Universitat Autònoma de Barcelona

2022/2023

Molecular Biology of Eukaryotes

Code: 100986
ECTS Credits: 6

Degree	Type	Year	Semester
2500502 Microbiology	OB	2	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

Other comments on languages

Catalan is the language preferentially used, but also Spanish

Teachers

Jordi Minguillon Pedreño
Jordi Moreno Romero

Prerequisites

There are no official prerequisites. However, it is assumed that the student has acquired the knowledge taught in the subjects of the first year, especially from: Biochemistry, Genetics and Microbiology.

Objectives and Contextualisation

Be able to describe and interpret molecular level aspects related to:

1) How the genetic material is structured and organized in the eukaryotic organisms.

2) How these organisms are able to transmit their genetic information from one generation to the next with a high fidelity.

3) How eukaryotic organisms are able to respond to environmental changes, altering gene expression.

4) Some of the basic molecular biology tools used in Research and in Biotechnological applications.

Competences

- Communicate orally and in writing.
- Identify and solve problems.
- Interpret, on a molecular scale, microbial mechanisms and processes.
- Obtain, select and manage information.

- Use bibliography or internet tools, specific to microbiology or other related disciplines, both in English and in the first language.

Learning Outcomes

1. Communicate orally and in writing.
2. Identify and solve problems.
3. Obtain, select and manage information.
4. Recognise the mechanisms that control gene expression and relate them to environmental conditions.
5. Solve problems in molecular aspects of microorganisms.
6. Understand and describe the structural and functional characteristics of nucleic acids and proteins, including their different levels of organisation.
7. Understand molecular mechanisms responsible for DNA replication and repair and for the regulation of these processes.
8. Understand the molecular bases of RNA transcription and processing, of mRNA translation and of the regulation of these processes.
9. Use bibliography or internet tools, specific to microbiology or other related disciplines, both in English and in the first language.

Content

1- Introduction

Molecular genetics: firstperiod and model organisms. Genomics and Genome projects. History of yeast as an experimental organism. Characteristics of *S. cerevisiae* genome. Analysis of homologies in the yeast genome. Yeast as a model system in Molecular Biology and some of its experimental approaches.

I STRUCTURE AND FUNCTION OF NUCLEIC ACIDS, AND PROTEINS IMPLIED IN THESE PROCESSES.

2- Genome organization

General characteristics of the genomes of eukaryotes. The sizes of the genomes. Gene families. The extranuclear genome: mitochondria and chloroplast.

3- Chromosomes, chromatin and nucleosome.

Chromosome concept. Gene concept, ORF and genome. Introns and pseudogenes in yeast. Functional elements of eukaryotic chromosomes: centromeres, telomeres and subtelomeric regions. The eukaryotic chromosome: model in yeast. Repetitive DNA in yeast. Topology of DNA, topological and supercoil link number, eukaryotic chromatin: histones, nucleosomes, fiber of 10 and 30 nm, heterochromatin and euchromatin. Structuring the metaphase chromosome. Interphase and mitotic chromatin. The cell cycle: regulation

4-The replication of the eukaryotic chromosome

The replication machine. The multiplicity of replicons and activation order. The replication fork. The termination of replication: formation of telomeres.

II MUTABILITY, REPARATION, RECOMBINATION AND TRANSPOSITION OF DNA

5-The recombination

Models of homologous recombination in the eukaryotes and proteins involved. Conversion of the mating type. Genetic consequences of the mechanism of homologous recombination. The gene conversion. The site-specific recombination. Recombination in yeast.

6-The transposition

Main mechanisms of transposition: classification of transposable elements (TEs). The Ty1, Ty3 and Ty5 elements of *S. cerevisiae*. Sex change in yeast by gene replacement: the cassette theory. Transposable elements in other microorganisms: microalgae, filamentous fungi and protozoa. Effects of transposition in the genome. Regulation of the transposition. Interactions between TEs and the genome. Role of TEs in the genome.

7- Mutation and repair of genetic material

Duplication errors and their repair: nature of mutations and repair of mating. Chemical mutagens. Mutations induced by UV light. Repair of DNA lesions: Repair by recombination. Repair by split of bases. Repair by nucleotides cleavage. Yeast specific mechanisms of repair.

8-The rRNA, tRNA and other specialized RNAs

The RNA chain. General types of regulatory RNAs RNAs. RNAs with catalytic activity. siRNA and guide RNA (CRISPR/Cas9)

III REGULATION OF GENE EXPRESSION

9-Chromatin remodeling.

Remodeling the chromatin. Modification complexes. Histone code. Chromatin remodeling complexes. Chromatin during replication, transcription and repair.

10-Transcription and control at the transcriptional level of gene expression.

Basal transcriptional machinery. The eukaryotic RNA polymerases. The Pol II basal transcription machinery. Conservation of the transcription machinery. Specific factors of gene, DNA binding proteins and promoters in Pol II dependent transcription. Transcription factors. Interaction of proteins with DNA.

11- Processing and regulation of the half-life of mRNA

Obtaining functional mRNA, processing and splicing. Control and regulation mechanisms mRNA half-life.

12-Translation and control of translation

The eukaryotic translation machinery. Translation and translation regulation mechanisms. Protein folding. Chaperones. Protein modification.

13-Control of the half-life of proteins

Ubiquitination and proteolysis programmed by the proteasome. Proteolysis in the vacuolar system. Molecules ubiquitin type, SUMO. Ubiquitin binding domains. The 26S proteasome. The 26S proteasome of yeast as a model system. Cellular distributionof proteasomes and regulation of proteasome activity.

14- Molecular biology techniques

Study of gene expression and techniques for the analysis of the regulation of gene expression. Methods on the study of chromatin structure and epigenetic marks. Genome-wide techniques. Gene function studies by forward and reverse genetics. Molecular biology techniques in yeast.

Methodology

The formative activities are divided in two sections: theory classes and seminar/case study.

Mentoring will be done in the teacher's office after contacting him/her and setting a specific date. If the teacher considers it convenient, he/she will be able to do mentoring in the classroom when the dates of the written exams/tests are close. In this case the teacher will agree with the group of students a specific date and time for such tutoring.

Theory classes

The teacher will explain the content of the subject with the support of audiovisual material that will be available to students in the Campus Virtual. These expository sessions will be the most important part of the theory section. The presentations may contain text in English, as well as in Catalan and Spanish.

Seminar/Case study

In the "Seminar/Case study" sessions, the group will be divided into two subgroups of approximately 30 students each; the lists will be made public at the beginning of the course. Students will attend the 6 sessions scheduled by their group. In the sessions intended for "Seminar/Case study", students will select the topics to work in group among those proposed by the teacher. Each group will work on gathering information on these topics, will analyse data and will prepare compilation works that will be presented in the classroom to the rest of the classmates. One week prior to the day scheduled by the teacher for their group presentation, the students will send to the teacher a detailed guide to the exhibitions they will perform as well as the slides they will show in the classroom. The exhibition will cover a period of time previously set by the teacher, after which they will answer the questions posed by the rest of the students and the teacher. As indicated in the evaluation section, the professor will evaluate the quality of the compilation of the information and data analysis made and the oral presentation in the classroom.

During these sessions, students' skills in the application of theoretical knowledge to solve practical problems as well as the discussion of them will be promoted. In addition, students will be responsible for solving different problems raised in class for later delivery and evaluation.

If necessary, a short evaluation may be done about the seminar sessions.

Materials available:

Material available in the Virtual Campus of the subject

Teaching guide

Presentations used by teachers in theory classes

Proposals for seminars to be carried out.

Proposals for practical case to be carried out.

Calendar of teaching activities.

Annotation: Within the schedule set by the centre or degree programme, 15 minutes of one class will be reserved for students to evaluate their lecturers and their courses or modules through questionnaires.

Activities

Title	Hours	ECTS	Learning Outcomes
Type: Directed			
Seminars	6	0.24	2, 3, 1, 9
Theory classes	40	1.6	7, 6, 8, 2, 4, 5
Type: Supervised			
Mentorship	2	0.08	
Type: Autonomous			

Bibliography search	8	0.32	3, 9
Preparation of Oral presentation	12	0.48	2, 3, 1, 9
Study	64	2.56	7, 6, 8, 2, 3, 4, 5, 9
Texts reading	12	0.48	

Assessment

Theory

The total weight of the evaluation of the theory part will be 80% of the total grade of the subject. The main evaluation of this part of the course will be with two partial exams/tests. To overcome this part of the subject a grade equal to or greater than 5.0 out of 10 should be reached. The partial exams/tests grade will average only when exceeding the minimum of 4.5 over 10.

Students who do not have the minimum grade in both partial proves or those who want to improve their grade, can attend to the recovery examination of one or the two partial exams, programmed at the end of the course.

The exams are designed as short questions or test. This part corresponds to the 80% of the course grade.

Seminar/Case study

The evaluation of the seminars represents 20% of the final grade. The students will work in groups on the topics provided by the teacher and will defend them in an oral presentation in the classroom. The defense will be evaluated. One week before of the presentation, the students will send the slides and a detailed guide of the presentation to the professor in charge; this work presented will also be evaluated.

To motivate class participation, a short test about the Seminars can be considered, by Kahoot or similar.

The evaluation of seminars cannot be recovered.

Global evaluation

The student will pass the subject when the sum of the different parts will equal or exceed 5.0 out of 10 points.

Revision of qualifications: after each exam it will be a review day and a time. The grades of the continued evaluation will appear in the Campus Virtual.

To participate in the recovery exam of theory, according to UAB regulations, the student has to be previously evaluated in at least two-thirds of the total qualification of the subject. Therefore, the student has to perform the two partial exams if he wants to opt to the recovery exam, otherwise the non-attendance to a partial will imply a "non-evaluable".

Students who cannot attend an individual evaluation for a justified reason (illness, death of a first-degree relative or accident) and provide the official documentation corresponding to the Coordinator of the course, will have the right of attend to a recovery exam, that can be oral if the teacher considers convenient.

The students with a justified cause that cannot participate in the continuous evaluation, may be evaluated by a final exam. In that case, the maximum qualification that it is possible to obtain is equivalent to approximately 80% of the maximum grade, as the student cannot meet the requirements and competences of the apprenticeship of the subject described in section 5.

Assessment Activities

Title	Weighting	Hours	ECTS	Learning Outcomes

Exams or tests	80%	5	0.2	7, 6, 8, 2, 4, 5, 1
Seminars	20%	1	0.04	2, 3, 5, 1, 9

Bibliography

1) Pierce, B.A. 2016. Genética. Un enfoque conceptual. (5th Edition). Ed. Médica Panamericana.

2) Watson, J.D.; Baker, T.A.; Bell, S. P.; Gann, A.; Levine, M.; Losick, R. 2016. Biología Molecular del Gen. (7th Edition). Editorial Médica Panamericana.

3) Lewin's. 2017. Genes XII. Jones and Bartllet Publishers. ALSO AVAILABLE AS ELECTRONIC BOOK

4) Brown, T.A. 2008. Genomes. (3rd Edition). Ed. Médica Panamericana. ALSO AVAILABLE AS ELECTRONIC BOOK

5) Latchman, D.S. 2015. Gene Control. (2nd Edition). Taylor & Francis Inc Garland Publishing Inc.

6) Latchman, D.S. 2005. Gene Regulation - A Eukaryotic Perspective. (5th Edition). Taylor & Francis Ltd

7) Feldmann, H. 2012. Yeast: molecular and Cell biology. (2nd Edition). John Wiley and Sons Ltd Wiley-VCH Verlag GmbH

8) Stansfiels, I. and Stark, M.JR. 2007. Yeast Gene Analysis. (2nd Edition). Academic Press.

Enllaços web:

Campus virtual interactiu https://cv2008.uab.cat/

Software

There is no specific software.