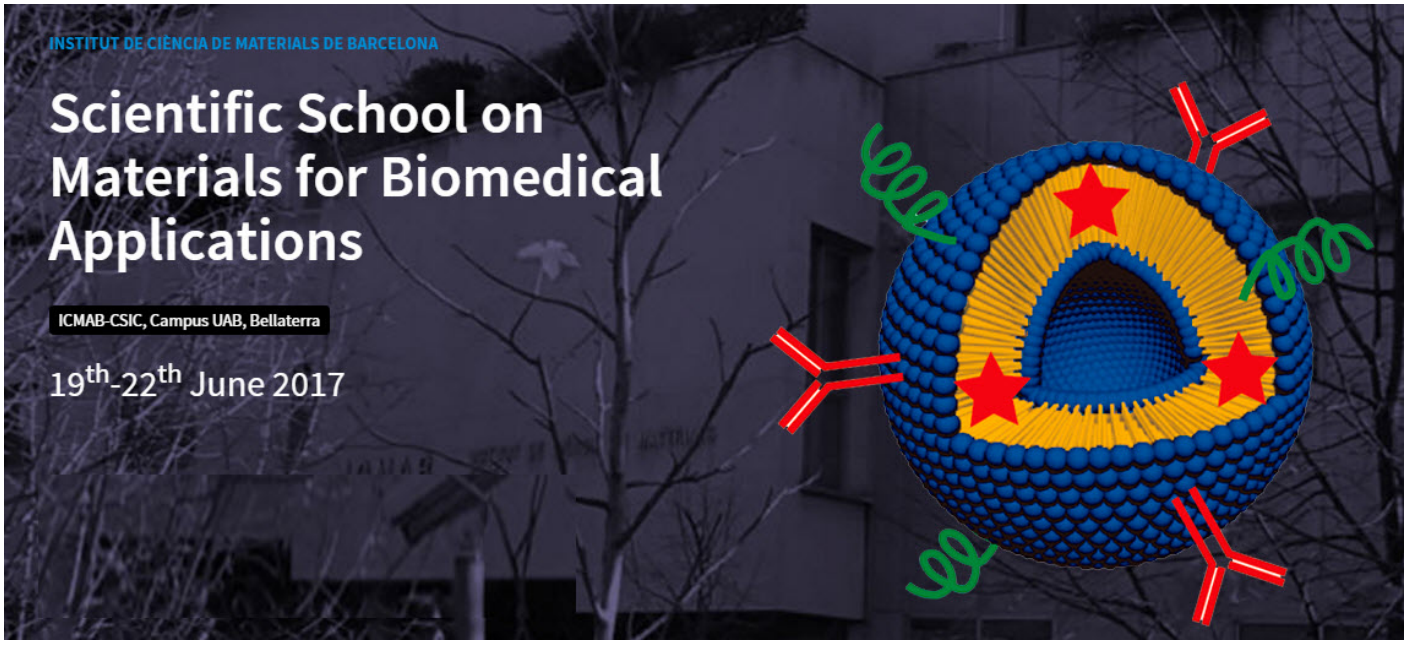

Institut de Ciència de Materials de Barcelona (ICMAB-CSIC)
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MATBIO2017

Welcome to MATBIO2017!

The summer school **"Materials for Biomedical Applications"** is addressed to last year undergraduate, master and PhD students, who are interested in the development of materials with biomedical applications. The aim of the summer school is to present the design, development and application of new materials for a wide range of biomedical applications.

The topics addressed are:

- Biosensors
- Drug delivery: carriers
- Imaging/diagnosis
- Tissue Regeneration
- Bioengineering Scaffolds
- Therapy
- Materials cycle

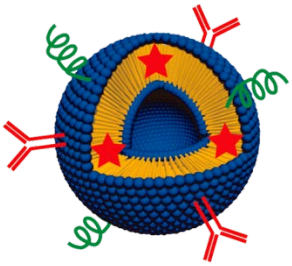
The school includes:

- Lectures from international and local scientists
- Hands-on and management activities
- Social activity: Science Dating on Tuesday afternoon
- ICMAB tours
- Coffee breaks

This Scientific School is an optimal opportunity to discover, learn and practice on material science focusing on fundamental science and applied research in the field of biomedicine.

The school is included in the Severo Ochoa activities of ICMAB.

We hope you enjoy this Scientific School and your stay with us!



MATBIO2017 is online!

Use the hashtag **#matbio2017** for photos in Instagram, Twitter and Facebook!

MATBIO2017 programme

VENUE

Lectures: Sala Actes Carles Miravitlles at the ICMAB

Meeting point for hands-on activities: MATGAS hall

Monday 19th June 2017	
8:30-9.00	Registration
9:00-9.10	**OPENING**
	Xavier Obradors – Director Institut de Ciència de Materials de Barcelona (ICMAB-CSIC)
TISSUE ENGINEERING (Chair: Nieves Casañ)	
9.10-10.10	Oscar Castaño (Institute for Bioengineering of Catalonia - IBEC) Tissue Engineering: towards 3D artificial tissues
10.10-11.10	Ann Rajnicek (Institute of Medical Sciences, University of Aberdeen) Tissue engineering for nervous system and tissue repair.
11.10-11.30	**COFFEE BREAK – ICMAB ground floor**
THERAPY (Chair: Anna Roig)	
11.30-12.30	Vanesa Sanz (Institute of Photonic Sciences – ICFO) Applications of plasmonic nanoparticles on lab-on-a-chip technology and nanomedicine
12.30-13.30	Puerto Morales (Institute of Materials Science of Madrid - ICMM) Magnetic hyperthermia: fundaments, progress and limitations
13.30-15:00	**Lunch – Restaurant Ciències UAB**
15:00-18:00	**HANDS-ON ACTIVITIES (1h sessions) – MATGAS hall** **Coffee break and change of activity 16:15-16:45 at MATGAS hall**
	Polymer swelling in $scCO_2$ - Ana López-Periago
	Electroactive materials as implants – Nieves Casañ
	Synthesis of Au-NPs - Anna Laromaine, Soledad Roig
	Synthesis and modification of 2D Materials – Stefania Sandoval, Gil Gonçalves
	Soft-litography; Microcontact printing to create patterns of molecules – Sandra Giraldo, Ezhil Amirthalingam, Raul Díaz
	Synthesis of boron-based molecular materials - Mahdi Chaari, Rosario Núñez
	$scCO_2$-Nanovesicles - Nathaly Segovia, Amable Bernabé

Tuesday 20th June 2017	
DRUG DELIVERY (Chair: Núria Aliaga)	
9.00-10.00	Marcelo Calderón (Institute of Chemistry and Biochemistry, University of Berlin) Environmental Responsive Dendritic Polymers for Theranostics
10.00-11.00	Natascia Grimaldi (Institute of Materials Science of Barcelona – ICMAB) Nanovesicles and compressed-fluid based technology: can they represent a paradigm shift in Nanomedicine?
11-11.30	**COFFEE BREAK – ICMAB ground floor**
BIOSENSORS (Chair: Imma Ratera)	
11.30-12.30	Pilar Marco (Institute of Advanced Chemistry of Catalonia, IQAC) Nanobiotechnologic perspectives for in vitro diagnostics
12.30-13.30	Encarnación Lorenzo (Autonomous University of Madrid - UAM) Biosensors: Fundamentals and biomedical applications

13.30-15	**Lunch – Restaurant Ciències UAB**
15:00-16.30	**HANDS-ON**
	Simulation - Jordi Faraudo, Silvia Illa
	Technology Transfer (Chair: Susana Garelik) Isabel Gavilanes (Institute of Microelectronics of Barcelona IMB-CNM)
16.30-18.00	**SCIENCE DATING**

Wednesday 21st June 2017	
9.00-11.00	**HANDS-ON (1h sessions) – Meeting at MATGAS hall**
	EPR - Vega Lloveras
	DLS/Z-potential - Amable Bernabé, Nathaly Segovia
	Magnetic properties – Bernat Bozzo
	C. elegans - Luo Zhongrui, Anna Laromaine
11-11.30	**COFFEE BREAK – MATGAS hall**
11.30-13.30	**HANDS-ON (1h sessions) – Meeting at MATGAS hall**
	X-ray diffraction – Anna Crespi, Fco. Javier Campos
	SEM - Anna Esther Carrillo
	Hydrogen Peroxide Biosensor Based on Horseradish Peroxidase - Isabel fuentes
	AFM - Andrés Gómez
13.30-15	**Lunch – Restaurant Ciències UAB**
	MATERIALS CYCLE (Chair: Clara Viñas)
15.00-16.00	Fernanda Marujo (Centre for Nuclear Sciences and Technologies – University of Lisboa) In vitro/in vivo biological evaluation of prospective antitumour drugs: insights into the mechanism of action by nuclear tools
16.00-17.00	Beatriz Morancho (Vall d'Hebron Institute of Oncology - VHIO) Immunotherapy: using the immune system to treat cancer
17.00-18.00	Angel Menargues (Barcelona Science Park - PCB) Overview and reflection on ecotoxicological risk assessment

Thursday 22nd June 2017	
	IMAGING (Chair: José Vidal-Gancedo)
9.00-10.00	Anna Roig (Institute of Materials Science of Barcelona – ICMAB) Introduction to in-vivo medical imaging techniques from materials science and nanoscience view point
10.00-11.00	Jordi Llop (CIC biomaGUNE) Radiochemistry and nuclear imaging: application to the in vivo investigation of nanomaterials
11-11.30	**COFFEE BREAK – ICMAB ground floor**
	BIOENGINEERED SCAFFOLDS (Chair: Concepción Domingo)
11.30-12.30	Mª Pau Ginebra (Polytechnic University of Catalonia - UPC) Biomimetic ceramic scaffolds for bone engineering
12.30-13.30	Julio San Román (Institute of Polymer Science and Technology - ICTP) Learning from the nature the structure and morphology of nanoparticles for advanced applications in nanomedicine
13.30	End-of-school

ICMAB

The Institute of Materials Science of Barcelona (ICMAB-CSIC) (www.icmab.es) is an internationally renowned public research institute in Advanced Functional Materials integrated in the National Research Council of Spain (CSIC). The mission of ICMAB is to generate new knowledge in Materials Science through excellent scientific research, useful for society and industry.

ICMAB has 57 permanent and 90 non-permanent scientists and a total of 220 people divided in 8 Research Groups. The center has outstanding international competitiveness, with a large number of high impact articles and citations and European research projects participation (9 ERC grants at present). The center has been recently awarded with the label of Center of Excellence “Severo Ochoa” by the Spanish Ministry.

The Strategic Research Program includes 5 mission-oriented Research Lines to face three social grand-challenges: clean and secure energy, smart and sustainable electronics and smart nanomedicine. The strategic Research Lines are: RL1: Energy storage and conversion; RL2: Superconductors for power applications; RL3: Oxide electronics; RL4: Molecular electronics; RL5: Multifunctional nanostructured biomaterials.

ICMAB welcomes applications from the best and brightest candidates with a degree in a field of science and engineering related to the ICMAB research activities, for a competitive and multidisciplinary training and research program. The diversity of our students and the interdisciplinary research fields related to Materials Science ensure an enriching working environment to develop your professional career.

RL5: Multifunctional nanostructured biomaterials

This RL provides key inputs in two of the current challenges of **nanomedicine**:

1. **Nano-objects for therapy and diagnosis** obtained by new manufacturing schemes and able to cross biological barriers.

   A. Smart multifunctional drug delivery systems decorated with targeting vectors and stealth agents, such as nanovesicles, nanocapsules, nanoparticles, dendrimers, nanotubes, containing bioactive molecules (small drugs, enzymes or proteins).

   B. Nano-objects for multimodal diagnosis enabling to obtain images of the different tissues and metabolites distribution based on contrast agents magnetic nanoparticles and organic free radicals, X-ray absorbers or radionuclei.

2. **Nanostructured materials for tissue repairing** to understand and control signals directing cell behavior towards vascular or neural reparation therapies.

   A. Novel biocompatible nanostructured electrodes based on graphene with high capacity and low faradaic effects for repairing the neural system.

   B. Endothelial cells and magnetic nanoparticles for cell therapy in brain neurorepair.

   C. Surfaces that trigger the organization of growth factors in a biomimetic way using electroactive molecular self-assembled monolayers for cell guidance towards vascular morphogenesis.

The actions to develop these targets are also supported by the experience on theory and simulation of soft and biomaterials.

ORGANIZING COMMITTEE

Anna Laromaine	Arántzazu González	José Vidal-Gance	Rosario Núñez	Gerard Tobías
alaromaine@icmab.es	agonzalez@icmab.es	pepe@icmab.es	rosario@icmab.es	gerard.tobias@icmab.es

Dr. Oscar Castaño

ocastano@ibecbarcelona.eu

Title: Tissue Engineering: towards 3D artificial tissues

There is a shortage of organ donors that leads to urgency to develop novel strategies able to engineer artificial organ and tissues in the laboratory. Tissue engineering, within the framework of regenerative medicine and tissue repair, is the most promising approach to address this problem, providing alternative regenerative therapies to enhance the quality of life of many patients. Different steps are needed depending on the tissue and applications. They usually involve cell-sourcing and gene manipulation, a 3D biomaterial scaffold design and fabrication, cell-colonization of the scaffold, bioreactor culture and monitoring, and vascularization and implantation in the host patient, not necessarily in that order.

There are important design considerations for all these steps to achieve the specific output of a 3D artificial tissue or even an organ. The selection of a suitable strategy strongly depends on the biological host environment and how the scaffold can mimic the properties of the extracellular matrix (ECM). Mimicking the tissue natural matrix means recreating the molecular architecture and the biochemical environment that surrounds the cells, providing the right signalling to drive cell behaviour. From a clinical point of view, a smart material/implant may be defined as a material that actively participates in the regeneration of the damaged tissue, and responds and reacts to stimuli from its environment in a valuable way.

Advances in existing knowledge have allowed the introduction of a new "outside the box" concept based on *in situ* tissue regeneration. This is based on the use of the own body's own capacity for regeneration by mobilizing host endogenous stem cells or tissue-specific progenitor cells to the site of the injury to promote repair and regeneration. This approach relies on the development of target-specific biomaterial scaffolding systems that can effectively control the host microenvironment and mobilize host stem/progenitor cells that are guided to regenerate structural and functional tissues: in other words, instructive biomaterials, which effectively combine two features that actively participate in the regeneration of the damaged tissue and respond and react to stimuli from its environment: bioactivity and biodegradability.

However, we are still far from accomplishing this goal. There are plenty of studies using up-to-date materials with complicated chemistries and fabrication methods, but they are difficult to scale up. Some of these studies have resulted in high-impact papers, but translation to the clinics is not yet feasible, at least in the medium term. An overview of the new trends and examples in conventional and *in situ* tissue engineering are presented.

Dr. Oscar Castaño is currently senior researcher at the Institute for Bioengineering of Catalonia (IBEC) in Barcelona, working on biomaterials for regenerative medicine and tissue engineering, with special emphasis on inorganic, polymeric and composite hybrid compounds with bioactivity (angiogenesis) features in the musculoskeletal system. He is also part-time lecturer in the Materials Science and Physical Chemistry department of the University of Barcelona (UB). As a materials scientist specializing in nanostructuration, Dr. Castaño performed his PhD in superconducting materials and buffer layers by wet methods in the group of Prof. Xavier Obradors at ICMAB.

During his career, he has had the opportunity to perform extended research stays in Germany and France as a postdoctoral researcher, and in South Korea and Berkeley as research scholar. He has also worked for a private company, Nexans Superconductors GmbH in Cologne, Germany, as R&D researcher. These enriching experiences culminated in his current position in IBEC's Biomaterials for Regenerative Therapies group, where he leads several research projects developing new approaches to structure inorganic, polymeric and hybrid biomaterials into 3D scaffolds with nanoscale surface control that promotes tissue regeneration (bone, skin, nerve) through proper vascularization. He also develops microfluidic models for the evaluation of angiogenesis in microscaffolds, trying to reduce the gap between in vitro and in vivo. He has also led several national and international projects. Together, he has published around 17 high impact factor articles, 3 book chapters, generated more than 750 cites in the last 5 years, and was awarded as the Best Young Biomaterials Researcher in Spain by CIBER-BBN-YSF for 2012-2014.

Dr. Ann M. Rajnicek

a.m.rajnicek@abdn.ac.uk

Title: Tissue engineering for nervous system and tissue repair

The ability of the central nervous system to repair itself spontaneously is severely limited. For example, there is no effective therapy for spinal cord injury (SCI). The barriers to restoration of sensory and motor function include fibrous scar tissue, a fluid filled cyst and an environment rich in growth inhibitory molecules. Each of these prevents nerve cells from growing across the injury site to restore nerve impulse conduction. The consensus is that an effective therapy will only emerge from a combined strategy using a growth supporting scaffold, drug treatment and electrical stimulation, perhaps also incorporating stem cells. This presentation will discuss the challenges of designing and testing such a therapy and how those challenges might be overcome.

Senior Lecturer, School of Medicine, Medical Sciences and Nutrition, Institute of Medical Sciences, University of Aberdeen

EDUCATION

BSc magna cum laude- Biology major, Chemistry minor 1984

Marygrove College, Detroit, Michigan (USA)

Awards: National Dean's List, Best Biology Student

PhD- Developmental Biology 1990

Purdue University, West Lafayette, Indiana (USA)

Thesis: Effects of Electrical Fields on Wound Healing and Directed Neurite Growth.

AWARDS

2000- Yasuda Award for excellence in biomedical research- Society for Physical Regulation in Biology and Medicine (Miami, USA)

2008- First prize: Scientific Image of the year- Institute of Medical Sciences (University of Aberdeen)

2011- Nominee, Student-Nominated Teaching Award-"Excellent Teaching" (University of Aberdeen)

PUBLICATIONS (Last 5 years)

•Kucerova R, Walczysko P, Reid B, Ou J, Leiper L, Rajnicek AM, McCaig CD, Zhao M & Collinson JM. (2011). The role of electrical signals in murine corneal epithelial wound re-epithelialisation. J. Cellular Physiology 226:1544.

•Canillas M, Rajnicek AM, Rosero C, Chinarro E,Moreno B. (2012). Ti4O7 used as electrode in biomedicine and for electrochemical study of scavenging mechanism. Key Engineering Materials 493-494:896-901.

•Kucerova R, Dorà N, Mort RL, Wallace K, Leiper LJ, Lowes C, Neves C, Walczysko P, Bruce F, Fowler PA, Rajnicek AM, McCaig CD, Zhao M, West JD, Collinson JM. (2012) Interaction between hedgehog signalling and PAX6 dosage mediates maintenance and regeneration of the corneal epithelium. Molecular Vision 18:139-150.

•Hoare J, Rajnicek AM, McCaig CD, Barker RN, Wilson HM. (2016). Electric fields are novel determinants of human macrophage functions. Journal of Leukocyte Biology. 99: 1141-1151. doi: 10.1189/jlb.3A0815-390R

•Pruski M, Rajnicek AM, Yang Z, Clancy H, Ding Y, McCaig CD, Lang B*. (2016). The ciliary GTPase Arl13b regulates cell migration and cell cycle progression. Cell Adhesion and Migration. *joint corresponding authors. 0:1-13 DOI: 10.1080/19336918.2016.1159380*

•Walczysko P, Rajnicek AM, Collinson JM (2016). Contact mediated migration of corneal epithelial cells. Molecular Vision. Vol 22: 990-1004. http://www.molvis.org/molvis/v22/990 (2015IF 2.12)

•Findlay AS, Panzica DA*, Walczysko P, Holt A, Henderson DJ, West JD, Rajnicek AM, Collinson JM. A planar cell polarity pathway directs adult corneal epithelial cell alignment and migration. (*equal contributions). Royal Society Open Science 3(10) DOI: 10.1098/rsos.160658.*

•Canillas M, Moreno B, Chinarro E, Rajnicek AM (2017). Electrical growth and guidance of neurons on TiO2 substrata. Materials Science and Engineering C. (published online April 2017)

Dr. Vanessa Sanz
vanesa.sanz@icfo.eu

Title: Applications of plasmonic nanoparticles on lab-on-a-chip technology and nanomedicine

The development of novel approaches for improved detection methods and more effective therapeutic systems represents some of the current trends in the medical field. This talk will be focused on the description of novel strategies to overcome these problems by the use of both optical biosensors and therapy based on plasmonic nanoparticles.

The first part of this lecture will be focused on the discussion of the use of these biosensors, including a description of strategies for the use of the optical properties of plasmonic nanoparticles and their applications on lab-on-a-chip technology. In the second part of the talk, the description of novel strategies for the use of nanoparticles in nanomedicine will be presented.

The advantages that nanomedicine offers for the development of more selective and effective therapeutic systems will be employed in the design of different systems for drug and gene delivery and also optical hyperthermia based on plasmonic nanoparticles. Procedures for the functionalization of these kind of nanoparticles to effectively bind and deliver the therapeutic agent will be described. The applications of the described systems in cancer treatment will be also evaluated.

Vanesa Sanz obtained her Degree in Chemistry Sciences at the University of Zaragoza in 2001. During her last year degree, she carried out a dissertation in the field of biosensors at the same university obtaining the Gregorio Casañal Poza Award 2002 for that work. She obtained her PhD in Chemistry at the University of Zaragoza in June 2006.

After this period, she carried out a postdoctoral stay at the Faculty of Health and Medical Sciences at the University of Surrey (United Kingdom) with a Marie Curie grant from March 2007 to May 2009. She was participating as experienced researcher in the Marie Curie Research Training Network (RTN) CARBIO (Multifunctional Carbon Nanotubes for Biomedical Applications). This stay involved the work of the researcher in a field different from her original background, obtaining experience within the multidisciplinary fields of nanotechnology and bionanomedicine. The researcher worked at the Institute of Nanoscience of Aragon at the University of Zaragoza (Spain), with a research contract under a European project (June 2009-March 2011). This project, NANOTRUCK, intended to develop an innovative kind of multifunctional gold nanoparticles for cancer diagnosis and treatment.

The researched performed another stay at the Institute of Material Sciences and Technology (IMT) at the Friedrich-Schiller-Universität in Jena (Germany) developing both teaching and research activities. She got experience in the field of Biomaterials, working on the development of novel chemically and physically nanopatterned surfaces for biomedical applications. Currently, she is working at the Institute of Photonic Sciences (Spain) as a Research Fellow in the group of Plasmon Nano-optics where she is applying her experience in the development of novel research lines on the field of nanomedicine, thermo-plasmonics and biosensing.

Dr. Maria del Puerto Morales
puerto@icmm.csic.es

Title: Magnetic Hyperthermia: Fundaments, progress and limitations

Magnetic hyperthermia is an emergent strategy particularly attractive for cancer treatment based on heat generation at the tumor site using magnetic nanoparticles and an alternating magnetic field. This approach presents fewer side effects compared to chemo- and radiotherapy, can be used in combination with all conventional therapeutic treatments and it has been approved by the FDA.

The recent achievements of magnetic hyperthermia in cancer therapy are very promising but the method still needs further improvement before becoming a standard medical procedure. Important problems are the adequate particle supply to the tumor tissue and the improvement of the specific heating power (SHP) of the nanoparticles to reach and maintain therapeutically suitable temperatures inside the tumor tissue with a minimum of magnetic material delivered into the tumor.

In this talk, we will analyze the fundaments of the magnetic hyperthermia, recent achievements and limitations.

María del Puerto Morales is senior scientist at the Institute of Material Science in Madrid (ICMM/CSIC), Spain since 2008. She got her degree in Chemistry by the University of Salamanca in 1989 and her PhD in Material Science from the Madrid Autonomous University in 1993.

From 1994 to 1996, she worked as a postdoctoral fellow at the School of Electronic Engineering and Computer Systems of the University of Wales (UK). Her research activities are focused on the area of nanotechnology, in particular in the synthesis and characterization of magnetic nanoparticles for biomedicine, including the mechanism of particle formation and its performance in biomolecule separation, NMR imaging, drug delivery and hyperthermia.

She has authored several book chapters in the field of nanoparticle synthesis and more than 190 articles in interactional scientific journals (h=46, 8500 citations). She was the principal investigator from the CSIC of two European-funded research projects in the 7FP (Multifun and NanoMag).

Dr. Marcelo Calderón

marcelo.calderon@fu-berlin.de

Title: Environmental Responsive Dendritic Polymers for Theranostics

Development of effective polymer-based nanocarriers which are able to target diseased tissues still remains as a great challenge in current research. Dendritic polymers have emerged as novel polymeric scaffolds that have demonstrated a great potential for diverse biomedical applications. These architectures have already proved their usefulness in therapeutic approaches related to multivalency, given by the synergy between the nanosized dimensions combined with the high density of functional groups. However, a continuous effort is necessary to modify and tailor dendritic polymer architectures to fit the future demands of biomedical applications.

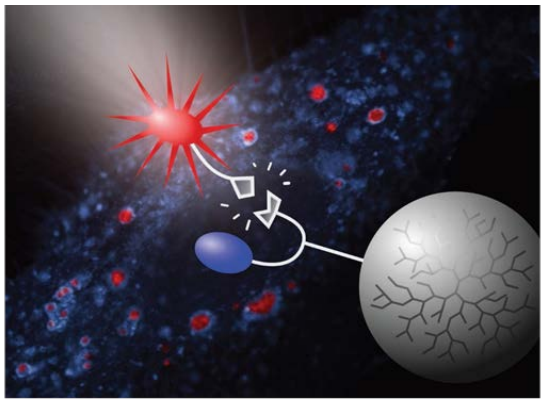


Figure 1. Evaluation of conjugate uptake and cleavage.[3b]

These polymeric scaffolds are currently used for the development of new delivery systems with focus on: (1) multifunctional polymer-drug conjugates, (2) self-assembling amphiphiles for the controlled delivery of bioactives, (3) dendriplex formation for gene therapy, and (4) new diagnostic technologies for theranostic approaches. Advances on the development of a general synthetic strategy that allows the linkage of dendritic polymers to drugs, fluorescent dyes, cell targeting ligands, and thermoresponsive polymers have been reported. The preliminary results highlight the potential of dendritic polymers to acts as new targeted theranostic nanocarriers.

Assistant Professor in Organic and Macromolecular Chemistry, Freie Universität Berlin
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ORCID: http://orcid.org/0000-0002-2734-9742

PUBLICATION OVERVIEW

***Total Publications**: 99 (60 articles in peer-reviewed journals, 20 reviews &editorials, 3 book chapters) **H-Factor**: 17 (Web of Science) **Total citations** (without self-citations): 1065 , **Patents**: 2*

KEY PUBLICATIONS (last 4 years)

*1. M. Asadian-Birjand et al. Macromolecular Rapid Comm. (**2016**), 37, 439-445.Transferrin Decorated Thermoresponsive Nanogels as MagneticTrap Devices for Circulating TumorCells2. F.*

*2. Rancan, M. et al. J. of Controlled Release (**2016**), 228, 159-169.Effects of thermoresponsivity and softness of polyglycerol-based nanogels on skin penetration and cellular uptake*

*3. G. Tiram et al. ACS Nano (**2016**), 10, 2028-2045. Identification of dormancy-associated microRNAs for the design of osteosarcoma-targeted dendritic polyglycerol nanopolyplexes*

*4. M. Molina et al. Chem.Soc.Rev(**2015**), 44, 6161-6186. Stimuli-responsive nanogel composites for biomedical applications.*

*5. H.R. Krüger et al. Nanoscale (**2015**), 7, 3838-3844.Dendritic polymer imaging systems for the evaluation of conjugate uptake and cleavage*

*6. M. Giulbudagian et al. Pol. Chem 5 (**2014**), 5, 6909-6913. Fabrication of Thermoresponsive Nanogels by Thermo-Nanoprecipitation and in situ Encapsulation of Bioactives*

*7. H.R. Krüger et al. J. ofControlled Release 194 (**2014**), 189-196.Imaging of Doxorubicin Release from Theranostic Macromolecular Prodrugs via Fluorescence Resonance Energy Transfer*

*8. **M. Calderón*** et al. J. Biomed. Nanotech. 10 (**2014**), 92-99. Receptor mediated cellular uptake of low molecular weight dendritic polyglycerols*

*9. A. Hussain et al. Biomacromolecules 14 (**2013**), 2510-2520. Targeted delivery of dendritic polyglycerol-doxorubicin conjugates by scFv-SNAP fusion protein suppresses EGFR+ cancer cell growth.*

Dr. Natascia Grimaldi
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Title: Nanovesicles and compressed-fluid based technology: can they represent a paradigm shift in Nanomedicine?

Molecular self-assembly has enabled the fabrication of biologically inspired, advanced nanostructures as lipid-based nanovesicles (L-NVs). The oldest L-NVs, liposomes have been widely proposed as potential candidates for drug delivery, diagnostic and/or theragnostic applications and some liposome-based drug products have already stepped from the lab-bench to the market. This success is attributed to their ability to encapsulate both hydrophobic and/or hydrophilic molecules, efficiently carry and protect them within the body and finally deliver them at the target site.

These positive features are also coupled with high biocompatibility. However, liposomes still present some un-solved drawbacks, as poor colloidal stability, short shelf-life, restricted and expensive conditions of preparation because of the inherent nature of their fundamental constituents (phospholipids). The new tools available in controlled molecules self-assembly have significantly advanced the field of L-NVs design and synthesis, and non-liposomal L-NVs have been recently developed; this new generation of nanovesicles can represent a paradigm shift in Nanomedicine: they may complement liposomes, showing their advantages and overcoming most of their drawbacks. Clearly, being still young, their rocky way to the clinic first, and then to the market has just started and it is still long, but they have all the potentialities to reach their objective target.

The purpose of this talk is to first present the large plethora of L-NVs available, focusing on this new generation of non-liposomal L-NVs and showing their similarities and differences with respect to their ancestors (liposomes). Since the overspread of a nanomaterial to the market is also strongly dependent on the availability of technological-scale preparation methods, I will also briefly review the current approaches exploited for L-NVs production. The most cutting-edge approaches based on compressed-fluid (CF) technologies will be highlighted since they show the potential to represent a game-changing in the production of L-NVs, favouring their step from the bench to the market. Finally, L-NVs applications in Nanomedicine, looking also to their future perspectives, will be discussed.

After receiving her PhD in Chemical and Materials Engineering in 2014, Natascia Grimaldi has conducted her first postdoctoral activity at the University of Palermo, working on radiation chemistry for nanogels formation. In 2015, she moved to the start-up Nanomol Technologies SA, in the frame of the Marie Curie Grant "Nano2Fun", developing a semi-continuous compressed fluid-based pilot-plant for lipid-based nanoparticles production.

Currently, she is a PostDoctoral Fellow at the Institute of Materials Science of Barcelona (ICMAB), where she continues to investigate on compressed fluid-based technologies for engineered nanomaterials and bio-hybrid functional nanomaterials for Advanced Medicine.

Dr. M. Pilar Marco
pilar.marco@cid.csic.es

Title: Nanobiotechnologic Perspectives for In Vitro Diagnostics

The so-called “omic” technologies have accelerated the number of candidate biomarkers discovered providing the perception that soon the health status of an individual will be defined by its molecular signature resulting from biomarker expression profiles. This fact calls for highly multiplexed devices able to measure simultaneously many biomarkers.

On top of this challenge, there is the demand for a more personalized and efficient medicine, which requires rapid, reliable, flexible and competent diagnostic technologies. The new knowledge on the unique properties of nanostructured materials has opened up the possibility to investigate the influence that biorecognition phenomena produce on the new optical and/or electrical properties of these systems. Novel micro/nano fabrication technologies offer the possibility to create improved transduction schemes.

Moreover, certain biomolecules such as the antibodies or the DNA have fascinating features such as the possibility to respond selectively to the presence of bioactive substances or to create multiplexed platforms based on synthetic oligonucleotide codified biomolecular probes. Nanostructured surfaces and nanoparticles of different materials can be the basis for the construction of novel functional biohybrid biomaterials which allow envisaging new exquisitely sensitive high performance biological sensors, giving rise to a new generation of enhanced diagnostic approaches able to give answers to the actual and future diagnostic challenges.

Nanobiotechnology for Diagnostics Group (Nb4D, www.iqac.csic.es/nb4d)
IQAC-CSIC (www.csic.es)
CIBER-BBN (www.ciber-bbn.es)
PhD in Pharmacy by the UB (1990). Postdoctoral researcher at UC Davis (Prof. B. D. Hammock, 1990-1993).
Senior Staff Scientist at CSIC in 1996 and since then, head of the Applied Molecular Receptors group (AMRg, nowadays Nanobiotechnology for Diagnostics group, Nb4D). In 2007 she got her position as Professor of Research of the CSIC. For almost five years (2006-2011), she was Head of the Chemical and Biomolecular Nanotechnology Department of the Advanced Chemical Research Institute of Catalonia (IQAC) of the CSIC.

Nowadays, she is vicedirector of IQAC-CSIC Since year 2011, she is the Coordinator of the Nanomedicine Research Program of the Networking Research Center for Bioengineering, Biomaterials and Nanomedicine (CIBER-BBN). Her research interests are focused on the investigation of new strategies and physical transducing principles to develop a new generation of bioanalytical multiplexed platforms for clinical diagnostics. In this context, she has been involved in a significant number of projects addressed to provide alternatives for the diagnostic of infectious and cardiovascular diseases, neurodegenerative disorders, and the assessment of adverse drug reactions, therapeutic drug monitoring, environmental and food safety. She has been principal investigator of an important number of EU (12) and Spanish (34) projects, and contracts (10) with European and US companies. As a result of her research, she has been co-author of near 190 publications of international relevance and of several patents (10), some of them under exploitation. Moreover, she has been the director of 17 PhD theses.

Dr. María Encarnación Lorenzo Abad

encarnacion.lorenzo@uam.es

Title: Biosensors: Fundamentals and biomedical applications

Biosensors are quite simple but useful devices which have been practically used since the half of 20th century and their popularity is still growing. This lecture is focused on the description of fundamentals and general biosensors construction with introducing of practical examples of their biomedical applications. The most applied recognition elements like enzymes, oligonucleotides, antibodies and viable cells as well as the most used immobilization techniques and usually employed transducers like optical and electrochemical will be presented.

Current topics on biosensing, modern approaches, novel materials and principals and unique combination of biorecognition elements and transducers will be also explained. Finally, the application of these useful devices in clinical diagnosis will be presented.

Full Professor in the Department of Analytical Chemistry and Instrumental Analysis at the Universidad Autónoma de Madrid. She received her degree in Chemistry in 1978 and her PhD degree in 1985 from the Universidad Autónoma de Madrid. Afterwards, she made a post-doctoral stage at the Department of Chemistry at Dublin City University. In 1990 and in 2016 she was visiting scientist (NATO Program and Fulbright Program) to the Department of Chemistry in Cornell University. She is the author/coauthor of more than 115 articles and reviews (3500 citations), several book chapters and 2 patents.

*During the last 15 years Prof. Lorenzo´ research focused on the design, construction, characterization and validation of sensing platforms, both chemical and biological, efficient, reliable and low cost. Therefore, they will be easily translatable to the sector productive for direct application in clinic, environmental and food analysis. She was pioneer on developing biosensor for direct determination of pesticides in fruits and water (Anal. Chim. Acta. **1994**, 295, 273), demonstrating the utility of these devices for the direct determination of analytes of interest in environmental (Anal. Chem. **1998**, 70, 2848; Anal. Chem. **1999**, 71, 5530), clinical (Anal. Chem. **2005**, 77, 2550; Biosensors and Bioelectronics **2005**, 20, 1549; Biosensors and Bioelectronics **2007**, 22, 2675; Anal. Chem. **2008**, 80, 77; Biosensors and Bioelectronics **2008**, 24, 184; Anal. Chem. **2008,** 80, 9443; Biosensors & Bioelectronics **2015**, 68, 521), agricultural and food analysis (Anal Chem. **2000**, 72, 3784; Nanoletters **2002**, 2, 577; Anal. Chem. **2006**, 78, 530.; Biosensors and Bioelectronics **2010**, 25, 2038; Anal. Chem. **2014**, 86, 4969), without performing tedious pretreatment procedures. From this year until now, the interest of the scientific community and the society for the biosensors has increased and actually it a subject of great interest.*

*Prof. Lorenzo has been also involved in the study of new molecular architectures on electrodes surfaces with electrocatalytic properties towards molecules of interest (Anal. Chem. **1994**, 66, 4337; Anal. Chem. **1996**, 68, 3688; Anal. Chem. **1996**, 68, 3135; Anal. Chem. **1997**, 69, 4065; Biosensors and Bioelectronics. **1998**, 13, 319)*

*In 1998, Prof. Lorenzo turned her attention to the development of compounds that can be used as redox indicators of DNA hybridization with the aim to develop DNA biosensors for rapid detection of genes mutation(Analytical and Bioanalytical Chemistry **2010**, 398, 1385; Chem. Sci., **2016**, 7, 5786, Biosensors and Bioelectronics **2011**, 27, 40).*

*Recently, Prof. Lorenzo´group has been involved within the area of nanoanalytica, in which nanomaterials are being included in the transductor or in the sensing layer for the development of improved (bio)sensors (Nanoscale **2016**, 8, 9842; Journal of Catalysis **2015**, 329 22).*

Dr. Fernanda Marujo Marques

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Title: In vitro/In vivo Biological Evaluation of Prospective Antitumour Drugs: Insights into the Mechanism of Action by Nuclear Tools

Metal-based antitumor agents have been the main goal of research in the area of Medicinal Chemistry. Over several decades of its approval, the platinum drug cisplatin is still one of the most used anticancer agents in the treatment of several cancer diseases, regardless some major drawbacks as its severe toxicity. Although more complex than described, the anticancer mechanism of cisplatin is based on its binding to DNA. Following this trend, most metal-based compounds discovered soon after cisplatin were designed to interact with DNA and their pharmacological properties were thought to be related with this mechanism.

Apart from DNA, a significant number of biomolecules and biochemical pathways have been implicated as drug targets for metal-based compounds. A major challenge in understanding drugs mechanism of action is finding the appropriate analytical tools. Recently, the focus on compound trafficking has shifted to identifying cellular targets. This lecture aims at elucidating *In vitro/In vivo* effects and mechanism of action of metal-based complexes and to establish its toxicological profile using a variety of imaging techniques as unique tools to assess pharmacological behavior.

Fernanda Marujo Marques is a researcher since 1994 at Grupo de Ciências Radiofarmacêuticas, Instituto Superior Técnico, Universidade de Lisboa.
She got her degree in Chemical Engineering from Instituto Superior Técnico, Universidade de Lisboa and a PhD in Biochemistry from Faculdade de Ciências da Universidade de Lisboa (FCUL). Her main expertises are: i) neutron reactions (radionuclide production, BNCT...); ii) development of radioimmunoassays; iii) development of receptor binding assays; iv) synthesis and characterization of radiocomplexes for therapy; v) biological evaluation of (radio) complexes as anticancer agents. She is author of more than 70 papers and more than 90 presentations.

Relevant Publications in International Peer-reviewed Journals- last three years

1. *da Silva AF et al. Synthesis, characterization and biological evaluation of carboranylmethylbenzo[b]acridones as novel agents for boron neutron capture therapy. Org Biomol Chem 12, 5201-5211 (2014).*
2. *F. Vultos et al. Gano. New estradiol based 111In complex towards the estrogen receptor. Radiochimica Acta 103, 765-776 (2015).*
3. *E. Ribeiro et al. Radiolabeled block copolymer micelles for image-guided drug delivery. Int J Pharm 515, 692-701 (2016).*
4. *C. Fernandes et al. Novel (188)Re multi-functional bone-seeking compounds: Synthesis, biological and radiotoxic effects in metastatic breast cancer cells. Nucl Med Biol 43, 150-157 (2016).*
5. *O. A. Lenis-Rojas et al. Heteroleptic mononuclear compounds of ruthenium(II): synthesis, structural analyses, in vitro antitumor activity and in vivo toxicity on zebrafish embryos. Dalton Trans 45, 19127-19140 (2016).*
6. *N. Mendes et al. In Vivo Performance of a Ruthenium-cyclopentadienyl Compound in an Orthotopic Triple Negative Breast Cancer Model. Anticancer Agents Med Chem 17, 126-136 (2017).*
7. *S Osati et al. BODIPY-17α-ethynylestradiol conjugates: Synthesis, fluorescence properties and receptor binding affinities Bioorg Med Chem Lett 27, 443-446 (2017).*
8. *G. Scalese et al. Evaluation of cellular uptake, cytotoxicity and cellular ultrastructural effects of heteroleptic oxidovanadium(IV) complexes of salicylaldimines and polypyridyl ligands. J Inorg Biochem 166, 162-172 (2017).*

Dr. Beatriz Morancho

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Title: Immunotherapy: Using the Immune System to Treat Cancer

Cancer has been considered for decades a cell-autonomous disease, driven by the uncontrolled proliferation of tumoral cells. For this reason, anti-cancer therapies have been designed to target the weaknesses of these malignant cells. However, this view has been expanded and other cellular populations have been unveiled as relevant for the control of tumor development. In particular, the immune system can recognize and eliminate nascent tumor cells unless malignant cells manage to escape this recognition or generate an immunosuppressive environment.

Anti-cancer immunotherapies aim to reinstate the immunological control of tumor growth using different strategies such as cancer vaccines, oncolytic viruses, and adoptive transfer of immune cells or immune checkpoint pathway modulators. The success of some of these therapies, like anti-CTLA-4 or anti-PD-1 antibodies, has boosted the development of this field.

Vall d'Hebron Institute of Oncology (VHIO, Preclinical Research Program
bmorancho@vhio.net

Positions and Employment

2009-Today Postdoctoral Researcher. Vall d'Hebron Institute of Oncology, Barcelona (Spain).
Principal Investigator: Dr. Joaquin Arribas.
2008-2009 Postdoctoral Researcher. Research Institute at Hospital Joan XXIII, Tarragona (Spain). Principal Investigator: Dr. Cristobal Richart.

Education

2008 Biology PhD. Universitat Pompeu Fabra, Barcelona (Spain).
2004 Postgraduate diploma. Handling of experimental animals. Universitat de Barcelona, Barcelona.
2003 Biology B. Sc. Universitat Pompeu Fabra, Barcelona (Spain).

Selected publications (last 5 years)

1. *Morancho B, Zacarías-Fluck M, Esgueva A, Bernado-Morales C, Di Cosimo S, Cortés J, Arribas J, Rubio IT. Modeling anti-IL-6 therapy using breast cancer patient-derived xenografts. Oncotarget 2016 Oct 18;7(42):67956-67965.*
2. *Morancho B*, Martinez-Barriocanal A*, Villanueva J, Arribas J (*Co-authors). ADAM17 controls the non-cell autonomous effects of oncogene-induced senescence. Breast Cancer Res 2015 Aug 12; 17:106.*
3. *Zacarias-Fluck M, Morancho B, Vicario R, Luque-Garcia A, Escorihuela M, Villanueva J, Rubio IT, Arribas J. Effect of cellular senescence on the growth of HER2-positive breast cancers. J Natl Cancer Inst. 2015 May 13;107(5).*
4. *Parra-Palau JL*, Morancho B*, Peg V, Escorihuela M, Scaltriti M, Vicario R, Zacarias-Fluck M, Pedersen K, Pandiella A, Nuciforo P, Serra V, Cortés J, Baselga J, Perou CM, Prat A, Rubio IT, Arribas J. (*Co-authors). Effect of p95HER2 / 611CTF on the response to trastuzumab and chemotherapy. J Natl Cancer Inst. 2014 Sep 24;106(11). Comment on Cancer Discovery 2015 Jan;5(1):OF7.*
5. *Morancho B, Parra-Palau J, Ibrahim YH, Bernado Morales C, Peg V, Bech-Serra JJ, Pandiella A, Canals F, Rubio I, Baselga J, Arribas J. A dominant negative N-terminal fragment of HER2 frequently expressed in breast cancers. Oncogene. 2013 Mar 14; 32(11):1452-9.*
6. *Ortells MC, Morancho B, Drews-Elger K, Viollet B, Laderoute KR, López-Rodríguez C, Aramburu J. Transcriptional regulation of gene expression during osmotic stress responses by the mammalian target of rapamycin. Nucleic Acids Res. 2012 May; 40(10):4368-84.*

Dr. Angel Menargues

amenargues@pcb.ub.cat

Title: Overview and reflection on ecotoxicological risk assessment

Chemicals and other products (e.g. pharmaceuticals, medical devices, imaging agents) are manufactured and used by humans to cure and palliate possible illnesses, in agriculture, livestock and industry. Depending on the yearly manufactured amounts of these products, the exposure and the concentration disposed on the nearby environment should be analyzed to know their fate and avoid therefore any unexpected return effect against our health. However, some substances (e.g. highly lipophilic compounds and endocrine disruptors) should be assessed regardless the amount released into the environment. In this context, the water cycle (evaporation, adsorption/desorption, rain, groundwater, rivers, reservoirs, seas) plays a relevant role for this assessment. The soil typology (raintight, permeable, sludge), the biotic systems and the capabilities and efficiency of the sewage treatment, for instance, should also be taken into account. With all these data, it is advisable to make a robust analysis, even modeling the compartmental lifespan of the different unaltered or metabolized/degraded residues in the biome.

As a transversal applied science, safety assessment (ecotoxicological risk assessment –ERA- included) is basically focused on characterizing the exposure of products on humans, animals and biotic systems and discerning the adverse effects induced by them in order to find the NOAEL (no observed adverse event level) to guarantee a safety margin. While a bibliographic risk assessment report is feasible in case of low productions and impacts, an experimental program is generally applied by phases (I and II) and by tiers (A and B). There is a high variety of assays involving physico-chemical characterization (LogKow, water solubility, hydrolysis as a function of pH, adsorption/desorption, dissociation constant, melting/boiling point, specific gravity/density and vapor pressure), toxicological assessment if required, aquatic (algal growth inhibition, Daphnia immobilization, fish and copepod toxicity) and terrestrial (earthworm reproduction, plant growth, aerobic and anaerobic and nitrogen transformation in soil, collembolan and dung fauna toxicity) studies. The environmental fate of the products and derivatives in water and soils (due to metabolism, bioaccumulation and biodegradation) allows the estimation of the predicted environmental concentration (PEC), the predicted non-effect concentration (PNEC) and the PEC/PNEC risk ratio.

As final remarks, massive production and consumption of products require an assessment, in the right time (i.e. before submission for registration and commercialization), measuring the risk, its magnitude and the potential adverse events induced on humans, animals, plants and the environment. Depending on the existing data, a program should be drawn in order to formulate future problems, identify unexpected hazard(s), evaluate their derived consequences and probabilities, ease a decision-making process and estimate the uncertainty associated to finally build the ERA report that should be included in the dossier for registration of each new product.

Parc Científic de Barcelona, Centro Plataforma de Toxicología Experimental y Ecotoxicología
Keywords: Biopharmacy, Toxocology, Medicine, Pharmacology, Pharma industry, Cell culture. Operating radioactive units – Universitat Universitat Autònoma de Barcelona 1994 Universitat de Barcelona 1991; Master in Pharmacology, Universitat de Barcelona 1987 Bs. in Biology, Universitat de Barcelona 1985

Publications:

1. Xavier Garcia Sala; et al. 2007. Absolute bioavailability of elomotecan in beagle dogs Methods and Findings in Experimental and Clinical Pharmacology. Prous. 29-Supplement 1,.105 (P-87).

2. Silvia Blanch López; et al.2007.Pharmacokinetic linearity following intravenous and oral administration of a steroid sulfatase inhibitor to rats Methods and Findings.Exper.& Clinical Pharmacol. Prous. 29-S1, 104 (P-86).

3. Àngel Menargues Baños; et al. 2002. Experimental and Clinical Pharmacology. Prous. 24-Supplement A, pp.119 (P-62).

4. Javier Guerrero Bertolín; et al. 1997. Monitoring veterinary care in pharmacokinetic studies Journal Veterinary Pharmacology and Therapeutics. Wiley. 20-Supplement 1, pp.21.

5. Àngel Menargues Baños; et al. 1997. Pharmacokinetic bioavailability and linearity study of lanreotide in dogs after single i.v. and s.c. administration of 80, 200 and 2000 µg/kg Methods and Findings in Experimental and Clinical Pharmacology. Prous. 19-Supplement A, pp.197 (PB-78).

Dr. Anna Roig
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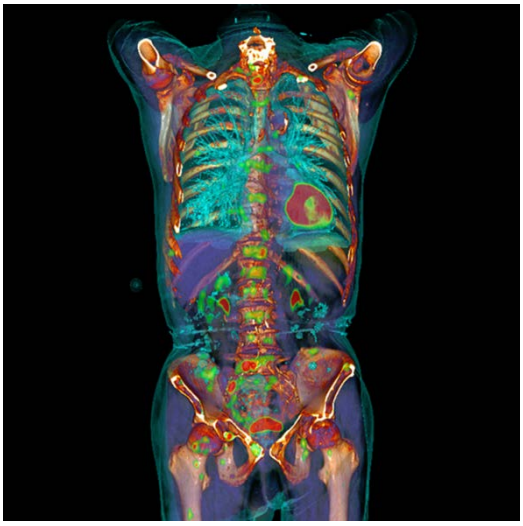
Title: Introduction to In-vivo Medical Imaging Techniques from Materials Science and Nanoscience view point

The lecture will start with some introductory concepts and will then follow with a brief explanation on each of the several techniques that are currently use for medical imaging: Ultrasounds, Magnetic Resonance Imaging (MRI), Fluorescence Imaging and Computed Tomography (CT).

After the lecture, the student should be able:

- To explain the basic working principles of these medical imaging techniques
- To know most important contrast agents used for each imaging techniques
- To understand the impact of nanotechnology and materials science in medical imaging and,
- To assess the future trends in nanomedicine regarding imaging techniques



https://www.medicalradiation.com/types-of-medical-imaging/

Anna Roig graduated in Physics and received a PhD in Materials Science from the Autonomous University of Barcelona. She completed her education at the KTH in Stockholm and at Northeastern University in Boston.

More recently she spent over two years in Brussels as a seconded national expert at the EC Research Directorate. At present, she is Senior Researcher at the Materials Science Institute of Barcelona where she leads the Nanoparticles and Nanocomposites Group (www.icmab.es/nn).

Her scientific activities revolve around the rational design and synthesis of inorganic and hybrid nanoparticles and functional nanocomposites and the study of their structural-functional properties including the understanding of nano/bio/interactions. Her driving force is the validation of nanomaterials in applications related to Nanomedicine (contrast agents for MRI, drug delivery vehicles, cell therapy) and Environmental Monitoring (heavy metals sensors). http://www.researcherid.com/rid/E-7616-2011.

Dr. Jordi Llop
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Title: Radiochemistry and nuclear imaging: application to the in vivo investigation of nanomaterials

The application of nanotechnology to the medical field, particularly for the treatment of complex diseases in which conventional medicines lack treatment or diagnostic efficacy, has been proposed during the last two decades. Nanoparticles (NPs) have a high surface-to-volume ratio and the capacity to be loaded with therapeutic and targeting agents; hence they can, theoretically, deliver cargo selectively to the site of action, increasing thus the therapeutic efficacy while reducing undesired side effects.

The promising properties of NPs and the wide range of opportunities resulting thereof have not resulted in apparent clinical advantages, neither in the diagnostic nor in the therapeutic arenas. This lack of translation from bench-top to bed-side is probably the result of a combination of factors, including scale-up and batch-to-batch reproducibility issues, as well as the lack of reliable toxicological and pharmacokinetic (PK) data.

Labelling NPs with positron or gamma emitters may constitute an ideally suited alternative to track NPs *in vivo* using nuclear imaging techniques, i.e. positron emission tomography (PET) or single photon emission computerised tomography (SPECT), in order to investigate biodistribution and biological fate. These imaging modalities are considered as minimally invasive and allow time-resolved and quantitative determination of the amount of labelled species within the organism. Attractively, due to the high penetration capacity of gamma rays, they can be easily translated from small experimental animals to humans without significant tissue-attenuation related issues.

In this session, the principles behind PET and SPECT will be briefly introduced and the main strategies for the radiolabelling of NPs will be briefly described. Examples covering the application of nuclear imaging to the evaluation of NPs as diagnostic or therapeutic agents will be provided. Main advantages and pitfalls of the technologies and their application will be highlighted.

Jordi got his degree in (Analytical) Chemistry at the Ramon Llull University (Barcelona) in 1996 and his degree in Chemical Engineering at Institut Químic de Sarrià (Barcelona) in 1997. Between 1998 and 2002 he worked on his PhD Thesis at Barcelona Material Sciences Institute (ICMAB-CSIC) under the supervision of Prof. Francesc Teixidor Bombardó and Prof. Lluís Victori Companys. In 2002, he worked as postdoctoral researcher at Navarra University Hospital under the supervision of Prof. Iván Peñuelas, and in 2003 at Uppsala University PET Centre under the supervision of Prof. Bengt Langstrom. In 2004 he moved back to Spain to work as Production Manager of the Radiopharmaceutical Laboratory at Institut d'Alta Tecnologia (IAT-PRBB, Barcelona).

Since October 2007, he is group leader at CIC biomaGUNE, where in collaboration with national and international researchers and industrial partners, he focuses his research on (i) developing strategies to radiolabel small molecules, macromolecules (peptides, proteins, polymers) and nanoparticles, characterise their pharmacokinetic properties, and evaluate their suitability as therapeutic and/or diagnostic agents; and (ii) investigate biological processes underlying disease (e.g. ischemia, Parkinson disease, Alzheimer disease, multiple sclerosis) using combined imaging modalities.

In the last 5 years, Dr. Llop has published >50 scientific papers in international peer-reviewed scientific journals, several book chapters and he has co-edited one book. He has h-index of 15 with 90 scientific contributions (since 2001) cited 868 times. He has been involved as Principal Investigator in projects funded by the Ministry of Science and Innovation and the Ministry of Economy and Competitiveness, has been involved as senior researcher in different EU-funded projects both in the context of FP7 and H2020 frameworks, and has an active participation in national and international networks.

Dr. Maria Pau Ginebra
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Title: Biomimetic ceramic scaffolds for bone engineering

Large bone defects pose a great clinical and socioeconomic challenge. In these situations it is necessary to induce bone formation beyond the capacity of the host tissue. The development of synthetic materials, able to work as scaffolds for new tissue growth is a promising strategy that overcomes some limitations associated with conventional bone autografts or allografts. Mimicking the extracellular matrix of bone tissue is a good approach, which has led to the development of a wide range of calcium phosphate based scaffolds, from high-temperature sintered calcium phosphates to biomimetic nanoapatites. When appropriately designed, these constructs have been shown to have promising properties, amongst them the capacity to trigger specific biological processes, acting as cell-instructive materials. An overview of the processing techniques, the properties and the biological performance of this type of scaffolds will be given in this lecture.

Maria-Pau Ginebra is the Head of the Department of Materials Science and Metallurgy, at the Universitat Politècnica de Catalunya, where she also leads the Biomaterials, Biomechanics and Tissue Engineering Group. Her research interests include the design and development of new biomaterials for bone regeneration, bone tissue engineering and drug delivery. Her research team has made significant contributions in the processing and characterisation of a new generation of low-temperature calcium phosphates which mimic bone extracellular matrix, including calcium phosphate cements and foams, incorporating synthetic or natural polymers, and/or biologically active molecules. She is involved also in new biofabrication strategies, including injectable scaffolds for bone tissue engineering, bioinspired substrates and 3D printing of regenerative medical implants. She is author of more than 160 articles in peer-reviewed International journals as well as of 9 patents. In 2013 she founded the spin-off company Mimetis Biomaterials. She has received numerous awards, amongst them the ICREA Academia Award in 2008 and 2013, the Narcis Monutriol Medal in 2012 and the Racquel LeGeros Award, for her contribution to calcium phosphate research, in 2013.

Dr. Julio San Roman

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Title: Learning from the nature the structure and morphology of nanoparticles for advanced applications in Nanomedicine

Julio San Roman, Luis García, M.R. Aguilar, B. Vazquez, Raquel Palao and Sergio M. Saldaña Group of Biomaterials, Institute of Polymers, CSIC and CIBER-BBN

Relevant advances in the new concept of "Nanomedicine" are based meanly on the design and preparation of polymeric chains with specific hydrophobic or hydrophilic character by the reversible linking of bioactive compounds to macromolecular systems. This is possible by means of the reaction of functional groups present in the macromolecule, or by copolymerization of functionalized bioactive compounds or drugs, with specific polymerizable functions. This biomimetic approach offers interesting designs by selecting polymerization mechanisms and composition of the active monomers, to give high molecular weight polymers with controlled microstructure, composition and morphology in a biomimetic scenario looking at the nature.
It is possible to obtain controlled sequenced copolymer by traditional free radical mechanism with the selective election of vinyl or acrylic monomers with very different reactivity. Examples of systems with specific properties as antioxidants, complexing agents or bioactive polysaccharides will be presented. The self-assembled systems can be applied as low toxicity and high activity "Polymer Drugs" or as nanocarriers of loaded traditional drugs with limited solubility in physiological conditions. Two families of polymer systems will be presented with different behavior and morphologies. The average composition of systems prepared at high conversion gives self-assembling polymers in physiological conditions with specific morphologies and very low toxicity, which allows the application as highly active antitumoral and antiangiogenic or anti-inflammatory compounds that can be applied by local injection in the human body.

Full research professor of the National Research Council of Spain CSIC, and active member of the CIBER-BBN, specialized in the design, preparation and application of biofunctionalised polymers for biomedical applications, including polymeric systems for drug delivery, tissue engineering and regenerative medicine. (www.ictp.csic.es/npb/biomat/).

He is associated professor of the University of the Basque Country, invited professor and member of the cathedra UNESCO of Biomaterials of the University of Havana (Cuba).

His scientific activity is centered on the design, preparation and application of polymeric systems from natural origin or synthetic one, for the development of advanced components for Tissue Engineering, Polymer Drugs, and biodegradable systems for controlled drug delivery. He has publisehd more than 430 articles, 35 book chapters He has participate as plenary speaker in more than 250 international congress in the fields of advanced polymers, controlled release systems and biomaterials. He has 25 patents on polymers and biomaterials.

Selected publications:

1. *Strontium folate loaded biohybrid scaffolds seeded with dental pulp stem cells induce in vivo bone regeneration in critical sized defects. Marcela Martin-del-Campo et al. Science 2016.*
2. *Self-assembling polymer systems for advanced treatment of cancer and inflammationR. Palao-Suay, et al. Progress in Polymer Science. DOI: 10.1016/j.progpolymsci.2015.07.005.. 53, 207-248 (2016)*
3. *Antimicrobial hydrogels based on autoclaved poly(vinyl alcohol) and poly(methyl vinyl ether-alt-maleic anhydride) mixtures for wound care applications. E.Callo et al. RSC Adv. 6, 55211-55219 (2016)*
4. *Anticancer and Antiangiogenic Activity of Surfactant-Free Nanoparticles Based on Self-Assembled Polymeric Derivatives of Vitamin E: Structure–Activity Relationship. Raquel Palao-Suay et al. Biomacromolecules (2015).*

Description activities HANDS-ON

19th June, 15-18 h

Polymer swelling in $scCO_2$ – Anna López-Periago

Supercritical CO_2 ($scCO_2$) is a clean and versatile solvent for the synthesis and processing of a large range of materials. In particular, $scCO_2$ is an excellent non-solvating porogenic diluent for the formation of well-defined porous polymers.

In this practice you will use a $scCO_2$ process for the preparation of porous polymers from non-porous polymeric materials. By modulating pressures and temperatures you will observe through the reactor windows the swelling of a polymer, and the creation of the pores upon system depressurization. The processed porous materials will be recovered as a dry product.

This process has interesting applications in drug delivery and tissue engineering.

Electroactive materials as implants – Nieves Casañ

1) Demonstration of electric conduction and fields in biological systems
K+ /Na+ Pump: A sketch of the electric fields in biological systems: Inside and outside cells and potential difference
The concentration gradient for K+ (mostly inside neural cells) and Na+ (mostly outside the cell) across membrane in the nervous systems, creates a 120 mV potential difference in resting mode in humans. When the channels are open, a "discharge" occurs and is transported along the axon towards a synapsis where chemical exchange will occur. The time scale is in the order of microseconds. Electrostimulation interacts with functional aspects, or may favor repair in case a lesion occurs.
The test will show the electric nature of the biological system.

2) Materials for electrostimulation and electroporation:
Electrostimulation requires conducting electrodes. Metals and flexible conducting polymers
Inert metals like Pt however, produce radicals at the surface because of O2 reduction (recall O2 is dissolved in our bodies) or water oxidation
O_2 + electrons --> O^{-n}
H_2O --> O_2 + H+ (-- > O^{-n})

COATING Electrodes with electroactive materials that undergo redox intercalation properties, increases charge capacities, and decreases impedance,
a) Preparation of coating
b) Evaluation of impedance changes. Evaluation of charge capacities changes

Synthesis of Au-NPs – Anna Laromaine and Soledad Roig

The simplest and by far the most commonly used preparation for gold nanoparticles is the aqueous reduction of gold salt by sodium citrate at reflux. Although sodium citrate is the most common reducing agent, metal nanoparticles can also be synthesized by the use of borohydride and other reducing agents. Particles synthesized by citrate reduction are monodisperse spheres if the particle size obtained is less than 30 nm.

Student will synthesize gold nanoparticles in the laboratory and check with how the change of size influences the optical properties of the solutions. Posteriorly those nanoparticles will be characterized by DLS, Z-potential.

Synthesis and modification of 2D Materials – Stefania Sandoval and Gil Gonçalves

Graphene and their derivatives hold great potential in the biomedical field. Therefore, many efforts have been focused on the development of new protocols of synthesis and modification to improve their properties. Moreover, the study of other 2D layered nanomaterials is attracting interest due to their unique characteristics. Students will learn different approaches of synthesis, namely, exfoliation of bulk layered materials, liquid phase or gas-solid reactions to obtain 2D nanostructures such as graphene-based derivatives or layered inorganic solids. The modification of the structures will be monitored by physical and colorimetric techniques.

Soft-litography; Microcontact printing to create patterns of molecules – Sandra Giraldo, Ezhil Amirthalingam and Raul Díaz

Positioning of proteins at surfaces has widened the scope of protein technological applications, allowing for the design and development of dynamic protein biochips. Microcontact has been employed as a viable approach to fabricate arrays of protein complexes at the chip surface, which are of interest in nanotechnology and materials science.

Students will be able to fabricate stamps of PDMS (polydimethysiloxane) to create patterns of fluorescent molecules and biomolecules using microcontact printing on functionalize surfaces. They will learn how to functionalize surfaces with active monolayers and visualize the final fluorescent patterns by fluorescent optical microscopy

Synthesis of boron-based molecular materials-Mahdi Chaari, Rosario Núñez

The recent advances in preparation of boron cluster-based materials for nanotechnology and drug design have greatly expanded their potential use in these fields. Furthermore, boron neutron capture therapy BNCT is a promising binary anticancer therapy that selectively targets and destroys malignant tumor cells, while restricting damage to healthy normal cells. An efficient BNCT treatment needs effective B-delivery agents and the boron carrier concentration should be easily quantified in the patient and it is advisable to be monitored.
In this practice we will show you the method of synthesis used to prepare a fluorescent boron cluster-substituted BODIPY. All reactions will be performed under an atmosphere of dinitrogen by employing standard Schlenk techniques, vacuum lines and dry solvents. The compound is characterized by IR, NMR and UV/Vis spectroscopies. This compound exhibits fluorescence properties and students will see the spectacular images of HeLA cells incubated with it using the confocal microscopy.

DELOS-SUSP a One-Step Methodology for Integration of Bioactives in Nanovesicles Using Compressed Fluids - Nathaly Segovia and Amable Bernabeu

In this practice session, we will demonstrate the efficiency of our new methodology to prepare nanovesicular systems, named Quatsomes, which are composed by sterols and surfactants, such as cholesterol and cetyltrimethylammonium bromide, respectively. For the preparation of these nanovesicular systems, we will use a high pressure reactor of 7.5mL which allow obtaining 25mL of final nanovesicular aqueous suspension.

Finally, this nanovesicular aqueous suspension will be characterized in terms of size and zeta-potential by Dynamic Light Scattering Technique (DLS). To carry out this characterization we will use a Zetasizer Nano ZS of Malvern.

20st June, 15-16:30h

Simulation -

Jordi Faraudo, Silvia Illa- (ICMAB)

In this hands-on "simulation party" session, we will learn in a 100% practical way some basic simulation tools useful for biomaterials simulation.
As a practical example, we will set-up a Molecular Dynamics Simulations of a single protein. Starting from the structure available at the Protein Data Bank, we will learn how to deal with atomic coordinates, how to add missing atoms or mutate a protein structure and how to make a live atomistic simulation at a desired temperature, analysing the results.

Technology Transfer: A tour around the Technology Transfer Process

Isabel Gavilanes (Institute of Microelectronics of Barcelona IMB-CNM)

The present training will be a tour around the technology transfer process, what it serves for; who are its players and what tools are available to get it.
During the presentation it will also be explained what industrial property means and why a correct protection and commercialization is important for a Research Institution like CSIC. A key part of it will be focused on what a patent is, its parts, advantages/disadvantages and differences versus other forms of industrial protection. Real examples of current patents currently in exploitation and successful technology transfer cases will shortly introduced.

21st June, 9-13:30h

C. elegans – Luo Zhongrui, Anna Laromaine

Caenorhabditis elegans (*C. elegans*) is a 1-mm-long soil free-living nematode that was postulated as animal model in 1974 by Sydney Brenner. *C. elegans* has a rapid-life cycle (3 days), a short lifespan (2-3 weeks) and it is facile and inexpensive to grow. Its small size and transparency permits the observation of NP uptake and distribution at the cellular, tissue and organism levels combining techniques and procedures from different fields such as materials science and biochemistry.

Students will be able to visualize the worms using optical microscopy, differentiate different organelles of the worm and learn how to maintain them in the lab.

Hydrogen Peroxide Biosensor Based on Horseradish Peroxidase - *Isabel Fuentes*

Hydrogen peroxide (H_2O_2) plays an important role in various industrial applications. It is an essential mediator in pharmaceutical, clinical and environmental research, and an important contaminant in several industrial products and wastes. We will develop an amperometric biosensor based on horseradish peroxidase. The immobilization of the enzyme will be done with a sol-gel method; further, redox mediators will be used to detect the electrochemical signal.

Students will visualize in live the operation of a biosensor.

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