Universitat Autònoma de Barcelona

2018/2019

Cellular Signalling

Code: 100864
ECTS Credits: 6

Degree	Type	Year	Semester
2500252 Biochemistry	OB	3	1

Contact

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Use of languages

Principal working language: catalan (cat)
Some groups entirely in English: No
Some groups entirely in Catalan: No
Some groups entirely in Spanish: No

Prerequisites

Basic knowledge and competences of Biochemistry, Cell Biology, Physiology and Histology, Chemistry, Mathematics, Physics.

Objectives and Contextualisation

The subject of Cell Signaling is included in the matter Biochemistry Functional . A subject of this matter has been studied during the second year, the others will be studied during this third year.

The behavior of a cell depends on the physiological situation in which it is found. This process requires the cell to have sensors of the external stimuli and respond appropriately to these stimuli. This process of recognition of the stimulus and response of the cell is known as cell signaling or signal transduction.

In this subject, the nature of the signal molecules and the mechanisms by which the cells recognize these molecules and respond appropriately to them will be studied.

Targets

Describe the molecules involved in intracellular and intracellular communication systems.

Have an integrated vision of the function of hormones, neurotransmitters and growth factors in the control of gene expression.

Explain the signal transduction pathways involved in the regulation of the cell cycle, apoptosis and cancer.

To know the experimental approaches to the study of signal transduction mechanisms.

Search bibliography and interpret information of biological signal transmission databases.

Interpreting experimental results and identifying the consistent and inconsistent elements.

Read specialized texts in the English language.

Know how to make an oral and visual presentation of a topic related to the subject to classmates.

Content

Topic 1. Cell signaling characteristics

Information and signals. Proteins are binary switches. Proteins form logical gates and "neural networks". Cross talking and network formation. Interaction domains: how the network is plugged together. Generation of signaling patterns

Topic 2. Basic Biochemistry of Signal Transduction.

Redox and nitrosylation switches. Switches operated by enzymes that hydrolyze energy-rich compounds. GTPase or G-protein switch. ATPase switches. Protein phosphorylation. Protein acetylation and methylation: tools of gene regulation and more. Protein ubiquitylation: more than a signal of protein degradation. Mono- and poly(ADP-ribosylation). Ion channel switches. Receptors: how energy-supplying reactions are combined with signal transduction. Experimental standard methods for investigation of signaling pathways. Model organisms for investigation of cellular signal processing

Topic 3. Evolution of Cellular Data Processing

Evolution of biological signal processing. The RNA world. Signal-controlled membrane transport. Sensor-dependent signal processing: two-component systems. From vagabonds to societies: "bacterial hormones". From bacteria to humans: evolution of signaling mechanisms

Topic 4. Basic Equipment: G-Proteins, Second Messengers, and Protein Kinases

Trimeric G-proteins: coupling of receptors with the protein network. Downstream of G-proteins: enzymes producing second messengers. The next level: protein kinases as sensors of second messengers

Topic 5. Signal Transduction by Receptors with Seven Transmembrane Domains

G-protein-coupled receptors: structure and mode of operation. Adrenergic receptors: sensors of stress and sympathetic signals. Muscarinic acetylcholine receptors are sensors of parasympathetic signals. Stress and the heart: the competition between sympathetic and parasympathetic signal. Protease-activated receptors. Adaptation of G-protein-controlled signaling. Arrestinsare multifunctional adaptors for signaling cross talk. Heptahelical receptors in hedgehog and Wnt signaling pathways. Other G-protein-independent heptahelical receptors.

Topic 6. Signal Transduction by Serine/Threonine Kinase-Coupled Receptors

The pinciple of oligomerization-driven signal transduction. Ser/Thr-kinases as receptors: transforming growth factor β receptor family. Cytokine receptors: key players in defense reactions

Topic 7. Signal Transduction by Tyrosine Kinase- and Protein Phosphatase Coupled Receptors

Receptor tyrosine kinases. Receptor associated with tyrosine kinases. Signal transduction by cell adhesion molecules. Protein tyrosine phosphatases and phosphatase-coupled receptors.

Topic 8. Eukaryotic Gene Transcription: The Ultimate Target of Signal Transduction

Transcription factors as hormone receptors. Ligand-controlled transcription factors are xenosensors of the toxic stress response. Chaperones and peptidyl-prolyl isomerases prepare signaling proteins for work. Transcription factors as substrates of protein kinases. The hypoxic stress response

Topic 9. Signals Controlling mRNA Translation

Signaling cascades controlling translation. Network for adjustment of cell growth to the supply situation. The signaling network of non-coding RNAs

Topic 10. Signal Transduction by Small G-Proteins: The Art of Molecular Targeting

Ras proteins: generation of order in signal transduction. Other G-proteins of the Ras subfamily. GTPases of the Rho family are master regulators of the actin cytoskeleton. Arf and Rab proteins control vesicle transport. Ran, nuclear transport, and mitosis

Topic 11. Mitogen-activated Protein Kinase and Nuclear Factor κB Modules

MAP kinase modules are universal relay stations of eukaryotic signal processing. MAP3 kinases, MAP4 kinases and G-proteins.. Organization of MAP kinase modules by scaffold proteins. DownstreamofMAP kinase modules: MAP kinase-activated protein kinases, Transcription factors. NFκB signaling pathway

Topic 12. Regulation of Cell Division

The cell cycle. Cyclins: cell cycle regulators. Cyclin-dependent protein kinases: dual control by phosphorylation and dephosphorylation. Cyclin-dependent kinase inhibitors: keeping the cell cycle under control. G0 cells, restriction points, and the effect of mitogenic signals. Retinoblastoma proteins: master regulators of the cell cycle. Regulation of G2 phase and G2-M transition. Genotoxic stress response. Ubiquitin ligase APC/C. Mitotic protein kinases: formation of the mitotic spindle. The spindle assembly checkpoint. Cytokinesis. Mitotic exit.

Topic 13. Signal Transduction by Proteolysis, and Programmed Cell Death

Secretase-coupled receptors: generation of peptide second messengers. Signal-controlled suicide of cells. Cancer: a disease of signal processing

Topic 14. Signal Transduction by Ions

Cation channels: prototypical structures and gating mechanisms. Voltage-gated Na^+ channels. The multi-talented Epithelial Na^+ channels .K^+-selective ion channels are regulators of hyperpolarization and osmotic pressure. Calcium ions: the most versatile cellular signals. Downstream of Ca^{2+} signals. Anion channels

Topic 15. Sensory Signal Processing

Taste. Mechanical stimuli: touch and sound. Temperature and pain. Smell. Vision. Sensory adaptation

Topic 16. Signaling at Synapses: Neurotransmitters and their Receptors

Acetylcholine receptors. γ-Aminobutyric acid and glycine receptors, inhibitory neurotransmission. Glutamate receptors. Nitric oxide: a Janus-faced signal molecule. Receptors of purine and pyrimidine nucleotides: the ATP signal. Cannabinoid and vanilloid receptors. Opioid receptors. Narcotics and drug addiction

Topic 17. The Approach of Systems Biology

Systems biology: origin and focus. System structure: basic network topologies and properties. The iterative cycle: laboratory experiments and mathematical model development. Problems of quantitative data generation and mathematical model development. Mathematical modeling of a signaling pathway