VNIVERSITAT DE VALÈNCIA

Course Guide
33135 Macromolecular biosynthesis and its regulation

COURSE DATA

Data Subject	
Code	33135
Name	Macromolecular biosynthesis and its regulation
Cycle	Grade
ECTS Credits	9.0
Academic year	2023 - 2024

Study (s)

Degree	Center	Acad. year	Period
1109 - Degree in Biochemistry and Biomedical Sciences	Faculty of Biological Sciences	2	Annual

Subject-matter

Degree	Subject-matter	Character
1109 - Degree in Biochemistry and Biomedical Sciences	9 - Genética y biología molecular	Obligatory

Coordination

Name	Department
PEREZ ORTIN, JOSE ENRIQUE	30 - Biochemistry and Molecular Biology
TORDERA DONDERIS, VICENTE	30 - Biochemistry and Molecular Biology

SUMMARY

"Biosynthesis of macromolecules and its regulation" is a compulsory annual subject of the second year of the degree in Biochemistry and Biomedical Sciences and corresponds to 9 ECTS credits. It is intended to provide students with knowledge about the molecular mechanisms that enable the perpetuation and transmission of genetic information. This subject is part of the molecular biology core, which has undergone a huge development in recent years. His field of study is at the crossroads of Biochemistry, Genetics, and Cell Biology. Its study is essential to understand the processes taking place in the cell at the molecular level.

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

1101 - Degree in Biochemistry and Biomedical Sciences

- Desarrollo de la capacidad de razonar y aplicar el método científico.
- Comprensión de la lógica molecular de los seres vivos como producto de la evolución.
- Capacidad para trabajar en el laboratorio de genética y biología molecular incluyendo seguridad, manipulación, eliminación de residuos y registro anotado de actividades.
- Conocer y comprender las bases moleculares de la información genética y los mecanismos de su transmisión y variación.
- Relacionar las características estructurales y funcionales de las macromoléculas.
- Conocer los elementos comunes y los diversos de la genética y la biología molecular de los diferentes tipos de organismos vivos.

LEARNING OUTCOMES

- Acquiring knowledge and understanding of genetics and molecular biology.
- Solving theoretical and practical exercises.
- Practical activities in the laboratory and analysis of the results.
- Generating a written work and oral presentation with visual support.

DESCRIPTION OF CONTENTS

1. Theme 1. Introduction

Stages in the history and development of molecular biology and the central dogma of molecular biology as a science. Definition and field of study of molecular biology. Working methods. Introduction to sources of information. (2 hours)

2. Theme 2: General features of the replication process

Semi-conservative nature. Orderly and sequential replication: the origin of replication. Unidirectional or bidirectional replication. (3 hours)

3. Theme 3. DNA polymerases

Historical iIntroduction: discovery of DNA pol I of E. coli. Catalyzed reactions. DNA polymerase activity: characteristics. Activities 3 'exonuclease 5' and 5 ' 3'. Three-dimensional structure of pol I. Other polymerases of E. coli. Features compared with pol I. Complexity of DNA pol III holoenzyme system. Other DNA polymerases. (3 hours)

4. Theme 4: Semi-discontinuous replication: elements involved

Okazaki experiences. Characteristics of DNA ligases of E. coli and phage T4. Reaction mechanisms. Roles of DNA ligases in vivo. Start of the replicative synthesis in the fork: the RNA as a primer. The primase. The primosome. SSB proteins. DNA helicases. Role of DNA topoisomerases during replication. (4 hours

5. Theme 5: The replication complex

General outline of all components of the replication complex in the replicative fork. The replisome and simultaneous replication of both strands: topological considerations. Initiation of replication in E. coli proteins involved. Ori sequences. End of the circular DNA replication. End of non-circular DNA replication. DNA methylation in prokaryotes: restriction-modification systems. (5 hours)

6. Theme 6: Specific characteristics of the replication in eukaryotes

Enzymology of replication in eukaryotes. The eukaryotic replication fork: a comparison with prokaryotes. Replicons and replication origins. Controlling initiation of replication. Replication of telomeres: telomerase. Chromatin structure and replication. Replication of DNA in organelles. (3 hours)

7. Theme 7: Transcription: definition and historical context of its discovery

Hypothesis of "bridging molecule". Demonstration of the existence of the mRNA. Features mRNA: differences between prokaryotes and eukaryotes. (2 hours)

8. Theme 8: Transcription in prokaryotes

The DNA-dependent RNA polymerase: structure and function of the subunits. The prokaryotic promoter. Stages of transcription. Start: sigma factor cycle. Elongation: transcription bubble. Movement of RNA polymerase. Transcription and supercoiling. Chain completion: intrinsic terminators and Rho-dependent protein. (4 hours)

9. Theme 9: Transcription regulation in prokaryotes

General scheme of the levels of regulation. Regulation of promoters by the sigma factor. Promoters regulated by protein CAP. Cis/trans regulation in prokaryotes. Regulation by positive and negative control, induction and repression. The lactose operon. Regulation of transcription by anti-termination. Regulons. (3 hours)

10. Theme 10: Transcription in eukaryotes

Differences with transcription in prokaryotes. Eukaryotic RNA polymerases. Chromatin and transcription. Necessary elements for the formation of the Pre-initiation Complex: Basal transcription factors and Promoters. Start of transcription by RNA pol I and RNA pol III (2 hours)

11. Theme 11: The transcription of RNA polymerase II

Transcription mechanism of RNA pol II. TATA binding protein. Transcription elongation in RNA pol II. Transcription termination: differences between the 3 RNA polymerases. (4 hours)

12. Theme 12: Regulation of transcription in eukaryotes

Differences at the molecular level between prokaryotes and eukaryotes. Regulation levels. Active and inactive chromatin concept. Regulatory mechanisms related to chromatic structure. DNA methylation as a regulator: epigenetics. (3 hours)

13. Theme 13: : Cis / trans mechanisms in the regulation of transcription in eukaryotes.

Cis / trans regulation in eukaryotes: some particular cases. Nuclear organization of transcription. Transcriptional organization of the eukaryotic genome. Cryptic transcription and gene redefinition. (2 hours)

14. Theme 14: Post-transcriptional modification of RNA

Types of RNA processing. Precursors of rRNAs and tRNAs. Role of snoRNAs. Processing of mRNA in eukaryotes. Correction of the mRNA sequence. (2 hours)

15. Theme 15: Post-transcriptional modification of RNA: splicing

Fragmented genes. Elimination of introns in nuclear mRNAs: the ayustosoma. Autocatalytic introns. Ribozymes. Evolutionary origin of introns (3 hours)

16. Theme 16: Transport and stability of RNAs.

Transport of mRNA and other RNAs to the cytoplasm. Stability of mRNAs. Degradation of defective RNAs in the nucleus and in the cytoplasm. Role of poly-A glue in regulation. (3 hours)

17. Theme 17: The genetic code and the translation machinery.

Characteristics. Exceptions to the universal code. tRNA suppressors. Selective use of codons. Origin and evolution. Current components. The tRNA: mating rules. The ribosome: structure and components. Aminoacyl-tRNA synthetases. Evolutionary origin of the translation. (2,5 hours)

18. Theme 18: Stages of translation.

Initiation in prokaryotes. Initiation in eukaryotes. Elongation. Energetics of translation. Termination. Translation inhibitory antibiotics. Energy balance of translation. Post-translational protein modifications. (2.5 hours)

19. Theme 19: Regulation of translation in prokaryotes.

Autogenous regulation of ribosome synthesis. Structures in the mRNA leader: ribo-switches and attenuation. Restrictive response. Landslides and jumps of the ribosomes. (1.5 hours)

20. Theme 20: Regulation of translation in eukaryotes.

Start regulation: eIF4G, eIF4E, eIF2. Routes of response to external stimuli. Restrictive response and the case of GCN4. Subcellular localization of the mRNA. (1.5 hours)

21. Theme 21: Regulation by RNA.

Antisense RNA as a regulatory mechanism in prokaryotes. Ribointerruptores. Antisense RNA in eukaryotes: RNA interference (RNAi) and post-transcriptional silencing. The long non-coding RNAs: lncRNA. (2,5 hours)

22. Theme 22: Integration of the mechanisms of regulation of gene expression

Role of regulation in each of the stages. Evolutionary and functional reasons for the existence of multiple stages of regulation. Some examples of multistage regulation: the case of phage l, the sex change in yeasts and examples of the control of embryonic development in animals. (1,5 hours)

23. Theme 23: Quality controls in genetic information.

Overview of the problem. Expression strategies: quality, expense and noise. Polymerase fidelity: correction mechanisms. Translation fidelity: control mechanisms during the stages. Structural information. Mechanisms of response to protein sequence alterations. Mechanisms of response to alterations in protein structure. (1 hours)

24. Laboratory experiences

PRACTICE 1. Chromatin structure.
PRACTICE 2. Checking for the presence of an intron in the gene ACT1 of the yeast Saccharomyces cerevisiae.
PRACTICE 3. Study of the regulation of the synthesis of -galactosidase enzyme in Escherichia coli.
PRACTICE 4. Subcellular localization and characterization of the high affinity transporter glucose Snf3p.

WORKLOAD

ACTIVITY	Hours	% To be attended
Theory classes	68,00	100
Laboratory practices	16,00	100
Classroom practices	6,00	100
Development of group work	20,00	0
Study and independent work	55,00	0
Readings supplementary material	7,00	0
Preparing lectures	30,00	0
Preparation of practical classes and problem	20,00	0
TOTAL	**222,00**	

TEACHING METHODOLOGY

The development of the subject is divided into:

Theoretical classes: A total of 60 sessions of one hour each are needed to cover the program. The teacher will present the relevant contents of the course, using audiovisual equipment for fast and consistent acquisition of the main concepts. The material will be available in advance in the institutional web page.

Problem sessions: 6 one-hour sessions will be held throughout the course, usually at the end of each of the sections of the agenda. These sessions reinforce the concepts presented in the theoretical sessions and stimulate the active participation of students through the resolution and group discussion of specific issues. The teacher will prepare a series of questions for each topic or subject block that students will work individually (at home) and collectively (through exposure and discussion of them in group class). The teacher may request the delivery of some of the problems, prior to the sessions. In these cases, the work will be submitted electronically through Virtual Classroom. For discussion of the problems,

students will be notified in advance of the date and the issues that will be brought about for discussion.

Hands-on labs: They are of compulsory attendance. The delivery of a written description is also mandatory. They will be done in 4 lab sessions, adding up to 16 hours.

Seminars: This activity will be organized jointly with the other subjects of the second degree course. The activity is the preparation and presentation for approximately 30 minutes by the students (in groups of two students) of a specific topic related to the subject. Students will complete the preparation and presentation of the seminar once during the school calendar. Their active participation in the discussion of other seminars can be taken into account. In "Biosynthesis of macromolecules and its regulation" 7 workshops, whose themes will be proposed each course by the teachers, will be included. Also a seminar of a visiting scholar will be held during lecture hours. The workshop activities will be compulsory.

EVALUATION

There will be two qualifying exams of the theoretical material. The first will assess acquisition of the contents for the first half of the agenda and will take place halfway through the academic year. The second test at the end of the lecturing period will cover the second half of the theoretical contents agenda. First test is scored on 4 points maximum and the second on 4,5. The exam of a party can be kept until the second call if the rating is greater than 35% on the highest score.

The total final grade comprises 85% of the test scores for theory (8.5 points), 10% of the score from lab work evaluation (1 point) and 5% of the mark of the seminar presented in any of the second-year subjects (0.5 points). The rating in practices (1 point) will result from the grade earned during the work at the lab: written memory (0,4 points) and specific test questions (0,6 points) included in the second exam of the subject. The mark to be obtained in the seminar will derived from the capacity of synthesis and integration of information shown by the student, the clarity and quality of the oral presentation and the debate generated around the questions raised by students and teachers. The scores for the lab written report and the seminary (up 0.5 points) will be saved for the second call.

To pass the course it will be essential to have made the practice (except those students who have performed in previous years, in which case it is not necessary to repeat the practices but the specific test questions) and participate in seminar activities. To pass the course will need to obtain a final score less than 5 out of 10 and have passed the grade of 35% of the highest score on the two tests of theory.

REFERENCES

Basic

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