



## IBEC year-by-year: major milestones

### 2007

#### **First ERC grant won by an IBEC researcher**

Pau Gorostiza of the Nanoprobes and Nanoswitches group was awarded a Starting Grant from the then newly-established European Research Council (ERC) to study neurosecretion by remote control of exocytosis and endocytosis with light, one of only 201 successful proposals from 9,167 submissions.

#### **First Nature paper**

*X. Trepap, L. Deng, S. S. An, D. Navajas, D. J. Tschumperlin, W. T. Gerthoffer, J. P. Butler, J. J. Fredberg (2007). Universal physical responses to stretch in the living cell. Nature, 447, 592-595*

### 2008

#### **First spin-off**

Aleria Biodevices was the first spin-off to come out of IBEC. The company developed tools to measure the electrical activity of neurons *in vitro*.

#### **First Science paper**

*P. Gorostiza, E. Y. Isacoff (2008). Optical switches for remote and noninvasive control of cell signalling. Science, 322, 395*

### 2009

#### **Nature Physics study sheds light on cell movement in development and disease**

Xavier Trepap found that collective cell mobility is the result of a cooperative process in which each cell contributes to the movement of the group, stretching to those around with a mechanism similar to a tug-of-war.

*Trepap, X., et al (2009). Physical forces during collective cell migration. Nature Physics, 5 (6): 426-430*

#### **First EU-funded project coordinated at IBEC**

BOND, or Bioelectronic Olfactory Neuron Device, proposed a new bioelectronic nose based on olfactory receptors. It was made up of a multidisciplinary European consortium of eight partners.

### 2010

#### **First joint research unit**

IBEC and the Centre de Recerca en Salut Internacional de Barcelona (CRESIB, now ISGlobal) established of a mixed unit of personnel from both institutes aimed at developing diagnostic and therapeutic nanomedicine-based systems to be applied to malaria – the Nanomalaria group.

### 2011

#### **Two Nature papers for the Nanoprobes and Nanoswitches group**

In a study published in *Nature Chemistry*, the Nanoprobes and Nanoswitches group and researchers at ICMAB characterized a robust molecular switch in solution that operates at very

low voltages, can be ‘patterned’ by electrical input and has exceptionally high long-term stability, reversibility and reproducibility, offering a very promising platform for use in memory devices.

*Simao, C. et al. (2011). A robust molecular platform for non-volatile memory devices with optical and magnetic responses. Nature Chemistry, 3 (5), 359-364*

Flick a switch, turn a knob or pull a lever and you’re operating an electromechanical device, albeit a complex one. Ismael Díez, a researcher in IBEC’s Nanoprobes and Nanoswitches group, broke new ground with a proven concept for the first such electronic component to operate using just a single-molecule electrical contact.

*Diez-Perez, I. et al (2011). Controlling single molecule conductance through lateral coupling of  $[pi]$  orbitals. Nature Nanotechnology, 6 (4), 226-231*

### **Plithotaxis: how crowds of cells find their way**

IBEC’s Integrative Cell and Tissue Dynamics group collaborated with Harvard investigators to come up with a brand new concept in biology, plithotaxis, which describes the way in which each cell pushes and pulls on its neighbours in a chaotic ‘dance’, yet moving the whole cooperatively in its intended direction.

*Trepat, X. and Fredberg, J. J. (2011). Plithotaxis and emergent dynamics in collective cellular migration. Trends in Cell Biology, 21 (11), 638-646*

## **2012**

### **Start of Tenure Track at IBEC**

In 2012 IBEC implemented its Tenure Track procedure, in which existing or new senior researchers are established on a career path that depends on regular evaluation.

### **Heads together with industry to develop driving app**

IBEC, UB and industry partner Ficosa joined forces to develop a new technology to combat dozing off when driving. The drowsiness alerter, Somnoalert, is an app that uses inertial sensors and GPS data to detect movements that are characteristic of nodding off at the wheel, such as deviation from the driving lane, or sudden corrections. By 2016, IBEC’s Signal and information processing for sensing systems group, led by Santiago Marco, would be proud to see their invention appearing in the new Lexus RX, known as a “Sway Warning”, following its commercialisation.

## **2013**

### **All change at the top**

The departure of founding director Josep A. Planell was followed by the appointment of Josep Samitier as new director.

### **Launch of Core Facilities**

The acquisition of the Nanotechnology Platform from the Park Científic de Barcelona was part of the institute’s longer-term strategic plan to create new scientific–technical facilities in nanofabrication and bionanocharacterization.

### **Pioneering breakthrough in drugs controlled by light**

Pau Gorostiza from IBEC and Ernest Giralt from the Institute for Research in Biomedicine (IRB) had a breakthrough in the development of light-regulated therapeutic molecules. The

scientists synthesized two peptides which, on irradiation with light, change shape, thereby allowing or preventing a specific protein-protein interaction. The researchers highlighted the immediate applicability of these molecules to study, for example, in vitro endocytosis in cancer cells – where this process is uncontrolled – which would allow selective inhibition of the proliferation of these cells.

*Nevola, L., et al (2013). Light-regulated stapled peptides to inhibit protein-protein interactions involved in clathrin-mediated endocytosis. Angewandte Chemie - International Edition 52, 30, 7704-7708*

## 2014

### First IBEC/industry joint unit

IBEC's first joint unit with industry alongside Genomica S.A. was launched in 2014. It is based at IBEC, and aims to develop and bring to market point-of-care diagnostic products and other medical devices and technologies.

### First functional human 'splenon-on-a-chip'

Scientists from Nanobioengineering and ISGlobal's research centre CRESIB designed the first-ever functional 3D splenon capable of reproducing the function of the spleen – filtering red blood cells. In the study published in *Lab on a Chip*. They described creating a microscale platform that reproduces the physical and hydrodynamic properties of the functional unit of the splenon, or splenic red pulp, including two flow-division channels to recreate the closed-fast and open-slow microcirculations of the blood in the spleen. The device was tested with healthy and malaria-infected human red blood cells, and may serve to investigate potential drugs for malaria and other blood disorders.

*Rigat-Brugarolas, L. G. et al (2014). A functional microengineered model of the human splenon-on-a-chip. Lab on a Chip 1410, 1715-1724*

### Uncovering a basic mechanism in breast cancer

In a study published in and featured on the cover of *Nature Materials*, researchers in IBEC's Cellular and Respiratory Biomechanics group and London's Barts Cancer Institute demonstrated how the molecules that cells use to attach to their environment, integrins, allow cells to detect and adapt to tissue rigidity, one of the first signs of tumor development.

*Elosegui-Artola, A et al. (2014). Rigidity sensing and adaptation through regulation of integrin types. Nature Materials, 13 (6): 631-637*

## 2015

### Severo Ochoa success

2015 will always be memorable as the one in which IBEC received the Severo Ochoa Excellence Award, becoming the nineteenth Spanish centre to do so. The award, a huge milestone in the evolution and consolidation of IBEC, was presented at a ceremony at MINECO in Madrid in July.

### Human Resources Excellence in Research

We received the 'Human Resources Excellence in Research' stamp from the European Commission, in recognition of our commitment to continuously improving our HR policies in line with The European Charter of Researchers and The Code of Conduct for the Recruitment of Researchers (Charter and Code). We were one of just ten CERCA institutes to have received the award; in Spain as a whole, only 21 institutions were recognized.



### **Banc Sabadell Award for Biomedical Research**

ICREA research professor Xavier Trepap, leader of the Integrative Cell and Tissue Dynamics group, was named winner of 2015's Banc Sabadell Award for Biomedical Research for his work on understanding the fundamental biophysical mechanisms underlying cell interaction and communication. As a physicist, he was the first ever non-life scientist to win the award.

### **3D bioprinter**

With the acquisition of a 3D bioprinter, the only one with the precision and characteristics required for regenerative medicine purposes in southern Europe and one of very few on the continent, researchers will be able to add biological properties to implanted tissues such as bone, and may eventually be able to manufacture entire organs for transplantation. By offering this possibility to its researchers as well as to companies and scientists across the region and beyond, IBEC stands at forefront of a new revolution in regenerative medicine.

### **Genetic “editing” to fight inherited disease**

Researchers at IBEC participated in a study that used molecular “scissors” to remove mitochondrial mutations in mouse eggs. In the study, published in *Cell*, researchers developed a simple technique to eliminate mitochondrial mutations in eggs or embryos at an early stage of development. The researchers focused on two types of molecules – nucleases – that can be designed to cut specific DNA strands and function like a sort of “molecular scissors”. A team at the Salk Institute, which led the research, designed nucleases that only cut the mitochondrial DNA in eggs or embryos containing mutations that cause disease, leaving healthy mitochondria intact. Nuria Montserrat contributed the characterization and design of cellular systems used. Reddy, P. et al (2015). *Selective elimination of mitochondrial mutations in the germline by genome editing. Cell* 1613, 459-469

## **2016**

### **Premi Nacional de Recerca al Talent Jove**

Samuel Sánchez received the 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).

### **Presenting the fruits of a collaboration**

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.

### **Resolution of a long-standing chemistry enigma**

Publishing in *Nature*, the Nanoprobes and Nanoswitches group announced one of the biggest breakthroughs of the period with their new way of catalysing chemical reactions by applying an electric field between 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, and the study provided experimental evidence for this for the first time.

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

### **Cells move en masse towards rigid tissues**

In a study published in *Science*, Xavier Trepat's group 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; 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, as cells need to physically interact with each other to transmit information collectively in order to move.

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

### **Record-breaking nanojets that use safe fuel**

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.

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