IBEC
Institute for Bioengineering of Catalonia

EXCELENCIA
SEVERO
OCHOA

Institute for Bioengineering of Catalonia (IBEC)

Engineering solutions for health

Who are we?

The Institute for Bioengineering of Catalonia (IBEC) is a **multidisciplinary research centre** in **bioengineering** and **nanomedicine**

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19
research groups
251
researchers and staff
from
21
different countries
496
media appearances
859
scientific publications
Clinical translation
20
patents
4 *iCrea
research professors
11
erc
grants
An interdisciplinary
research centre focused on
bioengineering for
- future medicine
- active ageing
- regenerative therapies
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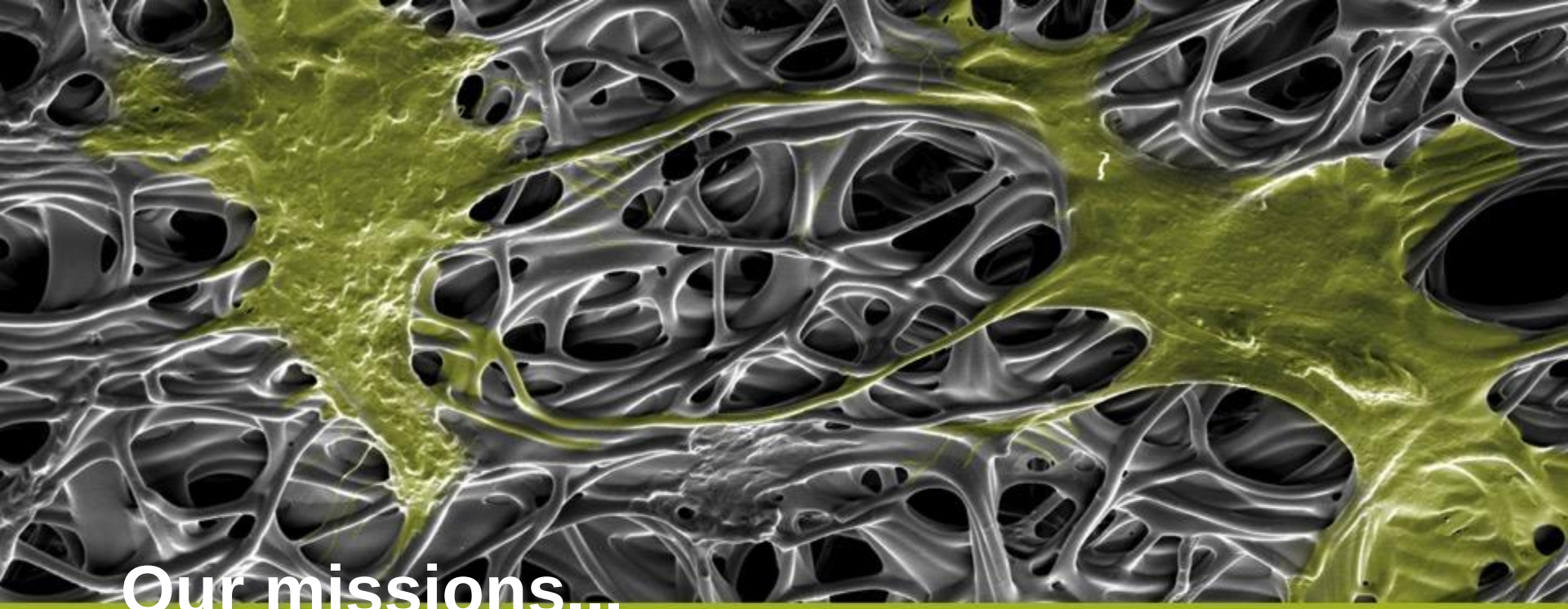
www.ibecbarcelona.eu



Our missions...

Basic and interdisciplinary research in bioengineering and nanomedicine

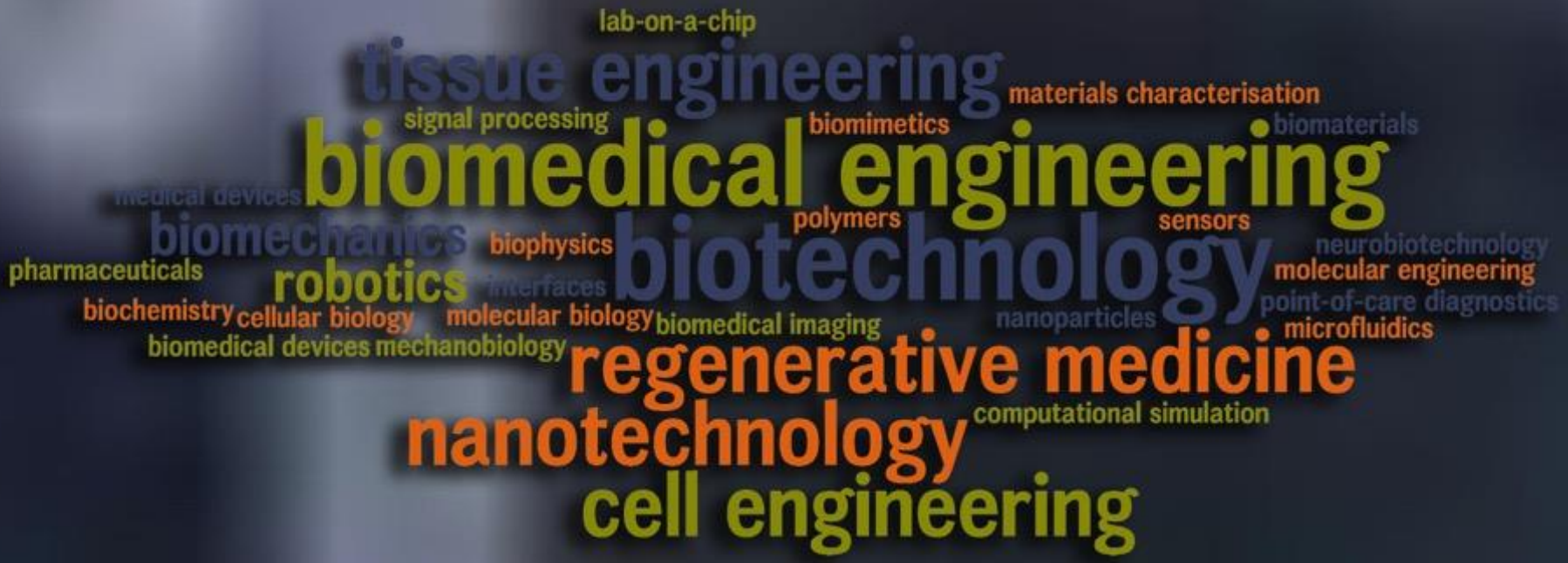
Knowledge and technology transfer to the biomedical sector

Collaborations with international academia, hospitals and industry

Training the next generation of experts in healthcare technology

Improving health and quality of life

Multidisciplinary research:
Fusion of basic sciences and life sciences with engineering



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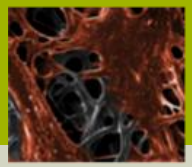
Engineering Solutions for Health

IBEC's diverse research interests can be divided into three targeted areas of knowledge –

Nanomedicine, Cell Engineering, and ICT for Health

Bioengineering for Active Ageing

- Telehealth
- Telecare
- Non-invasive sensing systems
- Age-related disease
- Antibiotic resistance



Bioengineering for Regenerative Therapies

- 3D bioprinting
- Stem cell engineering
- Intelligent scaffolds
- Cell/tissue interactions with biomaterials
- Cell niches

Bioengineering for Future Medicine

- Precision medicine
- Cross-disciplinary technologies
- Photopharmacology
- Organ on chip
- Mechanobiology
- Nanorobotics

These 3 ‘Bioengineering pillars’ promote interaction between IBEC's multidisciplinary groups and help the institute's research remain application-oriented.

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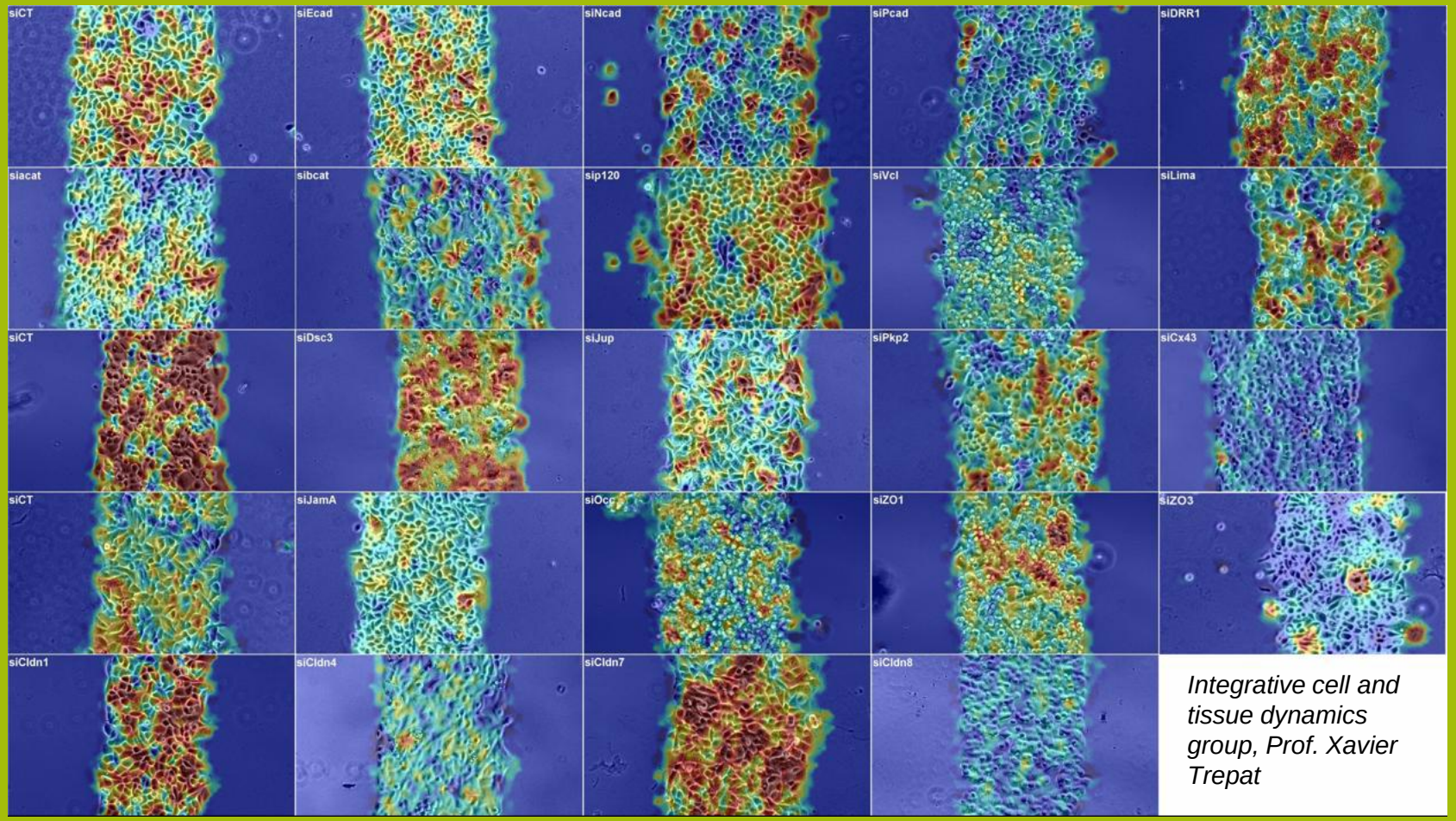
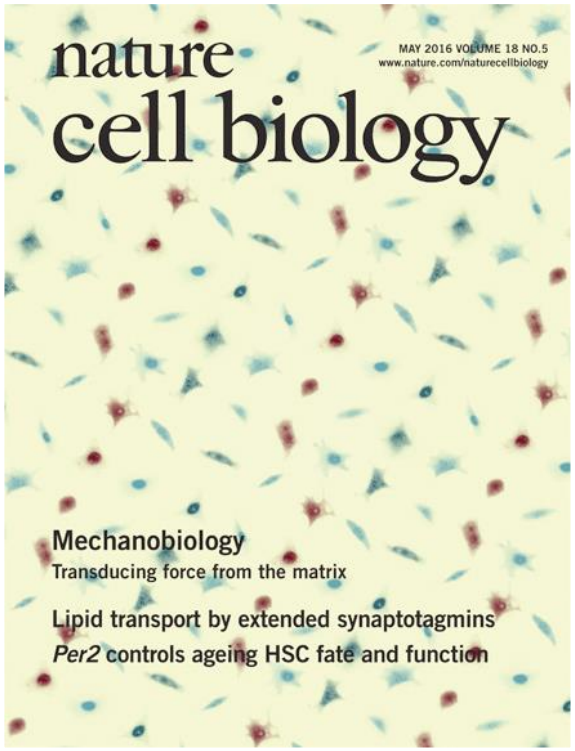
Cell mechanobiology



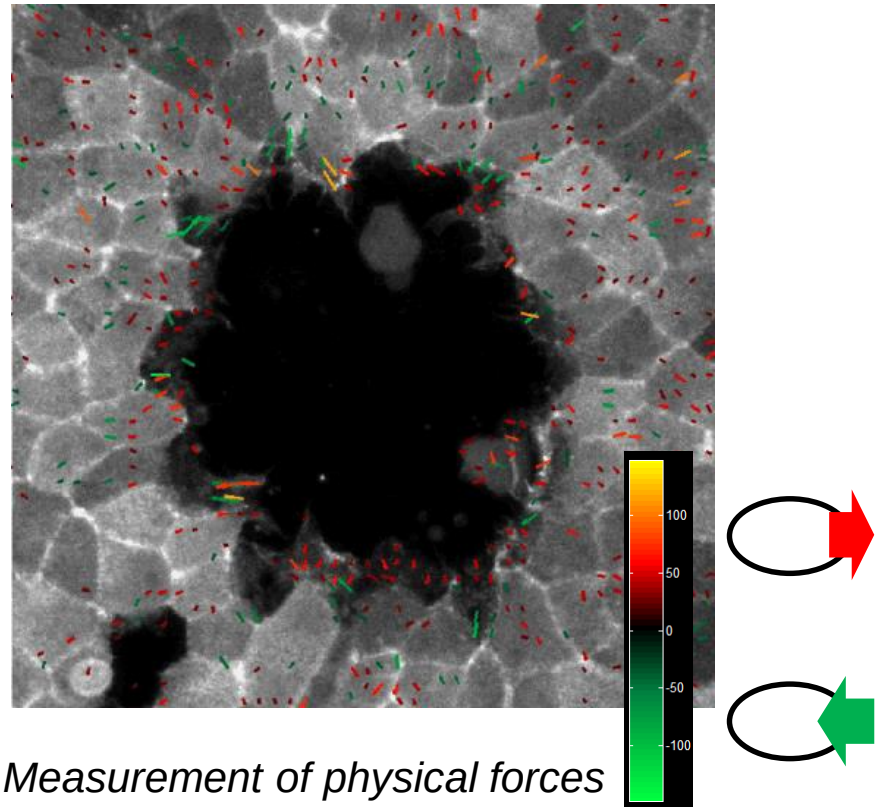
Integrative cell and tissue dynamics group, Prof. Xavier Trepat

Cell mechanobiology



Key protein has potential as cancer repressor

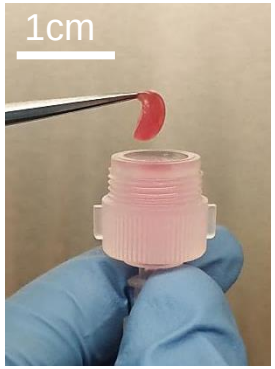
Wolfenson, H. et al. (2016). "**Tropomyosin Controls Sarcomere-like Contractions for Rigidity Sensing and Suppressing Growth on Soft Matrices**". Nature Cell Biology

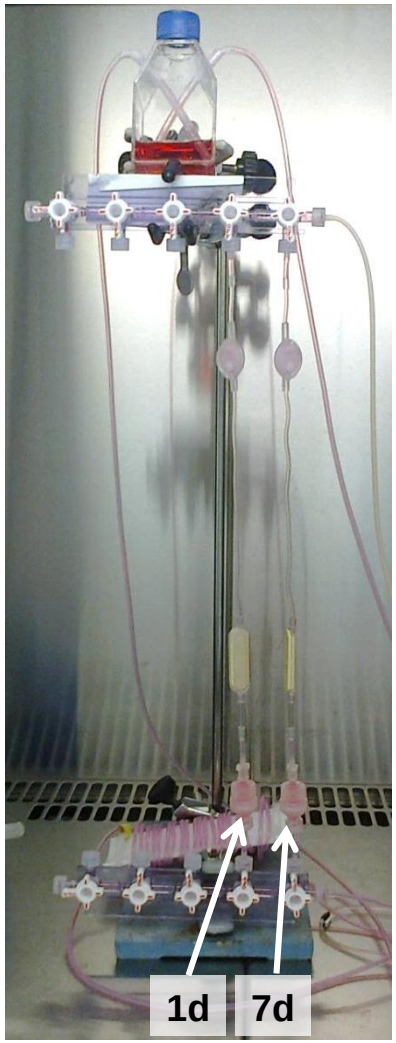


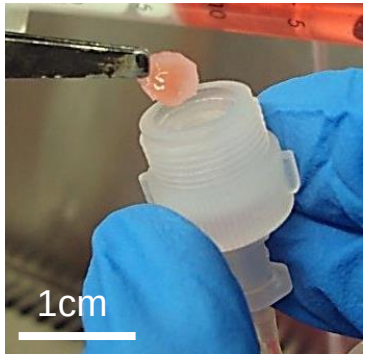
Measurement of physical forces driving wound healing

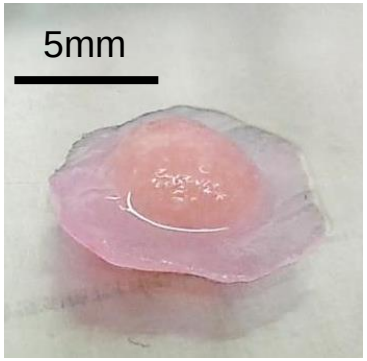
Brugués et al. **Physical forces driving wound healing**. *Nature Physics*. 10, 683–690, 2014

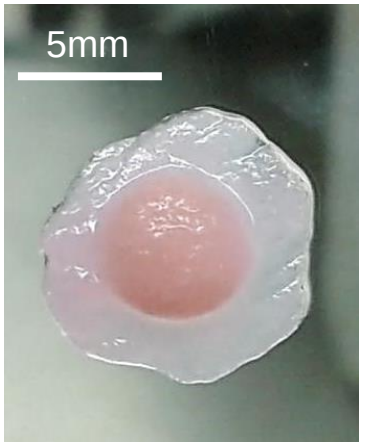
Generating a cardiac patch







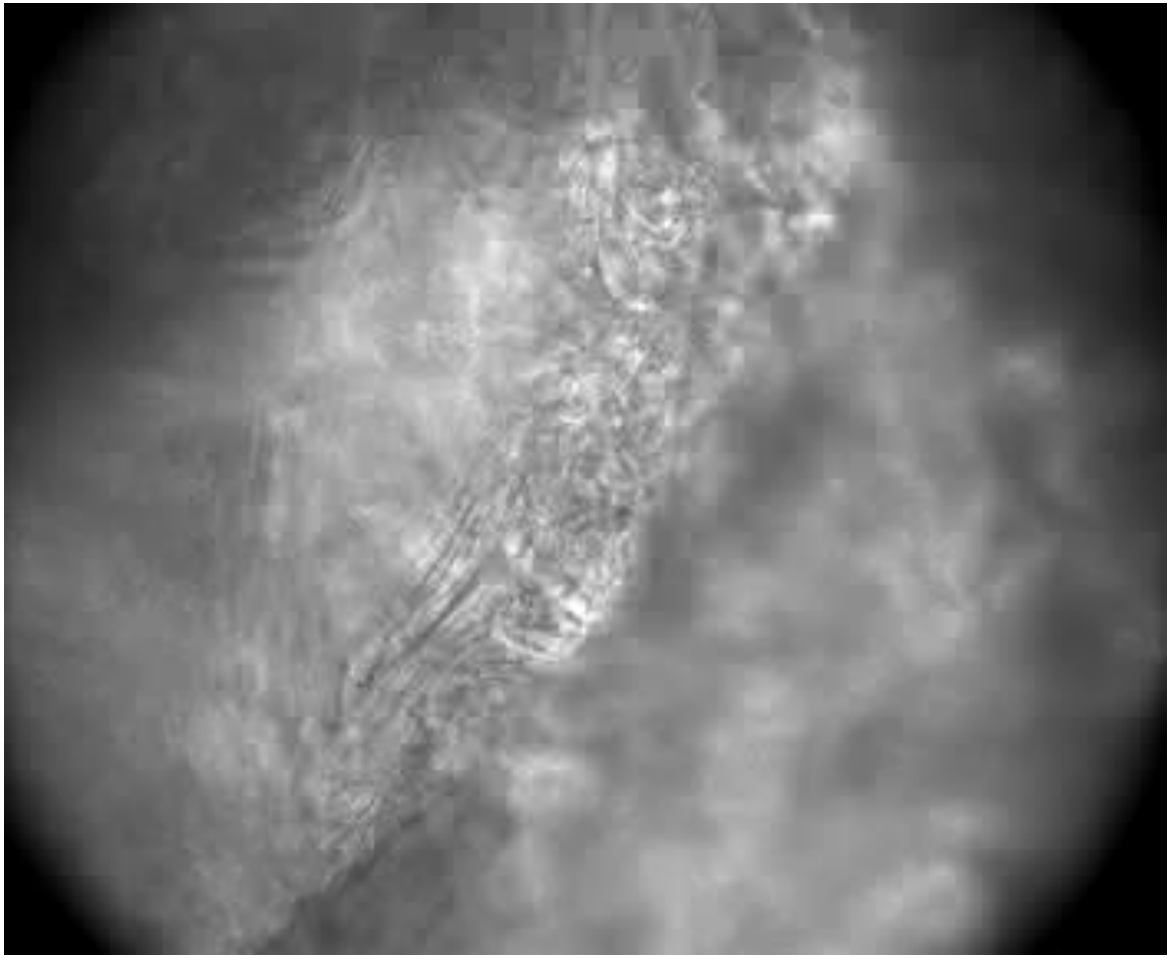




Cardiomyocytes in primary culture

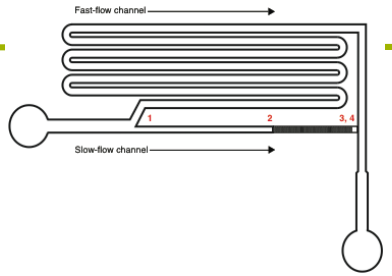
Scaffold: collagen-elastin matrix

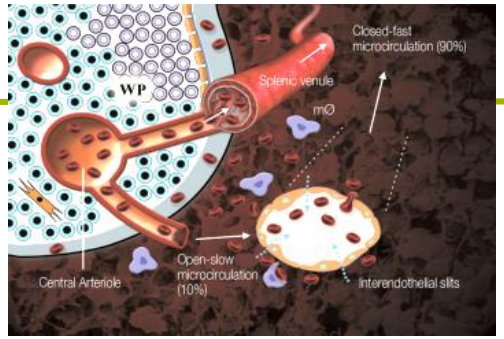
Generating a cardiac patch



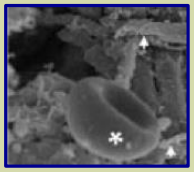
Splenon on a chip

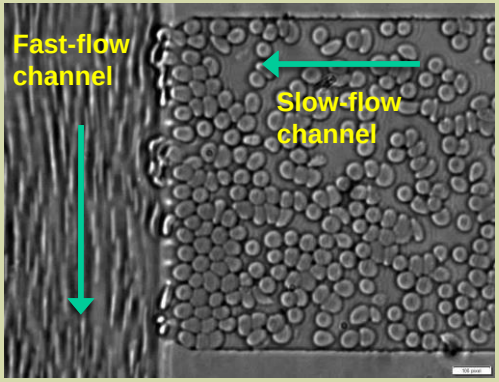
Rigat Brugarolas, L et al (2014). Functional microengineered model of the human splenon-on-a-chip. Lab Chip, 14, 1715-1724



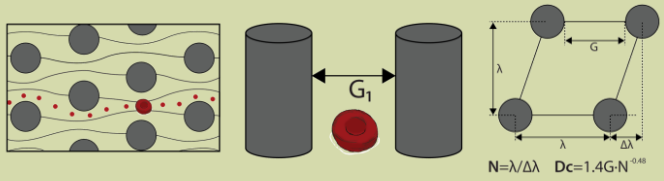


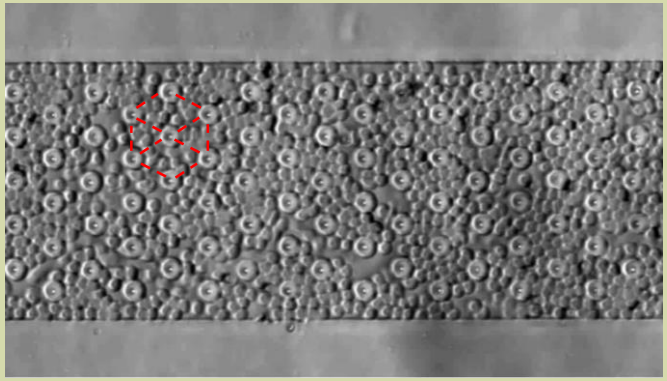
µConstrictions (IES) → Filtering capacity



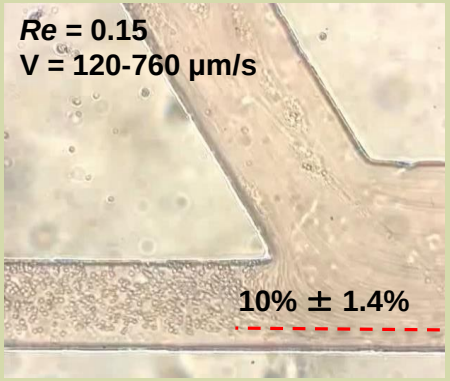


Reticular mesh modeling





Physiological flow dynamics: flow division/velocities observed in spleen



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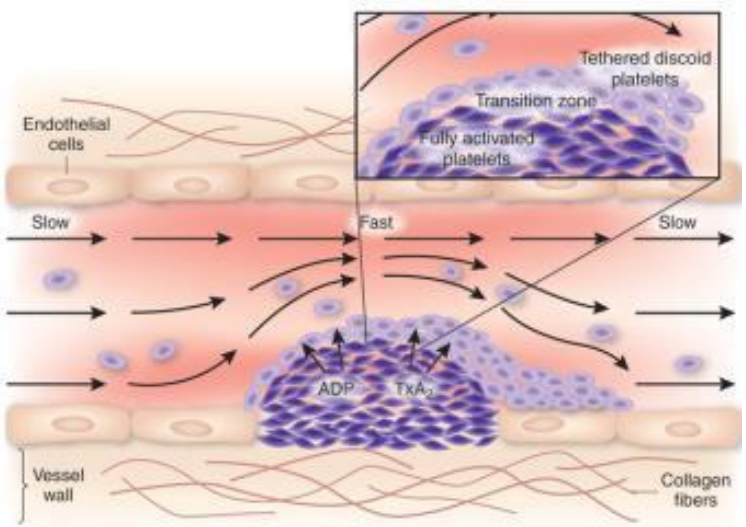
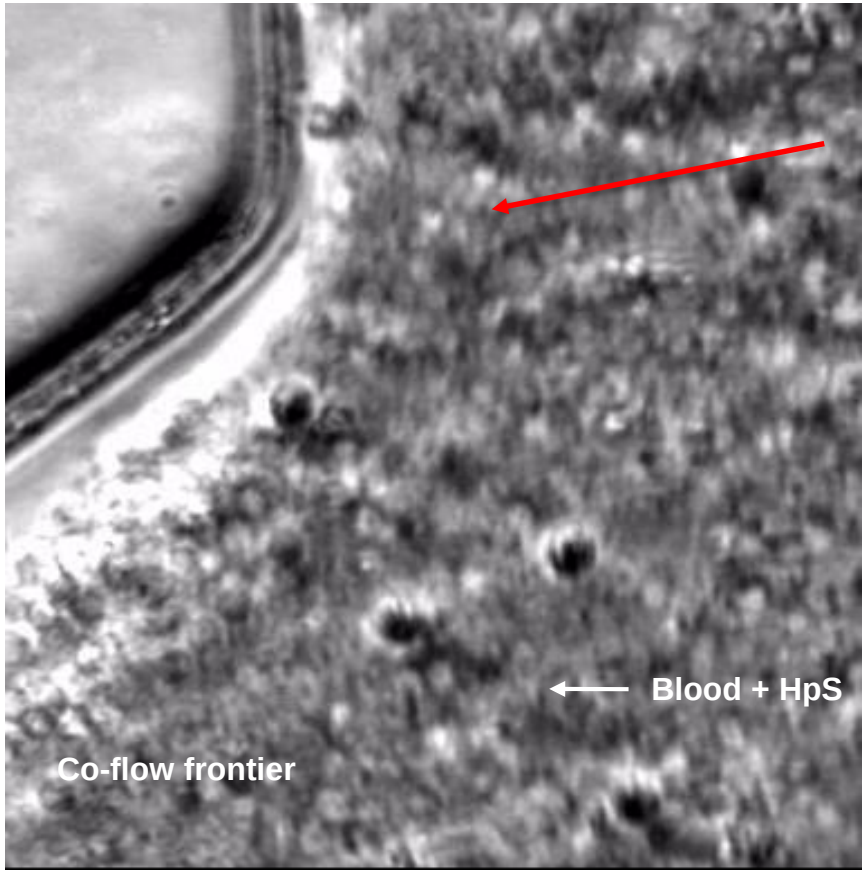
Splenon on a chip





Research highlights, June-December 2016

Cells move en masse towards rigid tissues

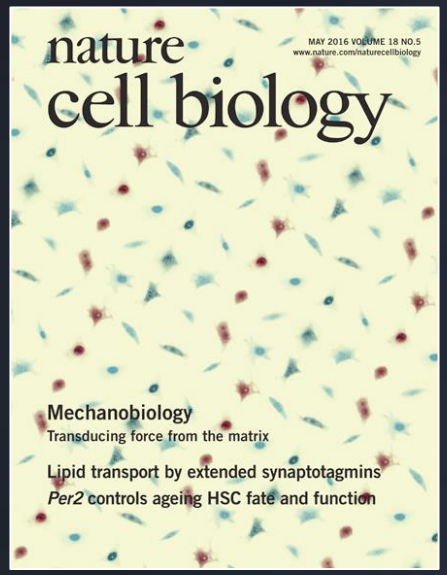
In a study published in *Science*, Xavier Trepat's group showed that several types of cells are attracted to the most rigid areas of tissues. They developed new techniques to create biomaterials with variations in stiffness, and used these to see which cell groups preferentially moved to the more rigid areas.

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

Key protein has potential as cancer repressor

In a paper published in *Nature Cell Biology*, Pere Roca Cusachs and his colaborators revealed the potential of a protein found in cell cytoskeletons as a repressor of cancer. They discovered that tropomyosin 2.1 acts as a suppressor of cell growth on soft matrices by cells usually able to do so, such as cancer cells, by controlling force production and supporting proper rigidity sensing.

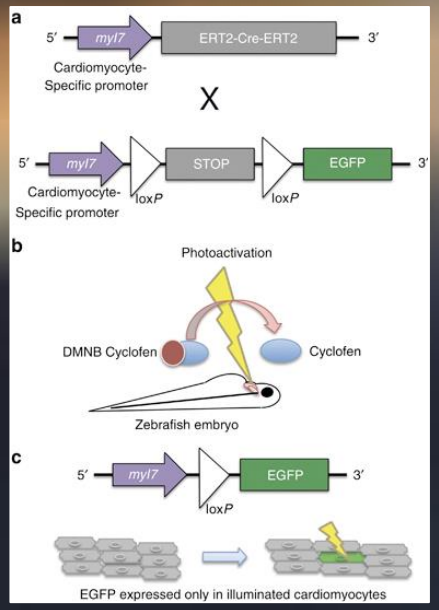
Wolfenson, H. et al. (2016). "Tropomyosin Controls Sarcomere-like Contractions for Rigidity Sensing and Suppressing Growth on Soft Matrices". Nature Cell Biology



Research highlights, June-December 2016

Non-invasive activation of proteins in deep tissue

Dobryna Zalvidea and her collaborators at the CMRB 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 (CreloxP) 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.



Tekeli I. 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 EFM to probe endospore survival strategies

The Nanoscale Bioelectrical Characterization group, working together with IBEC Associate Researcher and UB professor Antonio Juárez 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, as well as demonstrating 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

Research highlights, June-December 2016

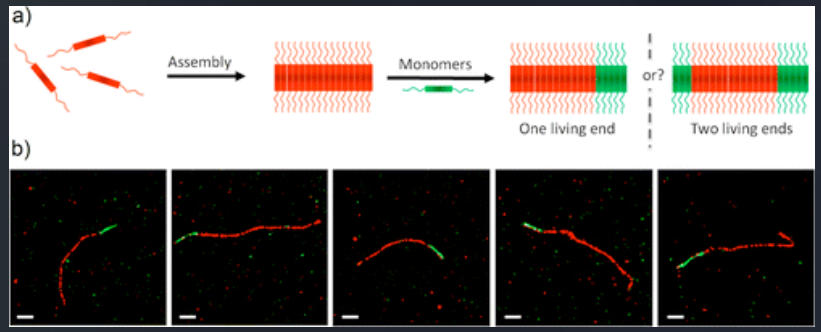
Record-breaking nanojets that use safe fuel

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

Super-resolution microscopy

Lorenzo Albertazzi published various papers on two-color Stochastic Optical Reconstruction Microscopy (STORM), a combination of super-resolution microscopy and single-molecule data analysis, useful for unveiling the behavior of nanoparticles during their entry into mammalian cells, among other hitherto unrevealed things.



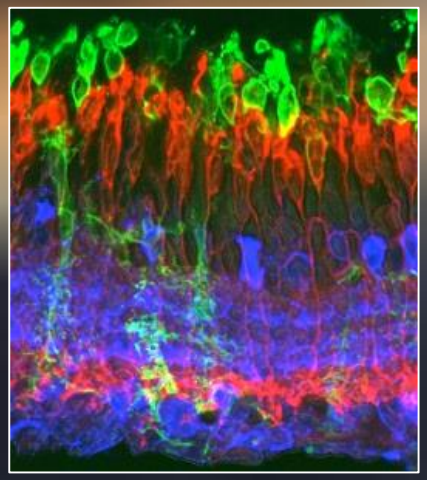
da Silva, Ricardo M. P. et al (2016). Super-resolution microscopy reveals structural diversity in molecular exchange among peptide amphiphile nanofibers. Nature Communications 7, 11561

Beun, L. H., et al (2016). Unidirectional living growth of self-assembled protein nanofibrils revealed by super-resolution microscopy. ACS Nano 10, 5, 4973-4980

Research highlights, June-December 2016

Vision restoration by molecular prostheses

Pau Gorostiza and his IRB collaborators developed molecules that can be applied as light-regulated molecular prostheses to help restore vision in cases of retinal degeneration. They 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.



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

Also in 2016, the same IBEC researchers published in *Cell Chem Bio* their light-activated molecules that can modulate the activity of glutamate receptors in the central nervous system.

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

Micromotors use surface variations for docking and guiding

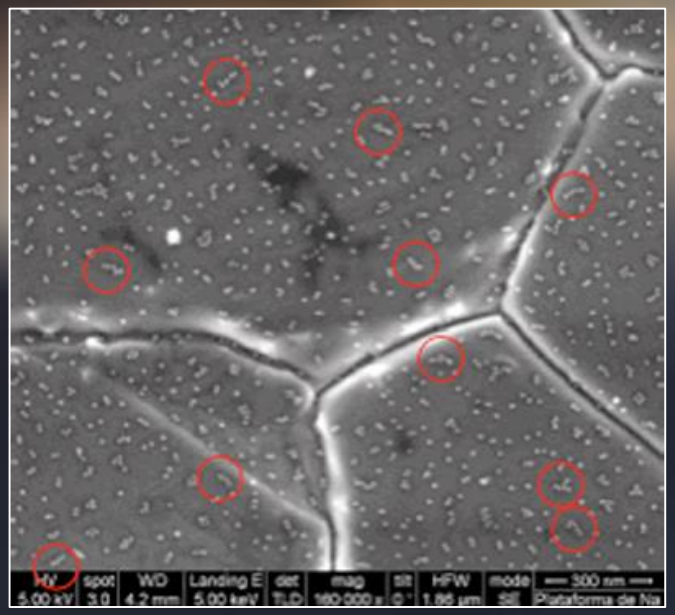
Samuel Sánchez and his collaborators at the Max-Planck Institute for Intelligent Systems and the University of Stuttgart revealed in an article in *Nature Communications* that micromotors can be guided using tiny topographical patterns on the surfaces over which they swim.

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

Research highlights, January-May 2017

New DNA-based technique for depositing materials with a resolution of less than 10 nanometers

A study led by CSIC and involving Josep Samitier's group proposes a new technique using molecules 'a la carte' to obtain nanoscale surfaces that will have many useful applications in microelectronics and biomedicine. The work has been published in the journal *Advanced Materials*. The new method means that researchers can obtain nanoscale surfaces with many molecules arranged in an ordered way.



Gállego, I., Manning, B., Prades, J.D., Mir, M., Samitier, J., Eritja, R. (2017). DNA origami-driven lithography for patterning on gold surfaces with sub-10 nanometer resolution. Adv. Materials, doi: 10.1002/adma.201603233

Light-regulated drugs as analgesics

A new study involving the Nanoprobes and Nanoswitches group at IBEC, IQAC/CSIC and CNRS in France uses light-regulated drugs to alleviate the negative emotions associated with chronic pain. Chronic pain's origin can be both physiological and emotional, and it is accompanied by symptoms such as hypersensitivity, anxiety and depressive behavior. It has no cure, treatment is difficult, and current drugs don't alleviate the symptoms.

Xavier Gómez-Santacana et al. (2017). Illuminating Phenylazopyridines To Photoswitch Metabotropic Glutamate Receptors: From the Flask to the Animals.
ACS Central Science DOI: 10.1021/acscentsci.6b00353

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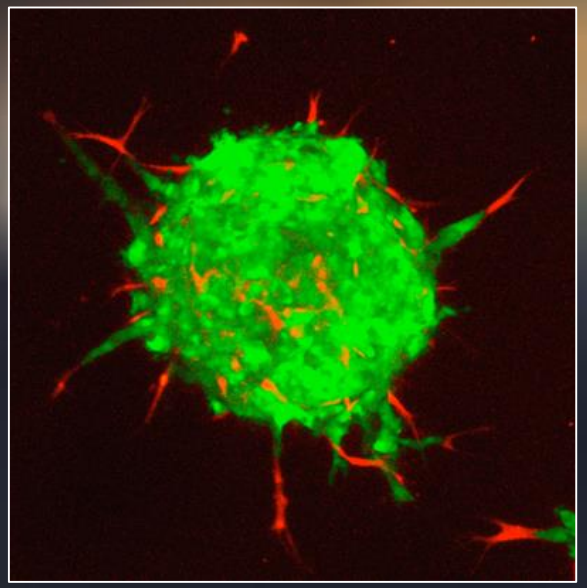
Research highlights, January-May 2017

An optogenetic tool that directs cellular contractility using light

Xavier Trepat's group has controlled the contractility of a group of epithelial cells using an optogenetic switch activated by light. The study, published in *Nature Communications*, explains how this novel technique allows for rapid, local and reversible changes in the forces exerted by cells, as well as tissue contraction.



Léo Valon, et al (2017). Optogenetic control of cellular forces and mechanotransduction. Nature Communications DOI: 10.1038/NCOMMS14396

How tumor cells hijack healthy cells to promote metastasis

In a study published in *Nature Cell Biology* and supported by Obra Social "la Caixa", Xavier Trepat's group have identified an interaction between two proteins that enables cancerous cells to use the physical forces of healthy cells to start tumor metastasis. Metastasis, responsible for the majority of deaths in patients with cancer, is the process by which cancer cells separate from the original tumor to form new tumors in other organs or tissues of the body.

A. Labernadie, et al (2017). "A mechanically active heterotypic E-cadherin/N-cadherin adhesion enables fibroblasts to drive cancer cell invasion". Nature Cell Biology

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Research highlights, January-May 2017

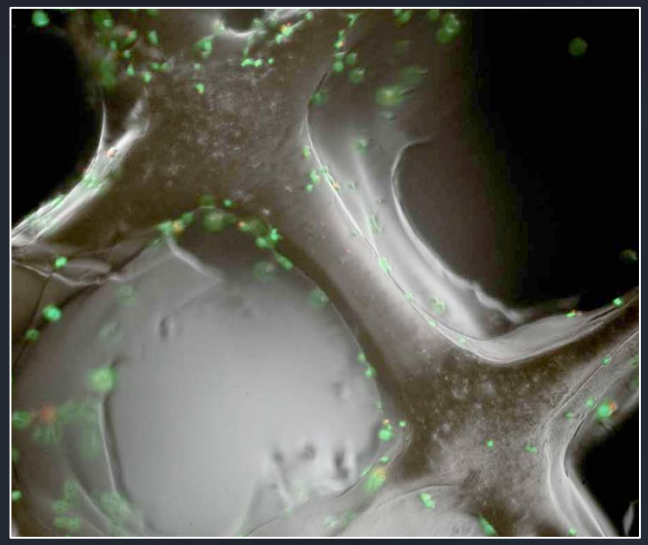
A new therapeutic target that could slow the progression of Parkinson's disease

Three IBEC groups have identified a potential way to slow down the neurodegenerative progression of Parkinson's disease. They focused their work on the cellular prion protein (PrP^c), a specialized molecule located in the membranes of neurons that's involved in a number of functions such as cell cycle control and neurotransmission.

Urrea L, et al. (2017). Involvement of Cellular Prion Protein in α-Synuclein Transport in Neurons. Mol Neurobiol

3D printing biocompatible hydrogels

The Biomaterials for Regenerative Therapies group laid the groundwork for faster advances in 3D bioprinting for regenerative medicine by creating a system of ink and matrices that offers a solid basis for tissue regeneration. Due to their high water content, hydrogels are highly attractive biomaterials for 3D printing as efficient 'surrogates' for the extracellular matrix, onto which cells can be cultured. However, while they are relatively easy to produce using a method called extrusion printing, their stability and structural integrity can weaken when they're in contact with biological fluids or extracellular matrices.

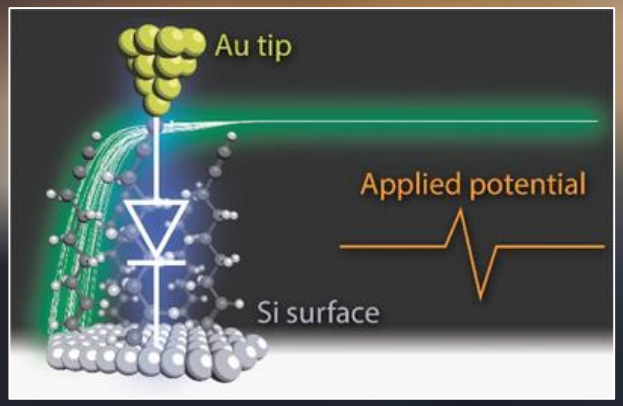


C. Echalier, (2017). Modular bioink for 3D printing of biocompatible hydrogels: sol–gel polymerization of hybrid peptides and polymers. RSC Adv., 2017, 7, 12231

Research highlights, January-May 2017

The most efficient single-molecule diode ever made

Nanoprobes and Nanoswitches researchers have created the most efficient single-molecule diode ever. Diodes are common in everyday electronic devices, in which they control the current by allowing it to flow in one direction while blocking it in the opposite direction. The researchers have created one of just 1 nanometer in size with a rectification ratio – the ratio of the current that flows in one direction compared to the other – several orders of magnitude higher than previously.



Aragones, A. C. et al. Single-molecule electrical contacts on silicon electrodes under ambient conditions. Nat. Commun. 8, 15056 doi: 10.1038/ncomms15056 (2017).

Screening improvements for asthma and obstructive pulmonary disease patients

Some IBEC research published in *PlosOne* offers a step towards better screening of patients with asthma and other sufferers of obstructive pulmonary diseases. The new integrated approach to continuous adventitious respiratory sound (CAS) analysis, developed by Raimon Jané's Biomedical Signal Processing and Interpretation group within the framework of IBEC's Joint Research Unit with the Institut d'Investigació Hospital Germans Trias i Pujol (IGTP), improves assessment in the clinic.

Lozano-García M, Fiz JA, Martínez-Rivera C, Torrents A, Ruiz-Manzano J, Jané R (2017). Novel approach to continuous adventitious respiratory sound analysis for the assessment of bronchodilator response. PLoS ONE 12(2): e0171455

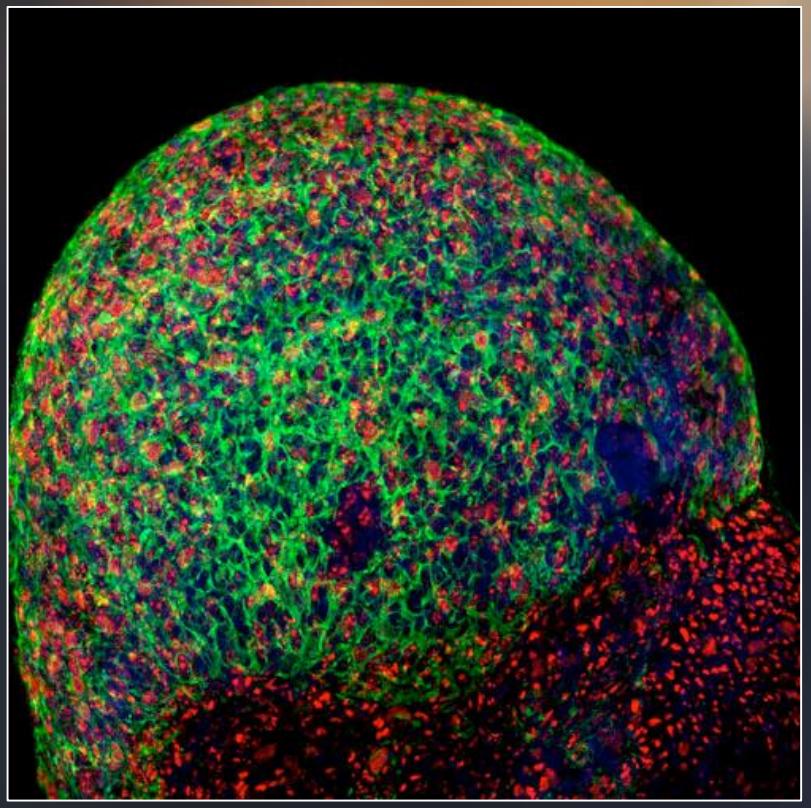
Research highlights, January-May 2017

A cellular model to help study the relationship between neurodegenerative diseases

From the cells of a patient with a rare neurodegenerative disease, Gerstmann-Sträussler-Scheinker syndrome (GSS), researchers at IBEC have managed to generate neurons that also present parallel neurodegenerative processes unrelated to the syndrome.

The image on the right shows a mass of neurons derived from GSS-affected pluripotent stem cells (iPS), developed in José Antonio Del Río's lab.

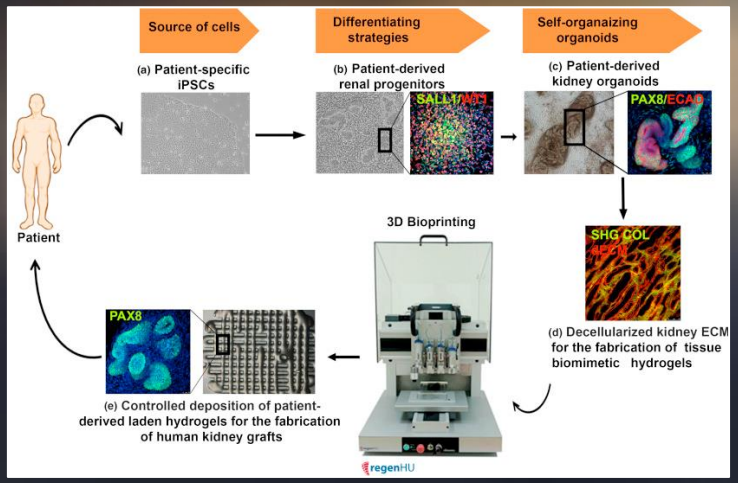
Matamoros-Angles, A., Gayosso, L.M., Richaud-Patin, Y. et al. (2017). iPS Cell Cultures from a Gerstmann-Sträussler-Scheinker Patient with the Y218N PRNP Mutation Recapitulate tau Pathology. Molecular Neurobiology, doi:10.1007/s12035-017-0506-6



Research highlights, January-May 2017

How IBEC groups work together to forge ahead in tissue engineering

With IBEC devoted to being the organization in southern Europe that provides 3D bioprinting capabilities to researchers, companies and clinicians, several IBEC groups published a review in the high-impact journal *Materials Today* examining recent progess in de- and recellularization techniques alongside the use of this emerging technology to create promising tissue constructs.



Human donor organs can provide decellularized extracellular matrix (dECM) scaffolds suitable for organ engineering, but what are needed are ways to properly reintroduce cells into these scaffolds and ensure their growth and functional activity.

One option is to use of human pluripotent stem cells (hPSCs) for recellularization, together with 3D bioprinting techniques using organ-specific dECM hydrogels – which offer the correct biochemical and mechanical cues that guide tissue formation – as printing “inks” to fabricate biomaterial constructs that mimic the *in vivo* environment and can be laden with cells.

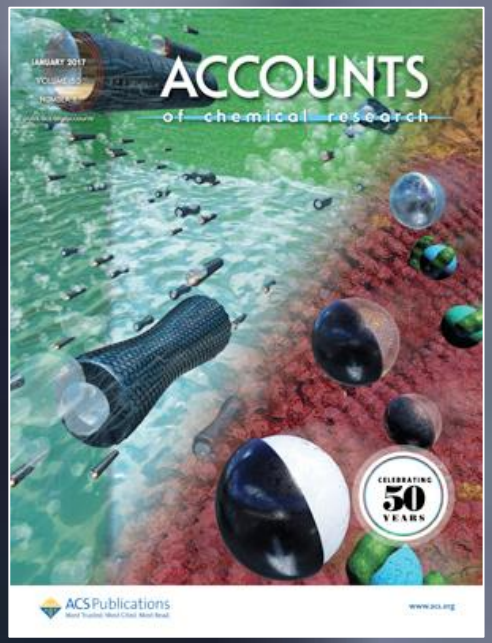
Elena Garreta, Roger Oria, Carolina Tarantino, Mateu Pla-Roca, Patricia Prado, Francisco Fernández-Avilés, Josep Maria Campistol, Josep Samitier, Nuria Montserrat (2017). Tissue engineering by decellularization and 3D bioprinting. Materials Today

Research highlights, January-May 2017

RAB5A induces large-scale, coordinated motility

Dynamics of epithelial monolayers has recently been interpreted in terms of a jamming or rigidity transition. How cells control such phase transitions is, however, unknown. Here Xavier Trepat's group and their collaborators show that RAB5A, a key endocytic protein, is sufficient to induce large-scale, coordinated motility over tens of cells, and ballistic motion in otherwise kinetically arrested monolayers.

Malinverno, C et al (2017). Endocytic reawakening of motility in jammed epithelia. Nat Mater. 16(5): 587-596



Designing Micro- and Nanoswimmers for Specific Applications

Self-propelled colloids are micrometer sized colloidal objects that transduce free energy from their surroundings and convert it to directed motion. This *Accounts of Chemical Research* paper by Samuel Sanchez's team, also featured on the cover, summarizes their efforts and those of other groups in the design and development of self-propelled colloids of different structural properties and powered by different propulsion mechanisms.

Katuri J et al (2017). Designing Micro- and Nanoswimmers for Specific Applications. Acc Chem Res. 50(1):2-11

Research highlights, January-May 2017

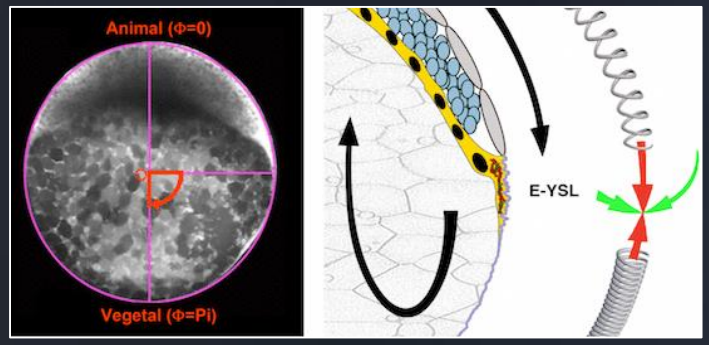
Highly versatile anisotropic chips

Suspended planar-array (SPA) chips embody millions of individual miniaturized arrays to work in extremely small volumes. Using just one device, we can enter a living cell and make multiple detections of many biological parameters. Here, the Nanobioengineering group demonstrates a robust methodology for the fabrication of these silicon chips using photolithography which dictates their physical anisotropy, while subsequent 2D or 3D chemical modifications extend their functionality by incorporating homogeneous or patterned chemical signatures. The high versatility of the anisotropic chips opens a vast number of applications for future life science applications.

J. P. Agusil, et al (2017). Highly Anisotropic Suspended Planar-Array Chips with Multidimensional Sub-Micrometric Biomolecular Patterns. Adv. Funct. Mater. 2017, 27, 1605912.

Examining epiboly

Daniel Navajas and his colleagues demonstrated in the *EMBO Journal* a new way to physically regulate concerted cellular movements that might be instrumental for the mechanical control of many morphogenetic processes. They applied hydrodynamic regression to identify biomechanically active structures and changes in cortex local tension during epiboly, an essential embryonic event in which three tissues coordinate to direct the expansion of the blastoderm, in zebrafish.



Hernández-Vega A et al (2017). Polarized cortical tension drives zebrafish epiboly movements. EMBO J. 2017 Jan 4;36(1):25-41.

Technology Transfer at IBEC

Joint Unit ‘IBEC-GENÓMICA’

Creation of a joint unit for research and development of point-of-care diagnostic devices

- 7 members from IBEC
- 4 members from GENOMICA
- 18 months
- 200 m^2 of lab facilities in the PCB

+

Spin-offs

Rob Surgical Systems (Robotic Surgery)
IBEC group: Robotics (Prof. Alícia Casals)
Participants: UPC, IBEC

Surgitrainer (Laparaoscopic surgery)
IBEC group: Robotics (Prof. Alícia Casals)
Participants: UPC, IBEC; Hospital SCSP.

Technology Transfer activities

2016-2017

Patents filed in 2016 and 2017

Ep16162079. **Patent in the field of biomaterials for ophthalmology.**
Authors: Elisabeth Engel, Riccardo Levato, Xavier Puñet, Josep A. Planell, Miguel Angel Mateos, Margarita Calonge, Teresa Nieto, Marina López, Sara Galindo De La Rosa

EP16382121. **Patent in the field of inhibitors of solid tumors for cancer treatment.**
Authors: Pere Roca-Cusachs, Alberto Elósegui-Artola

P 62/302,316. **Patent in the field of electrotherapy for antimicrobial resistant infections.**
Authors: Eduard Torrents, Joan Gavaldà, Víctor Puntes

P 62/301,946. **Patent in the field of thermotherapy for antimicrobial resistant infections.**
Authors: Eduard Torrents, Joan Gavaldà, Víctor Puntes

In process. **Patent in the field of nanobiomaterials for wound regeneration**
Authors: Elisabeth Engel, Joan Martí, Oscar Castaño, Josep A. Planell

Technology transfer news

IBEC signed a collaboration agreement with Bioibérica S.A., a company specializing 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 – 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.

Technology transfer news - continued

IBEC and Avinent engaged in a collaboration for the development of 3D bioprinted bone. Avinent Implant System is a company positioned at the forefront of implantology, with a large portfolio of CAD/CAM implants and prostheses. Combining the knowledge from the Group of Biomaterials for Regenerative Therapies –led by Dr. Elisabet Engel-, IBEC and Avinent will focus on the development of new products for bone regeneration.

AVINENT®

Telstar azbil

LUXIONA

Parc Taulí Hospital Universitari

A product based on LAMP technology scored his first sale. The technology, developed by the consortium composed by Corporació Sanitaria Parc Taulí, Azbil Telstar Technologies, Grupo Luxiona and IBEC's Robotics Group -led by Dr. Alícia Casals-, provides an intelligent lighting system for operating rooms.

Technology transfer news - continued

IBEC's Technology Transfer Unit attended MEDICA in Germany in 2016, 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.

Zeltia GENOMICA

IBEC Institute for Bioengineering of Catalonia

EXCELENCIA SEVERO OCHOA

Technology transfer news - continued

el Periódico

PAÍS: España
PÁGINAS: 26
TARIFA: 7915 €
ÁREA: 436 CM² - 41%
FRECUENCIA: Diario
O.J.D.: 87909
E.G.M.: 490000
SECCIÓN: ECONOMIA

15 Septiembre, 2016

INVESTIGACIÓN MÉDICA

Alianza contra el cáncer

Ferrer, IBEC y Mind the Byte crean un consorcio que usa el diseño computacional de fármacos para reducir costes y tiempo ≡ **La farmacéutica** suma una docena de proyectos colaborativos

AGUSTÍ SALA
BARCELONA

Alianza público-privada para combatir la metástasis del cáncer. La farmacéutica Ferrer ha constituido un consorcio con la bioinformática Mind the Byte y el Instituto de Bioingeniería de Catalunya (IBEC), ambas con sede en el Parc Científic de Barcelona (PCB), que se basará en el diseño computacional de moléculas terapéuticas, un sistema mediante el que se reducirán costes y tiempo en la investigación.

El trabajo se basará en la investigación del doctor Xavier Trepat, profesor de ICREA en el IBEC sobre la interacción de las cadherinas (las principales moléculas de adhesión celular) y su implicación en las células que causan metástasis. Los trabajos desarrollados por este investigador demuestran que algunas de esas moléculas de adhesión celular están presentes en el cáncer de mama más agresivo y contribuyen a diseminar las células cancerosas por otras partes del cuerpo (metástasis).

La nueva colaboración constituye «**un caso de transferencia tecnológica entre un centro de investigación público y dos empresas, donde cada cual aportará su conocimiento y experiencia**», según Andrés G. Fernández, director de Ferrer Advanced Biotherapeutics, y Alfons Nonell-Canals, fundador y consejero delegado de Mind the Byte. Según los promotores del proyecto, esta iniciativa sería difícil de llevar a cabo sin el diseño computacional.

En la primera fase de los trabajos, Mind the Byte modelará por ordenador las interacciones de las cadherinas y diseñará moléculas que actúen como potenciales bloqueantes. Esta actividad realizada de manera virtual es mucho más rápida y económica que mediante prueba y error en laboratorio. Esta operativa acelera el proceso de desarrollo de fármacos, con reducción de tiempos y costes.

El segundo paso en este proyecto correrá a cargo del doctor Trepat y su equipo de investigadores, que harán tests de las propuestas ensayadas por Mind the Byte. Ferrer, por su parte, aportará sus conocimientos químicos, farmacológicos y de desarrollo de fármacos.

A su vez, la farmacéutica será un socio industrial clave en fases posteriores en caso de que se obtengan los resultados previstos.

En la actualidad, Ferrer, que tiene presencia en unos 90 países, cuenta con una docena de proyectos de origen externo, ya que potencia la innovación con colaboraciones y alianzas con grupos de investigación públicos y empresas biotecnológicas para dar respuesta a necesidades clínicas no cubiertas. También el grupo Esteve ha desarrollado una estrategia similar.

El IBEC es un centro de investigación con el sello de excelencia de Severo Ochoa. ≡

▸▸ **Sinergia** ▸ Alfons Nonell-Canals, Xavier Trepat y Andrés G. Fernández

La tecnología se transferirá entre un centro público de investigación y dos empresas

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 Dr. Xavier Trepat.

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.”

Technology transfer news - continued

IBEC strengthens its position as a center of expertise and reference for the industry.

Dr. Santi Marco, gave a hands-on course on signal and data processing for chemical sensors to BSH staff, and stablished a long-term relationship as an expert consultant.

Clear-Cut company contracted Dr. Santi Marco's group expertise to further advance on data and algorithm exploration.

M3 Control sought Dr. Santi Marco advice to optimize their operations data management.

Gebro Pharma contracted Biomaterials for Regenerative Therapies group expertise –led by Dr. Elisabeth Engel- for deeper knowledge on Biomaterials.

Technology transfer news - continued

IBEC an active member of the Health Tech Cluster

The Technology Transfer Unit at IBEC is an active member of 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 presented its 3D bioprinting platform to the Health Tech Cluster community during the annual general assembly.

IBEC's Market Driven Technology Transfer at B·Debate

IBEC took part in 2016'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.

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.

Technology transfer news - continued

IBEC is the only one offering 3D bioprinting solutions at the first ever international IN(3D)USTRY event.

Director Josep Samitier and the Technology Transfer unit introduced IBEC's 3D bioprinting capabilities at the first ever international meeting devoted to 3D printing for industry.

"IN(3D)USTRY: From Needs to Solutions" saw leading companies and other organizations 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 autos and aeronautics, architecture and habitat, retail and consumer goods and, of course, healthcare.

IN(3D)USTRY
FROM NEEDS TO SOLUTIONS
Additive & Advanced
Manufacturing Global Hub

IBEC
Institute for Bioengineering of Catalonia

EXCELENCIA SEVERO OCHOA

Technology transfer news - continued

More IBEC success in CaixaImpulse

Two IBEC projects were granted funding as part of the 2016 CaixaImpulse programme, which is organized by ”la Caixa” Foundation and Caixa Capital Risc. One of the projects is led by Cellular and Molecular Mechanobiology group leader Pere Roca-Cusachs and is focused in the development of new compounds indicated in solid tumor therapy.

The second project is led by Monica Mir, senior researcher in Josep Samitier’s Nanobioengineering group, 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.

Technology transfer news - continued

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 was connected to the driver drowsiness alerter developed by IBEC and the company Ficosa.

FICOSA

IBEC
Institute for Bioengineering of Catalonia

EXCELENCIA SEVERO OCHOA

Technology transfer news - continued

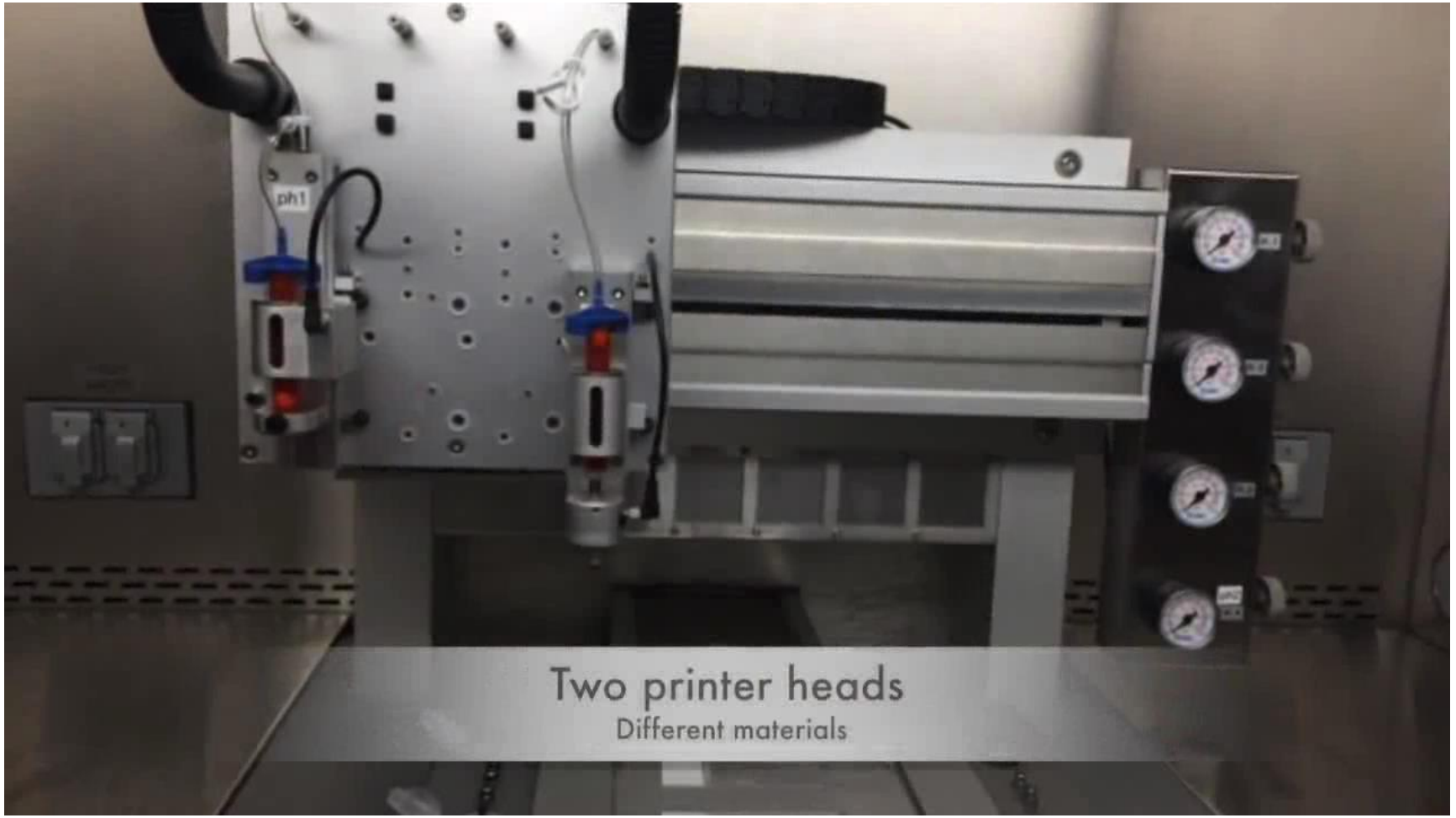
EIT Health Proof of Concept Program bets on IBEC projects.

Two IBEC projects, previously granted by CaixaImpulse, were granted additional funding by the EIT Health community to execute their valorization projects. One of the projects is led by Dr. Elisabeth Engel, from the Biomaterials for Regenerative Therapies group, and is focused on the development of new strategies for chronic wound healing.

The second project is led by Dr. Eduard Torrents, group leader of the Bacterial Infections: Antimicrobial Therapies group, and is focused on the valorization of a library of compounds with antibacterial activity against several pathogens.

Both projects received awards at December's EIT Health Spain event at the PCB.

3D bioprinting (contact jetting)



Printing on microscope slide

Clinical and translational collaborations

Vall d'Hebron
Institut de Recerca

VHIR-IBEC alliance on infectious diseases

With the Infectious Disease department of the Vall d'Hebron Research Institute, Eduard Torrents' Bacterial Infections and Antimicrobial Therapies group 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.

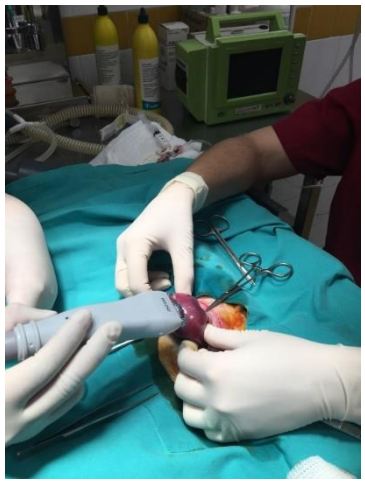
Creating a 3D in vitro model of the human intestine

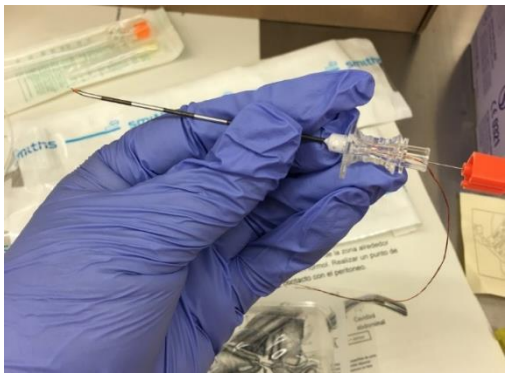
During 2016 Elena Martinez's Biomimetic Systems for Cell Engineering group signed a collaborative alliance with Barcelona's Vall d'Hebron Research Institute to evaluation and characterize the intestinal barrier in a 3D in vitro model of the human intestine. The collaboration will validate the model as an *in vitro* representation of functional intestinal disorders.

Clinical and translational collaborations - continued

A revolution in fetal surgery

IBEC is part of a revolution in fetal surgery and research into 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), involving IBEC.





Clinical and translational collaborations - continued

CLÍNIC BARCELONA Hospital Universitari

Kidney and iPS collaborations with Hospital Clinic

IBEC signed a collaboration agreement with Hospital Clinic during 2016 for Nuria Montserrat's group to work with Dr. Eduard Gratacós, Head of BCNatal (Hospital Clinic/Hospital Sant Joan de Déu) with embryonal kidney samples to study the molecular mechanisms of kidney diseases.

Clínica CEMTRO

Clinica CEMTRO collaboration on cartilage lesions

In 2016 Nuria Montserrat's group 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.

Clinical and translational collaborations - continued

Vall d'Hebron
Institut de Recerca

A potential therapeutic target for MS

Towards the end of 2016, IBEC's Molecular and Cellular Neurobiotechnology group 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.

Bellvitge
Hospital Universitari

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 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.

Clinical and translational collaborations - continued

CLÍNIC BARCELONA Hospital Universitari

Studying sleep apnea with Hospital Clinic

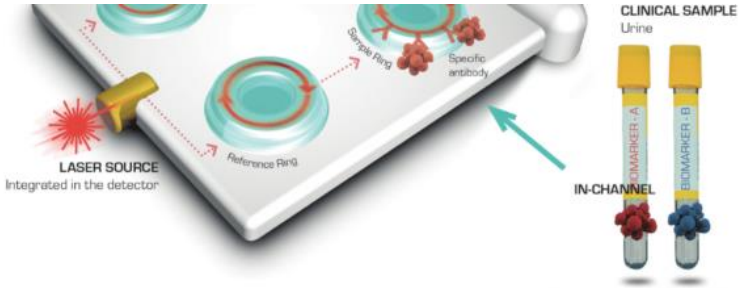
Daniel Navajas' Cellular and Respiratory Biomechanics group published two papers on sleep apnea during 2016, both in collaboration with the Sleep Laboratory of the Pneumology Department of Hospital Clinic, Barcelona.

Radboudumc

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 began working in collaboration with the Department of Urology at the Radboud University Medical Center in Nijmegen, The Netherlands during 2016.

glam



IBEC Institute for Bioengineering of Catalonia

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Clinical and translational collaborations - continued

Fibrosis Quística

Co-operation triangle against CF

At the end of 2016 Eduard Torrent's group's project with the Associació Catalana de Fibrosi Quística 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.

CLÍNIC BARCELONA Hospital Universitari

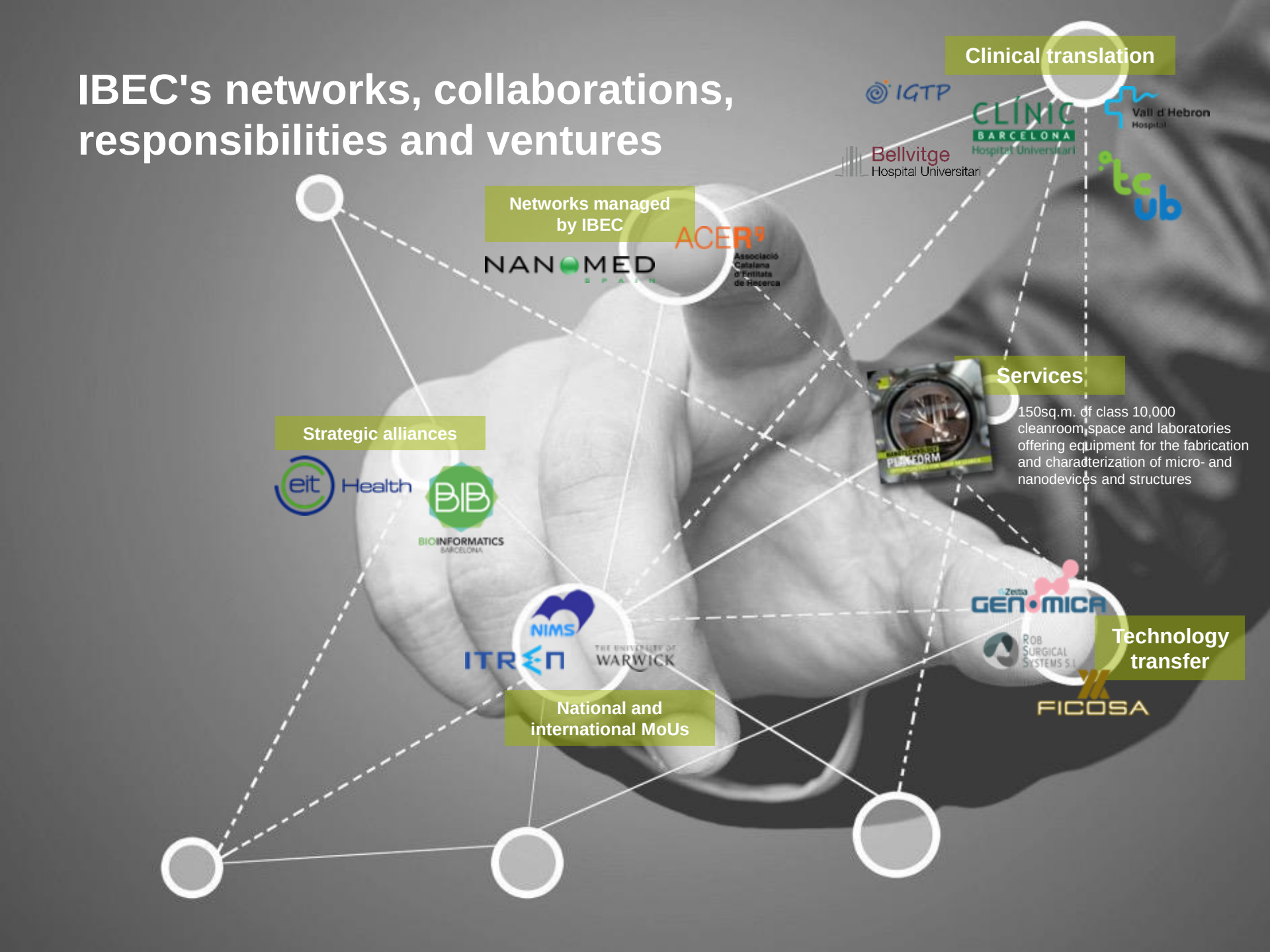
PoC tool for respiratory diseases with Hospital Clinic

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 Institute for Bioengineering of Catalonia

EXCELENCIA SEVERO OCHOA

IBEC's networks, collaborations, responsibilities and ventures



Strategic alliances: International: 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.

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.

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.

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.

Strategic alliances: International: Human Brain Project

ICREA Professor Pau Gorostiza 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.

Strategic alliances: International: EIP on AHA

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.

Strategic alliances: National: The Global 3D Printing Hub

IBEC is to be part of a multi-million euro 3D printing infrastructure in Catalonia.

The Global 3D Printing Hub, which will receive up to 28 million euros from the Generalitat by 2020, will aim to consolidate Catalonia as a world leader in 3D printing.

IBEC will contribute its expertise to the 3D bioprinting side of the platform. With its development of the Biospace infrastructure, which includes an advanced 3D bioprinter and 3D printer systems, the institute offers the level of precision, characteristics and know-how required to revolutionize regenerative medicine and medical devices using this emerging technology, and is already positioned as the 3D bioprinting provider to researchers and companies throughout southern Europe.

Strategic alliances: National: RIS3CAT / NEXTHEALTH

ADVANCE (CAT)
Accelerating Development of Advanced Therapies in Catalonia

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.

Strategic alliances: National: ITEMAS

IBEC has become 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.

The aim of ITEMAS is to facilitate the transfer of scientific, medical and healthcare knowledge in the field of innovation in health technology generated within the network, with the ultimate objective of improving the quality of the country's health system and its impact on society.
Other Barcelona-area partners include the University Pompeu Fabra and several biotech companies.

Attracting talent

IBEC International PhD Programme fellowships

- 299 people registered on the mini-site
- 133 submitted
- 124 evaluated online
- 24 interviewed
- 5 selected

Outcome of the call

Five candidates have been granted a fellowship. Three positions have not been filled.

Attracting talent

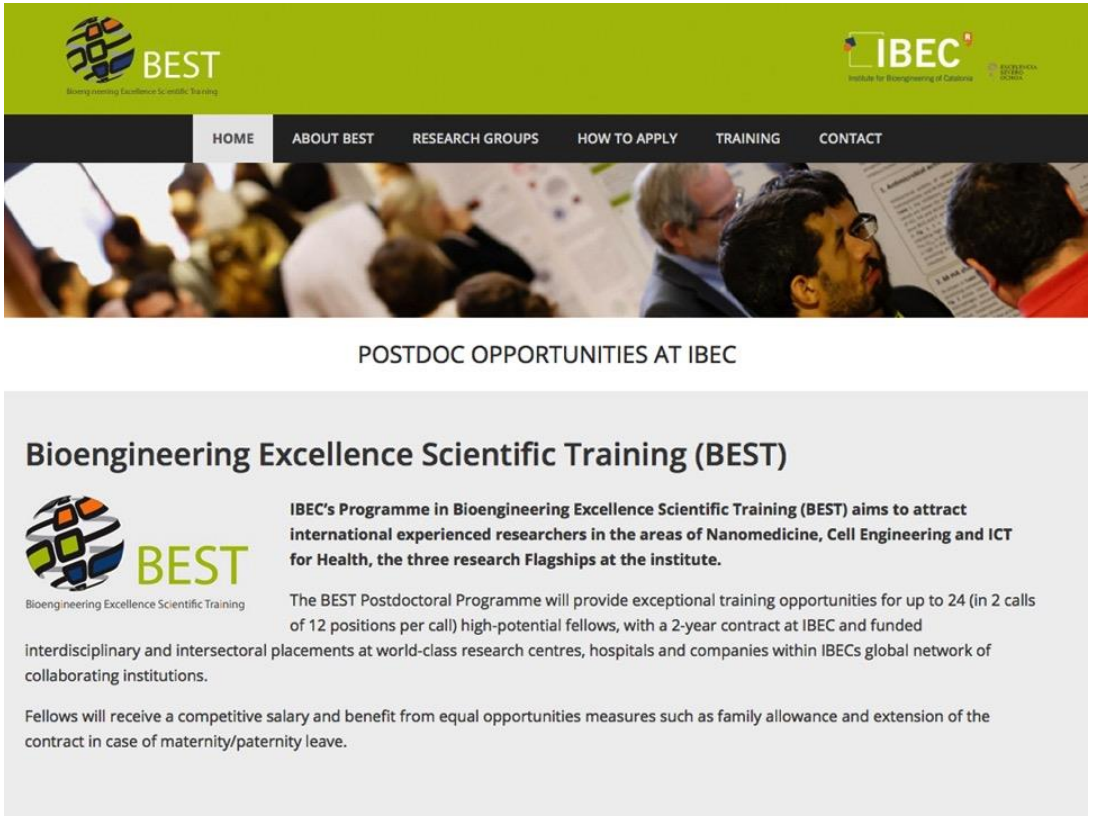
INPhINIT is a new doctoral fellowship programme devoted to attracting international Early-Stage Researchers to the top Spanish research centres in the areas of Bio and Health Sciences, Physics, Technology, Engineering and Mathematics.

INPhINIT is promoted by the "la Caixa" Foundation with the aim of supporting the best scientific talent and fostering innovative and high-quality research in Spain by recruiting outstanding international students and offering them an attractive and competitive environment for conducting research of excellence.

Attracting talent

By the deadline of September 11th 2016, IBEC had received a total of 49 applications for the BEST COFUND postdoc programme from 22 different nationalities.

Twelve of these candidates were granted a BEST COFUND postdoc fellowship for a duration of 24 months at IBEC



Next call opens in February 2018.

Attracting group leaders: Tenure and non-tenure track

Career opportunities

IBEC Institute for Bioengineering of Catalonia

EXCELENCIA SEVERO OCHOA

Junior Research Group Leader position

(Ref: JGL_NTT)

Postdoctoral and senior researchers with excellent scientific record in the following topics (but not limited to): Synthetic Biology, Computational Bioengineering, Diagnostic Technologies, Systems Biology, Neuroengineering, 3D Bioprinting, and Regenerative Medicine are invited to apply for a Junior Group Leader position in IBEC's non-tenure-track open call for 2017.

Applicants are expected to develop an ambitious project for their future group and to contribute to one or more IBEC's core applications areas. Candidates will be evaluated by IBEC's International Scientific Committee (ISC) based on scientific quality, feasibility of the proposed scientific approach, potential impact of the research, added value to the current IBEC research programme and structure, and their ability to carry out efficient leadership and management.

Apart from outstanding scientific output, the candidates must prove that they are active in the application of competitive proposals as principal investigators. Any mobility experience, e.g. a stay in another country/region, will be considered as a valuable contribution.

Desirable competencies and skills: Leadership; critical judgment in identifying and executing research activities; strategic vision for the future of the research field; proven record in securing research funding/budgets/resources; team building/collaboration; excellent communication and networking.

Junior Group Leaders at IBEC are offered a start-up package and provided with suitable laboratory space, access to the state-of-the-art core facilities at IBEC and access to outstanding predoc students and postdoc researchers. They are assigned a project manager to support their participation in competitive calls and the management of their projects, as well as their interaction with IBEC's friendly and researcher-oriented administrative staff.

The successful candidate will be appointed for an initial 4-year period. At the end of the fourth year, the Junior Group Leader will be evaluated by the ISC. A positive evaluation will allow the candidate to extend their appointment for another 4 years.

IBEC aims for a representative gender balance at all levels of staff, so we strongly encourage women to apply. At least 40% of shortlisted applicants invited to interview will be women.

Full description: www.ibecbarcelona.eu/wp-content/uploads/2017/01/nontenuretrack2017_long.pdf

Apply online: https://careers.ibecbarcelona.eu

The Institute for Bioengineering of Catalonia (IBEC) in Barcelona develops interdisciplinary research of excellence in the fields of biomedical engineering and nanomedicine, from basic research to medical applications. Its mission is to consolidate a strong international position in these fields while creating knowledge, contributing to a better quality of life, improving health and creating wealth.

IBEC has 19 research groups, and 250 researchers and support staff from 20 different countries. Its location offers a highly stimulating biomedical environment in which the institute can work closely with organisations from the public and private sector and increase its portfolio of technology transfer services available to the industry and the healthcare system.

The vision promoted at IBEC is to exploit and connect the multidisciplinarity of its groups, aligning their complementary capacities through three broad areas of expertise: Nanomedicine, Cell Engineering and Intelligent Healthcare. To this end, IBEC focuses its scientific and technological work around three core application areas: Bioengineering for future medicine (technology that goes beyond the existing paradigm of hospital care); Bioengineering for active ageing (meeting the needs of an ageing population); and Bioengineering for regenerative therapies (regeneration of damaged tissues or organs, or to develop cell therapies).

Applications should be submitted no later than **15th March 2017**

www.ibecbarcelona.eu

Junior group leader call

53 submitted applications

Currently under evaluation

Up to 5 candidates will be interviewed by ISC on 8-9 June for one position

IBEC Institute for Bioengineering of Catalonia

EXCELENCIA SEVERO OCHOA

Awards in the past year

Pere Roca-Cusachs

- American Society for Cell Biology's Gibco Emerging Leader Prize
- Accepted into the EMBO Young Investigator Programme

Samuel Sánchez

- Catalonia's National Research Award for Young Talent
- Círculo Ecuestre's Premio Joven Relevante
- New ERC PoC in 2016: Microcleaners

Xavier Trepat

- *La Vanguardia* Science Award (placed third), alongside associated researcher Marino Arroyo

Outreach activities

Workshops for teachers

Public talks

Fairs

School visits

Outreach blog

Mentoring and placements

FECYT BBVA Fundació Catalunya La Pedrera

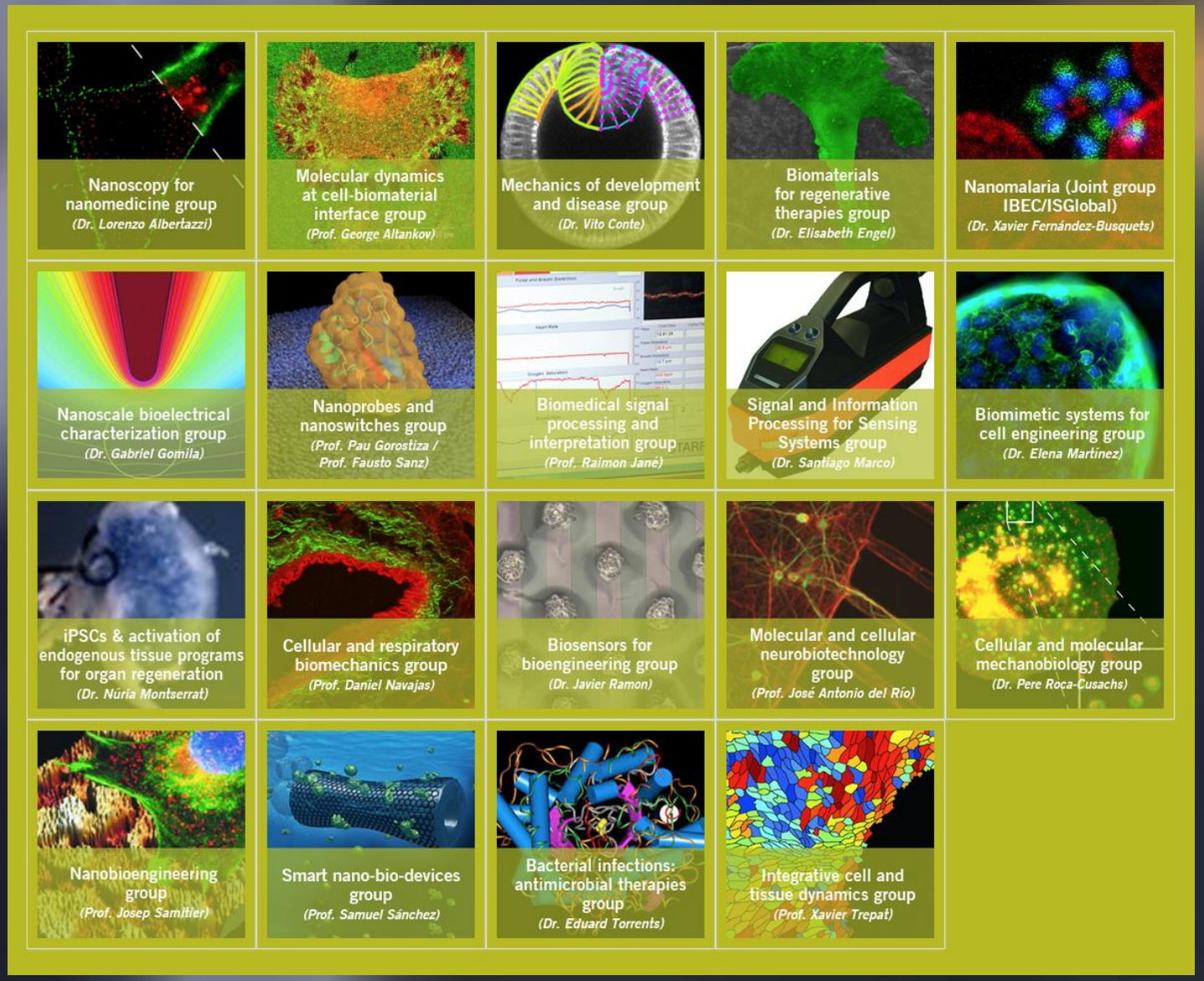
www.ibecbarcelona.eu

Generalitat de Catalunya

UNIVERSITAT DE BARCELONA

UNIVERSITAT POLITÈCNICA DE CATALUNYA

19 IBEC groups

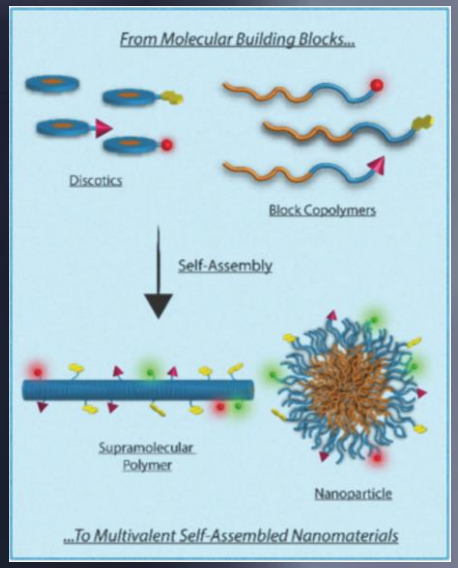


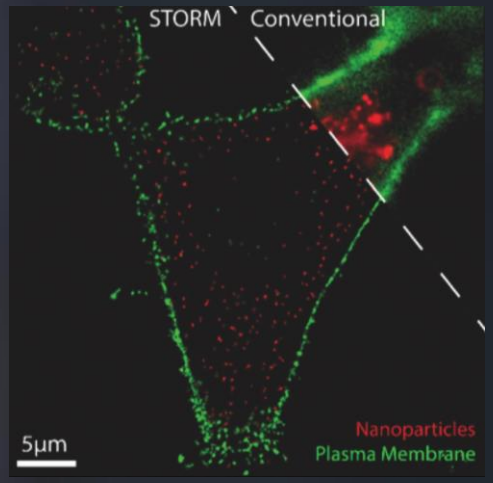
Nanoscopy for Nanomedicine

Dr. Lorenzo Albertazzi

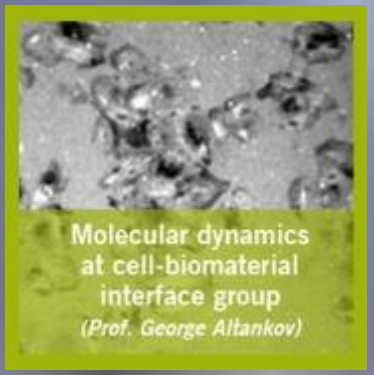
Using Super Resolution Microscopy (Nanoscopy) to visualize and track in living cells and tissues self-assembled nanomaterials with therapeutic potential (Nanomedicine).

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





Left: Widefield (upper right corner) and STORM super resolution image of HeLa cell internalizing polymer nanoparticles

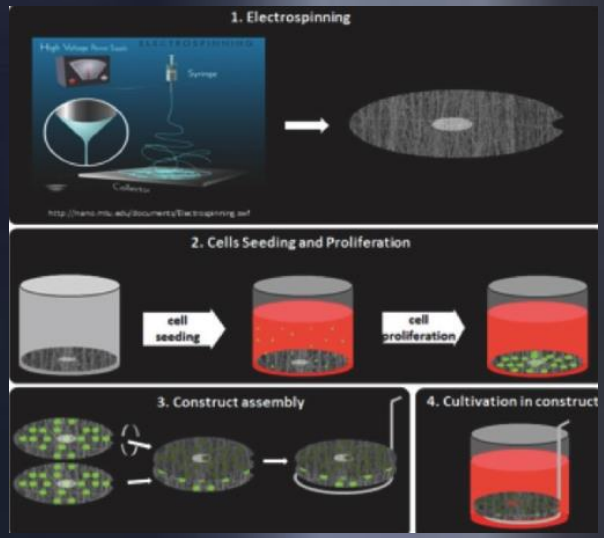


Molecular dynamics at cell-biomaterial interface

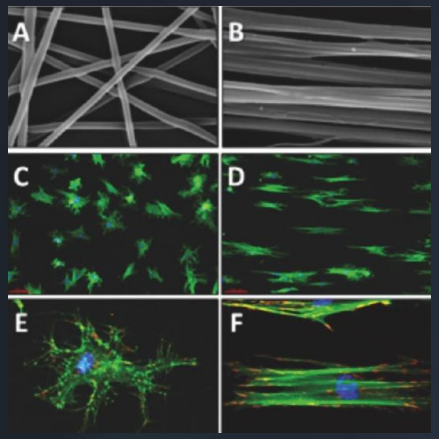
Prof. George Altankov

Understanding cell–biomaterials interaction, 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.



Left: Schematic illustration of the STRUCTGEL concept



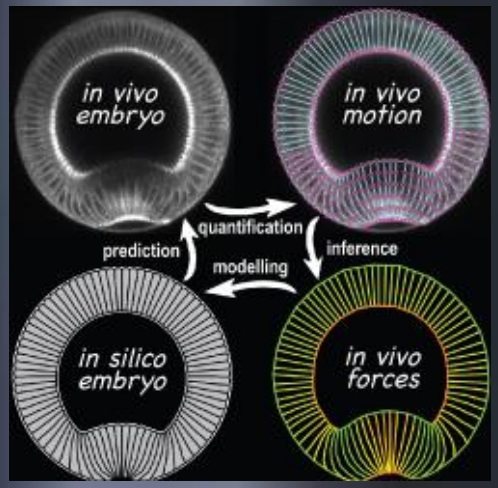
Right: Hybrid PLA/fibrinogen nanofibers deposited in random (A) and aligned (B) configurations. Human mesenchymal stem cells adhere to the fibers and acquire a stellate-like (C & E) or elongated (D & F) morphology, depending on the fiber orientations.

Mechanics of development and disease

Dr. Vito Conte

Deciphering the physical mechanisms of development and disease in biological organisms by studying how cell and tissue mechanics determine structure and function in these organisms.

We develop biophysical tools to compute cell and tissue forces in arbitrary 3D environments with realistic geometries and material properties, such as anisotropy, heterogeneity, poro-elasticity, and non-linear viscoelasticity.



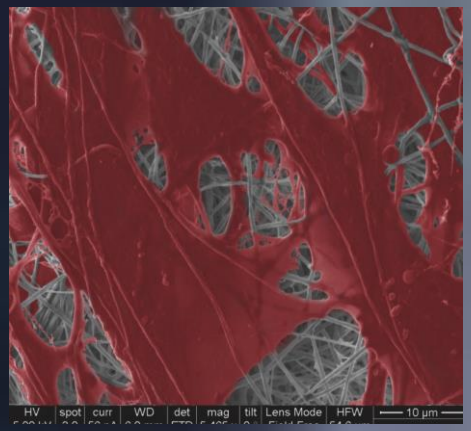
In vivo biomechanical quantification of ventral furrow invagination in the *Drosophila melanogaster* embryo.

Biomaterials for regenerative therapies

Dr. Elisabeth Engel

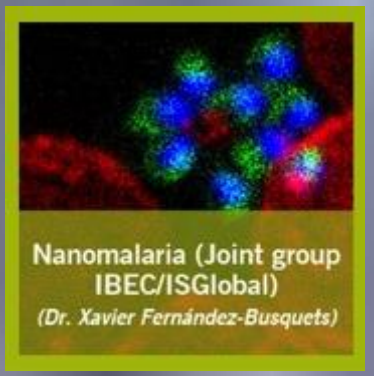
The development and knowledge transfer to industry of innovative biomaterials and scaffolds for tissue regeneration.

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 in mind. The aim is the repair and functional restoration of tissues or organs by means of 3D scaffolds, cells and signals.



Left: Endothelial precursor cells (red) seeded on ormoglass/PLA blends

Right: Biomimetic hydrogel implanted in mouse calvaria for 6 weeks. H/E staining of an osteoclast resorbing the hydrogel



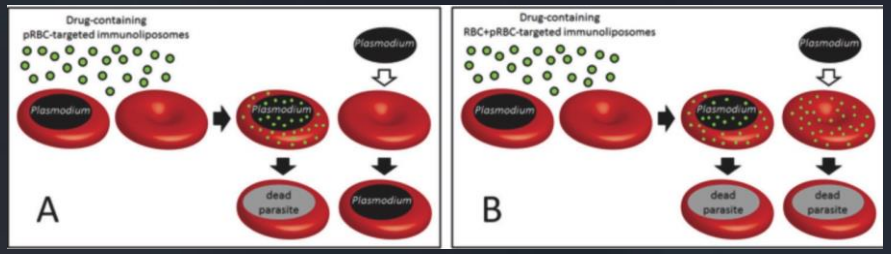
Nanomalaria (joint unit with ISGlobal)

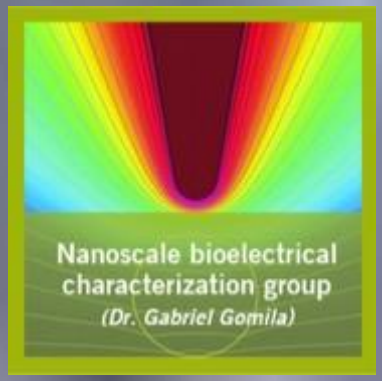
Dr. Xavier Fernández-Busquets

The development of nanomedicine-based systems for malaria prophylaxis, diagnosis and therapy.

The long sought-after magic bullet against malaria could take the form of a nanovector for the targeted delivery of antimalarial drugs exclusively to infected cells. Nanotechnology can also be applied to the discovery of new antimalarials through single-molecule manipulation approaches for the identification of drugs targeting molecular components of the parasite.

Left: 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. Below: Different outcomes expected when antimalarial drugs are targeted (A) only to -infected erythrocytes, or (B) to all erythrocytes. In the latter case the parasite will encounter the drug upon invasion





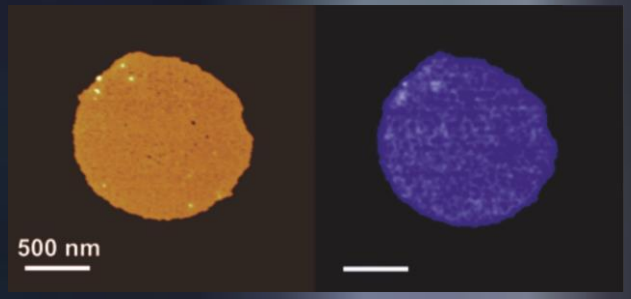
Nanoscale bioelectrical characterization

Dr. Gabriel Gomila

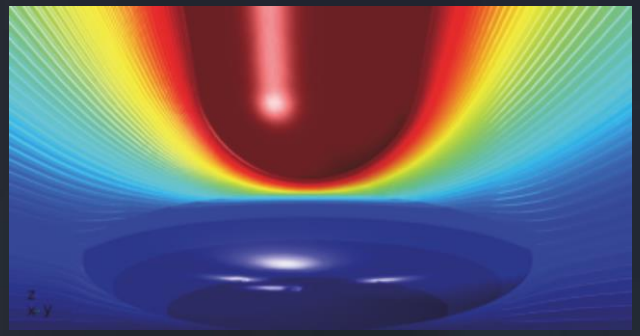
Developing new experimental setups based on atomic force microscopy and theoretical frameworks enabling the measurement of the electrical properties of biological samples at the nanoscale (for example, biomembranes, single viruses or single bacteria).

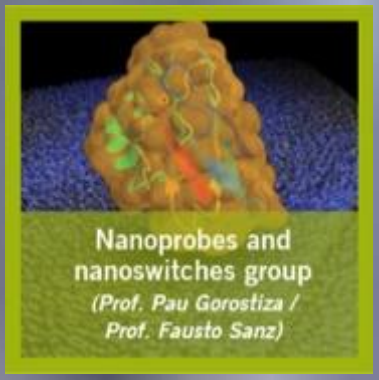
Our main objective is to contribute to develop new label-free biological characterization methods and new electronic biosensors.

Below: Topography and dielectric image (capacitance gradient) of a bacteriorhodopsin monolayer patch, 5.3 nm thick on a mica substrate. By combining information from the two images the dielectric constant of the protein layer can be determined with sub-50 nm lateral spatial resolution.



Below: 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.



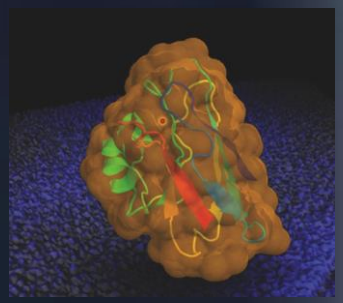


Nanoprobes and nanoswitches

Prof. Pau Gorostiza and Prof. Fausto Sanz

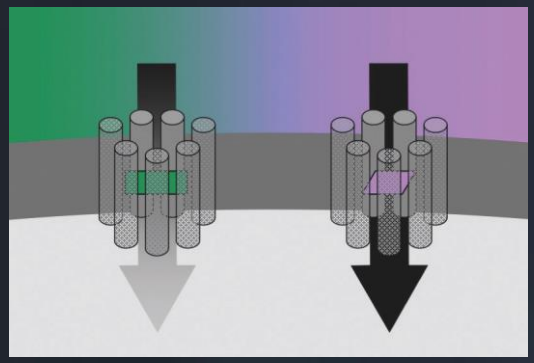
Developing nanoscale tools to study biological systems, including instrumentation based on proximity probes, such as electrochemical tunneling microscopy and spectroscopy, that we apply to investigate electron transfer in metal oxides and individual redox proteins.

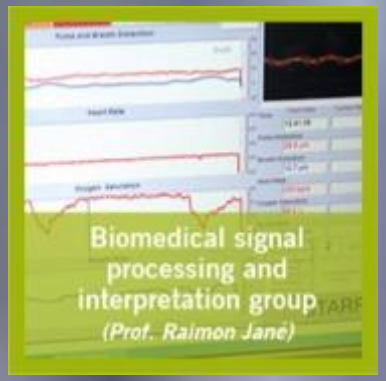
One set of nanotools is based on molecular actuators that can be switched with light, which can be chemically attached to biomolecules in order to optically control their activity.



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.

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.



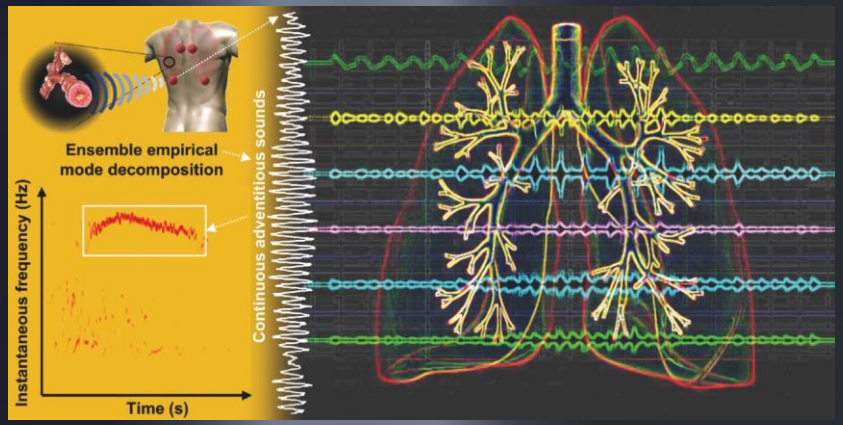


Biomedical signal processing and interpretation

Prof. Raimon Jané

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.



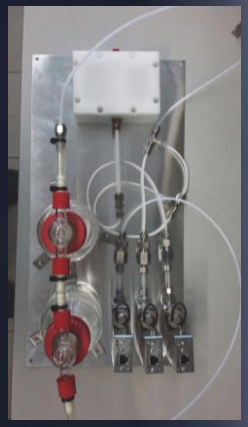
Novel method for differentiating normal from adventitious respiratory sounds (RS) to improve the diagnosis of pulmonary diseases. Particularly, continuous adventitious sounds (CAS) are of clinical interest because they reflect the severity of certain diseases. The new method is based on the multi-scale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

Signal and information processing for sensing systems

Dr. Santiago Marco

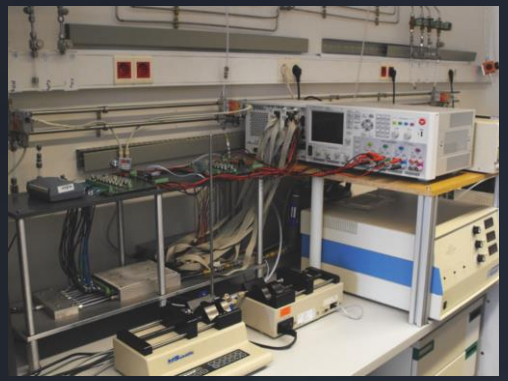
Intelligent chemical instruments for the detection of volatile compounds and smells.

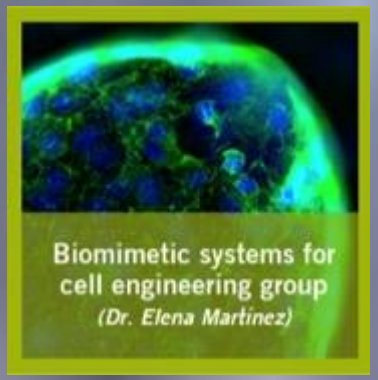
These systems can be based on an array of nonspecific chemical sensors with a pattern recognition system, taking inspiration from the olfactory system. Our group develops algorithmic solutions for the automatic processing of Gas Sensor Array, Ion Mobility Spectrometry (IMS) and Gas Chromatography-Mass Spectrometry (GC-MS) data for metabolomics and food samples.



System to test chemical chemical sensors for malodour detection

System to test chemical sensor arrays for diversity and redundancy



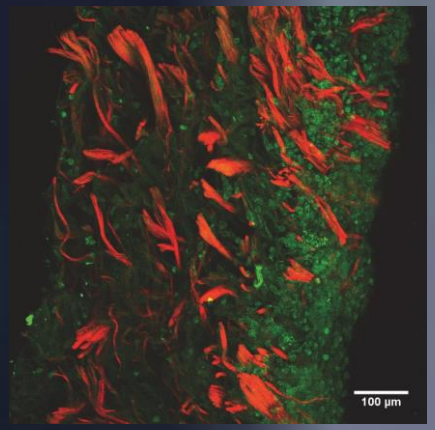


Biomimetic systems for cell engineering

Dr. Elena Martínez

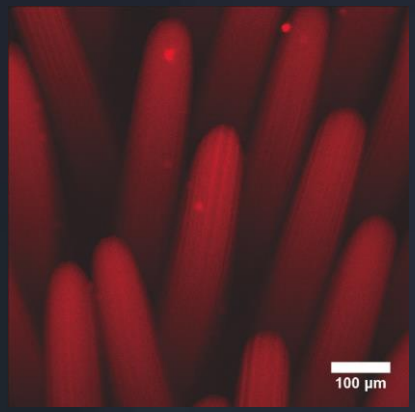
The development of biomimetic systems for cell-based assays that account for the structural, physiological and biochemical features of the *in vivo* cellular microenvironment.

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.



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) and elastin fibers (green))

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

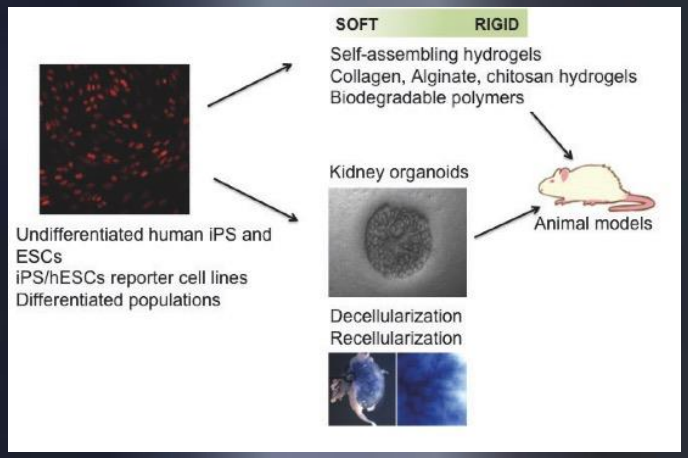


iPSCs & activation of endogenous tissue programs for organ regeneration

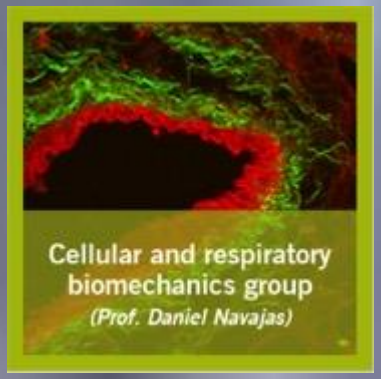
Dr. Nuria Montserrat

To generate and correct disease-specific hiPSCs for disease modeling and drug screening.

We are particularly interested in generation of transgene-free and disease free patient derived hiPSCs for disease modeling and the discovery of novel therapeutic targets. We take advantage of organ-isms that possess the ability to regenerate such as zebrafish, in order to understand which molecular and cellular pathways lead to organ regeneration.



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.

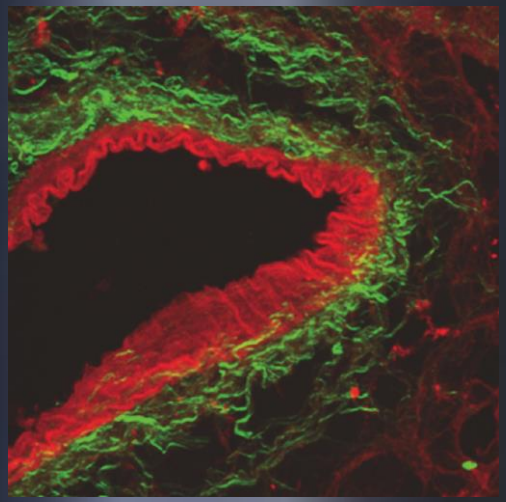


Cellular and respiratory biomechanics

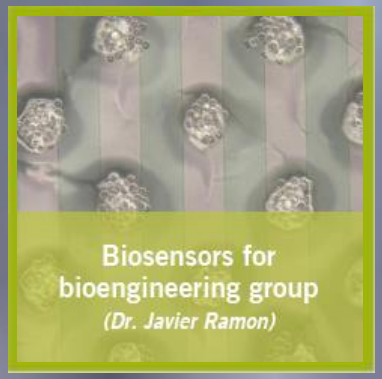
Prof. Daniel Navajas

To gain a deeper understanding of cellular and respiratory biomechanics in order to improve the diagnosis and treatment of respiratory diseases.

At the systemic level, we study the mechanical properties of airways and lung tissues and the mechanical dysfunctions associated with these diseases. At the cellular level, we have developed an AFM technique to probe micro/nanomechanical properties of the extracellular matrix of decellularized tissue scaffolds.



Vessel section from a decellularized lung showing the tunica intima, rich in elastin (red), and the tunica adventitia, with high concentration of collagen fibers (green). The image was obtained by two-photon and second harmonic generation microscopy.

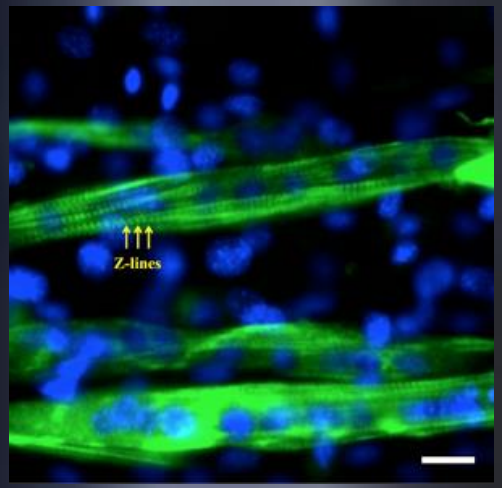


Biosensors for bioengineering

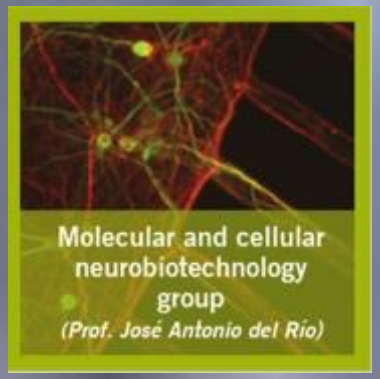
Dr. Javier Ramón

The Biosensors for Bioengineering group integrates biosensor technology and nanotechnology with stem cell research and with tissue engineering.

Engineered tissues are integrated with biosensing technology to obtain microdevices for detecting cellular responses to external stimuli, monitoring the quality of the microenvironment (e.g., metabolites, nutrients), and supporting diverse cellular requirements. Integration of fully functional tissues with microscale biosensor technology allowed us to obtain “organs-on-a-chip”.



Myotubes differentiated in a groove-ridge topography GelMA-CNTs composite loaded with 0.3 mg/mL CNTs. Immunostaining of cell nuclei/myosin heavy chain showing the highly aligned C2C12 myotubes. Z-lines were also observed for the myotubes indicating high maturation of muscle myofibers. Scale bar 20 µm.



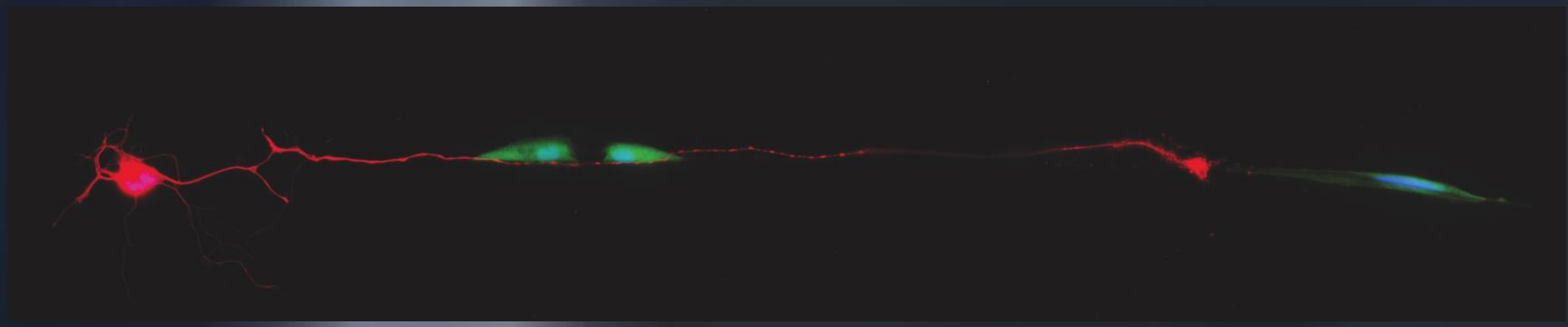
Molecular and cellular neurotechnology

Prof. José Antonio del Río

We focus on four main aspects of developmental neurobiology and regeneration:

1) Analysis of cell migration and functions of Cajal-Retzius cells during cortical development. 2) Cell therapy and pharmacological treatment to potentiate axon regeneration in lesioned central nervous system. 3) Neurodegenerative diseases. 4) Development of new lab on a chip devices for neurobiological research.

Corticospinal axon (red) follows axonal guidance cues of olfactory ensheathing cells (green).

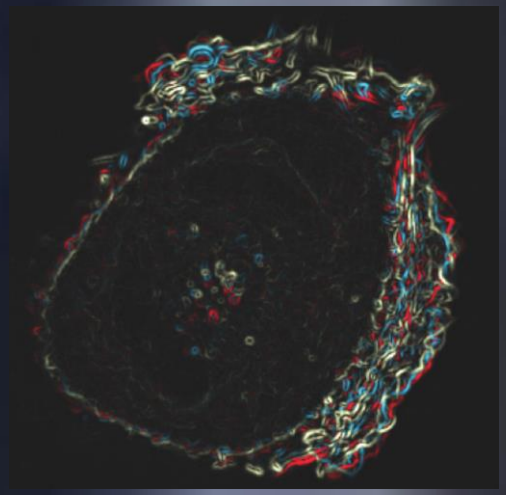


Cellular and molecular mechanobiology

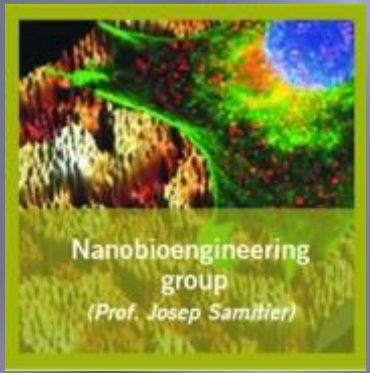
Dr. Pere Roca-Cusachs

Mechanical forces affect the links and conformation of a network of molecules connecting cells to the extra-cellular matrix.

We unravel the mechanisms that these molecules use to detect and respond to mechanical stimuli like forces or tissue rigidity, triggering downstream cell responses. Ultimately, we want to understand how forces determine development when things go right, and tumor formation when they go wrong.



Movement of the actin cytoskeleton of a breast myoepithelial cell, shown by superimposing images of the actin cytoskeleton in different timeframes.

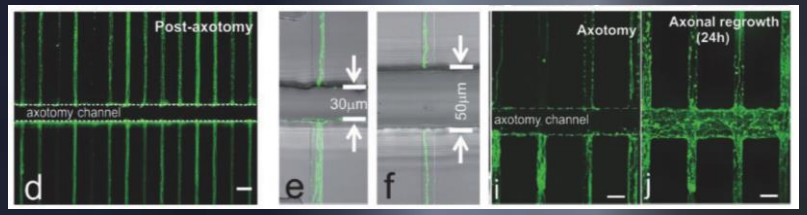


Nanobioengineering

Prof. Josep Samitier

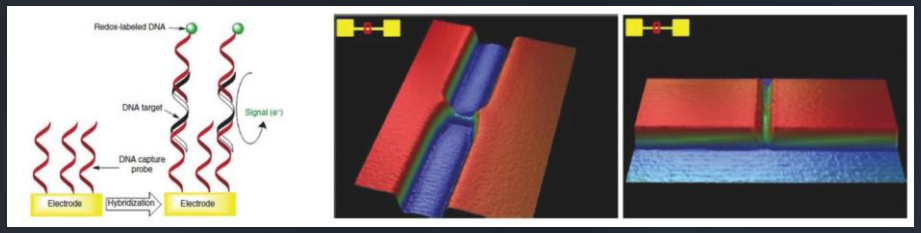
Nanotechnology for the development of biomedical systems and devices for diagnostic purposes and integrated microfluidic devices for organ-on-chip.

We carry out surface functionalization of materials integrated with micro-fluidics systems for the study of biomolecule and cell interactions. The goal is to fabricate micro-systems containing living cells that recapitulate tissue and organ-level functions *in vitro* and new portable diagnosis devices as Point-of-Care systems.



Proximal segments of axons showing regeneration formation in compartmentalized microfluidic devices

Nano-gap DNA sensors



Smart nano-bio-devices

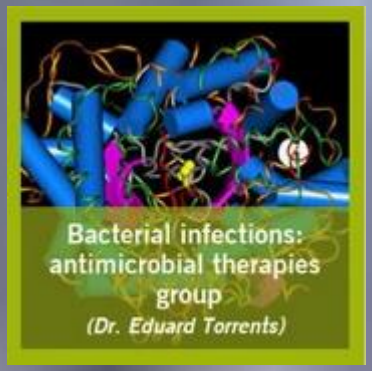
Prof. Samuel Sánchez

The design of miniaturized devices that bridge functional materials and bio-related applications.

Our main research topics are self-propelled micro-nanorobots, compact on-chip electrochemical (bio)sensors and biophysics of cells in confined spaces. Part of our activities are based on the shrinkage of “Lab-on-a-chip” to “Lab-in-a-tube” micro-analytical systems which can delicately control the positioning of single cells inside micro-tubular structures integrated on-chip.

Rolled-up nanotechnology with thin films of Pt as the top layer, which will remain inside the tube after rolling up. Then, since this can be a mass-production method, many of these tubes can be released from the substrate immerse in H2O2 solutions, which will be used as a fuel. There, when the fuel contacts the inner layer of the tube where Pt is, it decomposes into H2O and O2. This oxygen is accumulated inside the cavity as visible bubbles that grow and migrate towards the larger opening of the tube, propelling it in the opposite direction.

Their performance is not only limited to bulk solutions, since they can swim into the flowing streams of microfluidic channels. They have enough power to go upstream and to move spherical particles

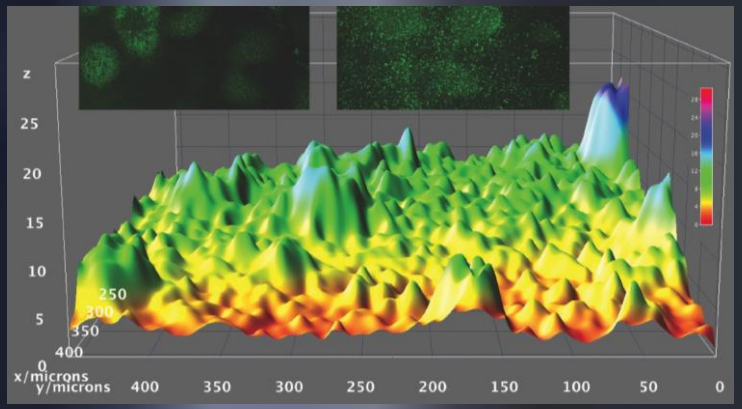


Bacterial infections: antimicrobial therapies

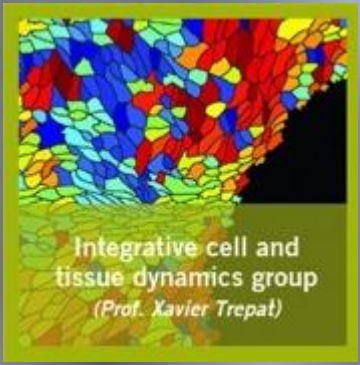
Dr. Eduard Torrents

We investigate new antimicrobial therapies to combat bacterial infections.

We aim to 1. establish the molecular basis for the regulation of RNR genes, their importance in virulence and biofilm formation; 2. identify and screen new molecules for the highly selective inhibition of bacterial RNR; 3. develop nanoparticles to deliver existing antibiotics or anti-microbial drugs; 4. use lab-on-a-chip technology to study the electrical fields in bacterial cell physiology.



Surface plot analysis of *Pseudomonas aeruginosa* wild-type PAO1 days. Biofilms were grown in a continuous flow cell system and visualized under confocal microscopy.

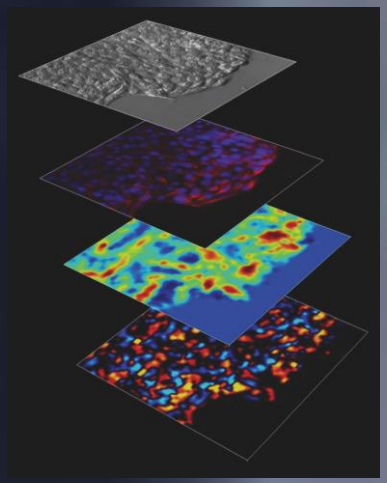


Integrative cell and tissue dynamics

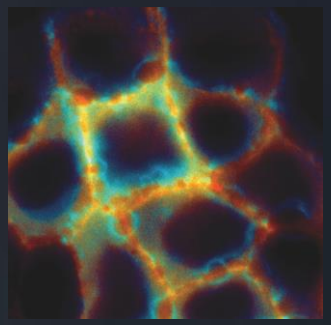
Prof. Xavier Trepat

Our research focuses on understanding the fundamental biophysical mechanisms underlying cell migration both at the single cell level and at the tissue level.

When properly regulated, cell migration enables morphogenesis, host defense and tissue healing. When regulation fails, however, cell migration mediates devastating pathologies such as cancer, vascular disease and chronic inflammation.



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



Fracking in epithelial layers: the small fractures between cells, in blue, close within minutes

Associated researchers

Prof. Alícia Casals, GRINS - Intelligent Robots and Systems, UPC
From 2008-2015, Alícia Casals led the Robotics group at IBEC, during which time she began a spin-off company with the UPC, Rob Surgical Systems. She was recognized for her work as a research scientist in the “16 Científiques Catalanes” exhibition organized by the ACCC in 2010, and received a 2015 fem.talent Award at the fem.talent Fòrum in Barcelona.

Prof. Maria Pau Ginebra, Biomaterials, Biomechanics and Tissue Engineering, UPC
Winner of ICREA Academia Awards in 2008 and 2013 and the Narcis Monutriol Medal from the Generalitat de Catalunya in 2012, and the Racquel LeGeros Award from the International Society for Ceramics in Medicine for her contribution to calcium phosphate research in 2013. In the same year she founded the spin-off company Subtilis Biomaterials.

Prof. Antonio Juárez, Bacterial Molecular Biology, UB
From 2007-2015, he led the Microbial Biotechnology and Host-pathogen Interaction group at IBEC. He and colleagues from the UB and IRB identified the strategy used by enterobacteria to acquire resistance and and worked with IBEC’s Nanoscale Bioelectrical Characterization group to demonstrate the potential of electrical studies of single bacterial cells.

Prof. Ralph Andrzejak, Department of Information and Communication Technologies, UPF
The development of advanced nonlinear signal analysis techniques and the study of recordings from the brain. An early paper of his on the detection of deterministic structures in experimental signals has become a seminal paper in the field and has received more than 430 citations.

Marino Arroyo is Associate Professor at the Universitat Politècnica de Catalunya (UPC), where he is a member of the Laboratory of Computational Methods and Numerical Analysis (LaCaN) group. His research goal is to develop theories and computational methods to understand the small-scale mechanics of materials and biological systems.