Molecular Biology

Code: ΝΠ18-25

Cycle/Level: 1st cycle / Undergraduate, elective

Semester: 3rd

Type of Course

X	Background
	Scientific Area (Pharmacy)

ECTS: 4

Lectures (hours): 2

Tutorials (hours):

Laboratory Work (hours): 2

Course Coordinator: Christos Panagiotidis, Professor

Faculty Instructors

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Teaching Assistants: -

Learning Outcomes:

- To enhance the student background of Molecular Biology of the cell.
- To promote the understanding of the complex inter-related and inter-regulated interactions between the various molecular processes of the cell, which are necessary for cell survival and function.
- To explain how the interactions between various biomolecules (e.g. protein- protein or protein-nucleic acid interactions) contribute to the regulation of cellular processes and to the biology of the whole cell.
- To provide knowledge on the molecular mechanisms involved in regulating the various cellular responses to environmental signals.
- To offer the students with hands-on expertise on some of the methodologies often used in the study of the molecular biology of the cell (through laboratory training).

The above targets are achieved through a combination of lectures and laboratory training that represent different and complementary forms of training. The lectures are the major means of

knowledge transfer but their major disadvantage is the relatively small audience participation (it should not escape our attention the fact that lecture attendance is not compulsory). On the other side, the compulsory laboratory training helps the students understand the methods used in the analysis of the cellular and molecular processes, as well as of the practical problems that arise during these processes.

General Competences: After the successful completion of the Molecular Biology course the students should be able to:

- Describe the major points of DNA structure and replication.
- Describe the key aspects of chromosomal organization, recombination and repair.
- Describe the transcription process and the mechanisms involved in its regulation, as well as the post-transcriptional gene regulation processes. Furthermore, they should be able to describe the mechanisms involved in translational regulation both in prokaryotes and eukaryotes.
- Describe important issues of protein biochemistry, including the processes of protein folding, targeting and transport to the various subcellular compartments.
- Describe major aspects of the cellular signaling processes, both in prokaryotes and eukaryotes, including the roles of tyrosine kinases, G-proteins, membrane and nuclear receptors and bacterial two-component signal transduction systems.
- Describe the molecular mechanisms leading to the regulation of cell proliferation and programmed cell death.

Teaching methods: Course lectures and laboratory exercises.

Course Content: Inheritance, genes and DNA. Genes and enzymes. The elucidation of DNA as the genetic material. Structure and organization of the genomes. Genomes of plant cells and of subcellular organelles (mitochondria, plastids). DNA replication. Expression of the genetic information. Relationship between genes and proteins. The role of messenger RNA. The genetic code. RNA viruses and reverse transcription. Transcription, RNA polymerase and transcription factors. Regulation of gene expression at the transcriptional, post –transcriptional level, as well as at the level of translation. Protein transport into subcellular compartments and its regulation. Signal transduction. Hormones and other molecules involved in signal transduction. Functions of membrane and intracellular receptors. Mechanisms of intracellular signal transduction. Signal transduction and cytoskeleton. Introduction to the recombinant DNA. Restriction enzymes. Cloning vectors. Expression of cloned genes. Principles of DNA sequencing. DNA amplification with the polymerase chain reaction. Functional analysis of genes. Genetic analysis using yeast cells. Site-directed mutagenesis and introduction of mutations in cellular genes.

Proposed literature:

1. Alberts B., Bray D., Hopkin K., Johnson A., Lewis J., Raff M., Roberts K., Walter P. "Essential Cell Biology", 3rd edition, 2015 (Greek translation, Publisher: Broken Hill Publishers Ltd.).
2. Watson, J. D., Myers, R.M., Caudy, A.A., Witkowski, J.A. "RECOMBINANT DNA" Edition: 3/2007, Publisher: Akadimaikes Ekdoseis I. Basdra & Co.

Educational activities: Attendance of course lectures and laboratory exercises.

Evaluation process and methods:

Written final exams at the end of the spring semester or in the autumn examination period. The exact dates and places are organized by the School of Pharmacy.
The students are provided with 20 statements and they are asked to define whether the question is correct or wrong (0.1 points per correct answer, -0.1 points per mistaken answer) and to justify their answer (0.4 points per question). All questions are equivalent (0.5 points). Questions that have not been answered correctly by any students are withdrawn and final grade is calculated based on the grades from the remaining questions. The examination time is 1 hour.

Use of ICT (Information and communication technologies) / Electtronic distribution of the course materials:

ICT is being in the lectures of the course (Powerpoint presentations, interactive tutorials using ICT, videos etc.).

Lecture material, as well as course and exam announcements, exam results etc. are posted on the Aristotle University's e-learning platform (https://elearning.auth.gr), as well as on the webpages of the course coordinator (Prof. Christos Panagiotidis, http://users.auth.gr/pchristo/), and of Assistant Professor G. Pampalakis, http://users.auth.gr/gpampalakis.

Teaching:

Teaching takes place with course lectures and experimental lab work.

A) Lectures. The lectures (2 hours each) take place once a week in Lecture Hall Δ12 of the School of the Exact Sciences. The lectures, together with related educational material, are freely accessed in the webpages of the two course instructors and on the Aristotle University's e-learning platform (https://elearning.auth.gr).

Lectures	Title	Instructor
1-3	Introduction to DNA technologies	C. Panagiotidis G. Pampalakis
4	Mutations and genetic diversity in bacteria	G. Pampalakis

5-6	Introduction to transcription and prokaryotic transcription	C. Panagiotidis
7-8	Eukaryotic transcription	C. Panagiotidis
9-10	RNA processing, introns/exons, post-translational regulation and microRNAs	C. Panagiotidis
11-13	Cell signalling	C. Panagiotidis

B) Laboratory exercises

Laboratory exercise	**Title**	**Instructor**
1	• *Escherichia coli* cultures • Experimentatl determination of bacterial numbers • Transformation of plasmid DNA into *Escherichia coli*	Panagiotidis Pampalakis
2	• Observation and recording of the results of Laboratory Exercise 1 • Identification of the antibiotic resistance of the transformed *E. coli* • *E. coli* colony recovery and initiation of bacterial cultures	Panagiotidis Pampalakis
3	• Recovery of the *E. coli* cells from liquid cultures using centrifugation • *E. coli* cell lysis by lysozyme treatment • Plasmid DNA recovery and ethanol precipitation.	Panagiotidis Pampalakis
4	• Recovery of the *plasmid* DNA pellet using centrifugation • Dissolution of plasmid DNA in appropriate buffer • Digestion of plasmid DNA with restriction enzymes	Panagiotidis Pampalakis
5	• Electrophoretic separation of DNA restriction fragments by horizontal electrophoresis in agarose gels • Determination of DNA restriction fragment size	Panagiotidis Pampalakis

	• Visualization of DNA fragments under ultraviolet light and documentation of the results	
6	• Introduction to the polymerase chain reaction (PCR) • PCR reactions to identify the presence of bacterial DNA in biological samples	Panagiotidis Pampalakis
7	• Agarose gel preparation for electrophoretic separation of PCR products • Electrophoretic analysis and characterization of PCR products • Visualization of PCR-amplified DNA fragments under ultraviolet light following gel electrophoresis and documentation of the results	Panagiotidis Pampalakis
8	• Evaluation and discussion of the results of the laboratory exercises	Panagiotidis Pampalakis
9	• Student preparation of lab reports	Panagiotidis Pampalakis