DEGREE CURRICULUM

COMUNICACIO I FUNCIO CEL·LULAR

Coordination: Mario Encinas

Academic year 2014-15

CELL COMMUNICATION AND FUNCTION 2014-15

Subject's general information

Subject name	COMUNICACIO I FUNCIO CEL·LULAR
Code	14707
Semester	Anual
Typology	Optativa
ECTS credits	4
Theoretical credits	0
Practical credits	0
Coordination	Mario Encinas
Department	Medicina Experimental, Ciències Mèdiques Bàsiques
Modality	Presencial
Important information on data processing	Consult this link for more information.
Degree	Màster
E-mail addresses	jordi.caldero@mex.udl.cat celia.casas@cmb.udl.cat joaquim.egea@cmb.udl.cat mario.encinas@mex.udl.cat Carme.Espinet@cmb.udl.cat josep.esquerda@mex.udl.cat ana.garcera@cmb.udl.cat marta.llovera@cmb.udl.cat joan.ribera@mex.udl.cat rosa.soler@cmb.udl.cat olga.tarabal@ mex.udl.cat valdivielso@medicina.udl.cat

CELL COMMUNICATION AND FUNCTION 2014-15

Jordi Calderó
Celia Casas
Joaquim Egea
Mario Encinas
Carme Espinet
Josep E. Esquerda
Anna Garcerà
Marta Llovera
Joan Ribera
Rosa M Soler
Olga Tarabal
Jose M Valdivielso
José R Bayascas

Learning objectives

1. To know the processes involved in cell signalling that regulate cell proliferation and differentiation.
2. To know the structure and function of ion channels involved in membrane excitability and the techniques used for study.
3. To advance knowledge of the process of synaptic transmission.
4. To know the intracellular pathways related to cell survival or death processes.
5. To know the process of programmed cell death during development, the apoptotic death, the excitotoxic death and the cellular and molecular mechanisms that control these processes.
6. To know the signaling mechanisms related to axon guidance.
7. To understand the mechanisms of cell communication mediated by gases.

Competences

CB1 Possess knowledge and understanding that provide a basis or opportunity for originality in developing and / or applying ideas, often within a research context

CB2 Being able to apply the acquired knowledge and have the ability to solve problems in new or unfamiliar environments within broader (or multidisciplinary) contexts related to their field of study

CB5 Possessing learning skills to enable them to continue studying in a way that will be largely self-directed or autonomous

CG1 Knowing how to select and apply different analytical methods at the molecular, biochemical, cellular, genetic and phenotypic level for the diagnosis and study of the diseases.

CG5 Ability to prepare process and interpret the results rigorously and applying appropriate technologies

CS7 To identify the molecules and processes important in the functioning of cells and recognize the mechanisms of integration of external signals that regulate complex functions such as differentiation, proliferation and survival

CT2 Mastering a foreign language

CT3 Mastering ICT

Subject contents

Overview (Mario Encinas, 2 hours)

Introduction to cell signaling. General principles of cell communication. G-protein coupled receptors. Cyclic AMP and protein kinase A. G-proteins and calcium signaling. G-proteins and ion channels. Tyrosine kinase receptors: docking proteins and modular signaling. Ras and other small GTPases. The MAP kinase and PI3-kinase pathways. Serine-threonine kinase receptors: the Jak-STAT and TGFb pathways. Proteolysis

and signaling: Notch and Wnt pathways, Sonic hedgehog, NFkB signaling. Nuclear receptors.

PDK1, the major transducer of PI 3-kinase actions (Jose Ramón Bayascas, 2 hours)

PI3-K pathway in the context of insulin signaling. PDK1 action as a master kinase phosphorilating and activating differentially its up to 23 different substrates. Study of PDk1 pathway by knock-in mutation and its role regulating metabolic responses to insulin.

Synaptic transmission (Josep E. Esquerda, 2 hours)

Historical aspects of synaptic transmission. Chemical neurotransmitters and their receptors. Presynaptic mechanisms. Postsynaptic mechanisms. Assembly of postsynaptic apparatus. Long-term potentiation and mechanisms of synaptic plasticity. Synaptogenesis.

Mechanisms of cell communication mediated by gases. Gases that act as mediators. Nitric oxide (NO) (Joan Ribera, 2 hours)

Production of nitric oxide by the cells: the nitric oxide synthase (NOS), types and regulation. Distribution in different cell populations. Histological localization of NOS. Detection of the production of NO by colorimetric methods. Diffusing capacity of nitric oxide. Physiological functions of NO. Pharmacology of NO. NO as neurotoxic agent.

Nuclear receptors. The vitamin D receptor and its role in cardiovascular diseases (José Manuel Valdivielso, 2 hours).

Nuclear receptors and their function regulating the rate of gene transcription. Review of the preclinical and clinical data that support a key role of vitamin D receptor activation in cardiovascular health.

Intracellular pathways related to neuronal cell survival or death: role in neurodegenerative diseases (Rosa Soler, 2 hours)

Neurotrophic factors and their specific receptors: activation. Intracellular pathways: from the external signal to their effect in the cell. Supressors or activators of intracellular proteins in neurodegenerative diseases.

Sprouty proteins as negative regulators of RTK signaling (Mario Encinas, 2 hours)

The Spry family members: from Drosophila to mammals. Functions of Spry genes as defined by gene targeting. Mechanisms of action: many open questions. Role of Spry proteins in tumor suppression. Novel functions of Spry genes and perspectives.

Pro-neurotrophins and neurodegenerative diseases (Carme Espinet, 2 hours).

Pro-NGF and pro-BDNF as ligands of p75NTR. p75NTR signaling pathways, intracellular interacting molecules and interaction with co-receptor partners. p75NTR processing and internalization. Pro-NGF/p75NTR modifications in Alzheimer's disease. pro-BDNF/p75NTR involvement in familiar depression.

Programmed cell death in spinal cord motoneurons during development (Jordi Calderó, 2 hours).

The process of naturally (programmed) cell death of neurons, particularly of motoneurons. Apoptotic death. Cellular and molecular mechanisms that control these processes and the role played by specific neurotrophic factors as modulator agents.

Excitotoxicity and selective motoneuron vulnerability (Olga Tarabal, 2 hours).

Glutamate receptors expression in neurons. Excitotoxic molecular mechanisms. Excitotoxic necrosis: the organotypic culture of chick embryonic spinal cord as a model to study excitotoxic necrosis. Chronic excitotoxicity and degeneration. Acute and chronic excitotoxicity in the model of chick embryo in vivo.

Signaling mechanisms of axon guidance receptors (Joaquim Egea, 2 hours)

Description of the signaling mechanisms of Eph receptors and the mouse genetic approaches used to address their relevance in vivo.

PRACTICAL AND SEMINAR PROGRAM

SEMINAR PROGRAM

- **Analysis of Membrane Protein Complexes by Blue Native PAGE (Celia Casas, 2 hours).** Solubilization of membrane protein complexes. Types of detergents. Effect of lipids on protein solubilization. Protocols for BN-PAGE. Applications of BN-PAGE.
- **Fluorescence Resonance Energy Transfer in living cells (FRET) (Marta Llovera, 2 hours).** The principle of FRET. Fluorochrom pairs useful on FRET analysis. Applications. Methods for FRET detection. FRET-based biosensors. Real-time molecular interactions within living cells.
- **Image acquisition and processing on FRET experiments (Marta Llovera, 2 hours).** Confocal microscope parameters for FRET image acquisition. MBF ImageJ software: image processing and quantification. Pseudocolouring and image composition.

PRACTICAL PROGRAM

- **DNA transfection methods (Marta Llovera and Celia Casas (4 hours).** Optimization of DNA transfection methods for a specific cell type in culture (lipofection, PEI, electroporation). Determination of the optimal condition for each cell line.
- **Methods to evaluate the involvement of a particular intracellular pathway in neuronal survival: experimental design (Rosa Soler and Ana Galcerá, 4 hours).** To define the pathway that we want to analyze; and to develop and experimental design to study which effect causes the activation or the inhibition of this pathway on cultured neurons.
- **Calcium signalling (Josep E. Esquerda and Olga Tarabal, 4 hours).** Intracellular calcium imaging after loading neurons with Fura-2 AM. Calcium transients after application of agonists and antagonists of glutamate receptors. Calcium release from intracellular stores. Calcium induced calcium release (CICR) mechanism.

Methodology

Development and homeostasis of metazoan organisms is absolutely dependent on communication between their building blocks, the cells. Such communication is usually achieved by the use of small, extracellular signaling molecules which act locally or globally to coordinate growth, differentiation, survival or metabolism of cells. Signaling molecules exert their actions on target cells through binding to specific receptors usually but not always located at the cell surface. Receptor binding causes a plethora of molecular responses, known as signal transduction pathways, meant to produce a characteristic biological response. In this course we aim to provide a general view of the vast field of signal transduction. Rather than systematically presenting current knowledge on the field, we will provide a first-hand view of specific topics, which will be presented by specialists who are actively developing their research on that particular aspect of the field. A practical block introducing state-of-the-art laboratory techniques will complement the theoretical sessions.

Evaluation

Attendance to lectures, practical and seminar sessions.

Presentation and discussion of scientific articles.

Activities related with lectures, seminars and practices.

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INTERNET RESOURCES

The Wnt webpage: http://www.stanford.edu/~rnusse/wntwindow.html

http://www.ionchannels.org/

http://www.nature.com/nrm/focus/polarity/index.html

Blue Native Electrophoresis Protocol. MitoSciences

http://www.mitosciences.com

Dr. Louis Ignarro Explains Nitric Oxide:

http://www.youtube.com/watch?v=DcIWX8C91s4 i http://www.youtube.com/watch?v=NBPjZJSHr4A

MBF ImageJ webpage:

http://www.macbiophotonics.ca/imagej/

Olympus Confocal Microscopy Tutorials

http://www.olympusfluoview.com/java/index.html

Olympus FRET webpage

http://www.olympusfluoview.com/applications/fretintro.html

Nikon FRET webpage

http://www.microscopyu.com/tutorials/java/fluorescence/fpfret/

Interactive tutorial explores various combinations of fluorescent proteins as potential FRET partners and provides information about critical resonance energy transfer parameters, as well as suggestions for microscope optical filter and light source configuration.