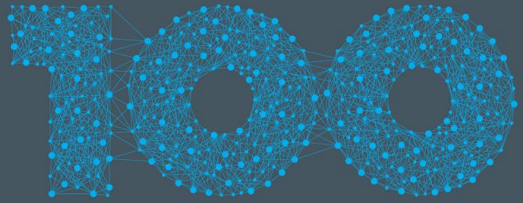
VIII Meeting on Biomedical Engineering

IST – FMUL



nebm
núcleo de engenharia biomédica

17th November 2010
Congress Centre
Instituto Superior Técnico
Lisbon - Portugal

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VIII Encontro de Engenharia Biomédica IST - FMUL

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Engenharia Biomédica além da Universidade

PLUX - da Investigação até ao mercado do equipamento médico

Hugo Gamboa

Resumo:

A PLUX Wireless Biosignals é uma spin-off do IST que há 3 anos desenvolve equipamentos médicos para aquisição de sinais fisiológicos. Será apresentado o processo de desenvolvimento, desde o contexto do problema até à solução final e colocação no mercado, do equipamento médico bioPLUX Clinical, um equipamento médico de biofeedback para reabilitação.

Nota Biográfica:

Director geral da PLUX e Professor Auxiliar do Departamento de Física da Faculdade de Ciências e Tecnologia da Universidade Nova de Lisboa. Membro do CEFITEC (Centro de Física e Investigação Tecnológica) onde estuda o processamento e classificação de sinais electrofisiológicos.

Medbone: da ideia à prática

Cláudia Ranito

Nota biográfica:

Claudia Ranito, Eng.ª de Materiais e com Mestrado Nacional na mesma área, é membra de várias organizações, incluindo a orientação de projectos e teses, venceu a 1ª Edição do prémio da Sociedade Portuguesa de Materiais / Federação Europeia de Materiais em 2003 e o Prémio da Ordem dos Engenheiros em 2006. Possui 10 anos de experiência em biomateriais, fundadora da Medbone em 2008, venceu o concurso de ideias de Cascais em 2008, o BES Inovação em 2009 e recebeu a medalha de mérito empresarial da Câmara Municipal de Cascais.

Engenharia e Gestão de Serviços de Saúde

Nuno Gonçalves

Resumo:

Na sua apresentação, Nuno Gonçalves falará um pouco sobre a função que desempenha no S24 Group, sobre as razões que o levam a crer que esta função se adequa ao perfil de um Engenheiro Biomédico, e sobre a forma como determinadas decisões, tomadas ao longo do percurso académico, se reflectem na sua situação actual.

Nota biográfica:

Nuno Filipe Gonçalves, natural de Grândola, nasceu a 11 de Agosto de 1988. Concluiu o Mestrado Integrado em Engenharia Biomédica no ano lectivo de 2009/2010, no Instituto Superior Técnico. No primeiro semestre desse mesmo ano, estudou na Akademia Górniczo-Hutnicza em Cracóvia, Polónia, uma das mais conceituadas universidades de Engenharia do país, ao abrigo do Programa Erasmus. Actualmente, é Gestor de Processos no S24 Group, um grupo empresarial dedicado ao outsourcing e à gestão global de serviços de saúde.

Multimodal Imaging in Surgery for Epilepsy

Prof. Alberto Leal

Hospital Júlio de Matos, Lisboa, Portugal. a.leal@netcabo.pt

Abstract:

Epilepsy is one of the most prevalent cronical neurological diseases in humans and in about 1/3 of the cases it is refractory to pharmacological treatment. The most effective therapy in such patients it is surgery for epilepsy, in which the brain area originating the seizure events is removed.

The determination of the brain area of onset of the epileptic events it is in general a difficult exercise, requiring a variety of neurophysiological, neuroimaging, neuropsychological, psychiatric and clinical techniques. In such setting multimodal functional evaluations including PET, fMRI, SPECT, EEG find a useful place and frequently play a major role in the decision to proceed to surgery.

We plan to give a flavor of the use of such techniques in this setting and to illustrate the wide range of different problems addressed as well as the contribution and limitations of the current methods.

Biosketch:

Alberto Leal is a Neurologist and Clinical Neurophysiologist with a special interest in epilepsy. He has worked in the surgical evaluation of patients for surgery of epilepsy since 1995 and is currently the physician in charge of the neurophysiological studies of patients in the Surgery for Epilepsy Program of the Hospital Center of Western Lisbon.

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Prefácio / *Foreword*

We are very pleased to welcome you to a special edition of our annual meeting, which coincides with the 10th anniversary of the entry of the first Biomedical Engineering students at Instituto Superior Técnico (IST) and the Faculty of Medicine of the University of Lisbon (FMUL). We believe that they have been ten very successful years and that today's programme is an excellent way to commemorate them. We will have three scientific sessions, dedicated to some the most exciting fields within the broad area covered by Biomedical Engineering: Regenerative Medicine, Neuro-Electronics and Multimodal Imaging. We count with the participation of leading scientists from the University College London and the CEA-Neurospin, Orsay, as well as the most prominent national researchers in these fields, coming from both biomedical and engineering backgrounds. We will close with a session on Biomedical Engineering beyond the University, with a few excellent examples of entrepreneurship in this area, which we hope will raise discussion on its present and future. Enjoy the meeting!

Lisbon, 17th November 2010

The Organizing Committee

Patrícia Figueiredo, Fernando Lopes da Silva, Paulo Freitas

Programa / *Programme*

9:15– 9:30 Abertura / *Welcome* (Prof. António Cruz Serra, President IST)

Medicina Regenerativa / *Regenerative Medicine*	**(Moderador/*Chair*: Prof. Joaquim Sampaio Cabral)**	
9:30 – 10:00	Prof. Manuel Abecasis Transplantação de células hematopoiéticas: uma terapia celular de sucesso	IPO, Lisboa
10:00 – 10:30	Prof. Domingos Henrique Como fazer neurónios: do embrião para o laboratório?	IMM / FMUL
10:30 – 11:00	Prof. Cláudia Lobato da Silva Bioengenharia de células estaminais	IBB / IST

11:00 – 11:30 Intervalo / *Coffee break*

Neuro-Electrónica / *Neuro-Electronics*	**(Moderador/*Chair*: Prof. Susana Cardoso)**	
11:30 – 12:00	Prof. Myriam Pannetier *Ultra-sensitive magnetometers based on spin electronics*	CEA-Neurospin, Orsay
12:00 – 12:20	Prof. Ana Sebastião *Recording and modulating synaptic and action potentials at hippocampal neurons*	IMM / FMUL
12:20 – 12:40	Prof. Susana Cardoso *Towards a system to measure action potential on mice brain slice with local magneto resistive probes*	INESC MN / IST
12:40 – 13:00	Prof. Moisés Piedade *TBA*	INESC ID / IST

13:00 – 14:30 Almoço / *Lunch break*

Imagem Multimodal / *Multimodal Imaging*	**(Moderador/*Chair*: Prof. Fernando Lopes da Silva)**	
14:30 – 15:15	Prof. Louis Lemieux *Fusion of EEG and fMRI to map epileptic activity*	UCL, London
15:15 – 15:35	Prof. Sónia Gonçalves *The co-registration EEG and fMRI in the study of the spontaneous activity of the brain*	AMC, Amsterdam
15:35 – 15:55	Prof. Alberto Leal *Multimodal Imaging in Surgery for Epilepsy*	HJM, Lisboa
15:55 – 16:00	Discussion	

16:00 – 16:30 Intervalo / *Coffee break*

Engenharia Biomédica além da Universidade	**(Moderador/*Chair*: Prof. Patrícia Figueiredo)**	
16:30 – 16:55	Prof. Hugo Gamboa PLUX - da Investigação até ao mercado do equipamento médico	Plux
16:55 – 17:20	Eng. Cláudia Ranito Medbone: da ideia à prática	Medbone
17:20 – 17:45	Eng. Nuno Gonçalves Engenharia e Gestão de Serviços de Saúde	S24 Group
17:45 – 18:00	Discussão	

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The co-registration EEG and fMRI in the study of the spontaneous activity of the brain

Prof. Sónia I. Gonçalves

Academish Medisch Center, University of Amsterdam, The Netherlands.
sonia.isabel.goncalves@gmail.com

Abstract:

The co-registration of Electroencephalography (EEG) and functional Magnetic Resonance Imaging (fMRI) is a new technique that shows great potential to study the brain in the sense that it may add additional information to that provided by EEG alone. EEG has long been used as a standard tool to localise the sources of brain electric activity. Nevertheless, this technique shows limitations in the spatial resolution with which these sources can be localised as well as difficulties related to the non-existence of a unique solution to the EEG Inverse Problem. Contrary to EEG, fMRI indirectly measures neuronal activity through the quantification of the variations in blood oxygen level that are coupled with this activity (the BOLD response). When EEG and fMRI are recorded simultaneously, phenomena such as the presence/absence of epileptic spikes can be correlated to the BOLD response. Furthermore it becomes possible to study phenomena, such as the spontaneous variations of the α-rhythm or memory related effects that are, by nature, not reproducible in time.

In this presentation, the use of co-registered EEG-fMRI is applied to the study of the α-rhythm. Attention will be focussed on the identification of the neuronal networks involved in the generation of this rhythm as well to the variation of the hemodynamic response function associated with this type of neuronal activity.

Bio sketch:

Sónia I. Gonçalves was born in Lisbon in 1973. She graduated in Physics from *Instituto Superior Técnico* in 1996 and the PhD in Biophysics from *Faculdade de Ciências, Universidade de Lisboa* in 2002. Her interests include the inverse problem of EEG/MEG, the co-registration of EEG-fMRI and its application to study spontaneous brain activity. At the present she works in the development of fast MR sequences for abdominal imaging.

Multimodal Imaging

Fusion of EEG and fMRI to map epileptic activity

Prof. Louis Lemieux

Institute of Neurology, University College London, United Kingdom. l.lemieux@ucl.ac.uk

Abstract:

Despite important advances in our ability to identify brain abnormalities responsible for epileptic seizures, there is still a large proportion of patients in whom anti-epileptic drugs do not work and who may benefit from surgery but current non-invasive tests do not provide satisfactory localising information. Furthermore, our understanding of the mechanisms that give rise to epileptic activity is limited, resulting mostly from electrophysiological studies at the cellular and small networks level. The possibility of mapping haemodynamic changes throughout the brain in relation to spontaneous pathological activity recorded on EEG has been a great advance over the last 10 years. I will report on our studies of pathological BOLD changes in patients with focal and idiopathic generalised epilepsy using combined EEG and fMRI measurements. I will discuss how quantitative EEG can be combined with fMRI and how the results of correlation studies can be used to look into causal relationships within the identified networks. I will also illustrate the first results of simultaneous intracranial EEG-fMRI in humans.

Bio sketch:

Louis Lemieux was born in Quebec City, Canada, and obtained his BSc (Montreal), MSc (Toronto) and PhD (Montreal) in Physics. He has been working at UCL, Institute of Neurology, London UK, since 1990 and he is Professor of Physics Applied to Medical Imaging since 2004. His research focus is on functional and structural imaging in Epilepsy, particularly on a 3T MR scanner dedicated to Epilepsy research. He has published more than 100 articles in peer-reviewed journals and has received funding from the Medical Research Council, Action Medical Research and Brain Research Trust. He has obtained the Clinical Scientist status by the UK Health Professions Council and he is a member of the Board of the Organization for Human Brain Mapping (Past Treasurer). He is also member of the editorial board of the journals Human Brain Mapping, Brain Topography and Epilepsy Research and Treatment.

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Regenerative Medicine

Transplantação de células hematopoiéticas: uma terapia celular de sucesso

Prof. Manuel M. Abecasis

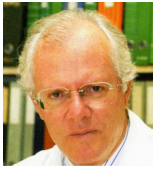
IPO, Lisboa, Portugal. mabecasis@ipolisboa.min-saude.pt

Resumo:

A transplantação de células estaminais hematopoiéticas é hoje um tratamento consolidado no tratamento de patologias derivadas de alterações nas células hematopoiéticas pluripotentes ou em populações celulares delas derivadas. Assim, é utilizada no tratamento de neoplasias hematológicas, como as leucemias, em doenças metabólicas resultantes de deficits enzimáticos no sistema monocitico macrofágico, como por exemplo a doença de Hurler, em imunodeficiências congénitas graves, em formas graves de anemia, como a talassemia ou a drepanocitose ou a anemia aplástica grave.

A transplantação de medula óssea é um processo complexo, dado que implica na realidade a transplantação da hematopoiese e do sistema imunitário, dai podendo advir uma complicação particular só encontrada neste tipo de transplante, conhecida por doença do enxerto contra o hospedeiro. Por outro lado a substituição do sistema imunitário tem 2 vantagens: a possibilidade de se exercer um efeito do enxerto contra a leucemia, se for essa a indicação para o mesmo, que contribui para a sua cura, e ainda o estabelecimento de tolerância entre o dador e o receptor, e vice-versa, que permite suspender toda a imunossupressão ao fim de algum tempo, o que não tem paralelo no transplante de órgãos sólidos.

Nota biográfica:



Manuel M. Abecasis é Director do Programa de Transplantação de Medula Óssea do Instituto Português de Oncologia de Lisboa. Fez a sua especialização em Hematologia no Reino Unido (Liverpool, Manchester e Londres) e foi "Leukemia Research Fund Fellow" (UK) em Marselha onde colaborou no estabelecimento da transplantação de medula óssea no Instituto de Oncologia de Marselha.

How to make neurons: from the embryo to the lab?

Prof. Domingos Henriques

IMM/FMUL, Lisboa, Portugal. henrique@fm.ul.pt

Resumo:

A aplicação da tecnologia baseada em células estaminais para regeneração de tecidos requer a produção in vitro (ou ex vivo) de quantidades apropriadas de células diferenciadas funcionais (ou os seus precursores imediatos). Para obter células diferenciadas a partir de células estaminais, é necessário mimetizar in vitro as condições de desenvolvimento dessas células no seu ambiente natural. O conhecimento actual dessas condiçoes é ainda escasso e nesta conversa discutir-se-á o que se conhece em relação à produção de neurónios, no embrião e ex vivo, a partir de células estaminais.

Nota Biográfica:

Licenciatura e Doutoramento em Ciências Farmacêuticas, pela Universidade de Lisboa. Formação pós-doutoral no Cancer Research UK. Investigador Auxiliar da Faculdade de Medicina da Universidade de Lisboa.

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Bioelectronic Systems

Prof. Moisés Piedade

INESC MN / Instituto Superior Técnico, Lisboa, Portugal. msp@inesc-id.pt

Abstract:

Some research results in the areas of Bioinpired artificial retina and visual prosthesis will be presented. BiomagCMOS Project, aiming the development of an Advanced Biochip Platform and a new type of biochip will be presented.

Biosketch:

Moisés Piedade received the Ph.D. degree in electrical and computer engineering from Instituto Superior Técnico (IST), Technical University of Lisbon, Lisbon, Portugal, in1983. He is Full Professor in the Electrical and Computers Engineering Department, IST, and was the Founder of Signal Processing Systems Research Group, http://sips.inesc.pt, Instituto de Engenharia de Sistemas e Computadores—R&D (INESC-ID), Lisbon, Portugal. His main research interests include electronic systems, signal acquisition and processing systems, and circuits and systems for biomedical applications.

Towards a system to measure action potential on mice brain slice with local magneto resistive probes

Prof. Susana Cardoso
INESC MN / Instituto Superior Técnico, Lisboa, Portugal. scardoso@inesc-mn.pt

Abstract:
The connections within the hippocampus are defined routes for information flow making the hippocampus a very popular target for the study of synaptic function. Extracellular electrophysiology techniques have been used in the recent years to perform high-resolution recording of the field potential from rat /mice hippocampus slices, using extracellular microelectrodes. Also, open gate field-effect transistors were proposed to measure the signals coming from the cell body of the neurons. The main advantage of chip based techniques is the high spatial resolution and the possibility of simultaneous measurement of brain activity in various areas.
This work shows how magnetoresistive sensors can be used to improve the field potential electrophysiology technique offering local measurements of extracellular currents with micron-size spatial resolution. Moreover, the comparison between the electrical potential and magnetic field produced by the neurons in different regions can be done. These magnetoresistive sensors can be located several tens of micrometers from the action/synaptic potential sources.
We will describe the integration of an extracellular electrophysiology system with a microfabricated device (magnetoresistive sensors) to measure the magnetic response of the neurons of a rat or mice hippocampus brain slice. The chip with 15 Spin Valve sensors (3 x 50 μm^2) was designed to be integrated in a recording chamber for submerged mice brain slices used for synaptic potential measurements. Under stimulation (rectangular pulses of 0.1ms every 10s) through a concentric electrode placed near the CA3/CA1 border of the hippocampus, the spin valve sensor readout signals with 20µV amplitude and a pulse length of 20 to 30ms were recorded only in the pyramidal bodies' cell region and can be interpreted as being derived from action potentials currents.

Biosketch:

Dr. Susana Cardoso de Freitas (1973) received her Ph.D in Physics from Instituto Superior Técnico (IST, Lisbon) in 2002, from her studies of GMR multilayers and magnetic tunnel junctions for read head and MRAM applications. Since 2002 she has been at INESC-MN, initially as post-doctoral fellow and presently as Senior Researcher, developing ion beam deposition of materials (tunnel junctions and spin valves) on up to 200mm wafers, for application in sensors, biochips and MRAMs. Since 2003 she is also an Invited Auxiliary Professor at IST, and is responsible for student coordination. Since 2003, she has coordinated 4 research projects funded by FCT, and has been the portuguese responsible for 2 EU Marie-Curie RTN. She is co-author of 118 publications, 13 conference proceedings and 5 book chapters.

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Bioengenharia de Células Estaminais

Prof. Cláudia Lobato da Silva

IBB / Instituto Superior Técnico, Lisboa, Portugal. claudia_lobato@ist.utl.pt

Resumo:

O Laboratório de Bioengenharia de Células Estaminais do Instituto de Biotecnologia e Bioengenharia (IBB), no Instituto Superior Técnico (IST) visa o desenvolvimento de sistemas de cultura para a expansão *ex-vivo* de células estaminais e sua diferenciação em tipos celulares específicos.

Uma vez que as células estaminais são raras, o seu isolamento e expansão/*diferenciação in vitro* permitirá aumentar o número de células disponível para utilização em Terapia Celular. O desenvolvimento de condições de cultura *ex-vivo* que permitam a manutenção e multiplicação de células estaminais com capacidade de repopulação *in vivo*, assim como células diferenciadas delas derivadas, é crucial e um grande desafio na área de investigação em Células Estaminais, assim como para sua utilização em práticas terapêuticas. Dois projectos de investigação em curso serão apresentados:

1. Expansão *Ex-vivo* de Células Estaminais Hematopoiéticas

O principal objectivo consiste na maximização da expansão *(i.e.* multiplicação) de células estaminais e progenitores hematopoiéticos, especialmente no que se refere ao sangue do cordão umbilical (que contém um número limitado de células) utilizando células estaminais mesenquimais como células suporte, à semelhança do que acontece na nossa medula óssea, onde os dois tipos celulares co-existem. Esta estratégia possibilitará alargar o campo de aplicação de células estaminais hematopoiéticas em Terapia Celular, mas também para utilização em Terapia Génica.

2. Expansão de *Ex-vivo* de Células Estaminais Mesenquimais

Utilizando uma abordagem multi-disciplinar entre a Bioengenharia de Células Estaminais e a Hematologia Experimental, pretende-se identificar condições óptimas para a expansão de células estaminais mesenquimais à escala clínica, mantendo o seu potencial de diferenciação multilinhagem e as suas características imunossupressoras, para suplementação em procedimentos de transplantação de células estaminais hematopoiéticas.

Agradecimentos: Associação Portuguesa Contra a Leucemia (APCL), Fundação para a Ciência e Tecnologia (FCT), Programa MIT-Portugal, Área de Bioengenharia.

Nota biográfica:

Cláudia Lobato da Silva (nascida em 1978) é licenciada em Engenharia Química, ramo de Biotecnologia, Instituto Superior Técnico (IST), Universidade Técnica de Lisboa (UTL) (2001). Obteve o seu grau de Doutoramento em Biotecnologia (2006) pelo IST/UTL, em colaboração com a Universidade de Reno, Nevada, EUA, focando a área de expansão de células estaminais humanas. Actualmente, Cláudia é Professora Auxiliar do Departamento de Engenharia Química e Biológica do IST e realiza as suas actividades de investigação na área de Bioengenharia de Células Estaminais no Instituto de Biotecnologia e Bioengenharia (IBB) no IST. Participa ainda no Programa MIT-Portugal, área de Bioengenharia.

Neuro-Electronics

Ultra-sensitive magnetometers based on spin electronics: biomagnetism and other biological applications

Prof. Myriam Pannetier-Lecoeur

Commissariat à l'Energie Atomique et aux Energies Alternatives, Saclay, France. myriam.lecoeur@cea.fr

Abstract:

Advances in spin electronics over the two last decades have offered new possibilities for data treatment and storage. Applications in the area of magnetometry develop very quickly as well and we have proposed new systems based on Giant Magneto-Resistances, with very high sensitivity capable of measuring extremely weak magnetic signals such as those generated by the electrical activity of tissues, like in neurons or nerves. I will present the principle of this sensor and their use for detection of the cardiac activity without contact. I will show as well how they can be used to realize Magnetic Resonance Imaging at very low field, opening new possibilities for functional imaging in life sciences.

Bio sketch:

Myriam Pannetier-Lecoeur is a physicist working at CEA Saclay in France. She received her PhD from the University of Caen, France, in 1999, on vortex dynamics in superconducting bridges. She had been working as a post-doctoral fellow on magneto-optical imaging for two years at the Condensed Matter Physics laboratory at the Vrije Universiteit Amsterdam in The Netherlands. In 2001, she joined the nanomagnetism group of Service de Physique de l'Etat Condensé, at CEA Saclay, France. Her research subjects include nanomagnetism and magnetoresistive sensors development. She has authored or co-authored more than 40 papers and deposited 12 patents. She received in 2008 together with Dr Claude Fermon the Aymé Poirson prize from the French Academy of Sciences for their work on magnetic sensors.

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Recording and modulating synaptic and action potentials at hippocampal neurons

Prof. Ana Sebastião

Institute of Pharmacology and Neurosciences, Faculty of Medicine, and Unit of Neurosciences, Institute of Molecular Biology, University of Lisbon, Portugal. anaseb@fm.ul.pt

Abstract:

Neurons communicate with each other by means of chemical and electric signals. An electric signal, so called action potential, travels along the axon of one neuron, depolarizes the nerve terminals and leads to the release of a chemical signal, the neurotransmitter molecules. These neurotransmitter molecules activate receptors located in a second neuron. Receptors for neurotransmitters are usually transmembrane ion channels, which upon activation allow the flow of ions into the cell, therefore leading to changes of the electric polarity of the cell membrane; if the neurotransmitter is excitatory, Na^+ ions go in, depolarizing the neuron and giving rise to the so called excitatory synaptic potentials; if the neurotransmitter is inhibitory Cl^- ions go in, hyperpolarizing the neuron and giving rise of the so called inhibitory synaptic potentials. Excitatory and inhibitory signals received by a single neuron eventually add, reach the cell soma and when the resulting depolarization is enough to attain the threshold, an action potential is triggered, which than travels along the axon to induce release of neurotransmitter molecules from the nerve terminal of this neuron.

These different bioelectric signals generated by neurons, action potentials, inhibitory synaptic potentials, excitatory synaptic potentials or the corresponding ionic currents can be recorded through microelectrophysiological techniques. Microelectrodes are placed inside or close to the neurons through the aid of micromanipulators and under microscopic visual guidance; the recorded signal is amplified, digitalized and analyzed with proper software. Neuronal responses can be evoked by electric stimulation of the afferent neurons, by focal application of neurotransmitter molecules or by direct electrical depolarization of the recorded neuron. Spontaneous neuronal responses can also be recorded and analyzed. In this presentation I will give several examples on how the different bioelectric signals can be recorded.

In my presentation, I will also give examples of research applications of the electrophysiological recordings by illustrating how neuronal responses can be biologically modulated. Indeed, besides releasing neurotransmitters, neuronal cells release several other molecules, the neuromodulators, which activate their own membrane receptors and regulate neuronal excitability, providing efficient feedback mechanisms used by neuronal cells to regulate their own excitability. Elucidation of these mechanisms involved in fine-tune modulation of neuronal activity is the major interest of our research group.

Biosketch:

Ana M. Sebastião is at present Associate Professor at the Faculty of Medicine, University of Lisbon. Her research interests relate to neuromodulation since 1983, where she starts using electrophysiological and neurochemical aproaches to evaluate changes in neuronal excitability. She has been interested in the characterization of adenosine receptors as well as on the role played by endogenous adenosine in the nervous system, in particular how they promote fine-tuning of neuronal activity. Microelectrophysiological approaches in her lab include patch clamp, extra- and intra-cellular recordings of synaptic potentials and synaptic currents from neurons in culture or in situ in brain slices, as well as from the neuromuscular junction. She has over 100 international scientific publications, 3000 quotations and an h index of 30.