Universitat Autònoma de Barcelona

2021/2022

Molecular Biology of Eukaryotes

Code: 100986
ECTS Credits: 6

Degree	Type	Year	Semester
2500502 Microbiology	OB	2	1

The proposed teaching and assessment methodology that appear in the guide may be subject to changes as a result of the restrictions to face-to-face class attendance imposed by the health authorities.

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 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

Yeast vectors. Methods for the transformation of yeast. Cloning by recombination. Expression vectors. Secretion of heterologous proteins in yeast. Post-transcriptional processing and modification of heterologous proteins in yeast. GFP fusion proteins. Cosmids. YACs. Collection of deletion mutants. Cassettes used in the genome modification.

Note: *Unless the requirements enforced by the health authorities demand a prioritization or reduction of these contents.

Methodology

The formative activities are divided in two sections: theory classes and seminars.

The 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.

Seminars

In the 6 seminar sessions the group will be divided into two subgroups of approximately 30 students; the lists will be made public at the beginning of the course. Students will attend the sessions scheduled by their group. In the sessions intended for seminars, students in a group will select a topic from among those proposed by the teacher. Each group will work on gathering information on these topics, and will prepare a compilation work that will be presented in the classroom with 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 exhibition they will perform as well as the slides they intend to 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 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 also 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 in each seminar session.

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

Calendar of teaching activities.

Model exam

Note: *The proposed teaching methodology may experience some modifications depending on the restrictions to face-to-face activities enforced by health authorities.

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 85% 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 punts over 10.

Students who do not have the minimum grade in both partial proves or those who want to improve the 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 85% of the course grade.

Seminars

The evaluation of seminars represents 15% of the final grade. The students will work in groups on one of the topics provided by the teacher and will make an oral presentation in the classroom. One week before of the data provided by the oral presentation the students will send the slides to the professor in charge.

To motivate class participation we will consider to do a short evaluation in each seminar session, 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 an hour. The grades of the continued evuation 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 three parts 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 cause (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 who cannot with a justified cause, 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 85% of the maximum grade, as the student cannot meet the requirements and competences of the apprenticeship of the subject described in section 5.

Note: *Student's assessment may experience some modifications depending on the restrictions to face-to-face activities enforced by health authorities.

Assessment Activities

Title	Weighting	Hours	ECTS	Learning Outcomes
Exams or tests	85	5	0.2	7, 6, 8, 2, 4, 5, 1
Seminars	15%	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.

4) Brown, T.A. 2008. Genomes. (3rd Edition). Ed. Médica Panamericana.

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.