



INTRODUCTION

Brief description

This course offers an integrative overview of **high-throughput omics technologies**—genomics, transcriptomics, epigenomics, proteomics, and metabolomics—and **their application in precision medicine**. Students will acquire a **conceptual and practical understanding** of how **omics** data are *generated, analyzed, and interpreted* to tailor medical decisions to individual patients and populations. The course emphasizes **real-world clinical applications** and a comprehensive understanding that enables the selection of the most appropriate methodologies for disease characterization.

- **Degree:** Master's in Biomedical Research
- **Module/Subject:** Omics Technologies and Precision Medicine
- **ECTS:** 3
- **Academic Year, Semester:** First semester
- **Type:** Module III: Complementary Training
- **Faculty:** Dr. Rafael Valdés Mas, Group Leader at CIMA – University of Navarra
- **Language:** English
- **Classroom, Schedule:** As defined by the Master's calendar

LEARNING OUTCOMES (Competences)

Basic Competences

- **CB6:** To possess and understand knowledge that provides a basis or opportunity for originality in the development and/or application of ideas, often in a research context.
- **CB7:** That students are able to apply the knowledge acquired and their ability to solve problems in new or unfamiliar environments within broader (or multidisciplinary) contexts related to their field of study.
- **CB8:** That students are capable of integrating knowledge and facing the complexity of formulating judgments based on incomplete or limited information, including reflections on the social and ethical responsibilities linked to the application of their knowledge and judgments.
- **CB9:** That students can communicate their conclusions—and the knowledge and rationale underpinning them—to both specialized and non-specialized audiences clearly and unambiguously.
- **CB10:** That students possess the learning skills necessary to continue studying in a manner that is largely self-directed or autonomous.

General Competences

- **CG1:** Ability to address biomedical challenges in depth, from different perspectives, identifying the current state of science.
- **CG2:** Ability to identify significant questions or hypotheses related to biomedical problems and to define the steps necessary for their resolution.
- **CG3:** Possession of creative ability and originality in order to respond to the questions raised in biomedical research.



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- **CG4:** Ability to select and use the appropriate techniques to effectively and accurately conduct biomedical research.
- **CG5:** Technical capacity to obtain precise and reproducible results from which valid and objective conclusions can be drawn in the field of biomedicine.
- **CG6:** Critical thinking skills in reading biomedical scientific literature and interpreting experimental results.

Specific Competences

- **CEE1:** Understanding the connection between different areas of knowledge that enables a broad and creative approach when designing a biomedical research project.
- **CEE2:** Deepening specific aspects that allow students to expand the knowledge acquired in their specialty.
- **CEE3:** Acquiring specific technical foundations to understand scientific literature and/or to carry out the research project.

PROGRAM

1. Introduction

- Evolution and impact of omics technologies in healthcare

2. Genomics

- Whole-Genome Sequencing (WGS)
- Whole-Exome Sequencing (WES)
- Long-read sequencing.
- Single-Cell DNA Sequencing (scDNA-seq)
 - Including targeted approaches for clonal architecture and mutation tracking

3. Transcriptomics

- Bulk RNA Sequencing (bulk RNA-seq)
- Single-Cell RNA Sequencing (scRNA-seq)
- Spatial Transcriptomics
 - Combining gene expression with spatial context in tissues

4. Epigenomics

- Targeted Epigenetic Panels
- Chromatin Immunoprecipitation Sequencing (ChIP-seq)
- Assay for Transposase-Accessible Chromatin using sequencing (ATAC-seq)
- Bisulfite Sequencing for DNA methylation profiling
- Single-cell epigenomics (e.g., scATAC-seq, scMethyl-seq)
- CUT&RUN / CUT&Tag
- Hi-C / 3D genome structure mapping

5. Proteomics

- Untargeted (Discovery) Proteomics
 - Mass spectrometry-based profiling of the proteome
- Targeted Proteomics



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- e.g., Selected Reaction Monitoring (SRM), Parallel Reaction Monitoring (PRM)
- SOMAscan (aptamer-based array)

6. Metabolomics

- Untargeted Metabolomics
- Targeted Metabolite Panels
- Fluxomics (stable isotope labeling)

7. Microbiome

- 16S rRNA Gene Sequencing
- Shotgun Metagenomics
- Metatranscriptomics
- Metaproteomics
- Integration with host data for functional interpretation.

8. Data Integration and Systems Medicine

- Bioinformatics pipelines and platforms
- Challenges in big data integration.

EDUCATIONAL ACTIVITIES

This is a course of 3 ECTS (75 hours). The work is distributed as follows:

1. Class activities (1.28 ECTS, 24 hours)

- **Lecture sessions:** *0.8 ECTS, 18 hours*
 - These sessions are based on the presentation of key concepts by the professor, following the course syllabus. PowerPoint slides will be made available to students in advance through ADI. In addition to the lectures, students will participate in guided visits to selected core facilities where they will gain first-hand insight into the technologies and workflows discussed in class.
 - *9 sessions, 2 hours each*
- **Paper presentation:** *0.16 ECTS, 2 hours*
 - These sessions aim to train students in the critical reading and synthesis of scientific literature on **emerging omics methodologies**. After the theoretical content has been covered, each student will select a relevant paper (from a set provided by the instructor), analyze it, and present the main findings in a **15-minute oral presentation**.
 - *1 session, 2 hours*
- **Project presentation:** *0.16 ECTS, 2 hours*
 - These sessions focus on applying course knowledge to real-world scenarios. Students will choose a proposed project topic, **develop a plan outlining objectives, and describe the omics methodologies required**—taking into account practical constraints such as a limited budget. They will then present their proposal in a **15-minute oral presentation**.
 - *1 session, 2 hours*
- **Final examination:** *0.08 ECTS, 2 hours*



- The final exam will consist of short questions assessing the fundamental aspects of the course.

2. Personal work (1.72 ECTS, 43 hours)

Independent study is a critical component of the learning process. It includes:

- Reviewing lecture content in depth
- Consulting scientific sources
- Preparing the assigned paper and project presentations
- Studying for the final examination

ASSESSMENT

ORDINARY CALL

To pass the course, students must obtain a **final grade of 5.0 (50%) or higher**. Additionally, students must score **at least 35% of the final examination grade** to be eligible to pass, regardless of their performance in the other components.

The evaluation is distributed as follows:

- **Continuous assessment** (participation and engagement): **5%**
- **Paper presentation**: **25%**
- **Project presentation**: **25%**
- **Final examination**: **45%**

RE-SIT EXAMINATION

Students who fail the final examination will have the opportunity to take a re-sit exam. The grades obtained in the **continuous assessment**, **paper presentation**, and **project presentation** will be retained and factored into the final grade.

GRADING SCALE

Final grade	Description
10.0 – 9.0	SB – Sobresaliente
8.9 – 7.0	NT – Notable
6.9 – 5.0	AP – Aprobado
4.9 – 0.0	SS – Suspenso

Students who achieve a final grade of **9.0 or above** may be eligible for **Honors (Matrícula de Honor)**, depending on course policy and faculty approval.



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OFFICE HOURS

Dr. Rafael Valdés Mas

- To contact with the professor ask for an appointment by e-mail:
rvaldesmas@unav.es

BIBLIOGRAPHY AND RESOURCES

- Integrative Omics for Health and Disease (10.1038/nrg.2018.4) [Find it in the Library](#)
- Methods and applications for single-cell and spatial multi-omics (10.1038/s41576-023-00580-2) [Find it in the Library](#)
- Best practices for analysing microbiomes (10.1038/s41579-018-0029-9)