC's director, Josep Samitier; visits to centres;

the chance to work on the projects in a lab; and many social activities. Biomaterials for Regenerative Therapies (pages 50-55) group leader Elisabeth Engel gave a talk, "Biomaterials, beyond a simple template" at Mon San Benet as part of the lectures schedule, and nine students came to IBEC's labs to start the hands-on part of the project.

August

■ 8-12 August

Batx2LAB mentoring

In this initiative, organised by the PCB and Catalunya Caixa, an IBEC researcher is assigned as a tutor to secondary school pupils who are starting their A-level/Baccalaureate research projects. This year, Carlos Pérez from the Integrative Cell and Tissue Dynamics group (pages 112-115) mentored a student from the Institut Torras i Bages.

October

■ 11 October and 24 November

"La regeneración de órganos como paradigma de la medicina del futuro"

Group leader Elisabeth Engel from the Biomaterals for Regenerative Therapies group gave a talk to 40 members of the public, "La regeneración de órganos como paradigma de la medicina del futuro", at the CaixaForum Girona in October, and again in November at CaixaForum Zaragoza. Her talk was part of the Fundació La Caixa's series of events for schools and the public featuring experts in various fields.

November

■ 5 November

Jornades d'ensenyament de la biologia i geologia

IBEC contributed to the Jornades d'ensenyament de la biologia i geologia (Conference on the Teaching of Biology and Geology) of the Col·legi Oficial de Doctors i Llicenciats en Filosofia i Lletres i en Ciències de Catalunya, which was organised with the "la Caixa" Foundation and CESIRE, the Generalitat's education department.

Biomimetic Systems for Cell Engineering (pages 78-81) PhD students Maria Valls and Jordi Comelles gave a workshop, "Enginyeria de teixits: estudi i muntatge de bioreactors" at the conference, which is aimed at young science teachers.

■ 15 November

Setmana de la Ciència

An audience of nearly a hundred enjoyed a special public seminar by IBEC group leader and ICREA research professor Samuel Sánchez (pages 102-107). The Smart nano-bio-devices group leader's talk, "Nanorobots de la ciència-ficció a la realitat", which took place in the PCB's Sala Dolors Aleu, was one of this year's Setmana de la Ciència events.

Now in its 21st year, the national Setmana de la Ciència (Science Week) festival, which is organised by the Fundació Catalana per a la Recerca i la Innovació (FCRI), aims to bring research closer to the public with a variety of talks, open days, activities and events happening both in the research centres themselves and elsewhere.

■ 28 November

Dilluns de ciència

Elena Lantero from the Nanomalaria joint unit (pages 56-59) gave a talk, "Nanotecnologia, una nova arma contra la malària" as part of the series "Dilluns de Ciència" at the Residència d'Investigadors in Barcelona.

Selected media coverage in 2016

■ January 18

"Des nanorobots pour lutter contre le cancer"

Following his appearance at Emtech France in Toulouse in December 2015, Samuel Sánchez featured in French daily newspaper *La Tribune*.

■ January 20

"Identificado el mecanismo que evita la perdida de memoria en pacientes de Alzheimer"

The research into Alzheimer's disease being carried out by José Antonio Del Rio's Molecular and Cellular Neurobiotechnology group (pages 88-91) was the subject of a video by UBTV.

■ 1 February

"La manipulación del cerebro con luz se asienta en Barcelona"

IBEC group leader and ICREA research professor Pau Gorostiza featured in an *El Periódico* article about optogenetics, which is booming in Barcelona.

■ February 3

"Seis aplicaciones robóticas que no conocías"

Samuel Sánchez's nanorobots are one of the "Seis aplicaciones robóticas que no conocías" described in an article in *El Pais*.

■ February 8

"Destacan las posibilidades de los virus oncolíticos en el tratamiento del cáncer"

Nano World Cancer Day, organised by the IBEC-led Spanish Nanotechnology Platform NanoMed Spain, was covered in an edition of *Gaceta Médica*.

■ February 9

La Sexta Noche, 06-02-16

IBEC group leader and ICREA research professor Samuel Sánchez was one of two scientists taking part in a studio discussion on La Sexta Noche, in a segment about what it's like to be a talented young scientist or entrepreneur in the financial climate of Spain today.

■ February 16

"Descubrir es encontrar lo que no esperas"

Xavier Trepat and the UPC's Marino Arroyo had their turn at being profiled in *La Vanguardia* as finalists in this year's edition of the newspaper's Science Award.

■ February 16

"Más cerca de la impresión de órganos en 3D"

IBEC Director Josep Samitier gave his expert opinion in an *El Español* article about the future of 3D printing applied to biomedicine.

■ February 24

"Micromotores, el próximo paso en el transporte de fármacos"

Samuel Sánchez's *Nature Communications* paper on micromotors that use surface variations for dock-


"Descubrir es encontrar lo que no esperas"

Marino Arroyo y Xavier Trepat

MARINO ARROYO

XAVIER TREPAT

Xavier Trepat and the UPC's Marino Arroyo profiled in *La Vanguardia* as finalists in this year's edition of the newspaper's Science Award

ing and guiding was the subject of an article in *El Mundo*.

■ March 2

"El sueño de un cuerpo recambiable"

La Vanguardia published a long article about the potential of 3D printing in biomedicine, speculating whether the dream of being able to 'print' spare parts for the body – new eyes, ears, limbs and even organs – is already within reach.

■ March 11

"Trabajar con cápsulas mil veces más pequeñas que el cabello humano"

Samuel Sánchez and the part of his lab that resides at the MPI for Intelligent Systems in Stuttgart feature in a chapter of a video series by *El Pais*, *La Carrera Especial*. In the video, Andrea Escobar, chemistry student Universidad Complutense de Madrid, spends 48 hours in Samuel's lab.

■ March 30

"Nanotecnólogo médico, guía de la información y maestro de emociones"

Samuel Sánchez featured on Oficiorama, a programme devoted to the technology of the future, which airs on TV2 on Saturdays.

■ April 11

"El tumor segresta cel.lules sanes perquè el portin fins a un altre òrgan a fer metàtasi"

Xavier Trepat was interviewed by Antoni Bassas, one of Catalunya's most eminent journalists, for the magazine *ARA*.

■ April 13

"Graphene Microbots Built to Scour Water of Heavy Metals"

Samuel Sánchez's *NanoLetters* paper about self-propelled tiny 'microbots' that can remove lead from contaminated water got lots of coverage by news channels such as Discovery News and Phys.org.

■ April 28

"Los ratones de laboratorio tienen frío, trasnochan y están demasiado limpios"

Crean moléculas que restauran la visión en retinas degeneradas

●●● La revista Nature publica la investigación ●●● El descubrimiento abre el camino a tratamientos revolucionarios, pero aún queda lejos la aplicación en humanos.

Las moléculas se pueden activar o desactivar mediante

Press coverage of Pau Gorostiza's group's *Nature Communications* paper describing their development of molecules that can be applied as light-regulated molecular prostheses to help restore vision in cases of retinal degeneration

La Vanguardia published a special report on animal experimentation in their 'Big Vang' science section.

■ May 4

"El present i el futur de la Fibrosi Quística"

The news programme L'Informatiu in L'Hospitalet featured the Cystic Fibrosis event, "El present i el futur de la Fibrosi Quística", that was organised by IBEC and the ACFQ on 27th April.

■ May 19

"Pepinos, algas y esponjas marinas para curar la malaria"

The *Sci Rep* paper by the IBEC/ISGlobal joint Nanomalaria unit got lots of news coverage, including in *La Vanguardia's Big Vang* science section.

■ May 20

Two bacteria papers in the news

Two papers from Eduard Torrents and Antonio Juárez on how bacteria can cause chronic infections and new bacterial virulence markers in *E. coli* respectively got some press coverage.

■ May 25

"La revolución de los organoides"

Muy Interesante magazine featured an article about organoids, three-dimensional cell/ tissue cultures which mimic organ structure and function, and quoted Nuria Montserrat as an expert opinion.

■ June 6

"Taller sobre la cél·lula"

The Escola Ausiàs March's May visit to IBEC featured on the BTV programme CataKrac.

■ June 29

"Más cerca de generar corazones bioartificiales"

An article about Nuria Montserrat appeared in *El Mundo* following her invovlement in a study in which the first human heart grafts from human pluripotent stem cells were generated.

■ July 1

"Continguts divulgatius de l'IBEC"

RECERCAT, the research-related newsletter pro-

duced by the Generalitat, featured an article about IBEC's outreach activities.

■ July 7

"Investigadors ICREA: el motor de la recerca catalana des de fa 15 anys"

Samuel Sanchez featured in an article in *ARA* magazine which marks the 15th anniversary of ICREA.

■ July 14

"Els Premiats FPdGi conversen amb l'humorista Juan Carlos Ortega"

A round table discussion involving Samuel Sánchez, last year's winner of the Princess of Girona Foundation (FPdGi) Award for Scientific Research, and other former winners was filmed at the FPdGi 2016 awards ceremony in Girona.

■ July 22

"La Masia de la ciencia"

This summer's Barcelona International Youth Science Challenge (BIYSC 2016), a new initiative that aims to stimulate scientific talent among young people, was covered in *La Vanguardia*, with the photo accompanying the article taken at IBEC.

■ July 26

"Crean moléculas que restauran la visión en retinas degeneradas"

There was lots of press coverage of Pau Gorostiza's group's *Nature Communications* paper describing their development of molecules that can be applied as light-regulated molecular prostheses to help restore vision in cases of retinal degeneration.

■ September 27

"Alianza contra el cáncer"

The news about the consortium comprising pharmaceutical company Ferrer, IBEC and the bioinformatics company Mind the Byte to study the development of new therapeutic molecules against cancer metastasis was covered in several national newspapers.

■ September 28

"El futuro en 3D"

La Sexta broadcast the documentary "El futuro en 3D" about the different options offered by 3D printing.

■ October 11

La 1: Telediario, 05/10/16

Group leader Samuel Sánchez appeared on Telediario, channel 1's news programme, commenting about the work of the Nobel Prize winners for chemistry, which were announced in the first week of October.

■ October 18

TV3, "Límits als avenços mèdics"

IBEC group leader and ICREA professor Xavier Trepat was a panel member alongside IRB director Joan Guinovart, doctor of philosophy Begoña Roman, and UAB professor of psychiatry Adolf Tobeña, on Els Matins de TV3.

■ October 20

La 2: Tips, 19/10/16

Group leader and ICREA professor Samuel Sánchez appeared as a guest on the La 2 magazine programme *Tips*.

■ December 21

EUCYS 2016: Miquel Bosch

A video of an interview of Miquel Bosch, a Marie Skłodowska-Curie fellow in the Nanoprobes and Nanoswitches group, talking about his research on drugs activated by light and demonstrating with a home-made cockroach armed with a light sensor.

PhD theses defended in 2016

PhD theses defended in 2016

The data shows the date of the defence, the name of the student, his or her group at IBEC, the title of the PhD thesis and the awarding body.

■ 22/01/16

Silvia Pittolo
Nanoprobes and Nanoswitches (pages 64-67)
"Development of light-modulated allosteric ligands for remote, non-invasive control of neuronal receptors"

■ 25/01/16

Luis Fernandez
Signal and Information Processing for Sensing Systems (pages 74-77)
"Understanding the role of sensor diversity and redundancy to encode for chemical information in gas sensor arrays" (UB)

■ 26/01/16

Xavier Puñet
Biomaterials for Regenerative Therapies (pages 50-55)
"Design and Fabrication of Functionalized High Porous Poly(lactic acid)-based Scaffolds for Tissue Engineering" (UPC)

■ 29/01/16

Ariadna Bartra
Signal and Information Processing for Sensing Systems (pages 74-77)
"Detecció d'estats inadequats per la conducció de un vehicle a partir de la degradació del control dinàmic" (UB)

■ 03/02/16

Isil Tekeli
Control of Stem Cell Potency (former group)
"Bioengineering approach to study the role of cell migration during zebrafish heart regeneration"

■ 19/04/16

Albert Hernansanz
Robotics (former group)
"Multi-robot cooperative platform: a task-oriented teleoperation paradigm" (UPC)

■ 06/05/16

Anita Joanna Kosmalska
Cellular and Molecular Mechanobiology (pages 92-95)
"Physical principles of membrane remodeling during cell mechanoadaptation" (UB)

■ 13/05/16

Xavier Gómez
Nanoprobes and Nanoswitches (pages 64-67)
"Design, synthesis and characterisation of photoswitchable allosteric modulators of metabotropic glutamate receptors" (UB)

■ 15/07/16

Manuel Lozano
Biomedical Signal Processing and Interpretation (pages 68-73)
"Multichannel analysis of normal and continuous adventitious respiratory sounds for the assessment of pulmonary function in respiratory diseases" (UPC)

■ 27/10/16

Oiane Urra
Robotics/Biomedical Signal Processing and Interpretation (former group/pages 68-73)
"Analysis of the interlimb similarity of motor patterns for improving stroke assessment and neurorehabilitation" (UPC)

■ 07/11/16

Luis Estrada
Biomedical Signal Processing and Interpretation (pages 68-73)
"Evaluación no invasiva del impulso neural respiratorio y su relación con la respuesta mecánica mediante el análisis de señales electromiográficas de músculos respiratorios" (UPC)

PhD theses defended in 2016

■ 14/11/16

Themis Toumanidou
Biomechanics and Mechanobiology (former group)
“Finite element simulation of the healthy and degenerated lumbar spine. Interplay between muscle activity and intervertebral disc multiphysics” (UPC)

■ 13/12/16

Lluís Rigat
Nanobioengineering (pages 96-101)
“Organ-on-a-chip microfluidic devices mimicking human splenic functions” (UB)

■ 14/12/16

Noelia Campillo
Cellular and Respiratory Biomechanics (pages 86-87)
“Cellular responses to intermittent hypoxia: a lab-on-a-chip approach” (UB)

■ 16/12/16

Juan Jose Uriarte
Cellular and Respiratory Biomechanics (pages 86-87)
“Multi-scale lung tissue mechanics in a mouse model of marfan syndrome” (UB)

■ 20/12/16

Maria Chiara Biagi
Nanoscale Bioelectrical Characterization (pages 60-63)
“Nanoscale electrical characterization of biological matter at microwave frequencies” (UB)

■ 21/12/16

Marc Van der Hofstadt
Nanoscale Bioelectrical Characterization (pages 60-63)
“Hygroscopic properties of single bacterial cells and endospores studied by electrostatic force microscopy” (UB)

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Picture credits: IBEC's Communications and Outreach Unit; Ricard Badia; Marc Vergés; Jordi Anguera; the staff and scientists of IBEC.

Cover (upper image): Cross-section of electrospun PLA hollow nanofibers by focused ion beam. Oscar Castaño, Biomaterials for Regenerative Therapies group (pages 50-55).

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