Teaching Guide				
Identifying Data				2022/23
Subject (*)	Chromosomes. structure. function and evolution		Code	610441016
Study programme	Máster Universitario en Bioloxía Molecular, Celular e Xenética			
Descriptors				
Cycle	Period	Year	Type	Credits
Official Master's Degree	2nd four-month period	First	Optional	3
Language	Spanish			
Teaching method	Face-to-face			
Prerequisites				
Department	Bioloxía			
Coordinador	Valdiglesias García, Vanessa	E-mail	vanessa.valdiglesias@udc.es	
Lecturers	Naveira Fachal, Horacio Valdiglesias García, Vanessa	E-mail	horacio.naveira.fachal@udc.es vanessa.valdiglesias@udc.es	
Web	campusvirtual.udc.gal/course/view.php?id=13920			
General description	This subject constitutes an advanced approach to the study of the eukaryotic chromosome as a structural and dynamic system responsible for the packaging, transmission, maintenance and regulation of DNA function in different cellular contexts. The contents are intended to complete the previous knowledge acquired by students in subjects related to Genetics and Molecular Biology during their undergraduate studies, contributing to establish a conceptual vision from the state of the art to the forefront of research.			

Study programme competences	
Code	Study programme competences
A1	Skills of working in a sure way in the laboratories knowing operation handbooks and actions to avoid incidents of risk.
A2	Skills of using usual techniques and instruments in the cellular, biological and molecular research: that are able to use techniques and instruments as well as understanding potentials of their uses and applications.
A3	Skills of understanding the functioning of cells through the structural organization, biochemistry, gene expression and genetic variability.
A6	Skills of understanding the functioning of cells through the structural organization, biochemistry, gene expression and genetic variability.
A11	Skills of understanding the structure, dynamics and evolution of genomes and to apply tools necessary to his study.
A12	Skills to understand, detect and analyze the genetic variation, knowing genotoxicity processes and methodologies for its evaluation, as well as carrying out diagnosis and genetic risk studies.
B1	Analysis skills to understand biological problems in connection with the Molecular and Cellular Biology and Genetics.
B2	Skills of decision making for the problem solving: that are able to apply theoretical knowledges and practical acquired in the formulation of biological problems and the looking for solutions.
B3	Skills of management of the information: that are able to gather and to understand relevant information and results, obtaining conclusions and to prepare reasoned reports on scientific and biotechnological questions
B4	Organization and work planning skills: that are able to manage the use of the time as well as available resources and to organize the work in the laboratory.
B5	Ability to draft, represent, analyze, interpret and present technical documentation and relevant data in the field of the branch of knowledge of the master's degree in the native language and at least in another International diffusion language.
B6	Skills of team work: that are able to keep efficient interpersonal relationships in an interdisciplinary and international work context, with respect for the cultural diversity.
B7	Personal progress skills : that are able to learn from freelance way, adapting to new situations, developing necessary qualities as the creativity, skills of leadership, motivation for the excellence and the quality.
B9	Skills of preparation, show and defense of a work.
B11	Possess and understand knowledge that provides a basis or opportunity to be original in the development and / or application of ideas, often in a research context
B12	That students know how to apply the knowledge acquired and their ability to solve problems in new or little-known environments within broader (or multidisciplinary) contexts related to their area of ??study

B13	That students are able to integrate knowledge and face the complexity of formulating judgments based on information, which, being incomplete or limited, includes reflections on the social and ethical responsibilities linked to the application of their knowledge and judgments
B14	That students know how to communicate their conclusions and the knowledge and ultimate reasons that support them to specialized and non-specialized audiences in a clear and unambiguous way
B15	That students possess the learning skills that allow them to continue studying in a way that will be largely self-directed or autonomous
C1	Ability to express oneself correctly, both orally and in writing, in the official languages of the autonomous community
C2	Ability to know and use appropriately the technical terminology of the field of knowledge of the master, in the native language and in English, as a language of international diffusion in this field
C3	Using ICT in working contexts and lifelong learning.
C4	Acting as a respectful citizen according to democratic cultures and human rights and with a gender perspective.
C5	Understanding the importanceof entrepreneurial culture and the useful means for enterprising people.
C6	Acquiring skills for healthy lifestyles, and healthy habits and routines.
C7	Developing the ability to work in interdisciplinary or transdisciplinary teams in order to offer proposals that can contribute to a sustainable environmental, economic, political and social development.
C8	Valuing the importance of research, innovation and technological development for the socioeconomic and cultural progress of society.
C9	Ability to manage times and resources: developing plans, prioritizing activities, identifying critical points, establishing goals and accomplishing them.

Learning outcomes			
Learning outcomes	Study programme competences		
To understand the knowledge of Genetics from a perspective of the eukaryotic chromosome as a structural and dynamic system.	AR2 AR3 AR6 AR11	BR1 BR2 BR3 BR4 BR5 BR6 BR7 BR9	CC1 CC2 CC3 CC4 CC5 CC6 CC7 CC8
Ability to understand the organization of genes, genomes and chromosomes from a comparative perspective and focusing on the relationship between structural, functional and evolutionary aspects.	AR2 AR3	BR1 BR2 BR3 BR4 BR5 BR6 BR7 BR9 BC1 BC2 BC3 BC4 BC5	CC1 CC2 CC3 CC4 CC5 CC6 CC7 CC8 CC9

To increase theoretical knowledge in the analysis of the structure, function and evolution of chromosomes in eukaryotic organisms.	AR2 AR3 AR11 AR12	BR1 BR2 BR3 BR4 BR5 BR6 BR7 BR9 BC1 BC2 BC3 BC4 BC5	CC1 CC2 CC3 CC4 CC5 CC6 CC7 CC8 CC9
To work safely in a biology laboratory and to learn different methodologies to be applied to cytogenetic studies.	AR1 AR2 AR3 AR11 AR12	BC1 BC2 BC3 BC4 BC5	

Contents	
Topic	**Sub-topic**
Block 1.- Structural organization of hereditary material.	Structural organization of hereditary material The hereditary material DNA/RNA. Levels of organization. The eukaryotic chromosome. Chromosomes and chromosomal proteins. Maintenance of chromosome organization from protozoa to the human chromosome.
Block 2. Chromatin and chromosome dynamics	Chromosome dynamics. Control of the cell cycle and mitosis. Euchromatin and heterochromatin. Histone variants and histone code. Chromosomes and function: polytene and lampbrush chromosomes.
Block 3. Chromosomes and evolution.	Karyotypes in different taxa. Comparative analysis. Cytotaxonomic and evolutionary aspects.

Planning				
Methodologies / tests	**Competencies**	**Ordinary class hours**	**Student?s personal work hours**	**Total hours**
Introductory activities	A1 A3 B3 B4 B6 C2 C3	1	1	2
Guest lecture / keynote speech	A6 A11 B1 C5 C6 C7	4	12	16
Laboratory practice	A2 A1 A3 A11 A12 B2 C8	4	4	8
ICT practicals	A3 A11 B3 B6 B11 B12 B15 C3	3	3	6
Seminar	A3 B3 B4 B5 B6 B7 B9 B13 B14 B15 C1 C2 C3 C9	2	10	12
Oral presentation	B1 B4 B5 B6 B7 B9 B13 B14 B15 C1 C2 C3 C9	5	10	15
Objective test	B2 B7 C4 C8	3	12	15
Personalized attention		1	0	1

(*)The information in the planning table is for guidance only and does not take into account the heterogeneity of the students.

Methodologies	
Methodologies	**Description**
Introductory activities	Teacher - Presents the teaching guide of the subject, the rules of risk prevention and safety in laboratories, documentary sources and bioinformatics resources available for the course. Clarifies doubts and organizes the students for the activities. Student: Takes notes, formulates doubts and questions.
Guest lecture / keynote speech	The professor will transmit theoretical knowledge in face-to-face lecture sessions, linked to the development of the thematic blocks of the subject. The content of these sessions will be adjusted to the previous knowledge acquired by the students in their undergraduate studies. The lectures will be supported by materials available through the Moodle platform of the UDC.
Laboratory practice	They will include learning methodologies mainly based on chromosomal techniques. A visit to a specialized laboratory will be made. A specific section for laboratory practices will be created in the Moodle UDC platform, which will include guides and documentation of all kinds to facilitate its monitoring by students.
ICT practicals	Use of computer tools for the study of chromosomal evolution and chromosome organization in the nucleus. As for the laboratory practices, a specific section for the bioinformatics practices will be created in the Moodle UDC platform of the course, in which guides and support material will be included to allow the asynchronous realization of the practical exercises.
Seminar	In parallel to the development of the lecture sessions, the teacher will organize the progressive elaboration of a single seminar-dossier by the students, using various telematic work resources through the Moodle platform and the Teams team of the course, with the aim of completing the basic knowledge acquired in the lecture sessions with more specific knowledge. This teaching dynamic will result in the elaboration of a final reference dossier on the subject for the students.
Oral presentation	Referring to the seminar-dossier elaborated jointly by the students. Each student will present a part of the seminar trying to frame it in the global context of the work elaborated in collaboration with his/her classmates.
Objective test	Final test that will contemplate basic questions on the subject, referred to both the lectures, seminar and practical sessions.

Personalized attention	
Methodologies	**Description**
Oral presentation	Personalized attention is understood as an orientation focused on improving and increasing the students' previous basic knowledge, learning to discern among the most appropriate and updated bibliography, helping to focus the subject matter of the seminars and tutored work, contributing to the improvement and promotion of the critical spirit within the scientific methodology. Students will receive one hour of personalized attention through the UDC Teams platform, where a specific team will be created for this subject.

Assessment			
Methodologies	**Competencies**	**Description**	**Qualification**
Laboratory practice	A2 A1 A3 A11 A12 B2 C8	They will include the development of practical situations typical of basic and applied research. The students will answer questionnaires on the practices that will be evaluated. It is necessary to obtain at least 5 points in these questionnaires to pass the subject.	10
Oral presentation	B1 B4 B5 B6 B7 B9 B13 B14 B15 C1 C2 C3 C9	Presentation of the seminar-dossier elaborated during the teaching of the subject by means of explanatory slides.	15
Seminar	A3 B3 B4 B5 B6 B7 B9 B13 B14 B15 C1 C2 C3 C9	Elaboration of a written work that the students will present to the professor at the end of the course. Its quality, context in the state of the art and coherence within the framework of the teaching given will be evaluated.	15

Objective test	B2 B7 C4 C8	This test, which constitutes the official examination of the subject, will be individual and cannot be taken in groups. It will allow students to demonstrate their mastery of the theoretical knowledge acquired on basic issues of the subject. It is necessary to obtain at least 25 points in this test to pass the subject.	50
ICT practicals	A3 A11 B3 B6 B11 B12 B15 C3	Students will answer questionnaires on bioinformatics practices, which will be evaluated. It is necessary to obtain at least 5 points in these questionnaires to pass the course	10

Assessment comments
In order to ensure equal opportunities, on-site and blended students must pass the same tests and answer the same questionnaires, which will be developed through the Moodle platform of the UDC. Official withdraw from the course is only possible if the student attends neither the final theoretical nor the practical exam. The final grade of the students who did not reach the minimum grade to pass the course in the practical or the objective test, but whose cumulative score happened to be higher than 50, will be a 4.9 (FAILED). In the second opportunity only those students who did not take the exam in the first one, or who did not get the minimum grade to pass the subject in the practical questionnaires or in the objective test of theory, will have to take the exam. The grades accumulated in the seminar work and in the oral presentation will be kept for the final grade in this second opportunity. The methodology of evaluation of the theoretical and practical knowledge will be the same as in the first opportunity. Should any student, for duly justified reasons, be unable to present his seminar work or oral presentation, he may attempt to recover the points lost by answering an additional block of questions and exercises in the objective test that constitutes the official examination of the subject, both in the first and in the second opportunity. The fraudulent performance of the evaluation tests or activities will directly imply the grade of 0 (FAILED) in the subject at the corresponding opportunity.

Sources of information	
Basic	- Ruiz-Herrera, Aurora (2021). Mechanisms driving karyotype evolution and genomic architecture. Mdpi AG - Jorde, Lynn B (2021). Genética Médica. Barcelona:Elsevier - Pierce, Benjamin A (2020). Genetics: A conceptual approach. New York: Freeman - Choi, Jung H (2017). Solutions and problem-solving manual to accompany: Genetics: a conceptual approach. New York: Freeman - Pollard, Thomas D (2017). Cell Biology. Philadelphia: Elsevier - Arsham, Marylin S (2017). The AGT cytogenetics laboratory manual. New Jersey: Wiley.Blackwell - Bass, Hank W (2012). Plant cytogenetics : genome structure and chromosome function. New York: Springer "Mechanisms driving karyotype evolution and genomic architecture" é un número especial de Genes, de acceso aberto, editado por Aurora Ruiz-Herrera e Marta Farré-Belmonte, dispoñible a través de https://www.mdpi.com/journal/genes/special_issues/Genomic_ArchitectureLIMA-DE-FARIA, A. 2008. Praise of Chromosome "Folly". World Scientific/Imperial College Press.LYNCH, M. 2007. The origins of Genome Architecture. Sinauer Associates, Sunderland, MA.REECE, R.J. 2004. Analysis of Genes and Genomes. Ed. Wiley & Sons.SUMNER, A.T. 2003. Chromosomes: Organization and Function. Blackwell Publishing.VAN HOLDE, K.E. 1988. Chromatin. Springer-Verlag, NY.VERMA, R.S. & BABU, A. 1995. Human Chromosomes: Principles and Techniques.2ª Ed. McGraw-Hill.WEINGARTEN, C.N. 2009. Sex Chromosomes: Genetics, Abnormalities and Disorders. Springer.WOLFFE, A.P. 1998. Chromatin: Structure & Function. Academic Press, San Diego, CA. ZLATANOVA, J. & LEUBA, S.H. 2004. Chromatin Structure and Dynamics: State-of-the-Art. Elsevier, Amsterdam.

Complementary	Annunziato AT (2005) Split decision: what happens to nucleosomes during DNA replication? J. Biol. Chem. 280:12065-12068Arents G, Moudrianakis E (1995) The histone fold: a ubiquitous architectural motif utilized in DNA compaction and protein dimerization. Proc. Natl. Acad. Sci. U S A 92:11170-11174Brown DT (2001) Histone variants: are they functionally heterogeneous. Genome Biol. 2:1-6Luger K, Mäder AW, Richmond RK, Sargent DF, Richmond TJ (1997) Crystal structure of the nucleosome core particle at 2.8 A resolution. Nature 389:251-260Cairns BR (2005) Chromatin remodeling complexes: strength in diversity, precision through specialization. Curr. Opin. Genet. Dev. 15:185-190 Downey M, Durocher D (2006) Chromatin and DNA repair: the benefits of relaxation. Nat. Cell Biol. 8:9-10Eirín-López JM, Ausió J (2009) Origin and evolution of chromosomal sperm proteins. Bioessays in press Eirín-López JM, Frehlick LJ, Ausió J (2006) Protamines, in the footsteps of linker histone evolution. J. Biol. Chem. 281:1-4 Eirín-López JM, González-Romero R, Dryhurst D, Méndez J, Ausió J (2009) Long-term evolution of histone families: old notions and new insights into their diversification mechanisms across eukaryotes. In: Pontarotti P (ed) Evolutionary Biology: Concept, Modeling, and Application. Springer-Verlag, Berlin Heidelberg, p in pressGrigoryev SA (2004) Keeping fingers crossed: heterochromatin spreading through interdigitation of nucleosome arrays. FEBS Lett. 564:4-8Henikoff S (2005) Histone modifications: Combinatorial complexity or accumulative simplicity? Proc. Natl. Acad. Sci. U S A 102 Henikoff S, Ahmad K (2005) Assembly of variant histones into chromatin. Annu. Rev. Cell. Dev. Biol. 21:133-153Kasinsky HE, Lewis JD, Dacks JB, Ausió J (2001) Origin of H1 histones. FASEB J. 15:34-42Kimmins S, Sassone-Corsi P (2005) Chromatin remodelling and epigenetic features of germ cells. Nature 434:583-589Lewis JD, Saperas N, Song Y, Zamora MJ, Chiva M, Ausió J (2004) Histone H1 and the origin of protamines. Proc. Natl. Acad. Sci. U S A 101:4148-4152Malik HS, Henikoff S (2003) Phylogenomics of the nucleosome. Nat. Struct. Biol. 10:882-891Ramakrishnan V, Finch JT, Graziano V, Lee PL, Sweet RM (1993) Crystal structure of globular domain of histone H5 and its implications for nucleosome binding. Nature 362:219-223Strahl B, Allis CD (2000) The language of covalent histone modifications. Nature 403:41-45van Holde KE, Zlatanova J (1995) Chromatin higher order structure: chasing a mirage? J. Biol. Chem. 270:8373-8376Vignali M, Workman JL (1998) Location and function of linker histones Nat. Struct. Biol. 5:1025-1028Woodcock CL, Dimitrov S (2001) Higher-order structure of chromatin and chromosomes. Curr. Opin. Genet. Dev. 11:130-135Recursos Webhttp://www.udc.es/grupos/xenomar/chromevol/Welcome.htmlhttp://www.ncbi.nlm.nih.gov/http://www.timetree.org/ http://tolweb.org/tree/phylogeny.htmlhttp://research.nhgri.nih.gov/histones/http://www.ebi.ac.uk/msd-srv/oca/oca-docs/ oca-home.htmlhttp://www.chromdb.org/http://www.ensembl.org/index.htmlhttp://swissmodel.expasy.org/

Recommendations
Subjects that it is recommended to have taken before
Genetic Variation Mechanisms/610441005 Proteomics/610441014 Human Genetics/610441017
Subjects that are recommended to be taken simultaneously
Protein Structure and Dynamics/610441012 Genomics /610441015 Bioinformatics and Biomolecular models /610441021
Subjects that continue the syllabus
Stem Cells and Cell Therapy/610441010 Genetic Toxicology /610441018 Project/610441023
Other comments
Green Campus Program Faculty of Science To help achieve an immediate sustainable environment and comply with point 6 of the "Environmental Statement of the Faculty of Sciences (2020)", the documentary works to be carried out in this area: a. Will be requested mostly in virtual format and computer support.b. To be done on paper: - Plastics will not be used. - Double-sided printing shall be used. - Recycled paper shall be used. - Drafts shall be avoided.

(*)The teaching guide is the document in which the URV publishes the information about all its courses. It is a public document and cannot be modified. Only in exceptional cases can it be revised by the competent agent or duly revised so that it is in line with current legislation.