

INTRODUCTION TO THE MOLECULAR BIOLOGY OF CANCER

1.- General information					
Code	303001	Plan		ECTS	3
Type	Mandatoy	Course	2026/2027	Periodicity	1 st Semester
Language	ENGLISH				
Department	CANCER RESEARCH CENTER				
Virtual Platform	https://cicloud.dep.usal.es/				

1.1.- Datos del profesorado*			
Professor Coordinator	Dr. Eugenio Santos de Dios		
Research area	Ras gene products in proliferation and differentiation signaling pathways		
Center	Cell Division and Genomic Instability		
Office	Cancer Research Center		
URL Web	https://www.cicancer.org/grupo?id=25		
E-mail	esantos@usal.es	Phone	+34 923294720

Professor Coordinator	Dr. Alberto Fernández Medarde		
Research area	Screening of inhibitors of Ras activation and signaling for cancer treatment		
Center	Biochemistry and Molecular Biology		
Office	Cancer Research Center		
URL Web	https://www.cicancer.org/investigador?id=c6ac8867-1ceb-4c8b-b641-e3dd57d9e01b		
E-mail	afm@usal.es	Teléfono	923 294801

2.- Previous recommendations

English proficiency. This subject will be imparted in English.

3.- Aims of the subject

This program aims at providing a comprehensive introduction to the understanding of cancer through the study of the molecular and cellular alterations linked to the development of tumors and the application of the basic knowledge on those areas to the development of diagnostic and/or therapeutic tools at the clinical level.

The study of cancer at the cellular and molecular level has progressed extraordinarily during the last three decades. The new body of knowledge generated in this field of study extends from lab to bedside, starting in areas of basic research (at the level of cellular and molecular biology, microbiology and virology) and reaching clinical research areas focused on diagnosis, prognosis or

therapy. This new knowledge straddles the traditional barriers separating Biology, Pharmacy or Medicine. The curriculum proposed here requires an interdisciplinary approach that should be of interest for professionals academically interested in any area of biomedicine. Special emphasis is put on integrating related molecular and clinical contents in each lecture of the course.

The program includes four main sections, each one composed by several thematic blocks. The first section focuses on general aspects of tumor biology. The second section provides basic information of the different genes involved in processes of tumor development. The third section refers to the functional characterization of the protein products of tumor genes at molecular, biochemical and cellular levels. Finally, the fourth section is centered on the utilization of the wide body of basic knowledge described in the previous sections for its application to the diagnosis, prognosis and treatment of cancer at the clinical level

Objectives of the sections:

- Knowing the basic general mechanisms that underlie all tumor processes at the molecular and cellular level. Providing a general introduction to tumor biology and genetics, beginning with the analysis of genes and proteins involved in cancer and continuing with the application of this basic knowledge at the clinical level in aspects of diagnosis, prognosis and treatment of the disease.
- Understanding the nature and function of the altered genes and proteins responsible for tumor initiation and maintenance, and how to use this basic knowledge for application in translational oncology, in the design of new clinical approaches and improvements in areas of diagnosis, prognosis and development of new therapies for this disease.

4.- Skills to be acquired / Learning outcomes

Competencias

4.1: Basic skills:

CG10 – Interpretation and discussion of experimental results presented in scientific publications. Learning the process of designing and conducting research projects related to this field, as well as evaluating and assessing their results.

CG5 – Developing the ability to understand, evaluate, and critically analyze specialized scientific publications in this field.

4.2: Specific skills:

CE9 – Recognize, at a general level, the genes and proteins involved in tumor processes and their basic mechanisms of action.

CE10 – Know how to interpret basic biological data on tumor-related genes and proteins for use in the evaluation of tumors at the clinical level and in the development of diagnostic, prognostic, or therapeutic applications.

4.3: Transferable skills:

5.- Contents (Syllabus)

PROGRAM

Theoretical classes/ lectures

SECTION 1. GENERAL INTRODUCTION. NATURE AND CHARACTERISTICS OF TUMOR PROCESSES.

Block I: Basic tumor biology.

- Biology of cancer. Basic concepts
- Characteristics of the neoplastic processes.
- Characteristics of the tumoral cell.

SECTION 2. GENES INVOLVED IN TUMOR PROCESSES. DISCOVERY AND CHARACTERIZATION

Block II: Viral Oncogenes

- Virus and cancer.
- Oncogenesis mediated by RNA and DNA tumor viruses.
 - Oncogenes in RNA virus (retrovirus).

Block III: Cellular Oncogenes

- Identification of oncogenes by means of gene transfection.
- Activation of oncogenes through retroviral insertion.
- Oncogenes and chromosomal alterations
- Amplification of oncogenes in tumors.
- General classification of oncogenes.

Block IV: Tumor Suppressor genes

- General concepts of suppressor genes. Hereditary cancer
- The retinoblastoma (RB) gene and the discovery of suppressor genes.
- The TP53 gene.
- Other tumor suppressor genes.

Block V: Genes involved in Tumor Susceptibility

- Maintenance genes. "Caretaker" and "Landscape" genes
- Genomic Instability in tumors

Block VI Chromosomal Alterations in Solid and Hematological tumors

SECTION 3. FUNCTIONAL CHARACTERIZATION OF GENE PRODUCTS INVOLVED IN TUMOR PROCESSES. YOUR ROLE IN SIGNAL TRANSDUCTION AND CONTROL OF CELLULAR PROLIFERATION AND DIFFERENTIATION

Block VII: Cellular Proliferation and Differentiation.

- Proliferation and cell differentiation. Signaling systems in eukaryotes.
- Alterations of proliferation in tumor cells.
- Alterations of cell differentiation in cancer.

Block VIII: Oncogenes and Signal Transduction Pathways

- Eukaryotic growth factors and oncogenes.
- Transmembrane receptor tyrosine kinases and oncogenes in cellular transformation.
- Non-receptor oncogenic tyrosine kinases.
- Proteins with guanine nucleotide binding capacity.
- Serine / Threonine cytoplasmic kinases. MAPkinase signaling in eukaryotes
- Oncogenic transcription factors.

- Mitogenic signal transmission pathways in eukaryotic cells.
- Conserved signaling pathways along the evolutionary scale.

Block IX: Tumor Suppressors and Cell Cycle Control.

- Retinoblastoma gene product and related protein.
- Functional aspects of the p53 protein
- Regulation of the eukaryotic cell cycle.

Block X: Normal and Tumoral Development and Cell Death.

- Tumor genes and development.
- Tumor genes and cell death. Apoptosis. Autophagy.
- Role of oncogenes and suppressors in the pathogenesis of neoplasms.
- Biology of tumor metastatic processes.

SECTION 4. NEW MOLECULAR APPROACHES TO DIAGNOSIS, PROGNOSIS, TREATMENT AND PREVENTION (CANCER CLINIC).

Block XI: Cancer Genomics and Bioinformatics

- Genomic and proteomic cancer databases and related bioinformatics tools

Block XII: Prevention and Diagnosis.

- The fight against cancer. Future perspectives.
- New perspectives in cancer prevention.
- New frontiers in early detection and molecular diagnosis of cancer.

Block XIII: New therapeutic approaches based on advances at the molecular level.

- Conventional therapies and their evolution.
- New experimental therapeutic approaches.
- Immunotherapy approaches
- Gene therapy. Experimental approaches

Bibliographic reviews and / or seminars:

Scientific articles selected for discussion (changed/updated every year):

A series of topics and an appropriate number of scientific articles that are relevant to cancer will be proposed and selected yearly on the basis of their significance or novelty in the field of oncology. Each student must prepare at least one written bibliographic report based on the review and criticism of a collection of selected articles of his/her choice and interest. Other students may attend and actively participate in the presentation and discussion of these review reports.

6.- Teaching methodology

The students must attend at least 75% of all lecture sessions, having previously read and understood the recommended bibliography. The first session will focus on explaining teaching approaches and organization of the lecture sessions as well as discussing doubts and comments by the students.

The students must also attend and participate in at least a minimum, indicated number of seminars from the CIC-IBMCC annual seminar series where published and unpublished cancer research work from intramural and extramural scientist is presented and discussed.

6.1.- Estimated learning time					
		Hours tutored by the teacher		Individual work (hours)	TOTAL HOURS
		Attendance required (hours)	Distance learning (hours)		
Lectures		30			30
Practices	- In classroom				
	- In laboratory				
	- In computer classroom				
	- Countryside				
	- Others (specify)				
Seminars					
Work presentations and debates		20			20
Tutorials		10			10
Online activities					
Work preparation		10			10
Other activities					
Exams - evaluation		5			5
TOTAL		75			75

7.- Materials, other bibliographical, electronic references or any other type of resource

Books

No obligation. Only as complementary material to the lectures. Latest, updated editions of :

Molecular Biology of Cancer. Mechanisms, Targets, and Therapeutics. L. Pecorino. Oxford University Press. ISBN 978-0-19-921148-7

The biology of cancer. Robert A. Weinberg. Garland Science, Taylor&Francis Group, LLC. ISBN 0-8153-4078-8(hardcover) and ISBN 0-8153-4076-1(softcover).

Oncogenes and Tumour Suppressors. Gordon Peters and Karen H. Vousden. IRL Press at Oxford University Press. ISBN 0 19 963594 3

Molecular Biology of cancer. F. Macdonald and C.H.J. Ford. BIOS Scientific Publishers Ltd. ISBN 1 859962 25 4

Oncogenes. Second Edition. Geoffrey M Cooper. Jones and Bartlett Publishers. ISBN 0-86720-937-2

Molecular Oncology. J. Michael Bishop and Robert A. Weinberg. Scientific American Inc. ISBN 0-89454-023-8

Genes and the biology of cancer. Harold Varmus and Robert A. Weinberg. Scientific American Library. ISSN 1040-3213

Oncogenes and the Molecular Origins of Cancer. Robert A Weinberg. Cold Spring Harbor Laboratory Press. ISBN 0-87969-340-1

Cancer. Principles and Practice of Oncology. Vicent DeVita, Jr., Samuel Hellman, Steven A. Rosenberg. Lippincot-Raven Publishers. ISSN 0892-0567

Cancer Medicine. James F Holland, Robert C Bast Jr, Donald L. Morton, Emil Free III, Donald W.

Kufe, Ralph R. Weichselbaum. William and Wilkins. ISBN 0.683-04095-2

The Genetic Basis of Human Cancer. Bert Vogelstein and Kenneth W. Kinzler. McGraw-Hill. ISBN 0-07-067596-1

<https://pubmed.ncbi.nlm.nih.gov/>

8.- Assessment

8.1: Assessment Criteria:

8.2: Assessment Systems:

The final grade awarded to each student will be calculated as a weighted average of the grades received in their individual evaluations of (i) the bibliographic report prepared by the student on a topic agreed with the teacher and their participation in the theoretical sessions and seminars, and (ii) the multiple-choice test exam performed at the end of the course.

8.3: General Considerations and Recommendations for Assessment and Resits:

9.- Weekly Teaching Schedule