
Academic Year of Degree: 2025/26

22148 - Advanced Synthetic Biology

Teaching Guide Information

Academic Course: 2025/26

Academic Center: 337 - Engineering School

Study: 3378 - Bachelor's degree in Biomedical Engineering

Subject: 22148 - Advanced Synthetic Biology

Credits: 4.0

Course: 3 and 4

Teaching languages:

Theory: Group 1: English

Practice: Group 101: English

Group 102: English

Seminar: Group 101: English

Teachers: Javier Santos Moreno

Teaching Period: First term

Presentation

Academic features

The Advanced Synthetic Biology course is a 4 ECTS optional class in the Bachelor's degree in Biomedical Engineering.

Coordination and teaching staff

The teaching activities will be coordinated by **Javier Santos Moreno**. Additional teaching personnel may also participate in selected lectures. The language of the course will be English, but optionally Catalan and Spanish can be used as well.

Introduction

Synthetic Biology is an emerging field of research where scientists construct new biological systems and redesign existing ones. Our ability to modify genomes has profoundly affected how we perform scientific research, or we design new medical therapies. Emergent consequences of reinventing biology have already started to reach society. For example, engineered human immune T cells (CAR-T) cure cancers

with outstanding performance, or 'ex vivo' gene therapy has successfully cured severe genetic diseases such as 'bubble boys', or sickle cell disease. Also, multiple non-medical applications have emerged. Genetically engineered salmon that grow faster, or 'CRISPR mushrooms' that rot less have been developed. Perhaps even one day, synthetic biology may help in reviving extinguished species. Biological technology will have a growing influence in our lives.

Associated skills | General learning outcomes

Instrumentals (INS)

INS1. Analysis and synthesis capacity.

INS3. Ability to apply knowledge to situation analysis and problem solving.

INS4. Skills in the search and management of information.

INS7. Ability to communicate in academic and professional contexts orally and in writing in English to both expert and inexperienced audiences.

Interpersonal (INT)

INT1. Ability to work in a team.

INT2. Ability to work in international and interdisciplinary contexts.

INT3. Leadership capacity, coordination and initiative.

Systemic (SIS)

SIS1. Ability to flexibly and creatively apply acquired knowledge and adapt it to new contexts and situations.

SIS2. Ability to progress in the training and learning processes in an autonomous and continuous manner.

SIS4. Ability to be motivated by quality.

SIS5. Ability to be motivated by innovation.

Specific competencies for basic engineering training (B):

B3. Have the ability to use specific tools for searching and manipulating resources in databases and information related to biomedical engineering or bioinformatics (e.g., UniProt, InterPro, EMBL Nucleotide Sequence Database, Gene Expression Atlas, Gene Ontology, Foundational Model of Anatomy).

B9. Ability to act in accordance with ethical and professional responsibility, as well as as established by the legislation applicable to their activity.

Biomedical Engineering Area Specific Competencies (IB):

IB5. Develop and implement computational tools to study biological systems and human physiology with an integrated approach.

Biomedical Specific Skills (BM) systems:

BM2. Ability to understand the stages of the gene expression process: phenomena of cell division and death in unicellular and pluricellular organisms, regulatory points and use of RNA as a functional molecule.

BM7. Use of biotechnology and pharmaceutical production tools and systems.

Learning outcomes | Specific learning outcomes

What will you learn?

- Basic technologies to build genetically modified organisms
- Elements of biological circuits
- Design, build and analyze biological systems
- Applications of synthetic biology
- Exposure to multiple professional outcomes of synthetic biology: academic research, entrepreneurship/startup, industry

Contents

Course program

Theory:

1. Introduction to synthetic biology
2. Synthetic DNA and its uses in synthetic biology
3. Genetic engineering & Gene editing
4. Synthetic biology for Diagnostics & Therapeutics
5. Fundamentals of synthetic gene circuits & Biocomputing
6. Advanced and applied gene circuits
7. Directed evolution & Biocontainment
8. AI for protein design
9. Industrial, Plant & Sustainability synthetic biology
10. Cell-free systems & Biomaterials
11. Computational tools for synthetic biology design
12. Bioeconomy, Biosafety & Bioethics

Seminars:

- A. Project 1: Report for an investment firm
- B. Project 2: Design and poster presentation of a research project

Lab sessions:

Building and testing CRISPR-based synthetic gene circuits

Sustainable Development Goals

- 3 - Good Health and Well-being
13 - Climate Action

Evaluation and grading system

Final grade= 40% final exam + 20% online multiple choice quizzes + 40% project grade (20% each project)