Pla Docent (Teaching Plan):

Cell Communication-30135
Master in Biomedical Research

1. Subject Description

- Course name: Cell Communication
- Academic year: 2014-2015: Trimester:1
- Degree: Master Biomedical Research. Subject code: 30135
- Credit number ECTS: 5. Hours of attendance/study: 125, of which 40-50 hours will correspond to classroom attendance.
- Language: English
- Teaching staff: José Manuel Fernández and Cristina López-Rodríguez (coordinators). Other professors/speakers that will participate in specific lessons/seminars: Miguel A. Valverde, Carles Cantí.

2. Course presentation

Context: This course aims to present students the basic principles governing cell communication. Hence, it analyzes how signals are transmitted via cell contacts, by extracellular soluble mediators and by chemical or physical stimuli. The course describes, from the molecular identification and characterization of different membrane receptors to the roles of ion channels. In addition, paradigms of intracellular signaling cascades and gene expression mechanisms located downstream of different receptors/sensors would be analyzed in depth. The course is intended for graduate students in the life sciences and is divided in two parts.

Focus: The course is not intended as an exhaustive listing of cellular receptors and their signalling mechanisms, but rather will be mainly based on the in depth analysis of different paradigms where intensive biomedical research is being developed nowadays. The course is structured with a proportion of introductory lectures and research seminars that will help to position the context and current views on the problems being discussed. The two blocks analyzed during the course are as follows:

1) Biology of cell surface receptors: ligand recognition and signalling pathways.

This section will address the role played by surface receptors in regulating complex cell functions, differentiation, growth and survival, taking the immune system as a paradigm. Current strategies and challenges related to the molecular characterization of immune receptor-ligand interactions and the integration of signal transduction mechanisms will be addressed, discussing practical implications.

2) Biology of ion channels: structure, function and signalling pathways.

This part focuses on molecular physiology and biophysics: The major topics covered include molecular structure and properties of membranes, transport of ions, ion channels and their regulation, membrane excitability, sensory transduction mechanisms, synaptic transmission and intracellular messengers involved in excitation-secretion coupling, contraction of muscles and neuronal functioning, among others.

These topics are covered in comprehensive, but didactic, manner, with each topic beginning in an elementary fashion and ending with discussion of selected published articles.

Key aspects: This is an optional course for master students with different orientation such us Bioinformatics, Biomedical Research, Pharmaceutical Industry and Clinics, Neurosciences. Special effort is then done in the introductory sessions that aim at balancing the experience of students with different backgrounds. These introductory sessions also try to identify students that might require an extra support from the teachers in order to progress properly during the course.

This course uses formal lectures as well as active discussion of related, and updated scientific literature, as tools to allow students to transition from previous courses, mainly based on lectures and well consolidated textbooks, to the scenario of acquiring and applying information from fast-changing sources.

Problems will be prepared as cases or from published articles and will be given to the students, together with the relevant material, at the beginning of the course. Students are expected to actively engage in discussion and problem solving individually and in groups.

Requisites:

Language. The course will be entirely imparted in English, and the articles and class materials will be in English as well. Students are expected to have an English level enough to understand scientific articles, and basic conversational and writing skills to engage into course discussions or make oral and written presentations of scientific literature.

Previous formation. Classes will be at an advanced level, with an emphasis on the analysis of biological processes from a molecular, biochemical, and cellular basis. Students are expected to have knowledge on Cell Biology, Molecular Genetics and Biochemistry equivalent to the level achieved in a University degree in Biology, Biochemistry or Biotechnology.

3. Competencies to be attained in the subject

General:

1) To develop skills in acquisition, critical processing, and communication of scientific information, as well as proposal and discussion of hypothesis.

2) To acquire basic abilities to outline and design experimental approaches to solve specific biomedical research questions.

Specific:

1) To get a comprehensive view of how cells integrate the responses from different external stimuli regulating the development of complex functions such as differentiation, growth and survival.

2) To identify major challenges in the characterization of surface receptor-ligand interactions and in the dissection of their intracellular signaling pathways and gene expression mechanisms. Understanding practical implications for current drug design.

3) To provide insights into general experimental strategies employed to unravel the role of ion channels in cellular physiology.

4) To integrate the progress in molecular biology into the understanding of the basic elements governing cellular excitability.

These competencies will unfold in the following aspects:

Instrumental:
Training of analytical and synthesis abilities.
Training in management of information sources.
Training in oral and written communication.

Interpersonal:
Training teamwork abilities (sharing tasks, collaborative work, active and positive ways to evaluate other team mates, accept criticism from team mates).
Training abilities for discussion in group.

Systemic:
Training in problem solving, decision making and time management.
Ability to produce, test and project own ideas.
To train in working for quality.

4. Contents of the course*

- Ligand recognition and signalling by surface receptors.

- Integration of signalling pathways and gene expression mechanisms regulating cell functions such as differentiation, growth and survival.
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- Ion channels and cellular excitability: structure-function and regulation of ligand-gated, Na^+, K^+ , Ca^{2+}, Cl^- , and cationic TRP channels.

- Cellular responses to physical stimuli: temperature, osmotic stress, mechanical stress.

- Stimulus-secretion coupling. Synaptic transmission.

* *Note: some parts within these topics are pending of confirming availability of speakers and might be substituted by related themes*.

5. Evaluation

Exams

There will be a final exam in December. The exam will consist on a written test with questions about the lectures, seminars and problems discussed during the course, plus an exercise of commentary and discussion of an article. The score obtained in the exam will be added to the grades obtained during the course in the problem discussion and presentation sessions. Percentages for the final grade are as follows:

Part I. Biology of cell surface receptors.

1. Oral presentations and scientific discussion of students (30% of the total grade).
3. Written test (40% of the total grade).
4. Article commentary (30% of the total grade).

Part II. Biology of ion channels.

1. Attendance (20% of the total grade).
2. Written test: questions regarding the research published in one scientific article that will be provided to the students during the first week of the course (60% of the total grade).
3. Scientific article presentation and discussion (20% of the total grade).

To pass is necessary to achieve at least 5/10 in the written test.

These evaluation activities are individual (except for the research reports presented by a group of students), and all are mandatory.

The dates with the specific evaluation activities will be announced at the beginning of the course.

Classes and activities in this subject will expand for 5 weeks and end by the 1st of November. Classes and activities in all subjects of the trimester will end by the 3rd or 4th of December, leaving 2 weeks for exam preparation. Exams usually take place between the 17th and 20th of December. Exam dates will be announced by the Academic Secretary.

6. Bibliography

The main sources of bibliography will be reviews on specific topics and selected original research articles. These are updated from year to year, and are available to students at the website of the course in Campus Global at the beginning of the classes.

In addition, comprehensive electronic resources and basic textbooks on general cellular and molecular biology and immunology are recommended for basic notions and refreshing forgotten concepts.

1) Cell signalling biology [Recurs electrònic] / Michael J. Berridge, that can be access through the UPF library.

2) An excellent reference book can be found in recent editions of "Molecular Biology of the Cell", 5th Edition (2007) by Bruce Alberts, Alexander Johnson, Julian Lewis, Martin Raff, Keith Roberts and Peter Walter. Published by Garland Science.

3) For an excellent background in immunology, see "Cellular and Molecular Immunology", 6th Edition (2007), by Abul K. Abbas, Andrew H. Lichtman, and Shiv Pillai. Published by Elsevier Science.

4) Note that NCBI website contains a number of previous editions of freely available books on numerous disease-related disciplines at http://www.ncbi.nlm.nih.gov/sites/entrez?db=Books

7. Format and methodology

The course will be divided into topics of current active research in different aspects of cellular communication. The format and distribution of classes will be: ***a)*** lectures, to present an overview of topics (30-40%); ***b)*** session of problem discussion among students (10-20%); and ***c)*** oral presentations by students of selected research papers (30-40%). Students are expected to actively participate in discussion and problem solving, individually and in groups.

The duration of the course is 5 weeks.

Lessons will comprise 40 hours. Attendance is mandatory.

Besides attendance to lessons, students will be assigned specific tasks (directed activities, such as presentation of articles and problems) whose calendar, as that of the lessons, will be posted at the website of the course at the beginning of classes. These activities will be organized as individual or group work and their load will be distributed along the course. Preparation of directed activities outside of the

classroom plus autonomous hours of personal study along the 5 weeks of the course requires approximately 80 hours per student.

8. Program

As the course is updated every academic year, the following program is merely orientative. In this regard, group and paper discussions are updated annually considering major advances in areas of active research that are connected to the topics analyzed during the course. Definitive lesson titles and seminars are provided at the beginning of the course. Out of classroom activities will include individual and group work, and will be assigned during the first days of the course. Evaluation format and organization of activities will be explained at the initiation of the course.

Lectures, Part I

Biology of cell surface receptors: ligand recognition and signalling pathways

First week:

Class number one: Introduction to cellular receptors for extracellular signals

Class number two: Organization of the course, groups of students and evaluations.

Class number three: Ligand recognition and signaling pathways coupled to multisubunit receptors. The T cell receptor paradigm.

Class number four: Integration of complementary signals. Immune co-receptors and co-stimulatory molecules.

Class number five: Control of cell functions, differentiation and survival by inhibitory receptors.

Class number six: Cell adhesion molecules. Integrins and selectins.

Class number seven: Regulation of cell motility, adhesion and gene expression by chemokine receptors.

Class number eight: The JAK-STAT cytokine receptor signalling pathway and cell differentiation.

Second and third week:

Class number nine: The TNF family of receptors. Regulation of cellular survival and apoptosis via a regulated balance of intracellular signalling events.

Class number ten: Self-nonself discrimination by immune pattern recognition receptors. Overview on Toll-like receptors, and cytoplasmic receptors for specific pathogens (RIG-like receptors and NOD-like receptors).

Class number eleven: The IKK/IKB/NF-kB pathway. A key player in response to various types of surface receptors. Multiple and distinct post-translational modifications regulate this signaling cascade at different levels.

Class number twelve: MAP Kinases. Role of scaffold proteins that joint signal cascades and are conserved during evolution.

Class number thirteen: The calcineurin/ NFAT pathway. Different intensity delivers a different signal outcome. Composite transcription factors and pathway convergence.

Classes numbers fourteen to nineteen (from 14 to 16, second week; from 17 to 19, third week): Paper discussion by students supervised by teachers.

Lectures, part II

Biology of ion channels: structure, function and signalling pathways.

Third week (continues):

Class number twenty: Introduction to ion channels.

Class number twenty one: Membrane receptors with ion channel activity.

Class number twenty two: Ion channels and cellular excitability I. Structure-function studies of Na^+ channels.

Class number twenty four: Ion channels and cellular excitability II. Structure-function studies of K^+ channels.

Fourth week:

Class number twenty five: Ion channels and cellular excitability III. Structure-function studies of Ca^{2+} channels.

Class number twenty six: Regulation of ion channels by G-protein.

Class number twenty seven: Regulation of ion channels by phosphorylation.

Class number twenty eight: Stimulus-secretion coupling. Synaptic transmission.

Classes twenty nine to thirty: Preparation and group discussion of oral presentation (supervised by teachers).

Class number thirty: Ion channels and cellular excitability IV. Structure-function studies of Cl^- channels.

Class number thirty one: Ion channels and cellular excitability V. Structure-function studies of cationic TRP channels.

Class number thirty two: Cellular responses to physical stimuli: temperature, osmotic stress, mechanical stress.

Fifth week:

Class number thirty three: Preparation and group discussion of oral presentation (supervised by teachers).

Classes thirty four to thirty nine: Paper discussion by students supervised by teachers.