CELL GROWTH, CELL DIVISION AND CANCER

1.- General information					
Code	303016	Plan		ECTS	3
Type	Elective	Course	2025/2026	Periodicity	2st Semester
Language		Spanish			
Department	Cancer Research Center				
Virtual Platform	https://cicloud.dep.usal.es/				

1.1.- Faculty			
Professor Coordinator	Prof. Sergio Moreno		
Research area	Microbiology and Genetics		
Center	Institute of Functional Biology and Genomics		
Office	Laboratory 2.6		
Tutorials	To be arranged		
URL Web	https://ibfg.usal-csic.es/sergio-moreno-en.html		
E-mail	smo@usal.es	Phone	+34 923 294916

Professor	Prof. Juan Pedro Bolaños		
Research area	Biochemistry and Molecular Biology		
Center	Institute of Functional Biology and Genomics		
Office	Laboratory 2.7		
URL Web	https://ibfg.usal-csic.es/juan-pedro-bolanos-en.html		
E-mail	jbolanos@usal.es	Phone	+34 923 294917

Professor	Dr. Sergio Rincón		
Research area	Microbiology and Genetics		
Center	Institute of Functional Biology and Genomics		
Office	Laboratory 1.7		
URL Web	https://ibfg.usal-csic.es/sergio-rincon-en.html		
E-mail	sarpadilla@usal.es	Phone	+34 923 294922

Professor	Dr. Juan Carlos García Cortés		
Research area	Microbiology and Genetics		
Center	Institute of Functional Biology and Genomics		
Office	Laboratory 1.8		
URL Web	https://ibfg.usal-csic.es/juan-carlos-ribas-en.html		
E-mail	cortes@usal.es	Phone	+34 923 294898

Profesor	Dr. Sergio Rincón		
Área de Investigación	Dynamics of Cell Division		
Centro	Institute of Functional Biology and Genomics		
Despacho	Lab. Lab 1.7		
URL Web	https://ibfg.usal-csic.es/sergio-rincon.html		
E-mail	sarpadilla@usal.es	Teléfono	+34 923294922

Professor	Dr. Rubén Quintana Cabrera		
Research area	Biochemistry and Molecular Biology / Neurosciences		
Center	Instituto Cajal		
URL Web	https://cajal.csic.es/laboratorios/fisiologia-mitocondrial/#personal		
E-mail	ruben310@usal.es	Phone	

2.- Previous recommendations

No prior requirements.

3.- Aims of the subject

Aims:

Cancer often arises as a result of uncontrolled cell proliferation. To prevent deregulation of the cell division cycle, eukaryotic cells have developed a number of crucial control mechanisms that ensure linear, orderly and unidirectional transition through the various phases of the cell cycle. At the molecular level, this transition is supported by the sequential activation and inactivation of the different CDKs (cyclin-dependent kinases) that is achieved mainly through fluctuation throughout the cell cycle of the levels of their regulatory subunits, the cyclins. Likewise, uncontrolled cell proliferation requires an adaptation of the metabolism capable of satisfying the special structural and energy needs that accompany the massive increase in cell mass.

This course aims to introduce the student to the molecular bases that regulate growth, cell division, metabolic reprogramming and the importance of these processes in cancer biology.

Summary of the objectives:

To understand the molecular mechanisms that control of the cell cycle by CDKs and cyclins, the mechanisms that ensure the fidelity of DNA replication, the segregation of sister chromatids in mitosis to generate two identical daughter cells after cytokinesis. The molecular basis of cell growth, proliferation and differentiation. The main alterations that take place in cell division that can lead to the appearance of cancer will be described. The main metabolic enzymes, transcription factors and oncometabolites responsible for metabolic reprogramming will be studied, as well as the importance of energy metabolism and, in particular, the function of the mitochondria in cell proliferation and cancer.

In addition, as a complementary training, students will become familiar with the main original articles that have contributed to illuminate the current knowledge of cell division and metabolic reprogramming.

4.- Skills to be acquired / Learning outcomes

Skills

4.1: Basic skills:

Develop critical capacity in the interpretation of published experimental results.

4.2: Specific skills:

To understand the molecular mechanisms that regulate cell growth, cell division and metabolic reprogramming in cancer cells.

4.3: Transferable skills:

5.- Contents (Syllabus)

Lectures and practicals:

1. Introduction to the cell cycle. Model organisms for the study of the cell cycle. The machinery of the cell cycle: CDKs and cyclins.
2. Cell cycle and cancer. Importance of SCF and APC/C-mediated proteolysis in cell cycle regulation and cell differentiation.
3. Cell growth. Regulation of TOR by nutrients. Control of cell size and aging.
4. Mitosis: chromosome dynamics, spindle assembly and sister chromatin segregation.
5. Molecular mechanisms of cytokinesis in eukaryotic cells.
6. Metabolic reprogramming in proliferation and cancer.
7. Mitochondria and cancer.

Seminars:

Ten papers will be selected that have been key to understanding the molecular basis of cell division, metabolic reprogramming and its control. Students individually or in groups of two will prepare and present a seminar on one of these articles.

6.- Teaching methodology

The student must attend all the lectures (12 lectures of 90 minutes each) having previously read and understood the recommended bibliography.

For the preparation of seminars, students will be organized in groups of 1 or 2 students.

The student must attend the seminars (10 hours) in which each group (or student) will present a research paper and a critical discussion will be established.

Time distribution:

18 hours of lectures and practicals (90 minutes each lecture).

8 hours of preparation of the lectures.

10 hours of seminars.

20 hours of preparation of the seminars.

2 hours of tutoring with the teacher.

15 hours of preparation for the final exam.

2 hours for the final exam.

6.1.- Estimated learning time

		Hours tutored by the teacher		Individual work (hours)	TOTAL HOURS
		Attendance required (hours)	Distance learning (hours)		
Lectures		12			12
Practices	- In classroom				
	- In laboratory			6	
	- In computer classroom				
	- Countryside				
	- Others (specify)				
Seminars		10			10
Work presentations and debates				20	20
Tutorials		2			2
Online activities					
Work preparation			8		8
Other activities			15		15
Exams - evaluation		2			2
TOTAL		**26**	**23**	**26**	**75**

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

Morgan, D.O. The Cell Cycle: principles of control. Oxford University Press.

Thomas, G., Sabatini. D.M. and Hall, M.N. TOR:target of rapamycin. Springer-Verlag.

Rappaport, R. Cytokinesis in animal cells. Developmental and Cell Biology Series. Cambridge University Press.

• **Electronic references**:

iBiology: David Morgan: https://www.ibiology.org/speakers/david-morgan/

iBiology: Michael Hall: https://www.ibiology.org/cell-biology/target-rapamycin/
iBiololgy: Thomas Pollard: https://www.ibiology.org/cell-biology/cytokinesis/#part-3

•General articles:

1. Chica N, Rozalén AE, Perez-Hidalgo L, Rubio A, Novak B and Moreno S. 2016. Curr. Biol. 26: 319-330.
2. Coudreuse D and Nurse P. 2010. Nature 468: 1074-1079.
3. Fontana L, Partridge L and Longo VD. 2010. Science 328: 321–326.
4. Gharbi-Ayachi A, Labbé JC, Burgess A, Vigneron S, Strub JM, Brioudes E, Van-Dorsselaer A, Castro A, Lorca T. 2010. Science 330: 1673–1677.
5. Loewith R, Jacinto E, Wullschleger S, Lorberg A, Crespo JL, Bonenfant D, Oppliger W, Jenoe P and Hall MN. 2002. Mol. Cell 10: 457-468.
6. Mochida S, Maslen SL, Skehel M and Hunt T. 2010. Science 330: 1670–1673.
7. Rappaport R. 1967. Science, 156:1241–43
8. Nurse P, Thuriaux P and Nasmyth K. 1976. Mol. Gen. Genet. 146:167-178
9. Green RA, Paluch E and Oegema K.l. 2012. Annu. Rev. Cell Dev. Biol., 28, 29-58.
10. Pollard TD and O'Shaughnessy B. 2019.Annu Rev. Biochem. 88:661-689.
11. Lens SMA and Medema RH. 2019. Nat. Rev. Cancer, 19: 32-45.
12. Pollard TD and Wu JQ. 2010. Nat. Rev. Mol. Cell Biol. 11: 149-155.
13. Cortés JCG, Ramos M, Osumi M, Pérez P and Ribas JC. 2016. Microbiol. Mol. Biol. Rev. 80: 779–791.
14. Hamanaka RB and Chandel NS. 2012. Science 335: 167.
15. Galluzzi L, Kepp O, Vander Heiden MG, Kroemer G. 2013. Nat. Rev. Drug Discov. 12: 829-46.
16. Frezza C. 2020. Br J Cancer 122: 133-135.
17. Vander Heiden MG, DeBerardinis RJ. 2017 Cell. 168: 657-669.
18. Vazquez A, Kamphorst JJ, Markert EK, Schug ZT, Tardito S, Gottlieb E. 2016. J. Cell Sci. 129 : 3367-3373.
19. Valcarcel-Jimenez L, Gaude E, Torrano V, Frezza C, Carracedo A. 2017. Trends Endocrinol Metab. 28:748-757
20. Cuylen S and Haering CH. 2012. Trends Cell Biol. 21: 552-559.
21. Joglekar AP, Bloom KS and Salmon ED. 2010. Curr. Opin. Cell Biol. 22: 57-67.
22. Lampson MA and Cheeseman IM. 2011. Trends Cell Biol. 21: 133-140.
23. Magidson V, O'Connell CB, Loncarek J et al. 2011. Cell 146: 555-567.
24. Mucacchio A and Salmon ED. 2007. Nat. Rev. Mol. Cell Biol. 8: 379-393.
25. Rago F and Cheeseman IM. 2013. J. Cell Biol. 200: 557-565.
26. Wadsworth P and Khodjakov A. 2004. Trends Cell Biol. 14: 413-419.

Walzak CE, Cai S and Khodjakov A. 2010. Nat. Rev. Mol. Cell Biol. 11: 91-102.

8.- Assessment

8.1: Assessment Criteria:

8.2: Assessment Systems:
Final written exam consisting of 6 questions (33 % of the final mark).
Participation in the theoretical sessions and seminars (33 % of the final mark).
Presentation and discussion of a scientific paper (33% of the final mark).

8.3: General Considerations and Recommendations for Assessment and Resit:

To answer the questions concisely and to the point.

A recovery exam will be offered if necessary.

9.- Weekly Teaching Schedule