COURSE DATA

Data Subject	
Code	33174
Name	Molecular biology
Cycle	Grade
ECTS Credits	6.0
Academic year	2023 - 2024

Study (s)

Degree	Center	Acad. year	Period
1102 - Degree in Biotechnology	Faculty of Biological Sciences	3	First term

Subject-matter

Degree	Subject-matter	Character
1102 - Degree in Biotechnology	84 - Molecular biology	Obligatory

Coordination

Name	Department
OLMO MUÑOZ, MARCEL.LI DEL	30 - Biochemistry and Molecular Biology

SUMMARY

The basic objective of this course is to explain the student the molecular mechanisms of genetic information flow and its regulation in prokaryotes and eukaryotes. The characteristics of the processes of replication, transcription and translation are discussed in detail, as well as the regulatory mechanisms of each one.
It also aims to familiarize students with the methodology used in molecular biology through practical sessions, and to allow them the understanding of the relationship with other experimental sciences as Cell Biology, Biochemistry or Genetics.

PREVIOUS KNOWLEDGE

Relationship to other subjects of the same degree

There are no specified enrollment restrictions with other subjects of the curriculum.

Other requirements

OUTCOMES

1102 - Degree in Biotechnology

- Saber interpretar datos de análisis de orígenes de replicación del DNA de microorganismos y de la replicación del DNA en su conjunto.
- Ser capaz de comprender las características estructurales y funcionales de un promotor transcripcional sencillo.
- Conocer y comprender los procesos de splicing de los pre-mRNAs y degradación de mRNAs.
- Understand the process of synthesis of proteins, their processing and their location in different sub-cellular compartments.

LEARNING OUTCOMES

The aim of this subject is to understand the General transfers of biological sequential information, the central dogma of Molecular Biology, in both prokaryotic and eukaryotic cells: replication, transcription and translation. The students must also understand how these processes are regulated.

DESCRIPTION OF CONTENTS

1. Transcription: mechanisms and regulation

UNIT 1.- INTRODUCTION. The central dogma of molecular biology. Historical aspects. Anomalies and exceptions to the central dogma.
UNIT 2.- THE MESSANGER RNA. Hypothesis of the "molecule bridge." Demonstration of mRNA. Characteristics of the mRNA.
UNIT 3.- TRANSCRIPTION IN PROKARYOTES. The RNA- polymerase DNA dependent: enzymatic activities and characteristics. Subunits of bacterial RNA polymerase. Prokaryotic promoter region. Start of transcription: the factor cycle. Elongation of the chains. Transcription termination: rho-dependent terminators and rho-independent.
UNIT 4.- TRANSCRIPTIONAL REGULATION IN PROKARYOTES. Regulation of promoters by the factor. Cis / trans regulation, positive and negative control, induction and repression. Promoters regulated by the CAP protein. The lactose operon. Tryptophan operon: attenuation. Antiterminadores.
UNIT 5.- TRANSCRIPTION IN EUKARYOTES. Eukaryotic RNA polymerases. Chromatin and transcription. Initiation of transcription: RNA polymerases I, II and III. Elongation and termination steps.
UNIT 6.- REGULATION OF TARNSCRIPTION IN EUKARYOTES. Levels of regulation, main differences with prokaryotic transcription. Concept of active and inactive chromatin. Regulatory mechanismf related

to chromatin structure. Cis / trans regulation: some examples.
UNIT 7.- POSTRANsCRIPTIONAL MODIFICATIONS. Processing Types: splicing, cutting, 5´cap and polyA-tail, chemical modification and editing. mRNA processing of non-coding RNAs. Splicing. Export of RNA. mRNA stability.

2. Translation and postranslational processing

UNIT 8. INTRODUCTION. The genetic code. Aminoacyl tRNA synthetases.
UNIT 9. THE PROCESS OF TRANSLATION. Ribosome cycle. Stages and protein factors involved, comparison between prokaryotes and eukaryotes. tRNA Suppressors. Inhibitors of translation.
UNIT 10. REGULATION OF TRANSLATION. Introduction. General regulation by modifying the translational machinery: proteolysis and phosphorylation. Specific regulation of mRNA: the area level of mRNA 5'-UTR and the area level of mRNA 3'-UTR. Regulation of translation in prokaryotes: autogenous regulation.
UNIT 11. FOLDING AND CHEMICAL MODIFICATION OF PROTEINS. General principles of the assembly. Molecular chaperones: types and functions. Foldases. Processing of the nascent polypeptide: amino acid modification and proteolytic cleavage.
UNIT 12. PROTEIN DEGRADATION. Introduction. Lysosomal proteolysis system in eukaryotes. Cytoplasmatic proteolysis: ubiquitin modification and the proteasome.

3. DNA replication

UNIT 13 .- OVERALL FEATURES OF THE REPLICATION. General properties of replication. Semiconservative and sequential nature. Replication fork. Bidirectional replication.
UNIT 14 .- DNA polymerases. General characteristics. DNA polymerases of E. coli. DNA polymerases of other bacteria and viruses.
UNIT 15 .- SEMIDISCONTINUOUS REPLICATION. ELEMENTS INVOLVED AND THEIR ROLE. Okazaki fragments. DNA ligases. RNA primer. The primase and the primosome. SSB proteins. DNA helicases. DNA topoisomerases.
UNIT 16 .- THE REPLICATION COMPLEX. Overal description of all components of the replication complex in the replicative fork. The replisome and the simultaneous replication of the two DNA strands. Replication initiation in prokaryotes and viruses. Termination of the replication in circular DNAs. Termination of replication in non-circular DNAs. Interaction between replication and transcription.
UNIT 17 .- SPECIFIC FEATURES OR THE REPLICATION IN EUKARYOTES. Enzymology of replication in eukaryotes: comparison with prokaryotes. Multiple originS of replication. ARS sequences. Eukaryotic ligases. Replication of telomeres. Replication of chromatin.

4. Laboratory classes

The following experiments are suggested:

1.- Regulation of the synthesis of -galactosidase enzyme in Escherichia coli.

2.- Verification of the presence of an intron in the ACT1 gene of yeast
Saccharomyces cerevisiae.

3.- Regulation of the expression of GAL genes in the yeast Saccharomyces cerevisiae.

4.- Regulation of the expression of osmotic stress response genes in the yeast Saccharomyces cerevisiae: characterization of the cis and trans elements.

WORKLOAD

ACTIVITY	Hours	% To be attended
Theory classes	44,00	100
Laboratory practices	16,00	100
Study and independent work	90,00	0
TOTAL	**150,00**	

TEACHING METHODOLOGY

As the goal is to enhance the active learning by students we propose lectures as general introductions to each topic and presentation of the most difficult aspects. All the presentations will be supplied to the students in advance. The lectures will be supplemented with some sessions to solve theoretIcal questions and practical problems related to the different topics. This will require the active participation of the students. We will also use these classes to describe with some detail experiments of particular relevance in the history of molecular biology.

The professor will give detailed and organized information, complemented with additional literature.

EVALUATION

The above mentioned methodological approach allows frequent and continuous contact between the students and the teacher, so it will be possible to know the progress of their learning and carry out an assessment of this considering several aspects.

On the one hand the teacher can obtain information about the knowledge acquired by the students through key elements such as the answers to questions discussed in the classroom, the activities in the labs and the practice memory.

At the end of the course there will be an exam for the evaluation of the theory, which represents 75% of the final value. The practice work represents 15% and it is determined by the resolution of several questions and the attitude and work in the laboratory. The remaining 10% corresponds to the student participation in other activities proposed along the course. To pass the course it will be necessary to obtain a final minimum score of 5 out of 10, pass the theory exam and attend all practices and have not obtained in any of the blocks of the subject (including practices) a score less than 25% of the maximum.

After the transcription in prokaryotes and eukaryotes sections, a partial exam will be carried out which will allow the content to be eliminated for the final exam if the grade obtained is equal to or higher than 5 and higher than 4 in each one.

REFERENCES

Basic

- KREBS, J.E., KILPATRICK, S.T., GOLDSTEIN, E.S. (2014). "Lewins Genes XI". Jones and Bartlett Learning. Existe la traducción al castellano de la edición de 2008 (Genes IX, McGraw-Hill Interamericana Ed.).
- WATSON, J.D. y otros (2013): Molecular Biology of the Gene, 7ª edición. Pearson International Education. Está traducida al castellano la 5ª edición (Editorial Médica Panamericana).
- CLARK, D.P., PAZDERNIK, N.J., MCGEHEE, M.R. (2019) "Molecular Biology". Third Edition. Academic Press (Elsevier), London.

Additional

- ALBERTS, B.M., JOHNSON, A., LEWIS, J., RAFF, M., ROBERTS, K., WALTER, P. (2014). "Molecular Biology of the Cell". 56ª ed. Garland Science. Taylor & Francis Group.
- KORNBERG, A., BAKER, T.A. (1992). "DNA replication". 2a ed. Freeman.
- LODISH, H., DARNELL, J. (2016). "Biología Molecular y Celular". 7ª ed. Panamericana.
- LUQUE, J., HERRAEZ, A. (2001) Texto ilustrado de Biología Molecular e Ingeniería Genética. Conceptos, técnicas y aplicaciones en Ciencias de la Salud. Ediciones Harcourt S.A.
- MATHEWS, C.K., AHERN, K., VAN HOLDE, K.E. (2013). Bioquímica. 4ª ed. Pearson Addison-Wesley.
- WEAVER, R.F. (2012) Molecular Biology. 5ª Ed. McGraw-Hill. Boston
- TORDERA, V., DEL OLMO, M., MATALLANA, E., PÉREZ ORTÍN, J.E. (2007). Qüestions en Biologia Molecular. Col·lecció Educació Laboratori de Materials. Universitat de València