Teaching guide

IDENTIFICATION DETAILS

Degree:	Biomedicine
Scope	Biology and Genetics
Faculty/School:	Experimental Sciences
Course:	GENETIC ENGINEERING
Type:	Compulsory
ECTS credits:	6
Year:	3
Code:	2157
Teaching period:	Sixth semester
Subject:	Biomedical Research Tools
Module:	Experimental Methodology in Biomedicine
Teaching type:	Classroom-based
Language:	Spanish
Total number of student study hours:	150

SUBJECT DESCRIPTION

Since the beginning of Genetic Engineering in the 70s of the last century and up to the present day, DNA manipulation techniques have developed exponentially and have become a fundamental pillar of Biomedicine. This progress is currently reflected in the availability of new diagnostic procedures, greater accuracy in the prognosis of many diseases and the development of new therapies, which aim at designing more personalized and, therefore, more effective treatments.

Genetic engineering as a biomedical tool is aimed at manipulating DNA with high precision to modify it, amplify it, sequence it, transfer it between different species or combine it appropriately, with the ultimate goal of achieving a product with value in basic science, medicine and industry.
Nowadays, both in research and development laboratories, it is common practice to isolate a specific fragment of

DNA from the genome of an organism, or of the products of its expression, to produce a high number of copies to determine its nucleotide sequence and analyze its function, as well as to modify it and incorporate it into bacterial or animal cells (germ or somatic cells) in such a way that it becomes a functional and inheritable part of the genome of these organisms. In this way, a gene can be used to produce proteins and other compounds useful at the pharmaceutical level, also to generate genetically modified animals that allow a more precise study of genetic alterations that lead to the development of a pathology, to test potential therapies, and methods of early and minimally invasive diagnostics for it.

These genetic engineering techniques have revolutionized medicine through the production of recombinant drugs, they are allowing advances in clinical diagnosis thanks to the identification of genes responsible for diseases, they have become an essential tool in current forensic sciences and in the development of gene therapy and regenerative medicine. Therefore, in order to play an active role in the progress of Biomedicine, it is essential, during the Degree, to immerse oneself in the knowledge of the molecular basis of the different DNA manipulation techniques and their application, the cloning methodologies for the expression of recombinant proteins in both bacteria and eukaryotic organisms, as well as for obtaining genomic libraries. We will also work on the different techniques for the generation of model cell lines for the study of gene functions, the obtaining of transgenic and clonic organisms and their applications in biomedical research. We will also focus on the possibilities of manipulating nucleic acids focused on the molecular diagnosis of diseases, possible therapies and regenerative medicine. In short, in this course we will delve into the fascinating field of study of Genetic Engineering.

The vertiginous advance of technology based on the manipulation of DNA and genomes requires professionals with comprehensive training, experts in their area of knowledge but also with a deep knowledge of the meaning and foundation of human dignity, to always seek truth and good, at the service of society and in defense of the rights of the human being. For this reason, biomedical doctors at UFV could become the ideal interlocutors between the scientific-technical and human fields in biomedical research and, thus, the reference professionals to go beyond the boundaries of the laboratory or the company, and to exert their positive influence in making decisions that are important for the progress of society, governed by the values present in the ideology of Biomedicine of the UFV.

In the Biomedicine Degree at UFV, the subject of Genetic Engineering belongs to the Experimental Methodology in Biomedicine module. It has an endowment of 6 ECTS credits that translate into 150 hours of student work. This course will allow students to obtain knowledge and mastery of the fundamental techniques of genetic engineering and recombinant DNA technology and will provide them with the necessary basis for understanding other subjects of the degree such as Genetically Modified Organisms, or Pharmacogenomics and Pharmacoproteomics.

The student will work on the contents of the subject by searching for information, reading and discussing scientific articles, solving problems and issues, laboratory work, analysis and drawing conclusions. The course will promote the development of the scientific method of the future biomedical professional, reinforcing rigorous habits of research, critical sense, the search for knowledge and creativity that will increase their capacity for intellectual adaptation to new professional situations in various fields, as well as their professional and personal maturity. The teacher will primarily serve as a guide or tutor for these activities.

GOAL

The final objective of the course is for students to know the techniques used by Genetic Engineering, their most frequent applications in basic, biotechnological and biomedical research, as well as their potential and scope, so that in their professional future students can become leading experts in the field of Biomedicine, with the

comprehensive, technical and human training provided by the UFV.
The specific purposes of the course are:

The specific aims of the subject are:

FAITH1. Appropriately apply the fundamental theoretical bases of genetic engineering.

FE2. Decide the most appropriate experimental strategies to carry out the manipulation of DNA or RNA for a specific objective.

FE3. Identify the fundamental requirements for the expression of heterologous proteins in different systems.

FE4. Differentiate the possible routes of transfer of DNA and RNA to prokaryotic or eukaryotic cells (different biological systems, different cell types) .

FE5. Select appropriate strategies for the use of nucleic acids in the therapy or diagnosis of human pathologies.

FE6. Propose in vitro or in vivo models (bacterial cultures, cell lines, genetically modified organisms) for the study of gene function, and its possibilities for application in biomedicine.

FE7. Evaluate the potential and risks of using genetic engineering techniques and the manipulation of genomes.

PRIOR KNOWLEDGE

For the correct development of the subject, the student must have a solid background in Cell Biology, Biochemistry and Molecular Genetics, more specifically with regard to the structure and properties of nucleic acids as well as to the mechanisms of replication, transcription and translation in prokaryotic and eukaryotic organisms.

COURSE SYLLABUS

TOPIC 1. INTRODUCTION.
• Content and organization of the subject.
• Concept and applications of Genetic Engineering.
TOPIC 2. FUNDAMENTAL TECHNOLOGIES IN GENETIC ENGINEERING.
• Basic techniques for analyzing nucleic acids: purification, electrophoresis, hybridization.
• Amplification of DNA and RNA sequences.
• Polymerase chain reaction (PCR): fundamentals, components of the reaction.
• Quantitative and real-time PCR.
• Analysis of amplification products.
• Variants and applications of PCR.
TOPIC 3. CLONING IN BACTERIA.
• General outline of the cloning process.
• Enzymes used in Genetic Engineering.
• Cloning vectors: general characteristics, plasmids, other vectors

• Cloning steps in bacteria through the use of restriction enzymes.
• Other cloning strategies.
• Recombinant protein expression in Escherichia coli
TOPIC 4. GENE TRANSFER TO ANIMAL CELLS.
• Recombinant protein expression in animal cells.
• Non-viral systems: chemical and physical methods of transfection.
• Cloning vectors derived from plasmids.
• Viral systems: virus-derived cloning vectors.
• Transfection and selection markers in eukaryotes.
TOPIC 5. GENETIC MANIPULATION OF ANIMALS.
• Applications of genetically modified organisms.
• Transgenic mouse models.
• Mutant knockout and knockin models through targeted gene replacement (gene targeting).
• Conditional mutants with temporal and spatial control.
TOPIC 6. CRISPR/Cas9.
• Introduction and fundamentals of technology
• Genome editing in mammal cells.
• Applications and variants.
• Scope and limits of technology.

EDUCATION ACTIVITIES

THE TEACHERS OF THE SUBJECT DO NOT AUTHORIZE THE PUBLICATION BY THE STUDENT OF THE MATERIAL PROVIDED BY THE TEACHERS OF THE SUBJECT IN THE VIRTUAL CLASSROOM, OR BY ANY OTHER MEANS.
AF1. Participatory exhibition class. The theoretical classes will be expository in which the topics will be presented synoptically, using different teaching resources. They may be taught by the teacher or some specific topics may be prepared by the students. Positive participation will be encouraged, jointly resolving any questions that arise, with an active search for information. The teacher will provide the students with the presentations in electronic format to facilitate their study, before or after class.
AF2. Practical classes I: experimental work carried out in the laboratory Conducting real experiments in the teaching laboratory where techniques and knowledge related to the contents of the subject are applied.
AF3. Practical classes II: exercises, practical cases in the classroom. Resolution of practical cases and problems: students will have at their disposal cases or practical exercises related to the contents for resolution in person or not in person.
AF4. Teamwork. The students will do a group work of 4 to 6 people. The topics to work on will be proposed by themselves and must be related to this subject. The objective is to design a research or innovative project in the field of biomedicine, applying Genetic Engineering techniques, to a problem that is of interest to the team, whose guidelines will be indicated at the beginning of the Course. The Project must be scientifically based and each Group will have mandatory tutoring with the teacher during the first part of the course to agree on the project, and they may then have voluntary tutoring. Autonomous learning will be encouraged. The results will be presented at the end of the course in an activity called the VII Congress of Genetic Engineering in Biomedicine, in which the fundamental questions that may arise from the proposal will also be posed.
AF5. Tutoring. Through tutoring, the teacher, at the request of the student and at the established time for this purpose, will answer questions or discuss the questions posed to him by the student, in order to guide him in learning the subject.

DISTRIBUTION OF WORK TIME

TEACHER-LED TRAINING ACTIVITIES	INDIVIDUAL WORK
66 Horas	84 Horas

LEARNING RESULTS

Know how to define and know how to apply genetic engineering techniques to the study of gene expression and function in different systems, as well as the manipulation and modulation of such expression.

To know the different methods for the generation of genetically modified animal organisms as the foundations of animal experimentation and their relevance for the study in the different areas of Biomedicine.

SPECIFIC LEARNING RESULTS

It properly applies the fundamental theoretical bases of genetic engineering in the resolution of characteristic problems derived from the subject.

Identify the appropriate strategy to carry out basic DNA or RNA manipulations according to the proposed objective.

Designs cloning protocols aimed at heterologous protein expression and gene modification of cell lines or organisms.

Select the most suitable method of transferring recombinant DNA according to the proposed biological system.

Designs experimental strategies for obtaining genetically modified animals for the study of gene function or disease models.

LEARNING APPRAISAL SYSTEM

Plagiarism, as well as the use of illegitimate means in evaluation tests, will be sanctioned in accordance with those established in the Evaluation Regulations and the University's Coexistence Regulations.
The students' learning outcomes will be evaluated using a varied methodology, taking into account the different activities carried out during the course. Thus, written tests will be proposed throughout the semester, tasks consisting of case studies, presentations, questions, problem solving, evaluation or self-evaluation questionnaires.
The final grade of the course will be obtained based on the grades obtained in the evaluation of the blocks indicated for each system specified below, and it will be necessary to obtain at least 5 points or more in the final grade (once all the corresponding percentages have been applied) to consider the course approved:
PRIMARY SYSTEM:
• IS1. Theory exam: 60% The main objective of the exam will be to verify that the basic concepts worked during the theoretical classes have been assimilated and understood, as well as the students' reasoning ability to solve genetic engineering problems.

• IF 2. Performing practical work in the laboratory: 20% Attendance at internships will be MANDATORY AND ESSENTIAL to be able to take the theory exam and the practice exam.
• IF 3. Tutorial action system (Job preparation): 15%
Teamwork will be evaluated with a rubric that will be made public and which will assess the approach, planning, presentation and defense of the work, and will take into account peer evaluation and self-evaluation.
• SE4. Seminars: 5%
The continuous evaluation will consist of carrying out exercises, questions, problems, tests or the delivery of exercises, both in person and in a Virtual Classroom. The carrying out of the notified practical work will be mandatory, both in person and not in person, in case of unjustified absence, or non-performance of these, said activity will be rated as 0. If a student can justify their absence from a notified face-to-face or synchronous activity, they will be given the opportunity to do one more activity to make an average, on a mandatory basis. After a justified absence, the score for the activity not performed will count as 0 and will be included in the final average of block SE4. The score for block SE4 will represent 5% of the final grade of the course and will take into account the grades obtained in each of the activities carried out and the active and positive participation in the classes.
To be able to average the different parts, it is essential to obtain a rating equal to or greater than 5 both in SE1, and in SE2 and SE3. If one of the parties is suspended from the ordinary call, the note of the approved party for the extraordinary call for the same academic year will be saved.
In SE4 it will not be necessary to get a minimum grade. However, if after applying all the percentages, the subject is suspended in an ordinary call, this item can be recovered, optionally, by carrying out an extra activity determined by the teacher of the subject and that evaluates these competencies in the extraordinary call. The grade for this extra activity will represent 5% of the final grade of the course.
ALTERNATIVE SYSTEM:
Only in the case of students in the second call and later, who have completed all the sessions of the practical work in the laboratory, and students with academic exemption, can they choose to take advantage of the previously specified primary system (in which case they must meet ALL the requirements, including class attendance) or take advantage of the alternative system. Students in second or subsequent enrollment must contact the teacher to request to take advantage of this system. Students who obtained a grade higher than 5 in SE1, SE2 or SE3 in the 2024-2025 academic year can ask teachers to keep that grade and apply the percentage corresponding to SEA1, SEA2 or SEA3, respectively. Grades from previous academic years will not be retained. This decision, such as the decision to opt for the primary system, must be communicated by email (Virtual Classroom) to teachers within the first two weeks of class.
If you do not report, the evaluation will be taken over by the alternative system, in which the following percentages will be applied:
SEA1. Final theory exam: 65%
SEA2.- Final internship exam: 20%
SEA3.- Carrying out a work that applies the topics covered in the subject, whose guidelines will be established and communicated by the teachers: 15%.
In order to average the different parts in the alternative system, it is essential to obtain a rating equal to or greater than 5 in each of the parts: SEA1, SEA2 and SEA3.

ETHICAL AND RESPONSIBLE USE OF ARTIFICIAL INTELLIGENCE

1.- The use of any Artificial Intelligence (AI) system or service shall be determined by the lecturer, and may only be used in the manner and under the conditions indicated by them. In all cases, its use must comply with the following principles:
a) The use of AI systems or services must be accompanied by critical reflection on the part of the student regarding their impact and/or limitations in the development of the assigned task or project.
b) The selection of AI systems or services must be justified, explaining their advantages over other tools or methods of obtaining information. The chosen model and the version of AI used must be described in as much detail as possible.

c) The student must appropriately cite the use of AI systems or services, specifying the parts of the work where they were used and describing the creative process followed. The use of citation formats and usage examples may be consulted on the Library website(https://www.ufv.es/gestion-de-la-informacion_biblioteca/).
d) The results obtained through AI systems or services must always be verified. As the author, the student is responsible for their work and for the legitimacy of the sources used.
2.- In all cases, the use of AI systems or services must always respect the principles of responsible and ethical use upheld by the university, as outlined in the Guide for the Responsible Use of Artificial Intelligence in Studies at UFV. Additionally, the lecturer may request other types of individual commitments from the student when deemed necessary.
3.- Without prejudice to the above, in cases of doubt regarding the ethical and responsible use of any AI system or service, the lecturer may require an oral presentation of any assignment or partial submission. This oral evaluation shall take precedence over any other form of assessment outlined in the Teaching Guide. In this oral defense, the student must demonstrate knowledge of the subject, justify their decisions, and explain the development of their work.

BIBLIOGRAPHY AND OTHER RESOURCES

Basic

Bernard R. Glick, Cheryl L. Patten. Molecular Biotechnology: Principles and Applications of Recombinant DNA/5th ed. Washington: ASM Press, 2017.

Brown, Terry A. Genomes 4/4th ed. New York; London: Garland Science, 2018.

R. M. Twyman, S.B. Primrose. Principles of Gene Manipulation and Genomics/7th ed. Oxford: Blackwell, 2006.

Additional

Tom Strachan, Andrew P. Read. Human molecular genetics/5th ed. Boca Raton (Florida) :CRC, 2019.

Julián Perera, Antonio Tormo, José Luis Garcia. Genetic Engineering/Madrid: Synthesis, 2002.