Universidad de Navarra

***Computational Biology (Ing.Gr.)***
*Guía docente 2026-27*

# PRESENTACIÓN

**Breve descripción**:

This course introduces basic mathematical modeling tools and algorithms that are commonly used in the field of Computational Biology.

**Titulación (Módulo/Materia)**:

- Ingeniería Biomédica (Bioingeniería/Técnicas high-throghput )

**Detalles**:

- **ECTS**: 4 ECTS
- **Curso, semestre**: 3.º curso, 1.º semestre
- **Carácter**: Obligatorio
- **Idioma**: English

**Profesores de la asignatura**:

- Planes Pedreño, Francisco Javier / Profesor Catedrático

# RESULTADOS DE APRENDIZAJE (Competencias)

### INGENIERÍA EN INGENIERÍA BIOMÉDICA

CG8 - Saber utilizar los instrumentos clínicos y biomédicos para obtener, organizar e interpretar la información científica y sanitaria.

CE3 - Conocer las ventajas y desventajas de los diferentes métodos estadísticos y las diversas hipótesis estudiadas.

CE9 - Comprensión de los conceptos relacionados con las técnicas computacionales de caracterización, evaluación y análisis del comportamiento del sistema músculo-esquelético del ser humano.

CE19 - Conocimiento de los algoritmos utilizados en microarrays de expresión génica (tanto estándar como de exones) y en arrays de SNPs.

# PROGRAMA

1- Introduction to Computational Biology

2- Optimization techniques in Computational Biology

a. Optimization theory

b. Linear Programming: models, applications and algorithms

c. Integer Linear Programming: models, applications and algorithms

d. Non-Linear Programming: models, applications and algorithms

3- Graph Theory in Computational Biology

a. Concepts and algorithms

b. Shortest paths problems and applications

4- Differential Equations in Computational Biology

a. ODEs in Computational Biology: algorithms and applications

b. Stability Analysis

## ACTIVIDADES FORMATIVAS

This course combines theoretical classes and exercises in the classroom with computer labs, where student learn mathematical models in computational Biology, algorithms and advanced software tools. In particular, the following computer labs are scheduled:

1- Implementation and resolution of linear and quadratic optimization models with IBM Ilog Cplex in Matlab environment:

- Metabolic models of cell proliferation. (2 Labs)
- Learning models in personalized medicine. (1 Lab)
- Least squares problems in mass spectometry and compound identification. (1 Lab)
- Extra labs. (2 labs)

2- Implementation methods and algorithms of graph theory in Matlab environment in the field of genomics. (1 Lab)

3- Solving systems of differential equations in Matlab environment. Applications in drug kinetics and dynamics. (1 Lab)

These computer labs will be assessed with two labs: October 16 and November 27 (class time).

## EVALUACIÓN

**CONVOCATORIA ORDINARIA**

Assessed Labs: 50%.

Graded Lab 1: October 15 (Miramon PC1) 25 %

Graded Lab 2: November 26 (Miramon PC1) 25 %

Final Exam: 50%

- Minimum score of 4 out of 10

**CONVOCATORIA EXTRAORDINARIA**

Assessed Labs 50% and Final Exam 50% (minimum score of 4 out 10)

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## HORARIOS DE ATENCIÓN

**Dr Francis Planes (fplanes@unav.es)**

- Despacho: Subdirección de Profesorado, Edificio Principal
- Horario de tutoría: Lunes 16:00-18:00

## BIBLIOGRAFÍA

Gusfield, D. (2019). *Integer linear programming in computational and systems biology: an entry-level text and course*. Cambridge University Press. Localízalo en la biblioteca [electrónico]

Klipp, E., Liebermeister, W., Wierling, C., & Kowald, A. (2016). *Systems biology: a textbook*. John Wiley & Sons. Localízalo en la biblioteca

Alon, Uri. *An introduction to systems biology: design principles of biological circuits*. CRC press, 2019. Localízalo en la biblioteca

Durbin, R., Eddy, S. R., Krogh, A., & Mitchison, G. (1998). *Biological sequence analysis: probabilistic models of proteins and nucleic acids*. Cambridge university press. Localízalo en la biblioteca [electrónico]

Bornholdt, Stefan, and Heinz Georg Schuster. "Handbook of graphs and networks." *From Genome to the Internet, Willey-VCH (2003 Weinheim)* (2001).