

Master I3

"Immunology and Immuno-Intervention"

I3 Graduate Program



Master's 1 and 2 Program

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INTRODUCTION

The **Immunology and Immuno-Intervention (I3)** program is organized by **Nantes University**. It is an integrated curriculum offering excellent opportunities for those wishing to pursue a career in academic research or corporate research and development.

I3 is supported by **the French National Research Agency (ANR)**, ensuring that the program draws on the expertise of three internationally renowned laboratories:

- **INCIT** (Institute for Clinical and Translational Neuroscience)
- **CRCI2NA** (Nantes-Angers Cancer and Immunology Research Center)
- **CR2TI** (Center for Transplantation and Immunology Research)

The I³ Master's program offers unique expertise in key areas:

- **Immunopathology** of chronic inflammatory diseases, transplants, cancer, and sepsis.
- **Innovative immunotherapies** in oncology, transplantation, infectious diseases, and inflammation.
- **Host-microbiota interactions** at the mucosal level.

It is part of a **dynamic ecosystem** rich in biotechnologies specializing in immunology based in Nantes.

The program also benefits from **close collaboration between clinicians and researchers** at the Nantes University Hospital, ensuring strong interaction between fundamental research and clinical applications.

The objective of the Master I3 program is to understand the functioning of the normal immune system, its dysregulation, and therapeutic manipulation strategies in human pathology.

The Master I³ is aimed at students from a variety of backgrounds in **fundamental sciences** and **health sciences**.

Teaching is conducted **in French and English** in the first year, then **entirely in English** in the second year.

MASTER'S PROGRAM COORDINATORS

- **Laetitia ROLLAND**
- **Jérôme MARTIN**

TEACHING LOCATION

Classes are held at **Nantes University**, within:

- The **Faculty of Science and Technology**,
- And from the **Faculty of Medicine and Medical Technologies**.

SKILLS ACQUIRED

Upon completion of the Master I3, students will have mastered the following skills:

- **Conducting research** and analyzing bibliographic and technological resources.
- **Designing a biology-health project** in their field of specialization.
- **Developing experimental expertise** in biology and health.
- **Analyze scientific data**, whether from fundamental, clinical, or pharmacological research.
- **Promote their results**, particularly through oral presentations, technical reports, and scientific publications.

Upon completion of the Master I3 (Immunology and Immuno-Intervention) program, graduates can pursue positions in **research and development** or continue their **academic research** career by pursuing a doctorate.

It is possible to prepare a **doctoral thesis** in France or abroad, with various funding options available, including:

- **CIFRE** agreements in partnership with a company,
- Funding from calls for projects from **EUR Biology Health** and its network,
- Other institutional or private support.

PROGRAM STRUCTURE

General presentation of the program

The I3 Master's program combines **fundamental** and **translational research**, drawing on an environment of scientific excellence. It focuses on three major themes:

- **Immunopathology** of chronic inflammatory diseases, autoimmune diseases, transplants, cancer, and sepsis.
- **Innovative immunotherapies** in oncology, transplantation, infectious diseases, and inflammatory diseases.
- **Host-microbiota interactions**, particularly at the mucosal level.

Teaching follows a **research-based training** approach, including:

- Gradual immersion in the laboratory,
- Scientific projects,
- Learning modern methods of cellular and molecular biology.

JOIN THE I3 MASTER'S PROGRAM

Scholarship

A **welcome scholarship of €1,500** is awarded to international students enrolled in our program. They can also apply for:

- The **Eiffel Excellence Scholarship**,
- Other scholarships offered by their embassies or national organizations.

MICAS program students doing an **internship abroad** may be eligible for mobility assistance in the form of a monthly allowance of **€500 to €700**, subject to eligibility.

How to apply

The prerequisites for admission and the application procedures are detailed in the **program information sheet**, available on the **Nantes University website**.

Master's 1 program

Specific teaching units for Master 1 I3



Teaching unit: Experimental approaches in immunology

Number of hours: 10.67

Year/Semester: Master 1 / Semester 1

Language of instruction: French/English

Prerequisites: Validated Bachelor's degree – Life Sciences

Objectives

By the end of this course, students will be able to:

- **Choose** the appropriate experimental technique for an immunological question.
- **Explain** and **present** experimental conclusions to an audience.

Content

Illustration of theoretical concepts and the main methods used in experimental immunology, in the form of exercises focused on the study of the immune response.

Teaching

- Classes are **entirely in-person**.
- Preparation of exercises and **oral presentations** during tutorials.

Bibliography

Immunology - The course by Janis Kuby (Dunod Publishing)

Immunology by Jean-Pierre Revillard (DeBoeck Publishing)

Immunobiology by Charles Janeway and Kenneth Murphy (DeBoeck Publishing)



UE: Bibliography in Immuno-Oncology

Number of hours: 16

Year/Semester: Master's 1 / Semester 1

Language: French/English

Prerequisites: Bachelor's degree – Life Sciences

Objectives

By the end of the module, students will be able to:

- **Summarize** a research topic.
- **Present and discuss** a scientific poster with peers and faculty members.

Content

Workshops on the following topics:

- Tumor escape mechanisms
- Tumor microenvironment
- T cell responses to tumor neoantigens

Students will work in groups on a scientific article and will have several deliverables to submit

Organization of sessions

1. **Sessions 1 to 3:** analysis of an article, summary in the form of a *speed poster*, presentation, and discussion.
2. **Session 4:** collective evaluation, in-depth analysis of results.
3. **Sessions 5 and 6:** writing a review summary (written + graphic format) and presentation.

Teaching methods

- Independent and group work.
- Oral presentations in the form of poster sessions.
- **Face-to-face** classes.

Bibliography

Immunology - The course by Janis Kuby (Dunod Publishing)

Immunology - Jean-Pierre Revillard (DeBoeck Publishing)

Immunobiology by Charles Janeway and Kenneth Murphy (DeBoeck Publishing)



EU: Bibliography on Immuno-Inflammation

Number of hours: 8

Year/Semester: Master's 1 / Semester 1

Language: French/English

Prerequisites: Bachelor's degree – Life Sciences

Objectives

By the end of the module, students will be able to:

- **Summarize** a research topic.
- **Present** a scientific poster and discuss its content.

Content

Workshops focused on:

- Chronic inflammatory diseases
- Anti-infectious responses
- Hypersensitivity reactions

Each group prepares a *speed poster* based on a scientific article, followed by a question and answer session.

Teaching methods

- **Face-to-face** lectures and tutorials.
- Independent group work to prepare the posters.

Bibliography

Immunology - Janis Kuby's course (Dunod Publishing)

Immunology by Jean-Pierre Revillard (DeBoeck Publishing)

Immunobiology by Charles Janeway and Kenneth Murphy (DeBoeck Publishing)



EU: Experimentation in Immunology

Number of hours: 40

Year/Semester: Master's 1 / Semester 1

Language: French/English

Prerequisites: Bachelor's degree – Life Sciences

Objectives

Students must be able to:

- **Master** basic techniques in cell culture and immunology.
- **Organize and manage** their workload during the practical week.

Content

Practical work illustrating:

- Analysis of lymphocyte response
- Study of apoptosis
- Cell culture and sorting
- Functional tests
- Microscopy
- Flow cytometry

Teaching methods

- "Wet" practical work carried out **entirely in person**.

Bibliography

Immunology - Janis Kuby's course (Dunod Publishing)
Immunology by Jean-Pierre Revillard (DeBoeck Publishing)
Immunobiology by Charles Janeway and Kenneth Murphy (DeBoeck Publishing)

UE: Applied Immunology

Number of hours: 24 hours
Year/Semester: Master's 1 / Semester 1
Language: French/English

(This course unit serves as an umbrella for the courses listed below)

Content consists of:

- **Immunology – Oncology (Course)**
- **Immuno-Inflammation (Course)**

Methods:

- **Face-to-face** course

EU: Immunology – Oncology (Course)

Number of hours: 16
Year/Semester: Master's 1 / Semester 1
Language: French/English

Objectives

By the end of the course, students will be able to:

- **Identify** the cellular and molecular actors involved in the antitumor immune response.
- **Classify** tumor escape mechanisms.
- **Describe** current strategies for cancer immunotherapy.
- **Explain** the mechanisms of normal and pathological inflammation.

Topics covered

- Immunity and cancer
- Tumor antigens
- Anti-neoantigen T cell responses
- Tumor microenvironment
- Immune escape
- Monoclonal antibodies
- Cancer vaccination
- Adoptive cell transfer
- Ionizing radiation and immunity

Teaching methods

- **Face-to-face** classes
- Regular surveys (formative assessment)
- Provision of a **toolkit** (visual aids)
- Self-assessments + discussion forum



EU: Immuno-Inflammation (Course)

Number of hours: 8

Year/Semester: Master's 1 / Semester 1

Language: French/English

Objectives

- Identify the actors involved in the inflammatory response.
- Understand normal and dysregulated inflammatory mechanisms.
- Describe the associated therapeutic strategies.

Topics

- Chronic inflammatory diseases
- Anti-infectious responses
- Hypersensitivity reactions

Teaching methods

Same as previous EU:

face-to-face, surveys, toolbox, forum, self-assessments.

Bibliography

Immunology - The course by Janis Kuby (Dunod Publishing)

Immunology by Jean-Pierre Revillard (DeBoeck Publishing)

Immunobiology by Charles Janeway and Kenneth Murphy (DeBoeck Publishing)



UE: Fundamental Immunology

Number of hours: 21.33

Year/Semester: Master's 1 / Semester 1

Language: French/English

Objectives

Students should be able to:

- **Deepen** their knowledge of the immune system.
- **Explain** the activation mechanisms and functions of immune system components.
- **Be familiar with** the main animal models used in immunology.

Topics

- T cell activation
- Presentation of antigen to T lymphocytes
- LB/LT signaling
- NK cells and ILCs
- Unconventional LT
- Regulatory lymphocytes
- Dendritic cells
- Immune tolerance
- Innate immunity
- Fc receptors

- Animal models
- Metabolism and immunology

Interdisciplinary modules for Master's 1



EU: Big Data 1-1 — Introduction to Bioanalysis

Number of hours: 24 hours (including 16 hours of lectures)

Year/Semester: Master's 1 / Semester 1

Language: French/English

Prerequisites: Validated bachelor's degree – basic knowledge of human and animal physiology

Objectives

By the end of this module, students will be able to:

- **Identify** the key steps in modeling a biological system.
- **Use** different data structures and algorithms to analyze biological data.
- **Use** a digital environment dedicated to bioanalysis.

Content

Lectures

- History and principles of modeling living organisms
- Introduction to scripting languages
- Algorithms and data structures
- Manipulation of biological files (FASTA, CSV)
- Sequence manipulation (DNA, RNA, proteins)
- Randomness management in programming

Practical work

- Extraction of biological information from FASTA sequences
- Automated alignments to produce a similarity graph

Teaching methods

Lectures, tutorials, and practical work **in person**, with applied exercises.

Bibliography

- Guttag JV. *Introduction to Computation and Programming Using Python*, MIT Press.
- Ekmekci B., McAnany C.E., Mura C. (2016). *An Introduction to Programming for Bioscientists: A Python-Based Primer*, PLOS Computational Biology.



EU: Big Data 1-2 — Introduction to Bioanalysis

Number of hours: 24

Year/Semester: Master's 1 / Semester 1

Language: French/English

Prerequisites: Validated bachelor's degree

Objectives

- **Practice** algorithmics and programming.
- **Analyze** genomic sequences.
- **Use** computer tools to represent and analyze biological data.

Content

Lectures

- Introduction to the computer environment
- Univariate statistical tests
- Types of data visualizations

Practical work

- Genomic sequence analysis
- Creating scripts for data analysis
- Visualization and representation of biological data

Teaching methods

Lectures and computer-based practical work.

Bibliography

- Haddock S., Dunn C. *Practical Computing for Biologists*, Oxford University Press.
- Antao T. (2022). *Bioinformatics with Python Cookbook*, Packt Publishing.

UE: Scientific writing workshops

Number of hours: 24

Year/Semester: Master's 1 / Semester 1

Language: French/English

Objectives

Students will learn to:

- **Analyze** raw biological data.
- **Present** results in graphical and statistical form.
- **Assemble** complete figures for publication.
- **Write** the different sections of a scientific article.

Content

The module covers all stages of producing a scientific publication:

1. **Introduction to the principles of publication**
2. **Processing and analysis of raw data**
3. **Statistical analysis** and graphical representations
4. **Organization of figures**
5. **Writing sections:**
 - Results
 - Introduction
 - Discussion
 - Abstract + graphic abstract
6. **Finalization of the article**
7. **Individual feedback interviews**

Teaching methods

- Competency-based learning
- Small group work and personalized supervision



EU: Genome manipulation tools – Workshops

Number of hours: 24 hours

Year/Semester: Master's 1 / Semester 1

Language: French/English

Prerequisites: Validated bachelor's degree

Objectives

Be able to:

- **Choose** the appropriate vectors for a gene expression strategy.
- **Design** a viral vectorization strategy.
- **Design** a knock-down, knock-out, or knock-in strategy.
- **Design** oligonucleotides suitable for cloning or mutagenesis strategies.

Content

- Cloning (plasmids, viral vectors)
- Choice of strategies: restriction, PCR, Gibson, Golden Gate, Gateway, etc.
- Expression of native, fused, or labeled proteins
- Knockdown (siRNA, shRNA)
- Genome editing via CRISPR-Cas9

Teaching methods

- Small group work
- Use of specialized web tools
- Submission of continuously assessed reports

Bibliography

Primrose, Twyman & Old – *Principles of Genetic Engineering*, De Boeck Université.



UE: Genome manipulation tools – Course

Number of hours: 24

Year/Semester: Master's 1 / Semester 1

Objectives

Students will:

- **Select** appropriate expression vectors.
- **Design** a viral or gene strategy.
- **Describe** the main methods of recombinant protein production.

Topics

- Enzymes and cloning vectors

- Modern cloning methods
- Production of recombinant proteins (prokaryotes & eukaryotes)
- Viral vectors for gene transfer
- Knockdown / Knockout / Knock-in
- CRISPR-Cas9

Teaching methods

Lectures and active participation.

UE: Bibliographic research tools

Number of hours: 0 hours (introductory module)

Year/Semester: Master's 1 / Semester 1

Language: French

Objectives

- Effectively **search** for scientific articles.
- **Use** databases (PubMed, etc.).
- **Manage** references using dedicated software (Zotero).

Methods

Madoc materials + library workshops as needed.

EU: Fundamental Principles of Organizations and Management I

Number of hours: 24 hours

Year/Semester: Master's 1 / Semester 1

Language: French

Objectives

- **Describe** an organization.
- **Identify** an organizational problem.
- **Analyze** managerial issues.
- **Organize** a project.
- **Implement** appropriate management practices.

Content

Two parts:

1. **Organizations and managerial issues (16 hours)**
 - Culture, power, strategy, decisions, management tools
2. **Introduction to project management (8 hours)**
 - Objectives, planning, internal/external communication

Methods

Lectures and case studies.

The fundamentals of organization II

Number of hours: 24
Year/Semester: Master's 1 / Semester 2
Language: French
Prerequisites: Validated bachelor's degree

Objectives

Be able to:

- **Work** within a highly interdisciplinary group
- **Understand** and use team leadership and collective intelligence tools
- **Master** the theoretical challenges of in situ design

Content

- Acquire project management and entrepreneurship skills through an intensive two-day interdisciplinary project. Each year, GS Santé + students will tackle a different theme related to a major transition (or technological challenge), for which they will be required to provide a response in a format defined by the teaching team (e.g., business project, initiative project, prospective scenarios, creation of a work of art, etc.).
- In addition to the project activity, students will take various course modules over the two days to acquire new knowledge:
- Introduction to the use and challenges of "canva" tools (economic model, circular model, impact models, etc.). Innovative design course to develop reflexes and the ability to produce prototypes and/or artifactual solutions to a given problem.

Face-to-face teaching methods

Bibliography

Lean Startup, Ries, 2012, Pearson

Value Proposition Design, Pigneur et al, 2015, Pearson

58 Tools for Systemic Design: For Planet-Centered Design, Daumal, 2023 Eyrolles



EU: Scientific communication and communication in English

Number of hours: 24
Year/Semester: Master 1 / Semester 2
Language: English

Objectives

Be able to:

- Give a presentation in English on a topic of your choice.
- Read an article in English, extract the key points, and present them in English.
- Listen to audio or video recordings on biology and health issues and summarize them in writing or orally.
- Acquire and use technical vocabulary related to biology and health.

Content

Methods

In-person and remote

Bibliography

Glendinning Eric H et al. *Professional English in Use: Medicine*. Reprint. Cambridge University Press 2015.



UE: Study and internship research work

Number of hours: 0

Year/Semester: Master's 1 / Semester 2

Language: English

Objectives

Students are responsible for finding their own internship, which requires them to put their communication skills into practice (resume, cover letter, interview). However, a number of internships in laboratories (mainly university laboratories in Nantes) and hospital departments (mainly Nantes University Hospital) will be offered to students. The aim of the internship is to strengthen the student's professional profile by placing them in a professional environment.

At the end of this course, students will be able to:

- **conduct** research and produce a bibliographic summary on a given topic (analysis of articles from scientific journals in English)
- **carry out** experimental protocols, after understanding all the steps involved
- independently **master** the techniques learned during their internship
- **Keep** a laboratory notebook in accordance with good laboratory practice
- **Critically analyze** the results of their experiments
- **Present** their work clearly, accurately, and rigorously in the form of an oral presentation
- **Answer** questions from the jury.

Topics covered

This "Internship" module is designed as an introduction to the professional world, under the supervision of an internship supervisor, researcher, or teacher-researcher in academia or industry, in France or abroad. It takes place at the end of the second semester, over an 8-week period integrated into the study program.

This professional training module takes several forms, depending on the student's career orientation:

- either an internship in a research laboratory or in a company whose field of activity is related to the biological sciences and the career profile chosen by the student (experimental research, bioanalysis)
- either an internship in a hospital department for students who have chosen the Clinical Research career profile.
- or a literature review on a biology research topic

Teaching methods

Students are supervised by an internship supervisor within the host organization.

Each student is monitored by a tutor who is a member of the teaching team and who ensures that the internship runs smoothly.

Bibliography Scientific articles related to the theme of the internship research project.



EU: Study and research work for thesis

Number of hours: 0

Year/Semester: Master's 1 / Semester 2

Language: French/English

Objectives

Students are responsible for finding their own internships, which requires them to put their communication skills into practice (resume, cover letter, interview). However, a number of internships in laboratories (mainly university laboratories in Nantes) and hospital departments (mainly Nantes University Hospital) will be offered to students. The aim of choosing an internship is to strengthen the student's professional profile by placing them in a professional environment.

At the end of this course, students will be able to:

- **conduct** research and produce a bibliographic summary on a given topic (analysis of articles from scientific journals in English)
- **carry out** experimental protocols, after understanding all the necessary steps
- independently **master** the techniques learned during their internship
- **keep** a laboratory notebook in accordance with good laboratory practice rules
- **critically analyze** the results of their experiments
- **present** their work clearly, precisely, and rigorously in the form of a written report.

Content

This "Internship" module is designed as an introduction to the professional world, under the supervision of an internship supervisor, researcher, or teacher-researcher in academia or industry, in France or abroad. It takes place at the end of the second semester, over an 8-week period integrated into the study program.

This professional training module takes several forms, depending on the student's career orientation:

- either an internship in a research laboratory or in a company whose field of activity is related to the biological sciences and the career profile chosen by the student (experimental research, bioanalysis)
- or an internship in a hospital department for students who have chosen the Clinical Research career path.
- This is a literature review on a research topic in biology.

Methods

Students are supervised by a supervisor within the host organization.

Each student is monitored by a tutor who is a member of the teaching team and who ensures that the internship runs smoothly.

To help students write their internship reports, a thesis writing guide is available on the university's Moodle teaching platform.

Bibliography Bibliography necessary for understanding and developing the internship topic.



EU: Biological data management: semantic web

Number of hours: 0

Year/Semester: Master 1 / Semester 2

Language: French/English

Objectives

Be able to:

At the end of this course, students will be able to:

- Be able to access biomedical data available on the web
- Formalize queries to explore this data
- Model medical knowledge using formal languages that can be understood by machines
- Reason symbolically based on medical data

Content

The lessons in this course focus on biomedical knowledge graphs available on the web:

- Knowledge graph modeling
- Linked data concepts
- Knowledge graph querying
- Biomedical ontology concepts
- Deduction of new knowledge
- Applications of ontology in biomedicine

Methods

Teaching will take the form of lectures based on scientific publications. It will also include the sharing of knowledge, expertise, and practical scenarios during practical work.

Bibliography

A bibliography updated annually will be included in the course materials.



EU: Exploration of metalism in pathologies

Number of hours: 24

Year/Semester: Master's 1 / Semester 2

Language: French

Objectives

Be able to:

Upon completion of this course, students will be able to:

have a general understanding of integrated and cellular metabolism

- Distinguish between homeostatic and pathological metabolism Become familiar with current approaches to the study of metabolism
- Propose the use of an approach based on the question asked
- Present this message in a brief oral presentation

Content

Lecture: 5:20 p.m.

General concept of energy metabolism (2 hours 40 minutes) Xavier Prieur Fundamental principles of cellular metabolism

Energy substrate and cellular phenotype (examples of metabolic diseases, oncology, and immunity)

Energy supply and exchange and inter-organ dialogue; concept of metabolic flexibility

Assessment of cellular metabolism (2 hours 40 minutes) (Claire Pecqueur)

Various techniques for exploring mitochondrial activity and oxygen consumption. Exploration of fluxomic approaches to deciphering the active metabolic pathway.

Analysis of a cell's substrate dependence and preferences in different situations (fasting or after a meal, normal or tumorigenic, activated or at rest, etc.).

An integrated view of metabolism in vivo (4 hours)

Kinetic studies of labeled molecules - In vivo fluxomics (Khadija Ouerram) 1 hour 20 minutes PET and metabolic imaging (18-F glucose monitoring) (see Françoise Kraeber Bodéré) 1 hour 20 minutes In vivo metabolic phenotyping (Xavier) 1 hour 20 minutes

Systems biology of metabolic data (4 hours) (Mikael Croyal 1 hour 20 minutes, Yann Guitton 1 hour 20 minutes, Damien Eveillard 1 hour 20 minutes)

Metabolomic, lipidomic, and high-throughput metabolite analysis: principles of analytical chemistry (mass spectrometry, NMR, etc.)

Analysis of metabolic networks using big data **Metabolic stress and cellular remodeling (4 hours)** Cellular stress and metabolism (Xavier Prieur) 1 hour 20 minutes

Hypoxia resistance and metabolic switching Claire Pecqueur (1 hour 20 minutes) Overview of immunometabolism (1 hour 20 minutes) Aurélie Moreau) **Tutorial: 6 hours 40 minutes**

Integrated overview: article from Cell Metabolism or Nature Metabolism studying a key phenomenon. The choice of articles will depend on the student's general focus (cardiometabolic, nutrition/health, immunometabolism, oncometabolism).

Tutorial 1: 1 hour 20 minutes After reading, summarize the scientific question in a graphic summary 1 hour 20 minutes Tutorial 2: Highlight a method

Presentation session: 4 hours, flash poster

Exam: a scientific question asked: proposal of an experimental plan to answer the question.

Methods

Lectures – Tutorials: analysis of articles and flash poster presentations

Bibliography

The one used during the course



EU: Genome manipulation tools: practical work

Number of hours: 10

Year/Semester: Master's 1 / Semester 2

Language: French/English

Objectives

By the end of this course, students will be able to:

This module aims to illustrate and enable the implementation of tools for manipulating and modifying genomes.

- Design a KO strategy
- Implement a CRISPR/Cas9 strategy (2020 Nobel Prize) to achieve a genetic knockout.
- Analyze and present their experimental results
- Integrate their experimental results into a broader panel

Content

Genetic editing using the CRISPR/Cas9 technique has changed research practices in many laboratories. Its use currently allows genes to be deactivated or manipulated. This technology is implemented in these practical exercises to switch off a gene in *E. coli*.

The steps are as follows:

- Analysis of the GFP sequence
- Definition of crRNA sequences enabling GFP silencing.
- Construction of an expression plasmid enabling the expression in bacteria of an sgRNA targeting GFP and Cas9.
- Co-transformation of *E. coli* bacteria with plasmids encoding GFP, an sgRNA targeting GFP, and Cas9.
- Induction of GFP +/- sgRNA and Cas9 expression in bacteria.
- Observation and analysis of differences in GFP expression.
- Performing an analysis using the T7 endonuclease test of the extinction of the eukaryotic P53 gene

Methods

Practical work in pairs in a fully equipped room allowing manipulations to be carried out under professional conditions

Bibliography

Principles of Genetic Engineering, Sandy PRIMROSE, Richard TWYMAN, Bob OLD, DE BOECK UNIVERSITÉ Publishing



EU: stem cells and organoids

Number of hours: 24

Year/Semester: Master's 1 / Semester 2

Language: French/English

Objectives

Be able to:

- Identify the hypothesis and experimental approach in an article
- Search for bibliographic resources
- Analyze and interpret scientific results

Content

Lecture section

- Human stem cells (General concepts: developmental biology and cell fate – Pluripotency – fetal and adult stem cells)
- Multicellular systems derived from stem cells (introduction to organoids, impact of environmental changes on organoids, complex organoids derived from pluripotent stem cells, 3D culture models)

Tutorial section:

- Application of stem cell culture processes
- Identification of hypotheses and experimental approach in a selected article
- Analysis of the results of a scientific study, selection of articles after a literature review

Methods

In-person and remote

Bibliography

The dedicated bibliography will be provided during the course



EU: Innovative strategies in therapy

Number of hours: 24

Year/Semester: Master's 1 / Semester 2

Language: French

Objectives

Be able to:

- identify the key stages of proof-of-concept studies in the clinical development of a biotherapy
- have a reasoned opinion on a range of therapies, including gene therapies, cell therapies, drug therapies, and immunotherapies
- assess the need for multidisciplinary knowledge to develop a health therapy
- summarize a research topic and discuss it with students and faculty in a graphic presentation based on the analysis of two scientific articles.

Content

Lecture portion – 14.67 hours

After an introductory lecture, two examples of therapeutic strategies currently in use will be presented in each of the topics associated with *graduate programs*: Cell therapies after allogeneic hematopoietic stem cell transplantation
Gene therapy for SCID-X

Generation of monoclonal antibodies for therapeutic use
Transfer of genetically modified lymphocytes

From skeletal pathophysiology to reconstruction
Duchenne muscular dystrophy

Fecal transplantation
Phage therapy

Cardiovascular stem cells Cardiovascular pharmacotherapy **Tutorial section – 9.33 hours**

Two articles related to a given topic will be distributed to a group of 2 to 3 students, who will be asked to present them in the form of graphic summaries.

Methods

All classes will be taught in person.

Live or online surveys will be conducted at the beginning of the

semester to assess prerequisites in immunology and/or physiology, then regularly during the course to ensure that students understand important concepts. Videos and photos (toolbox) will be made available on Madoc to illustrate the courses and techniques.

Self-assessment tests and sample exam questions will be provided, and an online forum will be open to allow for a question-and-answer exchange between teaching staff and students. Students will work independently and prepare summaries of two articles in written and graphic form.

Bibliography

Principles of Genetic Engineering, Sandy Primrose et al. (DeBoeck Publishing)

Immunology - The Course by Janis Kuby Judy Owen et al. (Dunod Publishing)

Fundamentals of Basic and Clinical Immunology by Abul K. Abbas et al. (Elsevier)

Master's program 2

The Master 2 program in **Immunology and Immuno-Intervention (I3)** offers an advanced study of physiological and pathological immune mechanisms, as well as innovative strategies for manipulating the immune system in a clinical context.

The courses draw on the recognized expertise of several cutting-edge research laboratories and on strong interaction between **researchers, engineers, teacher-researchers, and clinicians**.

The year includes:

- specialized teaching units,
- the design of a scientific project,
- a long laboratory internship,

- and professional simulations.

Master 2 I3 Experimental Research Profile for Scientists



EU: Big data 2 – Multivariate analysis

Number of hours: 4

Year/Semester: Master 2 / Semester 3

Language: French/English

Objectives

Be able to:

- Be able to access biomedical data available on the web
- Formalize queries to explore this data
- Modeling medical knowledge using formal languages that can be understood by machines
- Reasoning symbolically based on medical data

Content

The lessons in this course focus on biomedical knowledge graphs available on the web:

- Knowledge graph modeling
- Linked data concepts
- Knowledge graph querying
- Biomedical ontology concepts
- Deduction of new knowledge
- Application of ontology in biomedicine

Methods

Teaching will take the form of lectures based on scientific publications. It will also include the sharing of knowledge, expertise, and practical scenarios during practical work.

Bibliography

A bibliography updated annually will be included in the course materials.



EU: Big data 2 – Multivariate analysis

Number of hours: 24

Year/Semester: Master 2 / Semester 3

Language: French/English

Objectives

Be able to:

- Learn multivariate analysis techniques

- Learn data discrimination techniques
- Learn data regression techniques
- Learn data classification techniques
- Implement data analysis techniques in Python
- Use implementation results to identify relevant biological outcomes
- Introduction to multivariate data analysis
- Introduction to Python programming libraries for implementing multivariate analyses

Contents

Methods

Bibliography



EU: Innovative Therapeutic Strategies II

Number of hours: h

Year/Semester: Master's 2 / Semester 3

Language: French/English

Objectives

Be able to:

- Identify the key stages of proof-of-concept studies in the clinical development of a biotherapy
- form a reasoned opinion on a range of therapies, including gene therapies, cell therapies, drug therapies, and immunotherapies
- appreciate the need for multidisciplinary knowledge to develop a medical therapy

Content

Lectures: presentation of new strategies currently being developed to treat diseases in areas related to the various graduate programs. Speakers will be asked to begin by tracing the history of the development of treatments and tools:

GP-I3 and OHNU: new bioactive microbial metabolites for therapy, next-generation CAR-T cells for cancer, potentiation of cancer therapies

GP M4R: Bioprinting, large-scale production of viral vectors GP MICAS: Extracellular vesicles, medicinal bacteria

GP InnoCare: extracellular vesicles in cardiology, high-throughput screening for new therapeutic targets

Tutorials and practical work will enable students to work in groups of 2 to 3 to produce a poster illustrating an innovative strategy associated with a GP theme (possibly covered in M1 lectures) and 2 to 4 related articles dealing with development and progress (cell/gene therapy, animal models, etc.) up to the clinical stage for the treatment of a disease. The theme and articles will be validated by the teacher at the end of the presentation session.

Tutorial: introductory session/presentation

Practical work: preparation sessions during which students must read the articles, submit a detailed plan, and then prepare their poster. Poster to be submitted at the end of the practical work.

Methods

All teaching will be face-to-face.

Video and photographic material (toolbox) will be made available on Madoc to illustrate the courses and techniques.

Self-assessment tests and sample exam questions will be provided, and an online forum will be set up to enable a question-and-answer exchange between teaching staff and students. Students will work independently and prepare a poster.

Bibliography



EU: Industry and Technology

Number of hours: 20

Year/Semester: Master 2 / Semester 3

Language: French/English

Objectives

Be able to:

- Select the information needed to develop an appropriate experimental approach based on their knowledge and the literature;
- Identify the most appropriate complementary research techniques for developing a research project;
- Apply these techniques to a research project;
- Determine their limitations in the implementation of a research project.
- Students will also acquire knowledge about:
 - the industry
 - the applicability of the skills acquired during the master's program to industry

Content

The objective of this teaching unit is to present innovative technologies in biomedical research within the framework of research projects conducted by various laboratories in Nantes. It will focus on two main areas:

- a technological component: new technological approaches in biomedical research, such as transgenesis using the CRISPR/Cas9 approach, high-throughput sequencing and its applications, multiparametric analysis using cell imaging or flow cytometry, and IP, through various research projects;
- An industrial component: various speakers will be invited (former students of the Nantes master's program, start-ups, biotechnology companies, etc.) to present their professions and career paths.
- Some of the presentations will be renewed each year.

Teaching methods: lectures and round tables

Bibliography



EU: Animal models and integrated physiology

Number of hours: 24

Year/Semester: Master 2 / Semester 3

Language: French/English

Objectives

Be able to:

- Provide students with a solid foundation in integrative biology and the essential knowledge for an ethical and scientific approach to the use of animals in biomedical research (in the fields of anatomy, behavior, ecology, environmental footprint, evolution, genetics, genomics, and pathophysiology).
- Promote integrative analysis of animals, particularly in the context of the post-genomic era, at the interface of organoid, in vitro, and in silico approaches.
- Understand fundamental and methodological advances as well as the latest conceptual principles for studying genes and their products, their integrated regulation and pathophysiological implications, and their use as therapeutic targets and innovative therapies.

Content

Introduction

From the genome to integrative biology/The rational use of animals/Legislation and ethics in experimental animal research/From the genome to integrative biology

Integrated genomics

- Transgenic, Knock-Out, and Knock-In rodents and immunophenomics.
- Spontaneous genetic models for etiological, pathophysiological, and therapeutic approaches to human genetic diseases
- High-throughput study of gene function (zebrafish, Xenopus)
- Genetic modeling and evolution (animal and human phylogeny, choice of animal model) Environmental and post-transcriptional regulation models
- Epigenetic mechanisms of gene expression control and programming
- MicroRNAs, physiological and pathological roles
- Roles of extracellular vesicles in intercellular communication.
- Nutritional imprinting
- Nuclear medicine and phenotypic imaging
- Cognitive models of pathophysiology and therapeutic approaches
- Interface between the autonomic nervous system and the immune system
- Environmental factors
- Large animal models (translational and precision medicine, osteoarticular repair, transplantation , etc.)
- In vivo approaches in animal imaging

Methods

Conferences/Courses

Bibliography

EU: Reading club

Number of hours: 24

Year/Semester: Master 2 / Semester 3

Language: French/English

Objectives

Be able to:

- Conduct a literature review in biomedical research;
- Design a research project in this field;
- Determine the most appropriate strategies for its implementation;
- Oral presentation of this project and a relevant scientific publication related to it;
- Defend and argue in favor of the project presented and the scientific publication chosen.

Methods

Expectations will be specified during an introductory class.

Content

Students will give an oral presentation of the research project they will develop during their internship, including (1) its international context, supported by a relevant scientific publication (not from their host laboratory) and (2) the context of their host team.

Bibliography

EU: Interdisciplinary Project – Management I

Number of hours: 21

Year/Semester: M2 / S3

Language: French/English

Objectives

Be able to:

- Acquire specific tools for managing projects in uncertain situations
- Responding to a call for projects
- Knowing how to plan and organize over time
- Managing a team in uncertain situations
- Knowledge and understanding of the technological, human, and societal challenges associated with transitions
- Critical and analytical view of technologies
- Basic knowledge of local, national, and international innovation systems.

Content

As part of this teaching unit, students will:

Deepen their knowledge and tools in project management and address the major contemporary challenges of innovation and technology management as well as transitions. Two themes will be addressed:

Contemporary project management practices (tutorials/practical work): you will build on the knowledge acquired in semesters 1 and 2: in-depth understanding of research organization through calls for projects and the inherent difficulties, discovery and application of contemporary project management tools, discovery of agile methods for acting in conditions of uncertainty, etc.

Innovation Management in Transitions (lecture course): you will explore key concepts through elements of general culture, but you will also develop a critical and relevant perspective on both theoretical and more current topics (the place of technology in transitions, understanding innovation processes, the challenges of disseminating and accepting innovations and technologies in society, taking ecological constraints into account in innovation models, etc.). In particular, you will address three themes in this course: the question of the definition and possibility of managing innovation; the question of spatial anchoring in innovation ecosystems; and the question of paradigm shifts (growth, ecology, sobriety, etc.) through innovation.

Methods

Face-to-face

Bibliography

EU: Interdisciplinary project – Management II – professional integration

Number of hours: 24
Year/Semester: M2 / S3
Language: French/English

Objectives

Be able to:

- interview with a professional in the field (recruitment agency) real-life scenario
- preparing a resume based on a job offer
- interview preparation
- role-playing
- debriefing of stage 1 with course coordinators during an individual meeting

Content

professional integration support module – preparing for and conducting interviews with professionals

Methods

role-playing and individual interviews

Bibliography

Master 2 I3 Specific modules

EU: Innovative Concepts in Immunology

Number of hours: 24
Year/Semester: Master 2 / Semester 3
Language: French/English

Objectives

Be able to:

Content

Each theme will focus on an innovative concept in immunology and will be led by an expert researcher. Students will work in small groups to give an oral presentation on an article related to the theme that they will have studied beforehand. The researcher will then summarize the three articles presented during the session and guide students in developing their critical thinking skills.

Methods

In person

Bibliography

EU: Immunopathology

Number of hours: 24

Year/Semester: Master's 2 / Semester 3

Language: French/English

Objectives

Be able to:

Content

As part of this Immunotherapies course, teaching will be provided by researchers who are experts in their field in the form of lectures/conferences.

Classes will be held in person.

The program consists of three chapters:

- Immunity and Systems
- Autoinflammatory and Autoimmune Diseases
- Anti-infectious Responses

Methods

The assessment for this course unit is shared with the other two course units: Innovative Concepts in Immunology & Immunotherapies for CMD I3

An article, with the title, abstract, introduction, and discussion removed, related to a topic covered in the course unit, will be provided to the student.

relation to a topic covered in the course unit will be provided to the student.

During this exam, students will be required to propose a title, abstract, and introduction for this article.

In order to cover the three professional profiles of our CMD, the articles will cover clinical research, experimental research, and biological data research and analysis.

Bibliography

EU: Immunotherapies

Number of hours: 24
Year/Semester: Master's/Semester 3
Language: French/English

Objectives

Be able to:

- Explain the different strategies developed in immunology to fight cancer;
- Categorize these strategies;
- Apply these strategies to new fields of research;
- Integrate major advances in the field of immunology in relation to oncology;
- Propose an appropriate experimental approach.

Content

As part of this Immunotherapies course unit, teaching will be provided by researchers experts in their field in the form of lectures/conferences.

The program consists of two chapters:

- Cancer Immunotherapy
- Cell and Gene Therapies (for CMD I3)

Methods

Teaching will take the form of lectures with extensive illustrations from scientific publications. Teams of hospital researchers and practitioners will be trained to best illustrate the "bench to bedside" concept.

Teaching will take place in person.

Bibliography

The Biology of Cancer by Robert Weinberg & Janeway's Immunobiology

A bibliography updated annually will be included in each lecturer's materials.

UE: Immune Pathologies and Therapies

Number of hours: 48
Year/Semester: Master 2 / Semester 3
Language: French/English

Objectives

Be able to:

Content

- Immunopathologies - CMD I3 (XMS3BE150)
- Immunotherapies - CMD - I3 OHNU (XMS3BE160)

- Assessment of Specific Competency 3 I3 (XMS3BE181)

Methods

In person

Bibliography

UE: CMD M2 oral internship

Number of hours:

Year/Semester: Master 2 / Semester 4

Language: French/English

Objectives

Be able to:

- Conduct a review of relevant literature;
- Apply their acquired theoretical knowledge to the development of a research project;
- Design scientific protocols;
- Select the most relevant methodologies for implementing a research project;
- Critically analyze scientific results;
- Write and present an informative internship report;
- Defend hypotheses and results in a relevant manner during a discussion with a jury.

Methods

Immersion

Content

EU Internship evaluation through oral defense

Bibliography

EU: M2 internship report

Number of hours:

Year/Semester: Master 2 / Semester 4

Language: French/English

Objectives

Be able to:

- Conduct a review of relevant literature;
- Apply theoretical knowledge acquired to the development of a research project;
- Design scientific protocols;

- Select the most relevant methodologies for implementing a research project;
- Critically analyze scientific results;
- Write and present an informative internship report;
- Discuss hypotheses and results in a relevant manner during a panel discussion.

Methods

Immersion

Content

Students will complete a 6-month internship in a university or private laboratory.

Bibliography

EU: Internship evaluation form

Number of hours:

Year/Semester: Master 2 / Semester 4

Language: French/English

Objectives

Be able to:

Learners will receive an evaluation from the professional who supervised them during their internship, providing them with detailed feedback on their work.

Content

The purpose of this internship evaluation form will be explained to students and supervisors. This form, completed by the supervisor, will be used to evaluate the work performed by the student during their internship. This evaluation will be taken into account in the final grade for the internship.

Methods

Immersion

Bibliography

Career opportunities & Further studies

Career opportunities

Graduates can join:

- academic laboratories,
- pharmaceutical and biotechnology companies,
- hospitals,

- specialized technology platforms.

Continuing on to a PhD

The I3 Master's degree opens the door to theses in:

- immunology,
- oncology,
- inflammation,
- immunotherapies,
- microbiota and mucous membranes,
- cellular and molecular biology.

Possible funding:

- Doctoral schools
- National calls for proposals (ANR, FRM, etc.)
- CIFRE contracts
- European funding

