

Biosciences and Bioengineering Innovations for Precision Medicine (BeInPM) Erasmus Mundus Joint Master's Degree (EMJMD)

Educational programme

This document describes the educational programme for the first semester of Be In Precision Medicine (BeInPM).

The second semester the BeInPM EMJMD's programme is comprised of an internship and a research Master thesis, which the student can follow at either one of the three partner universities: UGA, UNINA or UB.

European Scientific Institute (ESI) – Archamps

This is a Summer School provided at the beginning of the BeInPM EMJMD's programme, in August. It is mandatory for all the students, and will account for 6 ECTS credits.

Coordinator: Bob Holland (bob.holland@archamps-technopole.com)

Course Title	ECTS credits	Description
Computer-Based Medicine for Chronic Diseases	6	COMPULSORY Based on a model disease such as Chronic Obstructive Pulmonary Disease (COPD), content covers the fundamentals of physiological and clinical processes, along with core medical principles, clinical research methods, and trials design, as well as basics of applied mathematics and computing. The program culminates in a capstone design-project in which students work in interdisciplinary teams co-advised by faculty members and investigators from industries and hospitals.

Université Grenoble Alpes (UGA)

Rules governing the course choices:

- Available Tracks are **Medical Biotechnology**, **Biomedical Engineering** and **Clinical Research**,
- The student must choose at least 24 ECTS credits' worth of courses,
- The final choices will be validated by the educational manager.

Coordinator: Jean Breton (jean.breton@univ-grenoble-alpes.fr)

Course Title	ECTS credits	Description
Methods and Means for Biohealth Research	6	COMPULSORY Analysing and synthesising scientific concepts, Reporting the results of my science (classes, tutorials, oral and written exercises).
<i>In vitro</i> Diagnostics Innovative Project	6	Basics of project management, market analysis, strategy (business models, ...), industrial property and finance, with a focus on <i>in vitro</i> diagnostic.
Biomedicines Innovative Project	6	Basics of project management, market analysis, strategy (business models, ...), industrial property and finance, with a focus on biomedicines.
Regenerative Medicine Innovative Project	6	Basics of project management, market analysis, strategy (business models, ...), industrial property and finance, with a focus on Regenerative medicine.
Micro and Nanotechnologies for Health	3	Applying nanotechnologies to health and diseases. Biomimetic nanotechnologies. Biosensors. Microarrays.
Current and Future Perspectives for the Control of Infectious Agents	3	Examples of life-threatening infectious agents (virus, bacteria, fungi, parasites). Presentation of recent studies about: epidemiology, diagnosis, treatment, management of antibiotic resistance, vaccination.
Innovative Cell and Gene Therapies	9	Fields covered by this course are: <ul style="list-style-type: none"> • Gene therapy, • Cell therapy and cellular engineering (stem cells, ...), • Tissue engineering (3D bioprinting, biomaterials, ...).
Biomarkers and <i>In Vitro</i> Diagnosis	6	Biomarkers play a key role in 70% of medical decisions by enabling screening, diagnosis, choice of the best treatment in all human diseases. Examples of new biomarkers in the fields of: (1) Oncology (personalized medicine, liquid biopsies, epigenetic biomarkers) (2) Infectious and inflammatory diseases. Examples of innovative bioanalysis tools and their biomedical applications: (1) Protein Biochips, (2) Point of Care Devices (mobile diagnostic technologies), (3) Next Generation Sequencing, ...
Technological Innovations in Health (e-learning)	3	Basic knowledge of innovative medical devices, their validation and access to the market.
Proteomics for Health Research	3	<ul style="list-style-type: none"> • Introduction to proteomic principles and applications, • Protein analysis by mass spectrometry, • Overview of separation methods and strategy, • Principles of bioinformatics and identification methods in proteomics, • Quantification methods in proteomics, • Study of post-translational modifications, • Interatomic Methods for research and validation of biomarkers.
Animal Experimentation	3	<ul style="list-style-type: none"> • Animal experimentation rules, • Basic notions on animal models, • Genetics and transgenesis, • Comparative anatomy and physiology in rodents, • Live imaging with visit of a platform, • Animal models in pharmacology, • Alternative methods (cell culture), • Role of toxicology and animal experimentation in the evaluation of drug safety, • Comparative anatomy and physiology in pigs, • Practical course - rat model or pig model.
Genetics and Epigenetics of Infertility	3	<ul style="list-style-type: none"> • Genetics of male infertility, • Genetics of female infertility, • Importance of environmental factors in male and female infertility, • Disorders of sex development (DSD), genetic causes and consequences on fertility, • Endocrine causes of male and female infertility, • Epigenetics and procreation.
French Language Courses	3	COMPULSORY Targeted French language courses, which content depends upon the student's command of the language, evaluated through a placement test.

* **New course choices will be available in the coming weeks.** *

Università degli Studi di Napoli Federico II (UNINA)

Track: Medical Biotechnology

The overall aim of this track is: to acquire innovative knowledge in the fields of pharmacology, diagnostics, therapies that can prevent and treat human diseases.

Coordinators: Prof. Gerolama Condorelli (gecondor@unina.it), Prof. Lucio Pastore (lucio.pastore@unina.it)

Course title	ECTS credits	Description
The student has to choose 1 of the following 2 courses		
Precision Medicine in Oncology	4 credits each	<p>Learning the different processes involved in the path from bench to bed in oncologic patients:</p> <ul style="list-style-type: none"> Basic knowledges of the oncologic process, dissecting how individual differences in people's genes, environments, and lifestyles may affect the oncological disease, Managing cancer heterogeneity for tailored therapy, Pharmacogenetic: the right drug for the oncologic patient, 2D, 3D, and PDX: different models for studying cancer, Integrating liquid biopsy, Sequencing cancer, Integrating liquid biopsies into the management of cancer, Cart-T therapy in cancer, Cancer vaccines, Gene therapy in cancer, RNA therapeutic, Machine learning and big data: advantages in cancer risk analysis.
Precision Medicine in Genetic Diseases		Learning modern approaches in the diagnosis and therapy of the inherited diseases.
The student has to choose 4 of the following 13 courses		
Developmental Biology	5 credits each	Students are expected to acquire knowledge and competence regarding the main molecular mechanisms that underlie development of multicellular organisms. Major focus will be on the main animal models used as tools in basic and biotechnological research.
Bioinformatics		Provide the students with tools for computational analysis of proteins and genomes.
Molecular Diagnostics		Provide knowledge on advances on new methodologies applied in molecular diagnosis
Molecular Biology		The aim is to provide knowledge about the technologies of gene expression and transfer in vitro and in vivo and of gene editing for medical applications in the fields of vaccination, passive immunotherapy and genetic dysfunction. Understanding of some fundamental mechanisms regulating gene expression and in turn cell identity and fate.
Development of molecular agents		Provide knowledge on advances on new agents for several applications in human diseases.
Molecular Tools in Regenerative Medicine		Provide knowledge on role of stem cells technology and applications in human diseases.
Synthesis of Biomolecules		To provide knowledge on the rational design and synthesis of biomolecules having an important biological role such as polypeptides, oligonucleotides.
Advanced Biochemistry		Provide knowledge on biochemical and metabolic profiles of major organs.
Advanced Therapeutic Technologies		Provide knowledge on the rational design of new therapeutic approaches for human diseases.
Advanced Cell Biology		This course will illustrate the current approaches involving high throughput screening, light microscopy imaging and cell differentiation to gain mechanistic insights on cell physiology and pathology.
Clinical Microbiology		Study of the molecular and cellular mechanisms of host-parasite interactions involved in the pathogenesis of infectious diseases.
Methods in Clinical Laboratory		Students are expected to develop the critical capacity for using the most advanced laboratory methods (in addition to traditional biochemical markers) in order to assess human organs and tissues functionality.

Track: Biomedical Engineering

It concerns the application of engineering and design concepts to medicine and biology for diagnosis, monitoring and therapy. It seeks to take advantage of combining the design and problem-solving skills of engineering with biosciences to advance health care treatment.

Coordinators: Prof. Stefano Guido (steguido@unina.it), Prof. Paolo Netti (nettipa@unina.it)

Course title	ECTS credits	Description
The student has to choose 24 ECTS credits within the following courses		
Biomechanics	6	The course furnishes the mathematical background and explicitly writes and (analytically and/or numerically) solves the PDEs needed to approach – in the framework of the continuum mechanics – some biomechanical problems of interest.
Systems Analysis for Bioengineering	6	By the end of the course, the student will be able to model and analyse biomolecular processes by means of linear dynamical system theory.
Advanced Thermodynamics	12	Provide essential concepts of biological thermodynamics and illustrate their application with examples to develop problem-solving skills.
Advanced Transport Phenomena	6	Transport phenomena are of great importance in quite diverse fields of living systems science and technology, such as medicine, biology, biotechnology and tissue and environmental engineering.
Diagnostic Devices and Drug Delivery	9	This course introduces the working principles and use of devices for the treatment and diagnosis of infectious and non-transmissible diseases.
Biomaterials	6	This course covers the analysis and design at a molecular scale and at a macroscopic level of materials used in contact with biological systems and particularly for clinical applications.
Tissue Engineering	6	The course will present designing criteria and technologies to fabricate functional scaffold for the in vitro or in vivo regeneration of complex tissues.
Mechanics in Tissues and Growth	6	The course aims at providing students with a deep understanding of the intimate relationship between tissue composition-structure and mechanical response.

PRECISION MEDICINE

Track: Clinical Research

This specialization focuses on project management and how to determine the safety and effectiveness of drugs, devices treatments and ethics directed for the human use. This specialization will expand the student career prospects by developing specialist knowledge within clinical research and places the student at hearth of healthcare research interface.

Coordinators: Prof. Gerolama Condorelli (gecondor@unina.it), Prof. Lucio Pastore (lucio.pastore@unina.it)

Course title	ECTS credits	Description
The student has to choose 1 of the following 3 courses		
Precision Medicine in Oncology	4 credits each	Learning the different processes involved in the path from bench to bed in oncologic patients: <ul style="list-style-type: none"> • Basic knowledges of the oncologic process, dissecting how individual differences in people's genes, environments, and lifestyles may affect the oncological disease, • Managing cancer heterogeneity for tailored therapy, • Pharmacogenetic: the right drug for the oncologic patient, • 2D, 3D, and PDX: different models for studying cancer, • Integrating liquid biopsy, • Sequencing cancer, • Integrating liquid biopsies into the management of cancer, • Cart-T therapy in cancer, • Cancer vaccines, • Gene therapy in cancer, • RNA therapeutic, • Machine learning and big data: advantages in cancer risk analysis.
Precision Medicine in Metabolic and Cardiovascular Diseases		Learning the different processes involved in the path: from bench to bed in Metabolic and cardiovascular Diseases.
Precision Medicine in Genetic Diseases		Learning modern approaches in the diagnosis and therapy of the inherited diseases.
The student has to choose 4 of the following 9 courses		
Clinical Immunology	5 credits each	Tools provided by biotechnology to study the molecular basis of immunological diseases applied to diagnosis and treatment.
Neurology		Tools provided by biotechnology to study the molecular basis of neurological diseases applied to diagnosis and treatment.
Medical Oncology		Tools provided by biotechnology to study the clinical basis of oncological diseases applied to diagnosis and treatment.
Internal Medicine		Tools provided by biotechnology to study the molecular basis of human diseases applied to diagnosis and treatment.
Clinical Microbiology		Study of the molecular and cellular mechanisms of host-parasite interactions involved in the pathogenesis of infectious diseases.
Molecular Oncology		Learning cellular and molecular mechanisms involved in physiological and pathological oncologic processes.
Development of Molecular Agents		To provide knowledge on the rational design and synthesis of biomolecules having an important biological role such as polypeptides, oligonucleotides and their analogues.
Molecular Tools in Regenerative Medicine		Provide knowledge on role of stem cells technology and applications in human diseases.
Advanced Therapeutic Technologies		Provide knowledge on the rational design of new therapeutic approaches for human diseases.

Universitat de Barcelona (UB)

Rules governing the course choices:

- The student must choose at least 24 ECTS credits' worth of courses,
- The choice of courses may exceed 24 credits,
- A minimum of 18 credits (75%) must come from the chosen track,
- Beyond the 18 credits, the courses may be chosen from the other tracks, or from the Maths courses,
- Maths courses are offered to students regardless of their chosen track, students are strongly advised courses of interest in the discipline,
- The final choices will be coordinated and validated with the student's mentor.

Track: Medical Biotechnology track

Coordinator: Prof. Josefa Badia (josefabadia@ub.edu)

Course Title	ECTS credits	Description
Genomics, Proteomics and Bioinformatics	5	The aim is to gain knowledge on the most significant contributions that these disciplines are making to better understand the integrated functioning of living beings, and therefore the possibilities of use of biotechnology and associated methodologies.
Genetic and Molecular basis of Biotechnology	5	The subject provides the most current knowledge on advance technologies from Genetic Engineering at the molecular, cellular and organ system levels. This subject is therefore organized in three sections: from genes to cells, from cell to transgenic animals, and from proteins to functions.
Biotechnological Applications	5	Overview of biotechnology and its applications. Application of molecular biotechnology techniques in different situations and disciplines, with special emphasis in challenges inherent to translating scientific discoveries into a successful business. Business principles in biotechnological companies.
Research Seminars	5	The aim of the sessions is to improve technological capacities for biotechnological research as well as to give the opportunity to the students to discuss with top scientists in the field of biotechnology. The student will learn to search methodologies related to biotechnological processes and will create their first Project collecting information based on practical experience, working hypothesis, objectives, a work plan, a schedule, a methodology and a budget.
Animal Biotechnology	5	Combines knowledge of biological sciences with the properties of animal organisms, their cells or molecular components in order to generate products and services using molecular and reproductive tools and technique with application mainly in the areas of food and medicine.

Track: Biomedical Engineering

Coordinator: Prof. Romen Rodriguez (romen.rodriguez@ub.edu)

Course Title	ECTS credits	Description
Health Economics	6	This course introduces how the microeconomics principles and concepts are applied to the analysis of decisions by consumers, firms and governments regarding health, pharmaceutical care and technologies, giving understanding of the economic issues, tools and methods confronting health systems, principles of microeconomics and regulatory economics, statistics and econometrics, and economic evaluation.
Management of Innovation and Entrepreneurship in MedTech Firms	6	The course provides knowledge in management of innovation projects in med tech firms: business innovation as phenomena, recognition of opportunities, the innovation process, innovation management challenges in med tech environment and the enabling factors for innovation and creativity within companies.
Microeconomic Foundations of Competitiveness	3	The aim is to provide students with models and tools to understand the functioning of non-competitive markets and the strategies followed by firms to raise profits. To achieve this aim, we study the behaviour of the firm within several market structures and predict the expected result given the restrictions.
Empirical Industrial Organization and Pharmacoeconomics	3	Reviewing the many arguments and concepts that are used to either justify or question interventions such as patents, compulsory disclosure of clinical trial results, centralized approval, procurement, price regulation or listing for public subsidy. Market responses will also be addressed.
Public Policies and Health	3	The main goal of this course is to understand the role of the government in the provision of health services and care. We will study the nature of health economics and identify the need for public intervention. We will study these issues from a theoretical and an empirical point of view.
Creating and Sustaining Successful Biomedical Companies	3	This course aims to explore business creation and growth as a multidimensional phenomenon. Both with theoretical and practical sessions, the course aims to provide students an entrepreneurial perspective and a hands-on experience in the development of new business ventures in the field of biomedical engineering.
Strategy and Biomedical Technology	3	The course offers an introduction to the range of research on technology and innovation, from the theoretical to the empirical, and from the classic to the current ability to explain performance differences between firms within biotech and pharma industries.
Organization and Management Systems	3	The objective of the subject is to introduce the different managerial practices to enhance the management of biomedical organizations. Aspects such as the continuous improvement processes, tools and management systems will be analysed with the main aim of satisfying all the stakeholders.
Business Marketing and Sales in the Biomedical Industry	3	This course introduces to the way marketing practitioners think. Marketing is an activity developed by organizations and their main objectives are design products, communicate their existence, and distribute them to consumers. The examples and cases analysed will be especially focused on the process of developing health promotion programs with a practical approach.
Financial Management of Biomedical Firms	3	This subject addresses four main issues: concepts and tools of accounting and financial management, Integrative framework for financial planning in new ventures. Financing sources in the biotech industry and Capital providers of biomedical firms and Investment project appraisal including risk assessment

Track: Clinical Research

Coordinator: Prof. Nuria Casamitjana (mrc@ub.edu)

Course Title	ECTS credits	Description
Systems Medicine	6	The subject focuses on strategies for deployment of systems medicine in the clinical scenario. We will identify the core components of such a deployment, share our own experience and provide skills to the students fostering future contributions into the field.
Research Tools and Methodology	6	From a good research of bibliography to have a good background of the subject, to decide the type of study to be carried out and sample size, objectives of the study, how to obtain financing resources and, how to analyse the results and to present them to the scientific community for the subsequent publication.
Main Health Problems and Solutions	3	Notions of epidemiology, biology, geography and demography. Principal actors in the architecture of global health. Identify the principle diseases that form the current global burden of disease and determine global health problems applying a critical approach to the analysis of health determinants and challenges.
Determinants of International Health	3	To assess the distribution of health and its determinants at global level distinguishing the characteristics of the main determinants that influence the health of populations from different areas of the planet. Analyze of the key factors of health inequities and their relevance in the design of policies.
Health Systems and International Health Organizations	3	Analysis of the main components of health systems and their functioning and interrelations, as well as global health policies and their implications for health systems and programs. Knowledge of the main actors in global health issues and the use of fundamental tools for the understanding of the structures and processes.

Mathematics courses

Coordinator: Prof. Laura Igual (ligual@ub.edu)

Course Title	ECTS credits	Description
Numerical Linear Algebra	6	Main objectives: Know the importance of numerical linear algebra and its role in the processing of large volumes of data. Know the computational cost and numerical stability of basic linear algebra operations. Model problems associated with standards. Recognize structures in matrices and know how to apply appropriate algorithms for their factorization. Recognize and apply projection methods. Being able to apply iterative methods of solving linear systems and matrix decomposition.
Optimisation	6	Main objectives: That the students can apply their knowledge and their ability to solve problems in new or unfamiliar environments within broader (or multidisciplinary) contexts related to their field of study
Bayesian Statistics and Probabilistic Programming	6	Main objectives: To master the Bayesian paradigm as the framework where assumptions and experimental evidences are quantitatively blended into a new outlook. To apply Bayesian thought to data modelling and prediction. To understand the rationale of and to know how to bring into practice Bayesian computations, mainly based on simulation. To be informed about and to be able to use ad hoc computer languages, specifically designed with the aim to handling probability distributions and their simulation.
Machine Learning	6	The goal of this course is to understand the fundamental principles of machine learning. This includes, understanding supervised and unsupervised learning, general learning theory as well as good practices for properly use machine learning tools.
Agile Data science	6	Main objectives: Learn about agile methodologies for software developing. Learn about what it's like to be a data scientist. Learn about infrastructures for data science.