COURSE DATA

Data Subject	
Code	43470
Name	Transit and intracellular signal transduction
Cycle	Master's degree
ECTS Credits	3.0
Academic year	2024 - 2025

Study (s)

Degree	Center	Acad. year	Period
2210 - Master¿s Degree in Research in Molecular, Cellular and Genetics Bio	Faculty of Biological Sciences	1	First term

Subject-matter

Degree	Subject-matter	Character
2210 - Master¿s Degree in Research in Molecular, Cellular and Genetics Bio	15 - Transit and intracellular signal transduction	Optional

Coordination

Name	Department
ANIENTO COMPANY, FERNANDO	30 - Biochemistry and Molecular Biology

SUMMARY

The subject is divided in two parts, one devoted to intracelular compartments and protein trafficking and the second focused in the main mechanisms of cell signaling and communication.

Part I. Compartments and intracellular trafficking.

It describes the two main routes of intracellular trafficking, the biosynthetic or secretory pathway and the endocytic pathway, with special emphasis in the molecular mechanisms responsible for the organized trafficking of proteins and lipids along both pathways to preserve the identity of the compartments involved in these proceses. The involvement of intracellular traffic in signal transduction and different pathologies will also be studied.

Part 2. Cell signaling and communication.

The binding of signaling molecules to their receptors initiates a series of intracellular reactions that regulate cell behavior, including metabolism, movement, proliferation, survival and differentiation. Understanding the molecular mechanisms responsible for this has become a major area for research, heightened by the fact that many cancers arise after the breakdown in signaling pathways that control normal cell proliferation and survival. In this part, we will study the different signal transduction pathways and its involvement in physiological and pathological conditions.

PREVIOUS KNOWLEDGE

Relationship to other subjects of the same degree

There are no specified enrollment restrictions with other subjects of the curriculum.

Other requirements

2210 - Master¿s Degree in Research in Molecular, Cellular and Genetics Bio

- Students should apply acquired knowledge to solve problems in unfamiliar contexts within their field of study, including multidisciplinary scenarios.
- Students should communicate conclusions and underlying knowledge clearly and unambiguously to both specialized and non-specialized audiences.
- Students should demonstrate self-directed learning skills for continued academic growth.
- Students should possess and understand foundational knowledge that enables original thinking and research in the field.
- To be able to assess the need to complete the scientific, historical, language, informatics, literature, ethics, social and human background in general, attending conferences, courses or doing complementary activities, self-assessing the contribution of these activities towards a comprehensive development.

- To know in detail the different routes of intracellular traffic and their function, as well as the structure and function of the organelles involved.
- To understand the basic principles which apply in every process of intracellular traffic.
- To know the molecular mechanisms responsible for the fidelity of vesicular transport and the maintenance of intracellular compartmental diversity.
- To know the molecular mechanisms by which intracellular and extracellular signals control the metabolism and other related cellular processes.
- To study in detail the different routes of signal transduction and their role in cell development and differentiation.
- To know the involvement of intracellular traffic and signaling in human pathological processes, such as cancer or diseases mediated by pathogens or toxins.

DESCRIPTION OF CONTENTS

1. Molecular mechanisms of vesicular transport and the maintenance of intracellular compartmental diversity

Main principles of intracellular trafficking. Vesicle formation: coat proteins. Clathrin and adaptor proteins; Non-clathrin coat proteins (COPI and COPII). The p24 protein family. Sorting of proteins in transport vesicles. Vesicle targeting, tethering and fusion with the target membrane. Role of rab GTPases and SNARE proteins in the specificity of vesicle fusion.

2. Membrane trafficking in the biosynthetic/secretory pathway.

The early secretory pathway: ER to Golgi transport. ER exit sites (ERES), ERGIC (ER-Golgi Intermediate Comparment) and COPI/COPII vesicles. The KDEL receptor and recovery of ER resident proteins. Models to explain intra-Golgi protein transport. Transport of lysosomal hydrolases from the trans-Golgi network (TGN) to the lysosomes: the mannose 6-phosphate receptor. Transport from the TGN to the cell surface: exocytosis. Constitutive and regulated secretion. Unconventional secretion.

3. Membrane trafficking in the endocytic pathway.

Fluid-phase and receptor-mediated endocytosis. Types of receptors involved in endocytosis. Sorting of receptors and ligands in clathrin-coated vesicles at the plasma membrane. Transport from endosomes to different plasma membrane domains: receptor recycling and polarity. Transport from early endosomes to late endosomes and lysosomes: the degradative pathway. Protein sorting in endosomes: the retromer and the ESCRT system. Caveolae and lipid rafts. Endocytosis and signal transduction.

4. Protein traficking in physiological/pathological processes

Temporal regulation of vesicle fusion and release of neurotransmitters in the synapse. Protein trafficking and diabetes mellitus: insulin biosynthesis and secretion in the pancreatic beta cells, insulin signaling and intracellular trafficking of the glucose transporter GLUT4. Protein trafficking and the Alzheimer disease.

5. Nuclear receptors as transcriptional regulators

Steroid and tyroid hormone signaling. Nuclear receptor superfamily. Implications in endocrine and oncologic human pathology.

6. Signaling through G-protein-coupled receptors

Signaling pathways. Contribution of G-protein receptor and heterotrimeric G protein dysfunction in cell transformation and human tumorigenesis. Mechanism of action.

7. Signaling through cell surface receptors with enzymatic activity

Receptor tyrosine kinases (RTK). Activation mechanism of the Ras /MAPK pathway. Protein serine/threonine kinase receptors: TGFbeta/Smads. Phosphoinositides as signal transducers. Cytokine receptors and non-receptor protein tyrosine kinase: the JAK/STAT pathway. mTOR regulation by PI3H/Akt and AMPK. Alterations in these signaling pathways in cancer and other human pathologies. Development of anti-cancer drugs.

8. Signaling pathways that depend on regulated proteolysis

Hedgehog and NF-kB pathways. Alterations in the Wnt pathway and colon cancer. Analysis of Notch/Delta and SREBP pathways. APP and the Alzheimer disease.

WORKLOAD

ACTIVITY	Hours	% To be attended
Theory classes	26,00	100
Other activities	4,00	100
Development of group work	3,00	0
Study and independent work	25,00	0
Readings supplementary material	3,00	0
Preparation of evaluation activities	8,00	0
Preparing lectures	6,00	0
TOTAL	**75,00**	

TEACHING METHODOLOGY

Lectures. They will develop the essential concepts of the course.

Group tutorials. These sessions should reinforce the concepts presented in the lectures and should encourage the active participation of the students. To do this, the teacher will propose questions to be discussed during the session. Also, it is the ideal means for students to ask questions or raise issues that may arise during the course. This will allow to see how the students are assimilating concepts and will help to identify any gaps or failures in the learning system and to directly evaluate the student's work.

Presentation and discussion of research articles. It will consist of the presentation of research articles on current topics related to the subject. This activity will be optional.

EVALUATION

The evaluation of the subject will be carried out by means of a written examination. To pass the subject, a 50% of the total score must be reached, with a minimum of 40% in each of the 2 parts of the subject. In the case of presentation of research articles, a percentage of the final grade will correspond to this activity. The student's participation in the development of different teaching activities will also be assessed.

REFERENCES

Basic

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- KUMAR, U., ABBAS, A.K., ASTER, J. Robbins & Cotran. Pathologíc Basis of Disease. 8th ed. Saunders. 2009.
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- WEINBERG, R.A. The Biology of Cancer. 2nd ed. Garland Sci., New York, NY, USA. 2013.
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- LIM, W., MAYER, B. PAWSON, T. Cell Signaling: Principles and Mechanisms. Garland Sci. New York, NY, USA. 2015.

Additional

- Artículos de revisión en revistas de biología celular:
Annual Reviews of Cell and Developmental Biology, Annual Reviews of Biochemistry, Nature Reviews in Molecular and Cell Biology, Current Opinion in Cell Biology, Trends in Cell Biology, Trends in Biochemical Sciences.

Revistas científicas especializadas en tráfico intracelular y señalización: Traffic, Cellular Signaling, Cell, Journal of Cell Biology, EMBO Journal.

Artículos científicos accesibles a través de PubMed:
http://www.ncbi.nlm.nih.gov/sites/entrez?db=PubMed

Libros on-line accesibles a través de PubMed (NCBI Bookshelf):
http://www.ncbi.nlm.nih.gov/sites/entrez/query.fcgi?db=Books