Universidad Zaragoza

Academic Year/course: 2022/23

68457 - Cell and Organism Biotechnology: experimental methodology

Syllabus Information

Academic Year: 2022/23
Subject: 68457 - Cell and Organism Biotechnology: experimental methodology
Faculty / School: 100 - Facultad de Ciencias
Degree: 626 - Máster Universitario en Biofísica y Biotecnología Cuantitativa/Biophysics and Quantitative Biotechnology
ECTS: 6.0
Year: 01
Semester: Second semester
Subject Type: Optional
Module:

1. General information

1.1. Aims of the course

This course pretends to fill the gap between *in vitro* or *in silico* experimentation and clinical assays in humans when a new therapeutic drug is being developed. It focuses on the use of the appropriate cellular and animal models to evaluate the toxicity and efficacy of a drug, as well as different modern techniques in cell and animal experimental biology.

These approaches and objectives are aligned with the following Sustainable Development Goals (SDGs) of the United Nations 2030 Agenda (https://www.un.org/sustainabledevelopment/es/), so that the acquisition of the learning outcomes of the subject provides training and competence to contribute in some measure to its achievement:

(1) No Poverty, (2) Zero Hunger, (3) Good Health and Well-being, (4) Quality Education, (5) Gender Equality, (8) Decent Work and Economic Growth, (10) Reducing Inequality, (16) Peace, Justice, and Strong Institutions.

1.2. Context and importance of this course in the degree

The major objective of this course is to learn the use of advanced techniques for the utilization of cells in culture and animal models in biotechnology. Advances with *in silico* and *in vitro* techniques often require at the end experimentation in living beings, either unicellular culture models or experimental animals and, finally, humans. This course will provide the student with the knowledge required for the execution of advanced experiments in cells and organisms related to the utilization of bioactive molecules mainly for therapeutic purposes.

1.3. Recommendations to take this course

Continuous work by the student is highly recommended, analyzing suggested bibliography and consulting with teachers any questions that may arise, either personally during classes, tutoring hours or permanently through the Digital Teaching Ring or by e-mail.

2. Learning goals

2.1. Competences

After finishing this course the student will be able to:

- select the microorganism, cellular model of pluricellular organism most adequate for each type of project or experiment.

- use different methods of cell culture, in prokaryotes as well as in eukaryotes, and manipulate the most commonly used animals in research in the fields of biochemistry, molecular biology, cell biology and biotechnology

- apply current legislation related to safety and work risks relative to the use of microorganisms, cell cultures and living beings in general, as well as legislation related to animal wellbeing euthanasia and genetically modified organisms.

- use the most common techniques for cell analyses: microscopy, cytometry and spectrometry.

- use several techniques to evaluate the different effects of experimental interventions from microorganisms to animals: viability, toxicity, efficacy.

- apply the major genetic manipulation techniques from microorganisms to animals.

2.2. Learning goals

The students will learn the use of advanced techniques for the utilization of cellular and animal models in Biotechnology, as well as basic legislation regulating it. They will be able to perform advanced experiments in model cells and organisms related to the use of bioactive molecules with therapeutic purposes. There will be magisterial lessons, practical training and seminars.

2.3. Importance of learning goals

In modern biotechnology it is essential to understand the molecular and cellular mechanisms underlying phenotypic manifestations of genetic information, and the effects of its alterations on human health as well as for therapeutic intervention when physiologic homeostasis is altered. Biotechnology related, for instance, to human nutrition (transgenic organisms that improve desired characters in animals or plants), relies also in experiments in model organisms before manipulating the final desired organisms.

Advances with experiments carried out in the test tube very often require further assays in model organisms to validate discoveries in a more complex environment, where not always the results obtained will match those obtained *in vitro*. Toxicity and efficacy effects of a drug, for instance, can only be adequately assayed in *in vivo* models.

3. Assessment (1st and 2nd call)

3.1. Assessment tasks (description of tasks, marking system and assessment criteria)

A written exam with questions that require short answers or those that require a more extensive explanation of the subject. The former are intended to screen the general knowledge of the student, whereas the latter are intended to evaluate their abilities to express and defend argumentations, as well as critical judgments. The written exam will be based on the programmed learning activities. This will account for 50% of the total qualification.

Practical classes in the laboratory or computer room. The performance of the student during the practical classes will be evaluated: the student should be able to work autonomously following protocols and good laboratory practices. The student must also present a written memory of the experiments performed, which will also be evaluated. This will account for 30% of the total qualification.

Workshops where each student should formulate at least one question to be discussed with teachers. The number of interventions and the interests of questions will be valuated. This will account for 10% of the total qualification.

Seminars. The student must prepare, present in public and defend a work related to the subject of the course for up to 15 minutes. The quality of the elaboration, presentation and debate will be evaluated. This will account for 10% of the total qualification.

4. Methodology, learning tasks, syllabus and resources

4.1. Methodological overview

Lectures using PowerPoint, or similar, presentations, with animations and videos.

Problems that will be handled mainly presentially in class and through the Teaching Digital Ring.

Preparation of seminars and public exposition and defense by the student.

Laboratory practices or workshops at the computer room.

Workshops and debates about state-of-the-art techniques or novel developments that will allow the students to express their opinions about the subject.

4.2. Learning tasks

Lectures by the teacher where theory will be explained and with the student expected to participate actively. 23 hours.

Practical classes at the laboratory and/or computer room. 22 hours.

Workshops and debates. Discussion of a relevant research or technology development topic between the teacher and the students. 12 hours.

Workshops and debates through the Teaching Digital Ring. 3 hours.

Work by the student. 90 hours.

4.3. Syllabus

LECTURES (23 H.)

Cell culture techniques (3 h.)

- Bacterial cultures. Species, strains and applications.
- Yeast cultures. Species, strains and applications.
- Insect cells. Protein expression using baculovirus.
- Mammalian cells. Monolayer and suspension cultures.

- Cell culture in three dimensions. Embryoid bodies, neurospheres and cell aggregates.
- Cell culture by continuous perfusion. Microfluidics chips: design and applications.

Determination of metabolic parameters: photosynthesis and respiration (1 h.)

Cytometry and advanced spectrometry in live cells (1 h.)

- Flow cytometry
- Biomolecule interactions in live cells. FRET, fluorescence complementation, ...

Advanced microscopy (6 h.)

- Multidimensional optical microscopy.
- Confocal microscopy.
- Electron microscopy.

Functional evaluation in animals (1 h.)

- Advanced techniques in fluorescence and luminescence in animals.
- Methods for behavioral studies in animals.

Genetic manipulation (6 h.)

- Gene delivery into cells. Transformation, transfection and viral transduction.
- Gene modification by CRISP-Cas9.
- Antisense RNA technology.
- Transgenesis methods in animals.
- Advanced techniques in genetic manipulation of microorganisms.

Nanomaterials in biomedicine (3 h.)

- Nanomedicine: Fundamentals and applications.
-Techniques in nanomaterial characterization for biomedicine.

Stem cells and regenerative medicine (2h).

- Embryonic stem cells (ESCs).
- Induced pluripotent stem cells (iPSCs).
- Cell therapy and regenerative medicine.

WORKSHOPS AND DEBATES (PRESENTIAL) (12 h.)

- Adipocyte differentiation.
- 3D cell cultures.
- Advanced microscopies.
- Artificial organs.
- Novel imaging techniques in animals.

PRACTICAL SESSIONS (22 h.)

- Multidimensional optical microscopy.
- Basics of microscopy image analysis.
- Ultracentrifugation.
- Single molecule confocal microscopy.
- Embryo manipulation and transgenesis.
- Laboratory equipment at BIFI.
- Visit to the Advanced Microscopy Laboratory (LMA; Titans).
- Visit to the laboratory of nanoparticle research.
- Fundamentals of Hollow Fiber System for antimicrobial research.

WORKSHOPS AND DEBATES (THROUGH TEACHING DIGITAL RING) (3 h.)

INDIVIDUAL WORK BY THE STUDENT (90 h.)

4.4. Course planning and calendar

This course will be taught from February till June. The precise schedule will be published in the School of Sciences webpage. The final evaluation will take place during the month of June.

The final evaluation will take place at the beginning of June and will be announced in time.

4.5. Bibliography and recommended resources

Individual teachers will give bibliographic references to the students during their presentations. Some other references are given below.

http://psfunizar10.unizar.es/br13/egAsignaturas.php?codigo=68457