# Module Handbook

## International Master of Science Biomedical Sciences (IMBS)

**Faculty of Medicine**

**University of Freiburg (UFR)**

UNI FREIBURG


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In cooperation with
**University of Buenos Aires, Argentina**
Faculty of Pharmacy and Biochemistry and
Faculty of Medicine

and
**Hochschule Furtwangen University**
**(HFU)**

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# 1. Concept of the IMBS Program

## 1.1 Purpose and characteristics

The International Master of Science Biomedical Sciences (IMBS) is a joint program between the Faculty of Medicine of the University of Freiburg (UFR) and the Faculty of Medicine and the Faculty of Pharmacy and Biochemistry of the University of Buenos Aires (UBA), Argentina. The program was implemented in a specific agreement co-signed by the Rectors of both Universities in 2008. The cooperation was strengthened by the UBA visit of the Minister President of Baden-Württemberg Winfried Kretschmann in 2011 when another agreement was signed. The IMBS course program with its Master in Biomedical Sciences at UBA was accredited by the National Commission for University Evaluation and Accreditation (CONEAU), Argentina, with the best possible rating A in 2014 and was successfully reaccredited in 2018. In fall 2017, the German accreditation agency AQUIN approved the IMBS program as a binational master program with double degree. This means that the students get a Master of Science Biomedical Sciences certificate from UFR and a Master of Biomedical Sciences certificate from UBA. In November 2018, this double degree program was also approved by CONEAU in Argentina.

The aim of the IMBS program is to provide scientific knowledge and state-of-the-art experimental experience to current and emerging biomedical research areas with a focus on translational research and development. It is also meant to foster teaching and research cooperation between the two Universities and to contribute to cultural exchange on the master student, PhD and professor level. The particularity of the program is therefore its **international, interdisciplinary and intercultural nature**.

The program is designed as an intensive time of studies and research with a specific and practical training that qualifies for success in academia or the private sector. IMBS modules treat the following topics: Biophysics, Bioenergetics and Biological Oxidation, Virology, Cellular and Molecular Immunology, Microbiology, Physiology, Pharmacology I, Toxicology I, Pathology, Biochemistry and Molecular Biology, Neurobiology, Molecular Oncology I, Clinical Medicine (at UBA) and Molecular and Cellular Biology, Pharmacology and Toxicology II, Molecular Cardiology, Molecular Oncology II, Pathology and Immunology, Materials and Microsystems, Biostatistics and Machine Learning and Bioethics (at UFR). After the modules at UFR, participants can choose up to two personal lab research projects (lab rotations) of a total duration of 4 months. Each research project is individually supervised and has to last at least 2 months. It involves experimental work, data analysis and a written lab report in the format of a scientific research publication for each lab research project. In addition to this mandatory curriculum, elective courses in Gene Editing and Flow Cytometry Analysis were introduced. The program is tailored to the interests of international graduate students with professional experience. Applicants should hold at least a Bachelor's degree or equivalent degree in Biology, Biochemistry, Medicine, Chemistry, Pharmacology or related fields and have at least one year of working experience.

Since 2008 **130 students have completed the innovative IMBS program with good to excellent grades** of which 16 received the double degree. 75% of them continued their training with a PhD thesis in Germany, Argentina or elsewhere, 25% got a job in university or industry.

## 1.2 Expected learning outcomes

**Knowledge**

After successful completion of the program, the participants:

- Understand how relevant methods can be applied to address particular research questions in the area of Biomedicine
- Have sufficient knowledge in human pathology, physiology, pharmacology and toxicology and specific research areas like cardiology, oncology and immunology to direct translational, clinical human research
- Have a profound understanding in Bioethics to assess contemporary and future ethical issues in a responsible way
- Know the right statistical tools to apply to future experimental studies in Biomedicine and translational human research
- Know how to design and implement interdisciplinary research projects
- Can correspond and work with scientists from different cultures and scientific backgrounds

**Cognitive skills**

After successful completion of the program, the participants are able to:

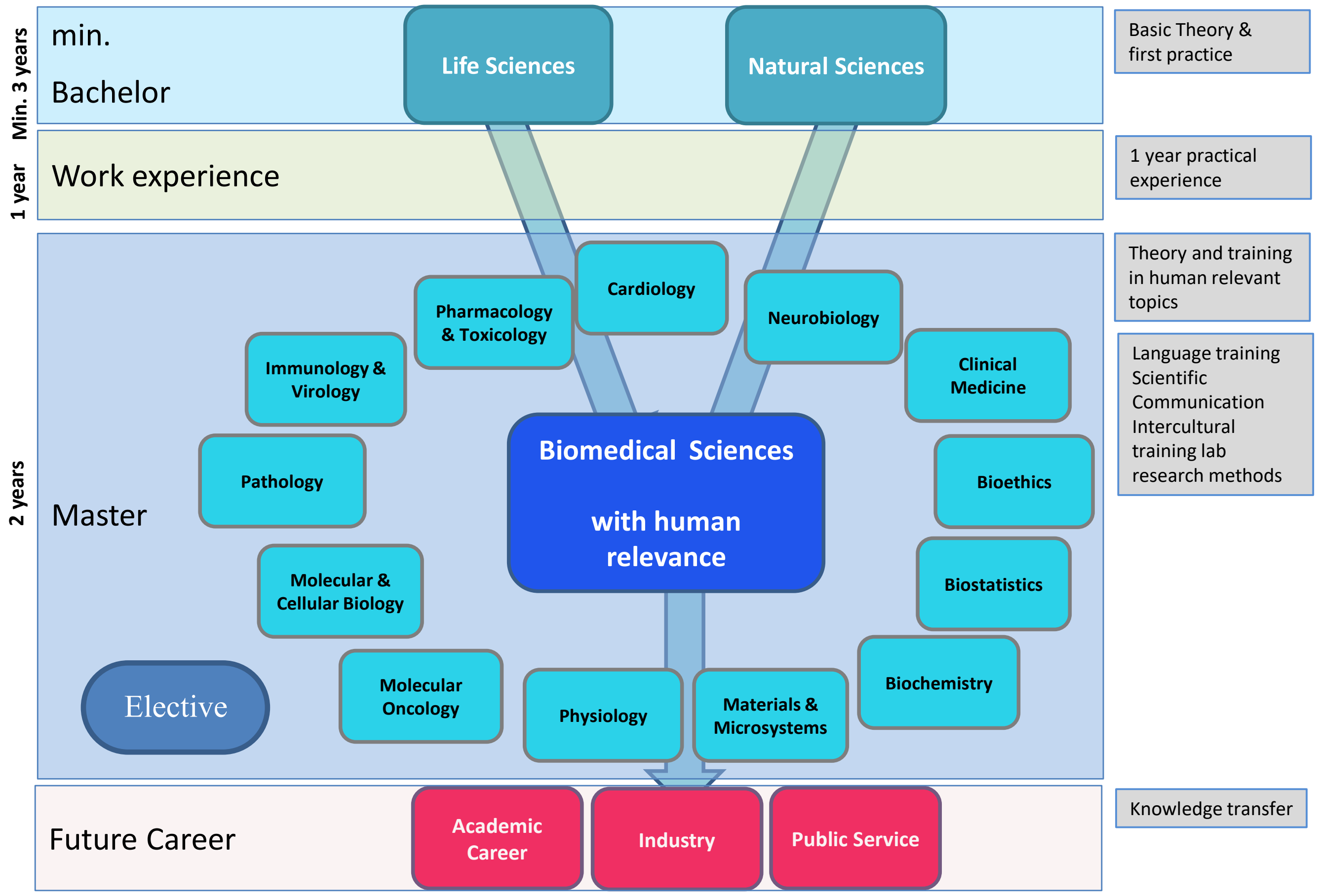
- Analyse, synthesize and evaluate information from a variety of sources in a critical manner
- Apply knowledge in a variety of contexts to analyse and reach evidence-based conclusions on complex human research problems and opportunities in the field of Biomedicine and translational research
- Put into practice the principles and values of ethical practice with regard to the design and implementation of operational research studies, consent and confidentiality in the collection, analysis, presentation, publication and dissemination of data
- Demonstrate creativity, innovation, inspiration and originality in the application of knowledge

**Practical skills**

After successful completion of the program, the participants are able to:

- Formulate research questions, develop an appropriate research strategy and implement a systematic approach to biomedical project planning and quality management
- Undertake research studies in an ethical and responsible manner and accurately record the data collected
- Efficiently and effectively collect, analyse, manage and disseminate data collected in the field
- Inform policy-makers about short-, medium- and long-term policy options for biomedical and translational research design and preparedness in an increasingly interconnected, global environment

## 1.3. Conceptual framework



The aim of the IMBS program is to provide undergraduate students from all different disciplines of life- and natural sciences (with at least a Bachelor's degree and one year of working experience) an in-depth training in human relevant Biomedical Sciences. We expect these people to build an interdisciplinary network that cross-fertilizes itself by bringing in different expertise with the same common goal, to apply knowledge to better understand human health and disease and to obtain better treatment options in the future. The charm of the program is not only its biomedical, translational orientation, but also its internationality. Participants from all continents (international) promote intercultural exchange and contribute to the increasing demand of solving scientific, economic, ethical and political issues on a global level. For the UFR the IMBS program has been the first international master program with a double master's degree (Master of Science from UFR, Master of Biomedical Sciences from UBA) involving a collaborating partner in a Latin American country (Argentina). In this respect the program is a novelty at UFR. Together with the University College Freiburg, which is also an international, interdisciplinary program (BSc), the IMBS master program has increased the international profile of UFR and contributed to a better visibility worldwide.

# 2. Structure and Organization

## 2.1 Interdisciplinary collaboration of institutions

The IMBS master program is a truly interdisciplinary and intercultural undertaking at Freiburg University incorporating different disciplines and faculties. The program is under the responsibility of the Faculty of Medicine and organized by the Institute of Molecular Medicine and Cell Research (IMMZ) in cooperation with the Faculty of Pharmacy and Chemistry and the Faculty of Medicine at the University of Buenos Aires, Argentina.

### 2.1.1 Faculty of Medicine at UFR

The Faculty of Medicine at UFR consists of the medical school and dental school and forms the university's biomedical research unit together with the University Medical Center Freiburg. The research at the Medical Center focuses on Immunology and Infectiology, Molecular Cell Research and Regenerative Medicine, Epigenetic and Functional Genetics, Neurosciences and Oncology and Functional Imaging. Professors from three of the five research areas teach in the IMBS program. In addition, the Faculty of Medicine encompasses eight research institutes, among them Molecular Medicine and Experimental and Clinical Pharmacology and Toxicology, which participate in the IMBS curriculum.

The Faculty of Medicine was founded in 1457 as one of Germany's oldest and is regarded among its most distinguished Institutes. It consistently ranks very highly in a variety of national and international rankings. According to the 2020 Humboldt Ranking, measuring the number of research stays by foreign fellows and award winners sponsored by the Humboldt Foundation, the Faculty of Medicine at UFR ranked as number six in the life sciences. Moreover, a recent survey done by the German Federal Ministry for Education and Research showed that the Faculty of Medicine at UFR topped the list of the most attractive medical schools for students, receiving the most applications for an MD program in Germany. Only about 5% of the applicants were admitted, also making Freiburg one of the most selective schools.

The Faculty of Medicine at UFr offers four study degree programs, Medicine, Dental Medicine, Molecular Medicine and Nursing (BSc). Currently, approximately 4800 (2020/2021) students are enrolled at the Faculty of Medicine, while the medical program is by far the largest with about 2500 students. Each year, around 340 students are admitted to the medical program and circa 40 each to the dental and molecular medicine programs. Admission to all three programs is highly competitive. A MD/PhD program is also available in cooperation with the Spemann Graduate School of Biology and Medicine (SGBM). Apart from the IMBS program, the Faculty of Medicine hosts the Master Online in Periodontics and the Master Online in Palliative Care, aimed at professionals and consisting of online and on-campus segments. The Faculty of Medicine employs 1334 physicians and researchers full-time and 116 professors.

#### Institute of Molecular Medicine and Cell Research (IMMZ)

The IMMZ was founded in 1999 as a cutting-edge institute of the Faculty of Medicine at UFR. It is committed to research and teaching in Molecular Medicine with a special focus on cancer and stem cell research, research on proteases and programmed cell death and proteomics. The institute hosts the study program Bachelor and Master of Science Molecular Medicine which was implemented in 1999 and has since produced hundreds of biomedical scientists who followed up successful careers in academia, industry, the public and publishing sector worldwide. The Institute is directed by Prof. Christoph Peters who is also the head of the Freiburg Cancer Center (CCCF). His deputy Prof. Dr. Dres. h.c. Christoph Borner has been the director of the IMBS program since 2014 and also has been leading the SGBM graduate school since 2007.

### 2.1.2 Faculty of Engineering at UFR

The **Faculty of Engineering** was founded in 1995. It is the eleventh and youngest faculty of the University of Freiburg. It consists of three departments: the Department of Computer Science, the Department of Sustainable Systems Engineering and the Department of Microsystems Engineering (IMTEK). Professors of the latter department teach in the IMBS program the module Materials and Microsystems. Here the master students get to know novel materials, which they can apply to human tissues or cells. In addition, they get trained in microfluids systems that allow them to analyse thousands of cell growth or behaviour conditions on a microscale. Since 2020, the Biostatistics module led by a professor at the Faculty of Engineering also includes an introduction into Machine Learning, a sub-field of Artificial Intelligence.

### 2.1.3 University of Buenos Aires

The **University of Buenos Aires** (Spanish: *Universidad de Buenos Aires*, **UBA**) is the largest university in Argentina and the second largest university by enrolment in Latin America. Founded on August 12, 1821 in the city of Buenos Aires, it consists of 13 faculties, 6 hospitals, and 10 museums and is linked to 4 high schools. Professors of the Faculties of Pharmacy and Biochemistry and the Faculty of Medicine teach in the IMBS program. They engage in renowned research projects in the area of mitochondrial biology, oxidative processes, oncology, immunology, virology, microbiology and parasitology. The implementation of the IMBS program in 2008 and the administration of the study program ever since has been managed by the Dean’s office of the Faculty of Pharmacy and Biochemistry. The reason for starting the IMBS program with UBA was the following: 1) The former Freiburg director of the program, Prof. Dr. Dr. h.c. em.

Roland Mertelsmann initiated an exchange program of medical students with his former study colleague Prof. Dr. Ben Koziner from the Faculty of Medicine at UBA. Medical students on different study levels (undergraduates, graduates, doctoral students and postdocs) visited the partner university for short research stays or clinical trainings (“Famulatur”, practical year (PJ). This gradually turned into an idea to create an international master program in Biomedical Sciences, which involved a curriculum that was split between UFR and UBA and resulted in a master certificate at UBA. 2) According to the QS World University Rankings (2021) the University of Buenos Aires ranks number 66 in the world, which is even better than the University of Freiburg (number 175). The goal was therefore to team up with one of the best Latin American Universities to create the IMBS program. 3) Cesar Milstein from UBA and George Köhler from the MPI in Freiburg won the Nobel Prize for the development of monoclonal antibodies in 1984. They are the role model for innovative research collaborations between UBA and UFR that needs to be maintained by a sustainable interdisciplinary, intercultural training of excellent young scientists on the master, doctoral and postdoctoral level.

### 2.1.4 Hochschule Furtwangen University (HFU)

The **Hochschule Furtwangen University** (HFU), located in Furtwangen, Black Forest, is one of Germany’s leading universities in the area of Applied Science. It is recognised for its excellence in the areas of high quality and innovation in teaching, practical focus through collaboration with industry, internationality, applied research, continuing education and lifelong learning, cooperation and motivation and social responsibility and safeguarding of the future. This makes it a perfect partner for our IMBS master program. HFU offers research and study tracks in Engineering, Computer Science, Information Systems and Management, Engineering Management, Media, International Business, Health, Molecular and Technical Medicine, Medical Technology, Biomedical Engineering and Applied Biology. A member of the Faculty of Medical Life Sciences participates, together with a member of the Faculty of Medicine at UFR, in the teaching of the Molecular Oncology II module within the IMBS program. In addition, four professors regularly act as external jury members for the IMBS master thesis defences.

### 2.1.5 Continuing Education (Bildungstransfer)

The section Continuing Education (Bildungstransfer) of UFR coordinates continuing education programs for those already working in a full-time job. These programs include certificate courses designed to provide further theoretical grounding for practical work experience and a selection of master programs, which can also be taken as distance learning programs.

## 2.2 Organisation

The administration of the IMBS program is organized by program directors and coordinators at both universities. They exchange information regarding implementation and changes in the study program, organize student recruitment, travel to and accommodation at both places, ensure supervision of the students, overview the finances (in particular the tuition fees) and make sure that exams and master thesis defences are correctly held and certificates are timely issued. Both of them also survey the quality of the teaching, the organization of the modules, determine the supervisors of the master thesis and the referees and jury of the defences and foster scientific exchange between the research labs at UFR and UBA. Each year UBA professors travel to Freiburg to attend the exam after the lab rotations (yielding the DAS certificate) as well as the master thesis defence and UFR professors travel to Buenos Aires for the master thesis defences. Both teams are equally involved in the assessment of the exam/defence. During the Covid pandemic in 2020 and 2021 when traveling was restricted or forbidden, the DAS and master exams took place online via teleconference. This new format has been approved by the legal offices at both UFR and UBA. As a consequence, it is planned that exams will be held in a hybrid format (presence and online) in the future. During the visits of the partner professors the hosting university usually organizes a symposium on Translational Medicine where UFR, UBA professors, IMBS alumni and external guest speaker present their newest research data in order to stimulate scientific interactions and to present to the IMBS students potential master or PhD projects. For the symposium at UBA we always invite a Nobel Prize winner from Germany, Switzerland or Austria who gives a lecture, meets the IMBS students and gets the honorary doctor title of UBA. This event is followed by a reception at the German Embassy in Buenos Aires. In October 2021, the symposium took place online for the first time. These activities make our master program visible to the world and transport the importance of a multidisciplinary, international training to other scientists and politicians. As an appreciation for setting up and maintaining the IMBS program, former Rektor Jäger and two UFR professors (Mertelsmann and Borner) received the Doctor honoris causa from UBA and the late former Dean of the Faculty of Pharmacy and Biochemistry, Prof. Boveris was awarded the Bundesverdienstkreuz.

## 2.3 Responsible persons

### 2.3.1 Scientific and program directors

UFR: Prof. Dr. Dres. h.c. Christoph Borner
UBA: Prof. Dr. Pablo Evelson

### 2.3.2 Program coordinators

UFR: Ana Cortés
UBA: María Belén Moyano

### 2.3.3 Teaching staff

The teaching staff includes professors and lecturers from the Faculties of Medicine, Biology, Engineering as well as Chemistry and Pharmacy of the University of Freiburg (UFR), professors and lecturers from the Faculty of Medicine and Faculty of Pharmacy and Biochemistry of the University of Buenos Aires (UBA) and external lecturers of the Furtwangen University/Black Forest (HFU) (see list of lecturers in the Annex A).

### 2.3.4 Contact

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www.biomedmaster.org

## 2.4 Methods of instruction and studying techniques

| | |
|---|---|
| **Language:** | English |
| **Presence:** | Lectures and seminars<br>Exercises<br>Group presentations<br>Practical lab work |
| **Self-Studies/ Homework:** | Scientific reading<br>Preparation of presentations in groups<br>Preparation of exams<br>Preparation of practical lab work<br>Consolidation of acquired knowledge |

## 2.5 Form and length of the program

This master program is tailored as a full-time curriculum for 24 months and divided in three parts: The first eight months (basic unit) take place at the University of Buenos Aires (UBA), Argentina, the second part with eight months studies (advanced unit) take place at the University of Freiburg (UFR), Germany, and the third part (research project), which includes the master thesis, can be performed either in Freiburg or in Buenos Aires.

### 2.5.1 Workload

The total workload is 3007 hours in 24 months full time study. It should be noted that 25 working hours equals 1 Credit Point (CP or ECTS).

## 2.6 Degree and credits

The program concludes with a double master's degree, i.e. a Master of Science (M.Sc.) at UFR and a Master of Biomedical Sciences at UBA with a total of 120 credit points in the European Credit Transfer System (ECTS).

### 2.6.1 European Credit Transfer System (ECTS)

ECTS is a learner-centred system for credit accumulation and transfer, based on the principle of transparency of the learning, teaching and assessment processes. Its objective is to facilitate the planning, delivery and evaluation of study programs and student mobility by recognizing learning achievements and qualifications and periods of learning

(http://ec.europa.eu/education/library/publications/2015/ects-users-guide_en.pdf).

According to the European Credit Transfer and Accumulation System (ECTS) one credit point corresponds to an average workload of 25-30 hours.

In Continuing University Education of the University of Freiburg, one credit point (CP) corresponds to an average workload of 25 hours (student effort). MSc students receive 90 CP (ECTS) in taught modules and 30 CP (ECTS) in the Master Thesis Research Project module which accumulates to a **total 120 CP (ETCS)**. The program consists of mostly 50 working hours per week.

### 2.6.2 Credit points and requirements

For being awarded credit points (ECTS) the following is required:

- Fulfilled study performances according to the study- and examination regulation of the UFR, i.e. oral presentations (single and as a team), seminars, lab protocols, lab reports, exercises and essays, project work, performance of practical experiments, poster presentations, paper reviews, homework (data analysis, documentation and reading)
- Passed written and oral examinations

### 2.6.3 Examinations and grading

After each module the students pass written or oral exams and in addition sometimes provide lab reports. After the lab rotations at UFR an oral exam of 20 min takes place yielding a Diploma of Advanced Studies (DAS) (study performance). At the end of the study program the master thesis defence of a total duration of 60 min takes place at UBA or UFR yielding a double master's degree.

**Grading Scale:** 1,0 / 2,0 / 3,0 / 4,0 / 5,0 (failed) (see conversion of grades in the study- and examination regulations of UFR)

## 2.7 Prerequisites and selection criteria of the master program

The master program is open to professionals in Life Sciences or Natural Sciences, holding a higher academic degree with a minimum of 3 years of academic fulltime training (180 ECTS; see below). Candidates are expected to have at least 1 year of working experience in a relevant field.

The medium of instruction is English. Proficiency in reading and speaking English is required (level B2) (Cambridge FCE: CAE (C1) and CPE (C2), PTE Academic: min. 59 points (Pearson Test), IELTS: min. 5,5 points, TOEFL: 72 points “online”/567 points “on paper”) (2 years validity) or TOEFL IBT or TOEFL home edition, OOPT: min. 60 points, TOEIC: min. 785 points “listening/reading”, 160 points “speaking” and 150 points “writing”, telc B2-C1University).

25 participants are accepted each year, drawn from a wide range of countries. We aim to achieve a balance in gender, discipline and between participants from industrialized and low-and-middle-income countries (LMICs)

## 2.8 General information on structure

The MSc IMBS is a modular program consisting of three major parts


Duration and ECTS: See duration of the modules in Table 2

### 2.8.1 Study performance

The various elements of a module consist of formal contact time (lectures, tutorials, discussions, practical exercises, lab research methods and others), assessment (preparing and completing assignments and examinations) and homework/self-studies.

### 2.8.2 Examination regulations

To pass the respective examinations the participants need to achieve at least the grade 4.0 (sufficient) for each module.

The final grade is calculated from the arithmetic mean of the grades of the modules I-VIII at UBA and I-V at UFR and the master module (oral examination and master thesis). The taught modules count for 60% and the master module for 40% of the overall grade. Grades are awarded according to the German grading scale (1-5) specified in Table 1.

| ECTS system | German system | Definition |
|---|---|---|
| A | 1 | very good |
| B | 2 | good |
| C | 3 | satisfactory |
| D | 4 | sufficient |
| F | 5 | fail |

Table 1: Grades according to the German and ECTS grading system and their definition.

To award credit points the following requirements are needed:

- Practical hands-on course work
- Oral and poster presentations, participation in discussionss
- Lab protocols and reports
- Seminars, paper reviews, exercises and essays.
- Homework and independent preparation and reworking of the lectures and reading materials.
- Completing the examinations during and after the sub-modules

**Methodologies:** Each module starts usually with an introductory lecture. All modules use a mixture of teaching lectures, seminars, group work and a major part in practical training and work in research methods for Biomedical Sciences. Self-studies/homework are included mostly during and after a module and partially in preparation for a module.

The IMBS program starts every year in March at UBA. The courses offered within this program are repeated annually. This fulltime program leads participants to a master‘s degree usually in two years (for more details see the document study- and examination regulatio

# 3. Study Schedule

| Nr | MODULES | Type of course | Credit points | Semester | Type of exam or study performance |
|---|---|---|---|---|---|
| | **University of Buenos Aires (43 ECTS)** | | | | |
| | Intensive Spanish language course | V+Ü | 3 | 1 | SL |
| I | Biophysics, Bioenergetics (Ia), Biochemistry and Molecular Biology (Ib) | V+U+Pr | 5 | 1 | SL, PL: written (Ia, Ib) (each 50%) |
| II | Physiology (IIa), Pathophysiology (IIb), Cellular and Molecular Immunology (IIc) | V+Ü+Pr +S | 5 | 1 | SL, PL: written (IIa, IIb, IIc) (each 33%) |
| III | Pharmacology (IIIa) and Toxicology (IIIb) | V+Ü+Pr | 5 | 1 | SL, PL: written (IIIa, IIIb) (each 50%) |
| IV | Virology (IVa) and Microbiology (IVb) | V+Ü+Pr | 5 | 1 | PL: oral (IVa), written (IVb) (each 50%) |
| V | Neurobiology | V+Pr+S | 5 | 1 | PL: written |
| VI | Pathology | V+Pr+S | 5 | 1 and 2 | PL: oral |
| VII | Clinical Medicine | V+Pr+S | 5 | 2 | PL: written |
| VIII | Molecular Oncology (VIIIa), Biostatistics and Experimental Models (VIIIb) | V+Pr+Ü | 5 | 2 | PL: written (VIIIa, VIIIb) (each 50%) |
| | **Subtotal** | | **43** | | |
| | **University of Freiburg (47 ECTS)** | | | | |
| | Intensive German language course | V+Ü | 3 | 2 | SL |
| | Scientific & intercultural communication training and lab research methods | V+Ü+PR | 5 | 2 | SL |
| I | Biostatistics and Machine Learning (Ia), Bioethics (Ib) | V+Ü+S | 5 | 2 | PL: written (Ia, Ib) |
| II | Pharmacology, Toxicology (IIa), Materials and Microsystems (IIb) | V+S+PR | 5 | 2 | PL: written and oral (IIa), oral (IIb) |
| III | Molecular Oncology (IIIa), Cardiology (IIIb) | V+S+PR | 7 | 2 | PL: written (IIIa, IIIb) |
| IV | Molecular and Cellular Biology (IVa), Immunology and Pathology (IVb) | V+S+PR | 7 | 2 | PL: written (IVa) and oral (IVb) SL: lab report (IVa) |
| V | Labor Research | PR | 15 | 2 and 3 | SL: DAS-presentation PL: lab report |
| | **Subtotal** | | **47** | | |
| | **University of Freiburg or University of Buenos Aires (30 ECTS)** | | | | |
| | Master Module | | 30 | 3 and 4 | SL: lab protocol PL: written master thesis PL: oral defence |
| | **Subtotal** | | **30** | | |
| | **Total credit points** | | **120** | | |

Table 2: Study schedule

**Type of course:** V = lecture, S = Seminar, Ü = Exercise, PR = practical work
**Credit points** = ECTS: 1 Credit point according to ECTS = 25 hours of workload
**PL = Prüfungsleistung** (examination performance) (grades included in final mark)
**SL = Studienleistung** (study performance) (no grades, but has to be passed)

| Study Progress | |
|---|---|
| **Time frame/ Locations** | 2 years full time master program consisting of three parts:<br>8 months – in Argentina, University of Buenos Aires (UBA)<br>8 months – in Germany, University of Freiburg (UFR)<br>8 months – either at UFR or at UBA for the master thesis |
| **Content** | Interdisciplinary knowledge transfer and practice in research methods in biomedical sciences on an international and intercultural level<br><br>**UBA:** Acquaintance of basic knowledge in lectures, seminars and exercises with first insights into methodologies<br><br>**UFR:** Consolidation of basic knowledge in practical modules and in lab research<br><br>**Master Thesis Research Project:** Obtaining data and learning methods on a specific own research project. Learn good scientific practice, how to write and present data |
| **Outcomes** | Two master's degrees, a Master in Biomedical Sciences from UBA and a Master of Science (M.Sc.) Biomedical Sciences from UFR (involving the same number of ECTS points mutually accredited to each degree). |
| **Examinations** | Each module at UBA and UFR is completed with an oral or written exam or a lab report which is graded.<br><br>After the lab rotation at UFR the students present their future master topic in a 20 minutes talk (hybrid) in front of UFR and UBA professors in Freiburg. Successful presentation and acceptable grades from the 8 months UFR modules entitle them for a Diploma of Advanced Studies (DAS). The DAS is provided by the Continuing Education ("Bildungstransfer") of UFR<br><br>After completing the master thesis, the students defend their work in a 30 min presentation followed by a 30 min discussion. The defense takes place as a hybrid format either at UFR or UBA depending on where the master thesis was performed. It always involves the evaluation by professors from both universities plus external jury members. In addition to the oral presentation, the students submit the written form of their master thesis, which is also evaluated and graded. |

# 4. Part I: Modules in Buenos Aires

The curriculum usually starts at UBA in March each year with a 1-month intensive language course (Spanish). In the subsequent 7 months the students continue language training on a weekly basis leading to a final Spanish certificate. Concomitantly, they attend the following modules: Biophysics, Bioenergetics and Biological Oxidations, Virology, Cellular and Molecular Immunology, Microbiology, Physiology, Pharmacology, Toxicology, Pathology, Biochemistry and Molecular Biology, Neurobiology, Molecular Oncology and Clinical Medicine. The modules primarily consist of lectures and are completed by seminars, conferences and methodological and/or practical courses. In total, 43 ECTS points are awarded for the 8 months course (March to October) at UBA.

| Nr | MODULES | Type of course | Credit points | Semester | Type of exam or Study performance |
|---|---|---|---|---|---|
| | **University of Buenos Aires (43 ECTS)** | | | | |
| | Intensive Spanish language course | V+Ü | 3 | 1 | SL |
| I | Biophysics, Bioenergetics (Ia), Biochemistry and Molecular Biology (Ib) | V+U+Pr | 5 | 1 | SL, PL: written (Ia, Ib) (each 50%) |
| II | Physiology (IIa), Pathophysiology (IIb), Cellular and Molecular Immunology (IIc) | V+Ü+Pr+S | 5 | 1 | SL, PL: written (IIa, IIb, IIc) (each 33%) |
| III | Pharmacology (IIIa) and Toxicology (IIIb) | V+Ü+Pr | 5 | 1 | SL, PL: written (IIIa, IIIb) (each 50%) |
| IV | Virology (IVa) and Microbiology (IVb) | V+Ü+Pr | 5 | 1 | PL: oral (IVa), written (IVb) (each 50%) |
| V | Neurobiology | V+Pr+S | 5 | 1 | PL: written |
| VI | Pathology | V+Pr+S | 5 | 1 and 2 | PL: oral |
| VII | Clinical Medicine | V+Pr+S | 5 | 2 | PL: written |
| VIII | Molecular Oncology (VIIIa), Biostatistics and Experimental Models (VIIIb) | V+Pr+Ü | 5 | 2 | PL: written (VIIIa, VIIIb) (each 50%) |
| | **Subtotal** | | **43** | | |

| Intensive Spanish language course | |
|---|---|
| **Lecturers** | External company |
| **Duration** | Intense for 1 month, then regularly once a week during 8 months |
| **Type of course** | Lectures, exercises, group work, practice with different media |
| **Workload** | **Total workload: 75 h**<br>**Presence: 18,75 h/week during 1 month** |
| **Credit points** | 3 |
| **Content** | Spanish Language training at Level A1 and A2 by using diverse communicative methods which are highly interactive and dynamic to suit different types of learners. The methods emphasize on listening & speaking skills, extension of vocabulary, the understanding and application of Spanish grammar. Teaching material and content additionally support the awareness, understanding and a good handling of the cultural diversity and the new environment. For Spanish speaking students a respective English course will be offered. |
| **Learning Outcomes** | Students can speak, write, listen and read Spanish on an Advanced Low level of Proficiency.<br>▪ Speaking: students are able to handle a variety of communicative tasks. They are able to participate in most informal and some formal conversations on topics related to school, home, and leisure activities. They can also speak about some topics related to employment, current events, and matters of public and community interest.<br>▪ Writing: students are able to meet basic work and/or academic writing needs. They demonstrate the ability to narrate, describe and express viewpoints about familiar topics in major time frames with some control of aspect.<br>▪ Listening and Reading: students are able to understand short conventional narrative and descriptive texts (spoken and/or written) such as descriptions of persons, places, and things, and narrations about past, present, and future events with a clear underlying structure though their comprehension may be uneven. They can understand the main facts and some supporting details. Comprehension may often derive primarily from situational and subject-matter knowledge.<br>▪ Students are able to communicate in Argentina in order to organize their daily life and academic matters and are able to network |
| **Exam (PL) Study performance (SL)** | PL: The first part is a written exam of 1 hour and 30 minutes of duration, the second part an oral exam of 15 minutes. The grammar, the vocabulary studied in the module and the ability to use them in both written and oral communicative situations are evaluated. The grade does not contribute to the final master grade.<br>SL: every week the students will have to complete a task in which they will have to integrate all the topics studied during the week. A detailed feedback on the performance of the task will be given to each student.<br>Required participation at module: 85% |

## 4.1. Module I: Biophysics, Bioenergetics, Biochemistry & Mol. Biol.

| Module I | Biophysics, Bioenergetics and Biological Oxidations (Ia), Biochemistry and Molecular Biology (Ib) |
|---|---|
| **Lecturers** | Prof. Dr. Mónica Galleano, Prof. Dr. Silvia Alvarez, Prof. Dr. Fernando Dominici |
| **Duration** | 4 weeks |
| **Type of course** | Lectures, exercises and practical work |
| **Workload** | **Total workload: 126 h**<br><br>**Presence: 25 h/week**<br>1 h/day lectures<br>2 h/day seminars<br>2 h/day lab work or exercises<br><br>**Self-study/homework: 6,5 h/week**<br>1,3 h/day: data analysis, documentation, and reading |
| **Credit points** | 5 |
| **Grade** | The grade of the module contributes 4% to the final master grade |

| Module Ia | Biophysics: Bioenergetics and Biological Oxidations |
|---|---|
| **Lecturers** | Prof. Dr. Mónica Galleano, Prof. Dr. Silvia Alvarez |
| **Duration** | 2 weeks |
| **Type of course** | Lectures, exercises and practical work |
| **Workload** | **Total workload: 63 h**<br>**Presence: 25 h/week**<br>1 h/day lectures<br>2 h/day seminars, exercises<br>2 h/day lab work<br>**Self-study/homework: 6,5 h/week**<br>1,3 h/day: data analysis, documentation, and reading |
| **Credit points** | 2.5 |
| **Content** | Bioenergetics: first and second law of thermodynamics applied to living systems. Gibbs free energy. Chemical equilibrium. Redox reactions. Chemical kinetics. Mechanisms of reaction. Photochemistry, fluorescence and oxygen excited states. Catalysis: relevance for biology and biochemistry. Biological membranes. Mitochondria: structure and compartmentalization. Electron transport chain: components of the respiratory chain: proton translocation, superoxide and hydrogen peroxide production. Chemiosmotic theory. Electron transfer and electrochemical potential. Chemistry and biochemistry of free radicals. Free radical-mediated alterations in cell redox state and cell signaling. Antioxidants in biological systems: thermodynamic and kinetic aspects. Nutrients and cell signaling. Free radicals and antioxidants in human physiology and pathology.<br>**Lab work:** Animal calorimetry. Free radicals and antioxidant effects measurement by Electronic Paramagnetic Resonance (EPR). Measurement of oxygen consumption in isolated mitochondria. Detection of mitochondrial complexes. |
| **Learning Outcomes** | ▪ The students can define the laws of thermodynamics as applied to living systems.<br>▪ The students can describe the membrane structure and its function.<br>▪ The students can measure animal calorimetry.<br>▪ The students can measure free radicals and antioxidant effects by Electronic Paramagnetic Resonance (EPR).<br>▪ The students can write a laboratory report.<br>▪ The students can isolate mitochondria and measure mitochondrial oxygen consumption.<br>▪ The students can critically analyze scientific publications on mitochondrial inner membrane potential. |

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| **Exam (PL)**<br>**Study performance (SL)** | PL: Written test of 120 min with multiple choice and open questions as well as exercises on thermodynamics applied to living systems, chemical equilibrium, kinetics, redox chemistry and biology, polyphenols and health (Galleano)<br><br>Written test of 120 min multiple choice, open questions and exercises on mitochondrial bioenergetics (Alvarez)<br><br>The average grade of both exams contributes 50% to the grade of the entire module<br><br>SL: Report on the exercises and practical work in animal calorimetry and Mitochondrial function<br><br>Required participation at the submodule: 85% |

| Module Ib | Biochemistry and Molecular Biology |
|---|---|
| **Lecturer** | Prof. Dr. Fernando Dominici |
| **Duration** | 2 weeks |
| **Type of course** | Lectures, exercises and practical work |
| **Workload** | **Total workload: 63 h**<br>**Presence: 25 h/week**<br>1 h/day lectures<br>2 h/day seminars, exercises<br>2 h/day lab work<br>**Self-study/homework: 6,5 h/week**<br>1,3 h/day: data analysis, documentation, and reading |
| **Credit points** | 2.5 |
| **Content** | Manipulation of proteins, DNA, and RNA. Fractionation of cells. Ultracentrifugation for separation of organelles and macromolecules, chromatography for protein separation, affinity chromatography, SDS-Polyacrylamide-gel electrophoresis, 2-D-gel electrophoresis, selective cleaving for identification, mass spectrometry. Analysis of protein structure and function with various methodologies. Study of gene expression and function. Random and site-directed mutagenesis. Genetic screening and reporter genes. Overexpression and purification of membrane proteins. Expression systems. Expression of membrane proteins fused to GFP. Visualizing enzyme function in living cells. Membrane structure and transport. Intracellular components and protein sorting. Cell communication: signal transduction. General principles of G-protein linked receptors: signaling pathways and activation consequences. Enzyme-linked receptors. NFkB-signaling. Cancer and gene expression control. Prokaryotic regulation of gene expression: operon lac. Eukaryotic regulation of gene expression: steroid transcription factors. Th1/Th2 paradigm.<br>**Lab work:** Determination of phosphorylation levels of the enzyme Akt/PkB after acute *in vivo* insulin stimulation to rats. |
| **Learning Outcomes** | ■ The students can define the elements of cell communication and signal transduction.<br>■ The students can determine *in vivo* insulin-induced phosphorylation of the serine/threonine kinase Akt/PkB.<br>■ The students can detect and quantify proteins by western blotting.<br>■ The students can write a laboratory report.<br>■ The students can critically analyze scientific publications on cell communication and signal transduction. |

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| **Exam (PL)**<br>**Study performance (SL)** | PL: Written exam of 120 min on main concepts of cell signaling, current techniques for isolation and structural analysis of proteins with focus on signal transduction components, basics of insulin signaling in physiology and pathology.<br>The grade of this submodule contributes 50% to the total grade of the entire module.<br>SL: Report on the exercises and practical work of the submodule.<br>Required participation at submodule: 85% |

## 4.2 Module II: Physiology, Pathophysiology, Cellular & Mol. Immun.

| Module II | Physiology (IIa), Pathophysiology (IIb), Cellular and Molecular Immunology (IIc) |
|---|---|
| Lecturers | Prof. Dr. Analia Tomat, Prof. Dr. María Inés Vaccaro, Prof. Dr. Emilio Malchiodi |
| Duration | 4 weeks |
| Type of course | Lectures, seminars, exercises and practical work |
| Workload | **Total workload: 126 h**<br><br>**Presence: 25 h/week**<br>1 h/day lectures<br>2 h/day seminars, exercises<br>2 h/day lab work<br><br>**Self-study/homework: 6,5 h or 6 h/week**<br>1,3 h/day: data analysis, documentation, and reading |
| Credit points | 5 |
| Grade | The grade of the module contributes 4% to the final master grade |

| Module IIa | Physiology |
|---|---|
| **Lecturer** | Prof. Dr. Analia Lorena Tomat |
| **Duration** | 1 week |
| **Type of course** | Lectures, seminars, exercises and practical work |
| **Workload** | **Total workload: 31,5 h**<br>**Presence: 25 h/week**<br>1 h/day lectures<br>2 h/day seminars, exercises<br>2 h/day lab work<br>**Self-study/homework: 6,5 h/week**<br>1,3 h/day: data analysis, documentation, and reading |
| **Credit points** | 1.25 |
| **Content** | Arterial blood pressure regulation and hypertension. Experimental models of hypertension. Endothelial function and dysfunction. Evaluation of renal, cardiac and metabolic function. Renin-angiotensin system. Morphological evaluation of renal, cardiovascular, hepatic and adipose tissues. |
| **Learning Outcomes** | ▪ The students can integrate physiological and molecular aspects of health and disease.<br>▪ The students can describe the cardiovascular, renal, and metabolic regulations.<br>▪ The students can understand the essential physiological events that maintain the health and develop disease in humans.<br>▪ The students can apply laboratory techniques to the study of physiology and molecular physiopathology. |
| **Exam (PL) Study performance (SL)** | PL: Written exam of 60 minutes on the last day of the module consisting of 30 multiple choice questions with 5 options and 1 correct answer. The students are examined on the theoretical and practical contents of the submodule, like those related to cardiac, vascular, and renal morphology and nervous, hormonal, humoral and immune mechanisms.<br>The grade of this submodule contributes 33% to the total grade of the entire module.<br>SL: Report on the exercises and practical work of the submodule.<br>Required participation at the submodule: 85% |

| Module IIb | Pathophysiology |
|---|---|
| **Lecturer** | Prof. Dr. María Inés Vaccaro |
| **Duration** | 1 week |
| **Type of course** | Lectures, seminars, exercises and practical work |
| **Workload** | **Total workload: 31,5 h**<br><br>**Presence: 25 h/week**<br>1 h/day lectures<br>2 h/day seminars, exercises<br>2 h/day lab work<br><br>**Self-study/homework: 6,5 h/week**<br>1,3 h/day: data analysis, documentation, and reading |
| **Credit points** | 1.25 |
| **Content** | Molecular and cellular pathology. Cellular response to disease. Mechanism of survival, adaptation, and cell death. Selective autophagy and cell death associated with autophagy: molecular mechanisms, involved genes, and mediators. Simple cellular models, genetic models and pharmacological inducers of autophagy. Cellular response to metabolic, inflammatory, ischemic, and neurological diseases. Mechanisms of cell death and survival in diabetes. Pancreatitis and pancreatic cancer. |
| **Learning Outcomes** | ▪ The students can describe the cellular and molecular mechanisms underlying the phenotypical changes of mammalian cells during disease.<br>▪ The students can apply research techniques to study these mechanisms.<br>▪ The students can recognize the adaptation and cell death mechanisms triggered by the cells in the state of disease.<br>▪ The students can identify causes of cell injury, oxidative stress, ischemia, and metabolic stress.<br>▪ The students can recognize the autophagy process and analyze the underlying molecular, cellular, and tissue mechanisms and their consequences in inflammatory, infectious, and degenerative disease. |
| **Exam (PL)<br>Academic Perf (SL)** | PL: Written exam of 60 minutes on the last day of the module. 50 multiple-choice questions to be answered about the topics of the submodule, including theoretical and practical activities carried out during the course.<br><br>The grade of this submodule contributes 33% to the total grade of the entire module<br><br>SL: Each student has to give an oral seminar on an original paper about one of the topics of the module and submits a written report discussing the results of the selected paper. The report is assessed by the module leader.<br><br>Required participation at submodule: 85% |

| Module IIc | Cellular and Molecular Immunology |
|---|---|
| Lecturer | Prof. Dr. Emilio Malchiodi |
| Duration | 2 weeks |
| Type of course | Lectures, seminars, exercises and practical work |
| Workload | **Total workload: 62 h**<br><br>**Presence: 25 h/week**<br>1 h/day lectures<br>2 h/day seminars, exercises<br>2 h/day lab work<br><br>**Self-study/homework: 6 h/week**<br>1,2 h/day: data analysis, documentation, and reading |
| Credit points | 2.5 |
| Content | Innate immunology. Antigen recognition by B cells. Generation of diversity. MHC antigens. Antigen recognition by T cells. Antigen presentation to T cells. T cell development and B lymphocyte traffic. Mucosal immunity. Regulation of the immune response. Vaccines against *Trypanosoma cruzi*. Super antigen interaction with receptors and T cell antigen and MHC-II molecules recognition. Interaction of NK cell receptors with cellular and viral molecules. Mechanisms of cell death and survival in tumors: implications in immune evasion and therapy. T cells, NK cells, and Cancer. Interaction of *Brucella sp*. with cells and relevance to human infection. Applications of flow cytometry and Surface Plasmon Resonance (SPR) to immune diagnosis and determination of affinity constants.<br><br>**Lab work:** Cell cultures, flow cytometry, Surface Plasmon resonance (SPR), protein separation by SDS-PAGE and blotting, titration by ELISA, and protein structure modelling with Pymol. |
| Learning Outcomes | ▪ The students can recognize the immune response to diverse pathogens including virus, bacteria, and parasites.<br>▪ The students can identify the function of cellular and humoral components of the innate and acquired immune response.<br>▪ The students can characterize super antigens.<br>▪ The students can describe the mechanisms used by virus, bacteria, and parasites to evade the immune response.<br>▪ The students can understand the advances in vaccines against infectious disease.<br>▪ The students can apply various molecular techniques to study the immune response.<br>▪ The students can model a protein structure.<br>▪ The students can critically analyze scientific publications on infections and immune response. |

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| **Exam (PL)**<br>**Study performance (SL)** | PL: Written exam of 120 min consisting of multiple choice and complex questions on the main concepts of immunology, immune responses to infectious agents, cutaneous immunology and current techniques for the analysis of the immune response.<br>The grade of this submodule contributes 33% to the total grade of the entire module.<br>SL: Each student has to give an oral seminar on an original paper about one of the topics of the submodule.<br>Required participation at submodule: 85% |

## 4.3 Module III: Pharmacology and Toxicology

| Module III | Pharmacology (IIIa) and Toxicology (IIIb) |
|---|---|
| Lecturers | Prof. Dr. Analía Reinés, Prof. Dr. Carlos Damin, Prof. Dr. Marcelo Wagner |
| Duration | 4 weeks |
| Type of course | Lectures, exercises and practical work |
| Workload | **Total workload: 126 h**<br>**Presence: 25 h/week**<br>1 h/day lectures<br>2 h/day exercises<br>2 h/day lab work<br>**Self-study/homework: 6,5 h/week**<br>1,3 h/day: data analysis, documentation, and reading |
| Credit points | 5 |
| Grade | The grade of the module contributes 4% to the final master grade |

| Module IIIa | Pharmacology |
|---|---|
| **Lecturer** | Prof. Dr. Analía Reinés |
| **Duration** | 2 weeks |
| **Type of course** | Lectures, exercises and practical work |
| **Workload** | **Total workload: 63 h**<br><br>**Presence: 25 h/week**<br>1 h/day lectures<br>2 h/day exercises<br>2 h/day lab work<br><br>**Self-study/homework: 6,5 h/week**<br>1,3 h/day: data analysis, documentation, and reading |
| **Credit points** | 2.5 |
| **Content** | The regulation of transcription in eukaryotic cells. General and specific transcription factors and signal integration. Mechanisms of control: epigenomics and translational control, microRNAs and RNAbp. Potential pharmacological targets. Mechanisms involved in mRNA stability and processing. Study and identification of potential mechanisms involved in drug action. Description and analyses of techniques aimed to determine mRNA processing. Basic concepts and relevance of pharmacokinetics. Pharmacokinetic models and parameters. Use of computational programs for pharmacokinetic parameters calculation. Interpretation of pharmacokinetic parameters. Use of microdialysis for the evaluation of drug tissue distribution. Clinical pharmacokinetics and translational research. Design and optimizations of dosage regimen. Therapeutic Drug Monitoring (TDM) and its role in HIV treatment. |
| **Learning Outcomes** | ▪ The students can understand the basic concepts of pharmacodynamics and pharmacokinetics.<br>▪ The students can apply research methodology to study the pharmacokinetics and pharmacodynamics of therapeutic agents.<br>▪ The students can estimate pharmacokinetics and pharmacodynamics of therapeutic agents.<br>▪ The students can use computational programs for pharmacokinetic parameters calculation. |
| **Exam (PL) Study performance (SL)** | PL: A multiple-choice written exam of 120 minutes at the end of the module. Topics are transcription and mRNA processing as drug targets, in vivo and ex vivo strategies for pharmacological preclinical studies. Pk/PD modelling in clinical pharmacology.<br><br>The grade of this submodule contributes 50% to the total grade of the entire module.<br><br>SL: Each student must submit a 5-min video presentation describing mechanisms, efficacy, side effects and some preclinical and clinical studies of the assigned drug. The assigned drugs target transcription or mRNAs and are either approved or under research. Deadline of submission is 14 days after the end of the module.<br><br>Required participation at submodule: 85% |

| Module IIIb | Toxicology |
|---|---|
| **Lecturers** | Prof. Dr. Carlos Damin, Prof. Dr. Marcelo Wagner |
| **Duration** | 2 weeks |
| **Type of course** | Lectures, exercises and practical work |
| **Workload** | **Total workload: 63 h**<br>**Presence: 25 h/week**<br>1 h/day lectures<br>2 h/day exercises<br>2 h/day lab work<br>**Self-study/homework: 6,5 h/week**<br>1,3 h/day: data analysis, documentation, and reading |
| **Credit points** | 2.5 |
| **Content** | Introduction to the Plantae Kingdom, its systematics, morphology and anatomy. Relations between plants and humans: biochemical and cultural aspects. Introduction to the toxicology and pharmacology of secondary metabolites. Toxicity of ornamental and wild plants: Morphology, anatomy, phytochemistry and mechanisms of action of paradigmatic cases. Plants as a weapon in world history. Toxic fungi of South America. Toxic plants in the South American folk medicine. Misuse of medicinal plants. Drug interactions between medicinal plants, synthetic drugs and food. Psychoactive plants and fungi in the world. Cultural and biological contexts. Plant drugs abuse: Classical and new drugs. Pharmacology and toxicology of its mechanisms of action. Overview of venomous and poisonous animals. Substance of abuse. Carbon monoxide poisoning. Smoke inhalation injury. Acute Chemical Emergencies. Pediatric Toxicology. |
| **Learning Outcomes** | ▪ The students can identify and evaluate the physio-pathological effects of toxicology.<br>▪ The students can analyze the toxicity and detoxification of the most common drugs and their consequences for the liver and CNS.<br>▪ The students can characterize the injury mechanisms and changes in the involved receptors.<br>▪ The students can define appropriate experimental models to study biological and pharmacological toxicities. |
| **Exam (PL) Study performance (SL)** | PL: A multiple-choice written exam to be completed in 30 minutes on the last day of the module. The exam evaluates main concepts of morphoanatomy, microscopy and active compounds in toxic plants and fungi.<br>The grade of this submodule contributes 50% to the total grade of the entire module.<br>SL: Each student has to give an oral seminar on an original paper about one of the topics of the submodule.<br>Required participation at submodule: 85% |

## 4.4 Module IV: Virology and Microbiology

| Module IV | Virology (IVa) and Microbiology (IVb) |
|---|---|
| **Lecturers** | Prof. Dr. Viviana Mbayed, Prof. Dr. Diego Flichman, Prof. Dr. Marta Mollerach |
| **Duration** | 4 weeks |
| **Type of course** | Lectures, exercises and practical work |
| **Workload** | **Total workload: 126 h**<br>**Presence: 25 h/week**<br>1 h/day lectures<br>2 h/day exercises<br>2 h/day lab work<br>**Self-study/homework: 6,5 h/week**<br>1,3 h/day: data analysis, documentation, and reading |
| **Credit points** | 5 |
| **Grade** | The grade of the module contributes 4% to the final master grade |

| Module IVa | Virology |
|---|---|
| **Lecturers** | Prof. Dr. Diego Flichman, Prof. Dr. Viviana Mbayed |
| **Duration** | 2 weeks |
| **Type of course** | Lectures, exercises and practical work |
| **Workload** | **Total workload: 63 h**<br>**Presence: 25 h/week**<br>1 h/day lectures<br>2 h/day exercises<br>2 h/day lab work<br>**Self-study/homework: 6,5 h/week**<br>1,3 h/day: data analysis, documentation, and reading |
| **Credit points** | 2.5 |
| **Content** | Introduction to Virology. Viral structure and taxonomy. Virus replication strategies. Viral evolution. Molecular mechanisms of genetic variation of viruses. Virus-cell interaction. Innate and adaptive immune response to viruses. Pathogenesis of viral infections. Molecular epidemiology. Diagnostic of viral infections. . Immunization against viral diseases. Antiviral agents. Emergence of viral diseases.<br>**Lab work:** Eukaryotic cell culture, viral grown, biological characterization of viruses, and phylogenetic analyses of viral genomes from an outbreak. |
| **Learning Outcomes** | ▪ The students can acquire knowledge on viral evolution, pathogenesis, epidemiology, antivirals, and vaccines.<br>▪ The students can manipulate cell cultures, infect cells in culture, and obtain a viral stock.<br>▪ The students can understand the principles of virology and acquire practical skills required in the virology lab.<br>▪ The students are able to perform and comprehend a basic phylogenetic analysis from viral genomic sequences.<br>▪ The students can critically analyze scientific publications in virology. |
| **Exam (PL)** | PL: Oral exam of 40 minutes on the topics Viral taxonomy, morphology, genomic organization, replication cycle, viral pathogenesis, epidemiology, diagnosis, immunization and therapy.<br>The grade of this submodule contributes 50% to the total grade of the entire module.<br>Required participation at submodule: 85% |

| Module IVb | Microbiology |
|---|---|
| **Lecturer** | Prof. Dr. Marta Mollerach |
| **Duration** | 2 weeks |
| **Type of course** | Lectures, exercises and practical work |
| **Workload** | **Total workload: 63 h**<br>**Presence: 25 h/week**<br>1 h/day lectures<br>2 h/day exercises<br>2 h/day lab work<br>**Self-study/homework: 6,5 h/week**<br>1,3 h/day: data analysis, documentation, and reading |
| **Credit points** | 2.5 |
| **Content** | Mechanisms of pathogenicity and host-parasite interaction. Molecular basis of microbial pathogenicity. Mechanisms involved in adhesion, multiplication, nutrient acquisition, inhibition of the phagocytic process, evasion of the immune response, direct damage, and indirect host mediated immunopathological processes. Emerging and re-emerging bacterial diseases. Bacterial envelopes, metabolism, and cell division as targets for drugs with antimicrobial activity. Mechanisms of action and resistance to antibacterial drugs. Resistant organisms and emerging pathogens. Epidemiology of hospital infections. Biomarkers used in outbreak characterization and criteria used to evaluate typing systems. Analysis of results by applying bioinformatics techniques. Detection without culture as a tool in the diagnosis of selected bacterial diseases. |
| **Learning Outcomes** | ■ The students can discuss theoretical concepts and recent advances in bacterial pathogenesis.<br>■ The students can describe the bacterial pathogenesis process from the molecular and structural assessments.<br>■ The students can define the bases of antimicrobial therapy based on laboratory assays and theoretical concepts of antimicrobial resistance.<br>■ The students can handle the most common emerging microorganisms that cause community and nosocomial infections. |
| **Exam (PL)** | PL: Written exam of 45 minutes consisting of multiple-choice questions on the main concepts of mechanisms of action and resistance to antibacterial drugs. Additionally, each student must submit a 5 min video presentation describing main features of an assigned bacterial pathogen. Including mechanisms of pathogenicity, epidemiology, treatment, and prevention (if it is available). The final grade of this submodule is obtained from the mean of the written exam and the video presentation.<br>The grade of this submodule contributes 50% to the total grade of the entire module.<br>Required participation at this submodule: 85% |

## 4.5 Module V: Neurobiology

| Module V | Neurobiology |
|---|---|
| **Lecturer** | Prof. Dr. Juana Pasquini |
| **Duration** | 3 weeks |
| **Type of course** | Lectures, seminars and practical work |
| **Workload** | **Total workload: 126 h**<br>**Presence: 35 h/week**<br>2 h/day lectures<br>3 h/day seminars<br>2 h/day lab work<br>**Self-study/homework: 7 h/week**<br>1,4 h/day: data analysis, documentation, and reading |
| **Credit points** | 5 |
| **Content** | Morphology of the nervous system: Neurons, macroglia (astrocytes and oligodendrocytes) and microglia. Myelin synthesis. Histochemical and immuno-histochemical techniques. Chemical signaling in the nervous system: Neurotransmitters and neuromodulators. Metabotropic and ionotropic receptors. Cholinergic receptors, neurotrophins and neurosteroids. Second messengers. Molecular basis of neurodegeneration and neuroplasticity. Cell death in neurodegenerative diseases. Charcot-Marie-Tooth and related neuropathies. Use of animal models: Wobbler mouse, Alzheimer´s disease. Peripheral nervous system. Schwann cell differentiation. Demyelination and re-myelination mechanisms. Studies using explants and neurospheres. Neural trauma. Differential reactions to trauma of the PNS and CNS. Spontaneous and intrinsic repair mechanisms (i.e. neuroplasticity, compensatory plasticity). Potential therapeutic interventions: stem cells. |
| **Learning Outcomes** | ▪ The students can differentiate cellular subtypes of the central nervous system.<br>▪ The students can analyze the structure, metabolic pathways, receptors, signaling pathways, and neuromodulators of the CNS.<br>▪ The students can discuss the biochemical and molecular basis of major CNS pathologies.<br>▪ The students can underscore the importance of animal models in the ethiopathogenic study of the main CNS pathologies.<br>▪ The students can apply the methodologies commonly used in neurobiology.<br>▪ The students can describe the traditional and new pharmacologic treatments of neuropathology.<br>▪ The students can critically discuss the key publications in the area of neurobiology. |
| **Exam (PL)** | PL: Written exam of 120 minutes on the final day of the module consisting of 30 multiple-choice questions, encompassing the topics covered during the module.<br>The grade of the module contributes 4% to the final master grade<br>Required participation at this module: 85%. |

## 4.6 Module VI: Pathology

| **Module VI** | **Pathology** |
|---|---|
| **Lecturer** | Prof. Dr. Manuel Rodriguez |
| **Duration** | 3 weeks |
| **Type of course** | Lectures, seminars and practical work |
| **Workload** | **Total workload: 126 h**<br>**Presence: 35 h/week**<br>2 h/day lectures<br>2 h/day seminars<br>7 h/day lab work<br>**Self-study/homework: 7 h/week**<br>1,4 h/day: data analysis, documentation, and reading |
| **Credit points** | 5 |
| **Content** | Ischemia and ischemia-reperfusion. Myocardial ischemia-reperfusion injury. Myocardial stunning. Mechanisms of cardio protection: preconditioning; post conditioning; adenosine; statins. Experimental models of ischemia-reperfusion. Myocardial infarction. Cardiac Hypertrophy. Heart failure. Cardiomyopathies. Experimental models of hypertrophy and heart failure. Glomerular histophysiology. Hematuria. Nephrotic syndrome. Hemolytic uremic syndrome. Experimental models of hemolytic uremic syndrome. Neoplasms: Characteristics, morphological study, immunohistochemical and molecular analysis. Bone neoplasms and pathology of renal tumors: classification, morphological study, immunohistochemical and molecular analysis. |
| **Learning Outcomes** | ▪ The students can analyze the traditional knowledge and the current molecular and cellular advances in cardiovascular, nephrology, and neoplasia pathologies.<br>▪ The students can explain the morphology and physiopathology of these pathologies.<br>▪ The students can handle experimental models and understand their relevance in the study of these pathologies.<br>▪ The students can characterize neoplasia on its morphological, immunohistochemical, and molecular bases.<br>▪ The students can indicate the steps and materials involved in the experimental models used. |
| **Exam (PL)** | PL: Students, in groups of two, must prepare and present a 20-minutes audiovisual presentation (Powerpoint) based on the bibliography used during the course, incorporating personal reflections and analysis.<br>The grade of the module contributes 4% to the final master grade<br>Required participation at this module: 85%. |

## 4.7 Module VII: Clinical Medicine

| Module VII | Clinical Medicine |
|---|---|
| **Lecturers** | Prof. Dr. Gabriela Berg, Prof. Dr. Ricardo Gelpi, Prof. Dr. Verónica D'Annunzio |
| **Duration** | 3 weeks |
| **Type of course** | Lectures, seminars and practical work |
| **Workload** | **Total workload: 126 h**<br>**Presence: 35 h/week**<br>2 h/day lectures<br>2 h/day seminars<br>3 h/day lab work<br>**Self-study/homework: 7 h/week**<br>1,4 h/day: data analysis, documentation, and reading |
| **Credit points** | 5 |
| **Content** | Mitochondrial diseases: Congenital and acquired diseases. Mitochondrial dynamics. Mitochondrial protein import. Obesity. Clinical obesity. Experimental model of obesity: ob/ob mice. Metabolic Syndrome and Diabetes: Insulin resistance and mitochondrial dysfunction. Immune markers for autoimmune diabetes. Regulation of body water: Disorders of water homeostasis. Cerebral Edema. Neurodegeneration: Parkinson's and Alzheimer's Disease. Physiopathogenesis. Systemic inflammatory response syndrome (SIRS): Mechanisms of multi-organic dysfunction: role of microcirculation. Toll-like receptors in SIRS. Respiratory cycle: Mechanisms of pulmonary injury in Pneumonitis and respiratory dysfunction. Respiratory insufficiency. Myocardial energetics: Myocardial ischemia. Pathophysiology and evaluation. Pharmacoresistance. ABC transporters. Epilepsy. |
| **Learning Outcomes** | ■ The students can integrally approach various pathologies to identify risk factors, diagnosis, and therapeutic alternatives.<br>■ The students can discuss the biochemical and molecular bases of complex disease.<br>■ The students can provide ideas for the development of early diagnosis or treatment options of the main Occidental diseases.<br>■ The students can understand the relevance of animal models and human studies in the context of translational clinical biochemistry and medicine.<br>■ The students can interpret the main scientific publications on the studies pathologies. |
| **Exam (PL)** | PL: Written multiple choice exam, 90 minutes long on the last day of the submodule, 20 complex questions to be answered with sentences about the topics of the seminars the student assisted to and the methods of the laboratory. Additionally, they must justify the answers of the multiple-choice exam.<br>The grade of the module contributes 4% to the final master grade.<br>Required participation at this module: 85%. |

## 4.8 Module VIII: Molecular Oncology, Biostatistics & Experimental Models

| Module VIII | Molecular Oncology (VIIIa), Biostatistics and Experimental Models (VIIIb) |
|---|---|
| **Lecturers** | Prof. Dr. Stella Ranuncolo, Prof. Dr. Alicia Brusco |
| **Duration** | 3 weeks |
| **Type of course** | Lectures, exercises and practical work |
| **Workload** | **Total workload: 125 h**<br><br>**Presence: 35 h/week**<br>2 h/day lectures<br>2 h/day exercises<br>3 h/day lab work<br><br>**Self-study/homework: 7 h/week**<br>1,4 h/day: data analysis, documentation, and reading |
| **Credit points** | 5 |
| **Grade** | The grade of the module contributes 4% to the final master grade |

| Module VIIIa | Molecular Oncology |
|---|---|
| **Lecturer** | Prof. Dr. Stella Ranuncolo |
| **Duration** | 2 weeks |
| **Type of course** | Lectures, exercises and practical work |
| **Workload** | **Total workload: 75 h**<br>**Presence: 30 h/week**<br>2 h/day lectures<br>1 h/day exercises<br>3 h/day lab work<br>**Self-study/homework: 7,5 h/week**<br>1,5 h/day: data analysis, documentation, and reading |
| **Credit points** | 3 |
| **Content** | Molecular mechanisms involved in the initiation, promotion, and progression of cancer. Cellular transformation, tumor cell characteristics, MET (mesenchymal-epithelial transition), migration, invasion, metastatic cascade, signal transduction pathways of tumor stratification. Radiological aspects: positron emission tomography (PET). Introduction to chemotherapy: Classification, advantages and disadvantages. Collateral effects. Development of new therapies. Introduction to radiobiology and radiotherapy. Clinical aspects of radiotherapy. Systemic radiotherapy. Introducing surgery, modern techniques. Immunotherapy in melanomas. Role of viruses in cancer. Most frequent tumors: breast cancer, urogenital tumors, lung cancer, and colon cancer. |
| **Learning Outcomes** | ▪ The students can describe the main molecular characteristics of a cancer cell.<br>▪ The students can understand the molecular biology of the more frequent tumors, diagnostic methods, and treatments.<br>▪ The students can analyze the utility of tumoral biomarkers in the diagnosis, prognosis, prediction, and assessment of the response to the treatment.<br>▪ The students can distinguish the concepts of precision medicine and targeted medicine. |
| **Exam (PL)** | PL: The students sit for a written exam for 60 minutes on the last day of the module. The exam consists of 40 multiple choice questions. Each question has only a correct answer. The topics are; Molecular biology of malignant tumor cells, role of pathologists in oncology, liquid biopsy, invasion and metastasis, metabolism of malignant tumor cells, extracellular vesicles, cancer stem cells, mechanisms of DNA repair, microbiome and cancer, lymphomas, acute leukemias, chronic lymphocytic leukemia, multiple myeloma, breast cancer, digestive tract malignant tumors, lung cancer.<br>The grade of this submodule contributes 50% to the total grade of the entire module.<br>Required participation at this submodule: 85%. |

| Module VIIIb | Biostatistics and Experimental Models |
|---|---|
| **Lecturer** | Prof. Dr. Alicia Brusco |
| **Duration** | 1 week |
| **Type of course** | Lectures, exercises and practical work |
| **Workload** | **Total workload: 50 h**<br>**Presence: 45 h/week**<br>2 h/day lectures<br>1 h/day exercises<br>3 h/day lab work<br>**Self-study/homework: 5 h/week**<br>1 h/day data analysis, documentation, and reading |
| **Credit points** | 2 |
| **Content** | The use of animals in biomedical research. International legislation and regulations related to laboratory animals care and use. Bioethics in animal research. Handling and restriction of rats and mice, drug administration ways, sexing, and age recognition. Animal welfare: 3 Rs and 5 freedoms. The bioethical principles of Russel and Burch. Descriptive Statistics. Numerical and graphical statistical summaries. Probability models for discrete and continuous random variables. Statistical inference. Hypothesis testing. Comparison groups. An introduction to statistical linear models and contingency tables for quantitative and qualitative variables. Biological bases of learning and memory. Experimental results of the study of memory and learning using animal models. Bio mathematical analyses of cell proliferation organization in the developing CNS. Characterization of deterministic and stochastic components and their morphogenetic roles. Animal models of brain injuries. A model of perinatal asphyxia in rats: Application of hypothermia as a therapeutic strategy against hypoxic-ischemic damage. An animal model of retinal degeneration induced by light. Effect of the perinatal exposition to CB1 Agonist in the development of the cerebral cortex. Mechanisms of intracellular movements in cellular models and their relevance in disease. Cell migration, extracellular matrix degradation of basal membranes: role in organogenesis and in pathological processes. Signaling molecules involved in regulating cell migration and extracellular matrix degradation. Cell differentiation. |
| **Learning Outcomes** | ▪ The students can apply biostatistics tools in biomedical research.<br>▪ The students can handle laboratory animals.<br>▪ The students can analyze biological imaging.<br>▪ The students can compare different animal models used in biomedical research.<br>▪ The students can describe and discuss the use of different experimental models to study the CNS. |
| **Exam (PL)** | PL: Written exam of 30 min with 20 multiple-choice questions. Topics: main concepts of statistics, animal models and research animal care.<br>The grade of this submodule contributes 50% to the total grade of the entire module.<br>Required participation at this submodule: 85%. |

# 5. Part II: Modules in Freiburg

In November of each year the master students fly to Freiburg and pass an 8 months module block at UFR (till June of the following year). It starts with a 2-weeks intensive language course in German, a short Scientific Communication and Intercultural Training and a lab week, when the students learn the basics of experimental work in order to bring them to the same level for the subsequent modules. As in Buenos Aires, the language training continues on a weekly basis yielding a German certificate. In parallel, 4 mostly practical modules providing a bench-to-bed side/translational training in Biomedicine deepen the theoretical knowledge acquired at UBA. The modules consist of Molecular and Cellular Biology, Immunology and Molecular Pathology, Pharmacology and Toxicology II, Molecular Cardiology, Molecular Oncology II, Materials and Microsystems for Life Sciences, Biostatistics and Machine Learning and Bioethics. The IMBS students then complete 5 months of intensive Laboratory Research to strengthen their experimental skills, to plan and realize experiments and to learn critical thinking. Moreover, during this phase the master students get familiarized with the various research topics that they can choose at UFR or UBA for their 8 months master thesis. Before starting their master thesis, the students must present the master topic in a 20 min hybrid talk in front of UFR and UBA professors in Freiburg. Successful presentation and acceptable grades from the 8 months UFR modules entitle them for a Diploma of Advanced Studies (DAS) of the Continuing Education section of the UFR.

| Nr | MODULES | Type of course | Credit points | Semester | Type of exam or Study performance |
|---|---|---|---|---|---|
| | **University of Freiburg (47 ECTS)** | | | | |
| | Intensive German language course | V+Ü | 3 | 2 | SL |
| | Scientific & intercultural communication training and lab research methods | V+Ü+Pr | 5 | 2 | SL |
| I | Biostatistics and Machine Learning (Ia), Bioethics (Ib) | V+Ü+S | 5 | 2 | PL: written (Ia, Ib) (each 50%) |
| II | Pharmacology, Toxicology (IIa), Materials and Microsystems (IIb) | V+S+Pr | 5 | 2 | PL: written and oral (IIa), oral (IIb) (each 50%) |
| III | Molecular Oncology (IIIa), Cardiology (IIIb) | V+S+Pr | 7 | 2 | PL: written (IIIa, IIIb) (each 50%) |
| IV | Molecular and Cellular Biology (IVa), Immunology and Pathology (IVb) | V+S+Pr | 7 | 2 | PL: written (IVa) and oral (IVb) (each 50%)<br>SL: lab report (IVa) |
| V | Labor Research | Pr | 15 | 2 und 3 | SL: DAS presentation<br>PL: lab report |
| | **Subtotal** | | **47** | | |

| Intensive German language course | |
|---|---|
| **Lecturers** | External company |
| **Duration** | Intense for 2 weeks, then regularly once a week for 27 weeks |
| **Type of course** | Lectures, group work, practice with different media |
| **Workload** | **Total workload: 75 h**<br>**Presence: 18,75 h/week during one month** |
| **Credit points** | 3 |
| **Content** | German Language training at Level A1 and A2 by using diverse communicative methods which are highly interactive and dynamic to suit different types of learners. The methods emphasize on listening & speaking skills, extension of vocabulary, the understanding and application of German grammar. Teaching material and content additionally supports the awareness, understanding and a good handling of the cultural diversity and the new environment. For German students a respective English course will be offered. |
| **Learning Outcomes** | Students can demonstrate on Advanced Low level of Proficiency in German in speaking, writing, listening and reading<br>▪ Speaking: students are able to handle a variety of communicative tasks. They are able to participate in most informal and some formal conversations on topics related to school, home, and leisure activities. They can also speak about some topics related to employment, current events, and matters of public and community interest.<br>▪ Writing: students are able to meet basic work and/or academic writing needs. They demonstrate the ability to narrate, describe and express viewpoints about familiar topics in major time frames with some control of aspect.<br>▪ Listening and Reading: students are able to understand short conventional narrative and descriptive texts (spoken and/or written) such as descriptions of persons, places, and things, and narrations about past, present, and future events with a clear underlying structure though their comprehension may be uneven. They can understand the main facts and some supporting details. Comprehension may often derive primarily from situational and subject-matter knowledge.<br>▪ Students are able to communicate in Germany (and Switzerland and Austria) in order to organize their daily life and academic matters and are able to network |
| **Study performance (SL)** | Students who participated in at least 85% of the course receive a participation certificate. In addition, they can register at the Goethe Institute in Freiburg for the official A1 or A2 German exam |

## 5.1 Scientific & intercultural communication & lab research

| Scientific & intercultural communication training and lab research methods | |
|---|---|
| **Lecturers** | Dr. Lukas Peintner, Dr. Evguenia Alechine, Iván Acevedo Monterrosa |
| **Duration** | 2 weeks |
| **Type of course** | Lectures, courses, training, exercises, homework, preparation, practical work |
| **Workload** | **Total workload: 125 h**<br>**Introduction: 50 h/week**<br>40 h scientific writing, communication and presentation<br>10 h intercultural training<br>**Lab methods: 75 h/week**<br>40 h practical work in the lab<br>10 h preparation: reading<br>25 h knowledge transfer: reading, writing a lab protocol |
| **Credit points** | 5 |
| **Content** | During the introduction week the students will have training in scientific writing, communication and presentation. Additionally, the students will have an intercultural communication training with exercises, group work and discussions. |

## Scientific & intercultural communication training

| | |
|---|---|
| **Lecturers** | Dr. Lukas Peintner, Dr. Evguenia Alechine, Iván Acevedo Monterrosa |
| **Duration** | 1 week |
| **Type of course** | Lectures, courses, training, exercises, self-study/homework, preparation |
| **Workload** | **Total workload: 50 h**<br>40 h scientific writing, communication and presentation<br>10 h intercultural training |
| **Credit points** | 2 |
| **Content** | Intense training during the introduction week and then monthly meetings with presentations.<br>**Scientific writing, communication and presentation:**<br>Lectures and training about methods, resources, citation, publishing and structure of scientific papers, abstracts and master thesis. Lectures, group work and training in poster and oral presentations including standard rules and tools in design, presentation and writing, rhetorical skills, professional use of voice, facial expression, gestures and body postures. Learning through practice and group feedback.<br>**Intercultural competence:**<br>Lectures, group work and training in following topics: definition of culture, cultural models and cultural identity including foreignness and its impact. With awareness of the own cultural imprint the training focuses on stereotypes, prejudices and cultural dimensions. Understanding different communication techniques, verbal and non-verbal, the training leads to strategies of successful cultural interaction including German historical and temporary facts as well as practical information about the “dos and don’ts” for living in Germany. |
| **Learning Outcomes** | **Scientific communication:**<br>■ Presentation of research projects orally and in writing<br>■ Label the components of a scientific paper and master thesis<br>■ Decide when it is appropriate to use the different types of scientific literature such as primary literature, reviews and textbooks<br>■ Identify thesis and development statements<br>■ Explain how scientific research is published (including the peer review process, open-access journals, and the embargo system)<br>■ Use online research tools (e.g. databases, e-journals, Google Scholar, Web of Science) to collect relevant information (e.g. scholarly articles, websites, blog posts) on a particular topic<br>■ Cite different types of scientific literature appropriately<br>■ Use an outline to organize a scientific argument with a claim and supporting evidence<br>■ Read scientific literature and assess the quality of the claims and evidence used to support them |

| | |
|---|---|
| | ■ Defend the validity of an argument by evaluating evidence in a variety of genres, including popular media, websites and scientific journals<br>■ Write an abstract by using the standard structure<br>■ Write and deliver a presentation by using the state of art<br>**Intercultural competence:**<br>Students demonstrate knowledge and understanding of other cultures and their products. By the time they graduate from our program, they are able to:<br>■ Be aware of their own cultural imprint and its impact on their way of thinking and acting<br>■ Examine the validity of one's own cultural beliefs, behaviors and norms by contrasting and comparing them with those of the target culture<br>■ Recognize and describe the historical, social, economic, and political forces that shape society in the target culture<br>■ Understand and respect cultural diversity and its impact<br>■ Choose adequate techniques to handle cultural diversity in daily life, e.g. perform change of perspective adequately or handle the feeling of foreignness<br>■ Communicate appropriately in an intercultural environment<br>■ Perceive and value cultural diversity and reinterpret the place of the self as an identity culturally situated in the global context |
| **Study performance (SL)** | Each student has to give a 15 min Powerpoint presentation in scientific communication and intercultural training. Participation can be in presence or online via ZOOM and has to be 85%. |

| Lab research methods | |
| --- | --- |
| **Lecturer** | Dr. Lukas Peintner |
| **Duration** | 1 week |
| **Type of course** | Lecture, practical work, seminar presentation, self-study/homework |
| **Workload** | **Total workload: 75 h**<br>40 h practical work in the lab<br>10 h preparation: reading of introductory literature<br>25 h knowledge transfer: compiling data and writing a lab report |
| **Credit points** | 3 |
| **Content** | The introduction into lab research methods aims to convey the basic knowledge how to work and behave in a biological laboratory. A special focus is set on skills that will be needed in other advanced lab courses of the IMBS master program. The student will be introduced into the basic “dos and don’ts” in laboratories. He/she learns to perform chemical calculations and prepare buffers based on these calculations. Then the student learns to handle sterile cell culture and to maintain cells for long term periods. Based on the cells isolated, students will further analyse protein content, visualise cells using two kinds of microscopy and perform flow cytometry to assess the health status of the cells. |
| **Learning Outcomes** | Students will get hands-on experience on:<br>▪ Chemical calculations<br>▪ Safe handling of chemicals and buffers<br>▪ Sterile work using cell culture benches and handling of adherent cells (maintenance, spitting, counting, seeding)<br>▪ Quantification of protein concentrations from self-prepared lysates<br>▪ Visualisation of cells and proteins using microscopy and flow cytometry<br>▪ Maintaining a lab notebook and translating lab results into a lab report<br>▪ Reporting specific topics in a 10-minute seminar presentation |
| **Study performance (SL)** | Each student has to submit a written lab report of max. 10 pages about the experiments performed. The report is assessed by the lecturer. Feedbacks are given and in order to pass the SL, the student evtl. has to adjust the report based on the lecturer’s recommendations.<br>Each student has to give a 10 min oral seminar about the methods learned in this module<br>Participation at the seminars and practical work has to be 85% |

## 5.2 Module I: Biostatistics and Machine Learning, Bioethics

| Module I | Biostatistics and Machine Learning (Ia), Bioethics (Ib) |
|---|---|
| **Lecturers** | Prof. Dr. Joschka Bödecker, Prof. Dr. Ignacio Mastroleo, Dr. Romina Zuppone, Dr. Tenzin Wangmo, Dr. Melanie Weismann |
| **Duration** | 2 weeks |
| **Type of course** | Lectures, exercises and practical work |
| **Workload** | **Total workload: 125 h**<br>**Presence: 50 h/week**<br>3 h/day lectures<br>3 h/day exercises<br>4 h/day lab work<br>**Self-study/homework: 12,5 h/week**<br>2,5 h/day data analysis, documentation, and reading |
| **Credit points** | 5 |
| **Grade** | The grade of the module contributes 4% to the final master grade |

| Module Ia | Biostatistics and Machine Learning |
|---|---|
| **Lecturers** | Prof. Dr. Joschka Bödecker |
| **Duration** | 1 week |
| **Type of course** | Lectures, exercises |
| **Workload** | **Total workload: 62,5 h**<br>**Presence: 50 h/week**<br>6 h/day lectures<br>4 h/day exercises<br>**Self-study/homework: 12,5 h/week**<br>2,5 h/day case-studies |
| **Credit points** | 2,5 |
| **Content** | The second submodule deals with modeling and the application of statistical analysis methods in order to train the interpretation of the results. The course teaches the following:<br>▪ Introduction into the statistical software R<br>▪ Descriptive statistics, colors and diagrams<br>▪ Probability distributions<br>▪ Point estimation and confidence intervals<br>▪ Statistical tests, multiple testing<br>▪ Linear regression and classification<br>▪ Cross validation<br>▪ Feature and model selection<br>▪ Principal Component Analysis<br>▪ K-means Clustering |
| **Learning Outcomes** | ▪ Students know the difference between descriptive and inferential statistics<br>▪ Students can perform a descriptive statistical analysis of their data<br>▪ Students know the most important probability distributions for biomedical research<br>▪ Students can apply important inferential statistical methods<br>▪ Students know how the results of their statistical analysis have to be interpreted<br>▪ Students get familiar with an open-source statistical software for biostatistics and bioinformatics, i.e. the statistics software R (free, non-commercial implementation of statistical programming language S), using the statistical programming language R<br>▪ Students can apply linear models for regression and classification analysis to new data, and are able to estimate the generalization error based on cross validation training<br>▪ Students know how to select the most important features and select the best model based on information criteria.<br>▪ Students can visualize and interpret their data with Principal Component Analysis and can perform unsupervised clustering with k-means. |

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|---|---|
| **Recommended Literature** | ■ Dalgaard (2008). Introductory Statistics with R. 2nd edition. Springer.<br>■ Dancey, Reidy, Rowe (2012). Statistics for the Health Sciences. Sage.<br>■ Kohl (2015). Introduction to statistical data analysis with R. bookboon.com.<br>■ Whitlock, Schluter (2015). The Analysis of Biological Data. 2nd edition. Roberts and Company Publishers.<br>■ James, Witten, Hastie, Tibshirani (2021). An Introduction to Statistical Learning with Applications in R. 2nd edition. Springer. |
| **Exam (PL)** | Written exam for 90 minutes on the last day of the submodule, seven multiple choice and 15 complex questions to be answered with sentences from the full range of topics of the lecture (with emphasis on the Biostatistics part).<br>The grade of this exam contributes 50% to the total grade of the entire module<br>Participation at the seminars and practical work has to be 85% |

| Module Ib | Bioethics |
|---|---|
| Lecturers | Dr. Ignacio Mastroleo, Dr. Romina Zuppone, Dr. Tenzin Wangmo, Dr. Melanie Weismann |
| Duration | 1 week |
| Type of course | Lectures, seminars, exercises |
| Workload | **Total workload: 62,5 h**<br>**Presence: 50h/ week**<br>4 h/day: exercises<br>3,5 h /day: lectures<br>2,5 h /day: discussions<br>**Self-study/homework: 12,5h/week**<br>2,5 h/day: preparation of presentations, case-studies |
| Credit points | 2,5 |
| Content | Professors from University of Basel (Wangmo), UBA (Mastroleo) and the University of Barcelona (Zuppone) and UFR (Weismann) give lectures and interactive workshops (e.g. group works, etc.) covering core contents in Biomedical Ethics, Human Health Research Ethics, Philosophy of Biomedicine and Ethics of Reproductive Medicine, for an entire week. Biomedical scientists are increasingly exposed to bioethical issues given the rapid advances in biomedical innovations such as whole genome sequencing, gene editing, or artificial intelligence for health; long-standing ethical and epistemic issues in biomedicine (e.g. research misconduct and reproducibility crises) and recently emergent issues related to ethics of public health emergencies. It is therefore crucial to train critical thinking skills and discuss such issues with our master students as early as possible during their career path. |
| Learning Outcomes | ▪ Students learn the importance of considering ethical and epistemic aspects in biomedical sciences<br>▪ Understanding the principles of bioethical research and its practical implementation |
| Exam (PL) | Written exam of 60 minutes. The students choose two (2) out of four (4) topics based on the lectures and follow the instructions of each assignment (questions and critical summaries of papers worked during the lectures). The suggested extension of each answer is 300 words maximum. Topic 1. Biomedical Ethics (Wangmo), Topic 2. Research Ethics (Mastroleo), Topic 3. Philosophy of Biomedical Sciences (Zuppone), Topic 4. Ethics of Reproductive Medicine (Weismann).<br>The grade of this exam contributes 50% to the total grade of the entire module<br>Participation at the seminars and practical work has to be 85% |

## 5.3 Module II: Pharmacology, Toxicology, Materials & Microsystems

| **Module II** | **Pharmacology, Toxicology (IIa), Materials and Microsystems (IIb)** |
|---|---|
| **Lecturers** | Prof. Dr. Robert Grosse, Dr. Robert Mallmann, Prof. Dr. Jürgen Rühe, Dr. Oswald Prucker |
| **Duration** | 2 weeks |
| **Type of course** | Lectures, seminars and practical work |
| **Workload** | **Total workload: 125 h**<br><br>**Presence: 50 h/week**<br>3 h/day lectures<br>2 h/day seminars<br>5 h/day lab work<br><br>**Self-study/homework: 12,5 h/week**<br>2,5 h/day data analysis, documentation, and reading |
| **Credit points** | 5 |
| **Grade** | The grade of the module contributes 4% to the final master grade |

| Module IIa | Pharmacology and Toxicology |
|---|---|
| Lecturers | Prof. Dr. Robert Grosse, Dr. Robert Mallmann |
| Duration | 1 week |
| Type of course | Lectures, seminars, practical work |
| Workload | **Total workload of 62,5 h**<br>**Presence: 50 h/week**<br>4 h/ day lectures and seminars<br>2 h/day preparation of oral presentation<br>4 h/ day practical course<br>**Self-study/homework: 12,5 h/week**<br>2,5 h/day preparation of presentations, reading |
| Credit points | 2,5 |
| Content | The first part of this module offers basic and advanced knowledge about pharmacological studies of interaction between drugs (chemicals of synthetic or natural origin) and organisms (biological systems). Students will understand pharmacodynamic actions of drugs with a focus on drug-induced interaction with membrane receptors and subsequent signaling events.<br>Part of this module is the regulation of the cytoskeleton and its pharmacological inhibition. In addition, we will discuss optogenetic tools to regulate and manipulate the actin cytoskeleton during tumor cell division, motility and invasion. We will also discuss the intricate connection between cytoskeletal dynamics and transcriptional regulation that is critical for tumor progression and cancer cell survival and motility.<br>Participants will be able to integrate up-to-date views of structures, regulation and physiological functions of ion channels. They will receive an overview of current techniques, design and generation of in vivo and in vitro knock-out models of ion channels. Students gain insight into basic techniques for behavioral characterization of pharmacologically treated or genetically engineered (knock-out) mouse models.<br>Principles of toxic effects (risks, hazards) and pathogenetic mechanisms of drugs will be delineated by presentation of various groups of bacterial protein toxins, which act with extremely high potency and efficiency on target cells and organs. |
| Learning Outcomes | ■ The students are able to design and perform experiments to unravel basic actions of drugs.<br>■ The students will be able to assess general requirements and limitations of behavioural phenotyping assays. |

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|---|---|
| | ■ Students gain individual laboratory skills.<br>■ Participants have the ability to get into specific topics of the field by reading current publications and to interpret and communicate the data. |
| **Exam (PL)** | At the end of the submodule the content of the seminars and the practical work is tested in a written exam (multiple choice and complex questions, duration 60 min.<br><br>Each student has to give a 10-minute presentation on a recent scientific article that is related to methods discussed in the practical course. The literature is provided by the module supervisor.<br><br>The average of the grades from the written test and the presentation results in the final grade of the entire submodule.<br><br>The final grade of the submodule contributes 50% to the total grade of the entire module<br><br>Participation at the seminars and practical work: 85% |

| Module IIb | Materials and Microsystems for the Life Sciences |
|---|---|
| **Lecturers** | Prof. Dr. Jürgen Rühe, Dr. Oswald Prucker |
| **Duration** | 1 week |
| **Type of course** | Lectures, seminars, practical work |
| **Workload** | **Total workload of 62,5 h**<br>**Presence: 50 h/week**<br>6 h/day laboratory work<br>4 h/day lectures<br>**Self-study/homework: 12,5 h/week**<br>2,5 hrs/day journal club work |
| **Credit points** | 2,5 |
| **Content** | Special knowledge and state of the art methods for the generation, use and characterization of biomaterials are of great importance in Biomedical Sciences. For example, polymers are used for implants (heart valves, breast implants, artificial joints, retina implants) as well as for drug release or dental materials. Biointerfaces are also a key for the performance of bioanalytical devices (e.g. lab-on-disc or lab-on-CD devices).<br>The lecture submodule gives the students a basic introduction into the field of biomaterials used in various biomedical applications and into methods used to characterize such materials. A special focus is placed on the use of polymeric materials in biomedical applications and on methods employed for the generation of tailor-made biointerfaces. The importance of surface interactions of biomolecules with surfaces in vivo and in vitro are discussed. Additionally, models describing the interaction of biological cells with artificial materials are presented.<br>The laboratory submodule explores 1) the generation and use of DNA-chips for the detection of bacteria 2) the measurement of protein adsorption to surfaces by surface plasmon spectroscopy. 3) Students study cells on microstructured surfaces with the help of Atomic Force Microscopy (AFM) and they learn how to probe surfaces with small tips.<br>The literature submodule consists of instructions on the performance of literature work. The CPI research lab organizes a journal club for all students to help them keep up with the literature produced by others who work in the biomaterial area. Taking part in the journal club helps participants to become familiar with the advanced literature and data in in the biomaterial area. This helps to rapidly improve the students' skills of understanding and debating current topics of active interest in this field. |

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| **Learning Outcomes** | ■ Students obtain basic knowledge about biomaterials and microsystems.<br>■ Students obtain a basic understanding of the interaction of biomolecules with surfaces.<br>■ Students gain an impression on the generation and use of selected, modern bioanalytical devices.<br>■ Students gain individual laboratory skills.<br>■ Students become acquainted with the assessment and evaluation of scientific literature and also with interdisciplinary work. |
| **Exam (PL)** | Students will form groups of four students to present a paper from the journal club. Presentations are 20 min plus five minutes for discussion. Students will be graded with respect to their contribution to the talk, the quality of the slides presented and their participation in the discussion.<br><br>The final grade of the submodule contributes 50% to the total grade of the entire module<br><br>Participation at the seminars and practical work: 85% |

## 5.4 Module III: Molecular Oncology and Cardiology

| Module III | Molecular Oncology (IIIa) and Cardiology (IIIb) |
|---|---|
| **Lecturers** | Prof. Dr. Ralph Wäsch, PD Dr. Dennis Wolf, Prof. Dr. Timoteo Marchini, Dr. Mark Colin Gissler |
| **Duration** | 3 weeks |
| **Type of course** | Lectures, seminars and practical work |
| **Workload** | **Total workload: 175 h**<br>**Presence: 50 h/week**<br>2 h/day lectures<br>2 h/day seminars<br>6 h/day lab work or exercises/ presentation<br>**Self-study/homework: 8,3 h/week**<br>1,7 h/day data analysis, documentation, and reading |
| **Credit points** | 7 |
| **Grade** | The grade of the module contributes 4% to the final master grade |

| Module IIIa | Molecular Oncology |
|---|---|
| **Lecturer** | Prof. Dr. Ralph Wäsch |
| **Duration** | 1 week |
| **Type of course** | Lectures, group work, exercises, practical work |
| **Workload** | **Total workload: 62,5 h**<br><br>**Presence: 50 h/week**<br>3 h/day lecture<br>3 h/day seminar<br>4 h/day presentation<br><br>**Self-study/homework: 12,5 h/week**<br>2,5 h/day data analysis, documentation, and reading |
| **Credit points** | 2,5 |
| **Content** | Current selected topics in cancer research and diagnostic techniques:<br><br>1. Relevance of the genetics, including chromosomal aberrations and mutations, in the pathogenesis, diagnosis and therapy of myeloid malignancies<br><br>2. Targeting RAS and PI3K signaling in cancer: A large subset of difficult-to-treat cancers including pancreatic, lung and colorectal cancer harbor activating mutations within the RAS and/or PI3K signaling pathways. The lecture discusses current approaches to target oncogenic signaling in these tumors and also highlights novel approaches to bypass drug resistance.<br><br>3. Cell cycle control in cancer and stem cells with a focus of the role of the ubiquitin-proteasome system on genomic instability of cancer cells, its function on differentiation in hematopoietic stem and progenitor cells and implications for therapy are discussed.<br><br>4. Molecular Diagnostics in Hematology/Oncology including a current overview of the most important molecular diagnostic methods with the focus on the FISH technology. Important molecular markers in hematology and the necessity and technique of cell selection is discussed. In a second, practical part the students perform the pretreatment of FISH method and do short analyses using a fluorescence microscope.<br><br>5. Flow Cytometry: This course is designed to familiarize students with the basic principles of flow cytometry. Students learn the technical principles behind flow cytometry, as well as how to apply them at both the theoretical and practical levels. The morning session consists of a lecture and the afternoon includes a practical session showing basic usage of flow cytometry in an example experiment. |
| **Learning Outcomes** | ■ Basic concepts and techniques in the field of molecular biology of cancer are understood.<br>■ Participants have the ability to get into specific topics of the field by reading current publications and to interpret and communicate the data, which should be applicable to other subjects in life science. |

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| | ■ The lectures impart on principles of personalized cancer medicine by understanding targetable individual cellular aberrations in selected malignant neoplasms, which is key in current oncology.<br>■ The practical application of important techniques for the diagnosis and evaluation of treatment outcome of cancers are learned. |
| **Exam (PL)** | Written multiple choice test (30 minutes) on current selected topics in cancer research and diagnostic techniques as taught in the module.<br>The final grade of the submodule contributes 50% to the total grade of the entire module<br>Participation at the seminars and practical work: 85% |

| Module IIIb | Molecular Cardiology |
|---|---|
| **Lecturers** | PD Dr. Dennis Wolf, Prof. Dr. Timotheo Marchini, Dr. Mark Colin Gissler |
| **Duration** | 2 weeks |
| **Type of course** | Seminars, practical work |
| **Workload** | **Total workload: 112,5 h**<br>**Presence: 50 h /week**<br>4 h/day: lecture<br>1,5 h/day: seminar<br>3 h/day: practical course<br>1,5 h/day: preparation time for presentations and practical courses<br>**Self-study/homework: 6,25 h/ week**<br>1,25 h/day data analysis, documentation, and reading with whole learning days |
| **Credit points** | 4,5 |
| **Content** | This module is focusing on recent key aspects of translational research in cellular and molecular cardiology. The participants learn about basic immunologic and inflammatory mechanisms promoting atherosclerosis, myocardial infarction, myocarditis, and the metabolic syndrome, as well as about the fundamental processes governing cardiac metabolism and dysfunction, and angiogenesis. They practice standard techniques of molecular biology and physiology in wet lab practical work related to cardiovascular disease. Methods covered include: necrobiopsy techniques, flow cytometry, histology, experimental atherosclerosis in the mouse, angiogenesis, and state-of-the-art 4D imaging. A specific emphasis is the translation bench-to-bedside, which will be covered by an introduction in clinical trial design, translational concepts, and practical experiences in the echocardiography laboratory. Scientific soft skills will be taught in journal clubs. |
| **Learning Outcomes** | ▪ Participants can define and describe underlying mechanisms of cardiovascular disease focusing on inflammatory and immune mechanisms in atherosclerosis, myocardial infarction, myocarditis, the metabolic syndrome, angiogenesis, and heart failure.<br>▪ Participants know principles and interpret results of state-of-the art techniques of molecular biology and physiology widely used in cardiovascular disease research.<br>▪ Participants can outline the fundamental strategy in establishing a novel preclinical therapy as treatment in daily practice. They know types of clinical studies and can name principles of clinical statistics.<br>▪ Participants can summarize and present key findings of published studies and critically discuss results. |

| | |
|---|---|
| **Exam (PL)** | Written exam with 25 multiple choice questions covering all topics of seminars, lectures, and practical work. Duration: 1.5 h.<br>The final grade of the submodule contributes 50% to the total grade of the entire module<br>Participation at the seminars and practical work: 85% |

## 5.5 Module IV: Molecular and Cellular Biology, Immunology & Pathology

| Module IV | Molecular and Cellular Biology (IVa), Immunology and Pathology (IVb) |
|---|---|
| Lecturers | Prof. Dr. Dres. h.c. Christoph Borner, Prof. Oliver Schilling, Dr. Melanie Föll |
| Duration | 3 weeks |
| Type of course | Lectures, seminars and practical work |
| Workload | **Total workload: 175 h**<br>**Presence: 50 h/week**<br>2 h/day lectures<br>2 h/day seminars<br>6 h/day lab work or exercises/ presentation<br>**Self-study/homework: 8,3 h/week**<br>1,7 h/day data analysis, documentation, and reading |
| Credit points | 7 |
| Grade | The grade of the module contributes 4% to the final master grade |

| Module IVa | Molecular and Cellular Biology |
|---|---|
| **Lecturer** | Prof. Dr. Dres. h.c. Christoph Borner |
| **Duration** | 2 weeks |
| **Type of course** | Lectures, seminars, practical work |
| **Workload** | **Total workload: 112,5 h**<br>**Presence: 50 h/week**<br>1,5 h/day seminar<br>8,5 h/day experimental work in the lab<br>**Self-study/homework: 6,25 h/week**<br>0,5 h/day data analysis & documentation<br>0,75 h/day reading |
| **Credit points** | 4,5 |
| **Content** | In this module a variety of biochemical and cellular tools and methods are used to quantify apoptosis in eukaryotic cells by various biochemical and cellular methods. The goal is to get experienced with culturing, handling and counting mouse and human cells, to induce apoptosis either genotoxic stress or by cell detachment (anoikis), to then prepare a cell extract, measure protein content and caspase-3 activity in an fluorescent-based enzymatic assay and determine the levels of active caspase-3 and its substrate PARP, the pro-apoptotic protein p53 and members of the Bcl-2 family by Western blotting. In addition, cells are subjected to flow cytometry analysis (FACS) to determine the proportion of apoptotic cells, which have phosphatidylserine exposed on the surface (detected with FITC-Annexin-V) and necrotic cells, which have a permeabilized plasma membrane and therefore allow the entry of the red fluorescent dye propidium iodide. The number of necrotic cells is also determined by a lactate dehydrogenase (LDH) release assay. Finally, the students learn to fix cells on coverslips, incubate them with various primary and secondary fluorescent labeled antibodies and perform an immunofluorescence analysis to determine the amount and subcellular localization of Bcl-2 family proteins and cytochrome c (which is retained in mitochondria in healthy cells and released into the cytoplasm in apoptotic cells). In this way they learn to properly handle a fluorescent microscope and to use photo capturing and the software to produce nice fluorescence pictures of eukaryotic cells. The students are organized into working groups of 3 to max 4 people, but each student performs the experiments with his/her own hand. This course is therefore a really HANDS-ON practice module. Each group is supervised by a senior PhD student or postdoc who assists them with the practical work, gives advice and introduces each method in the form of a seminar. The students also learn to critically and statistically analyze their data and to write a scientific lab report with the data obtained, which is critically evaluated by the supervisors. If not satisfactory, the reports have to be corrected (“Studienleistung”). |

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| **Learning Outcomes** | At the end of the module the students have:<br>▪ Knowledge of cellular and biochemical methods on eukaryotic cells<br>▪ Knowledge of rules and safety measures of genetically modified organisms and hazardous substances and the ability to work accurately under sterile conditions<br>▪ Statistical analysis of the data<br>▪ Proper data mining and lab reporting |
| **Exam (PL) Study performance (SL)** | PL: Written exam for 120 minutes on the last day of the submodule, Nine multiple choice and 17 complex questions to be answered with sentences about the topics of the seminars given by the students and the methods of the practicum.<br>The grade of this exam contributes 50% to the total grade of the entire module<br>SL: Each student has to submit a written lab report of max. 20 pages about the experiments performed after two weeks of the submodule. The report is assessed by the module leader. Feedbacks are given and in order to pass the SL. The student evtl. has to adjust the report based on the leader's recommendations.<br>Each student has to give two 15 min oral seminars about the topics of the module based on literature provided by the module leader.<br>Participation at the seminars and practical work: 85% |

| Module IVb | Immunology and Pathology |
|---|---|
| Lecturers | Prof. Dr. Oliver Schilling, Dr. Melanie Föll |
| Duration | 1 week |
| Type of course | Seminars, lab work, student's presentation of publications on (multi-)omics characterization of diseases |
| Workload | **Total workload of 62,5 h**<br>**Presence: 50 h/week**<br>4 h/day: lectures<br>3 h/day: seminars incl. student's presentation<br>3 h/day: lab work/hands-on training<br>**Self-study/homework: 12,5 h/week**<br>1 h/day: reading, data analysis and documentation<br>1,5 h/day: exam preparation |
| Credit points | 2,5 |
| Content | The students will understand pathology, molecular pathology, and its links to immunology as an interdisciplinary subject. This includes basic knowledge of organ-specific tissue architecture and disease patterns as well as knowledge of basic pathomechanisms, especially in the field of oncology. The students understand the basics of the pathological diagnostic process including histopathology, immunohistochemistry and genomic-molecular pathological approaches. The students can integrate new developments in the subject in perspective. Using current case studies, the students can apply their technical and indication-related knowledge. The students are able to understand scientific texts on current topics in pathology and molecular pathology, to analyze their contents and to present them in the form of short presentations. The students learn and deepen the basic techniques of molecular pathology (e.g. ISH, microdissection, qPCR,NGS) and their diagnostic applications. The indication-related molecular diagnostic portfolio in molecular pathology is taught. Concepts for classification, prognosis and therapy prediction of selected diseases are mastered. The course provides a practical introduction and application to aspects of histopathology and immunohistochemistry along with applications from the field of molecular pathology. The course will also cover basics of immunology, its cellular components and regulatory principles, and its connection to human pathology. |

| | |
|---|---|
| **Learning Outcomes** | Participants will get an overview of the following topics:<br>▪ Histomorphology<br>▪ Basics of human pathology<br>▪ Molecular pathology<br>▪ Molecular and cell biology foundation of pathological conditions<br>▪ Omics-approaches and their data analysis<br>▪ Understanding the role of different components of the immune system in human disease<br>▪ HLA System class I and class II<br>▪ Human natural killer cells: NK receptors, role in tumor defense and stem cell transplantation. NK education<br>▪ Tumor immunology<br>▪ Introduction to cardiovascular pathological conditions |
| **Exam (PL)** | Oral exam, based on critical assessment of published multi-omics analysis of human pathological condition; held as group exam (up to 4 group members), 30 min duration.<br>The grade of this exam contributes 50% to the total grade of the entire module<br>Participation at the seminars and practical work: 85% |

## 5.6 Module V: Laboratory Research

| Module V | Laboratory Research |
|---|---|
| **Lecturers** | All Faculty at UFR |
| **Duration** | 4 months (16 weeks / 80 days) |
| **Type of course** | Practical work and self-study/homework |
| **Workload** | **Total workload: 375 h**<br>**Presence: 23,5 h/week**<br>Laboratory work including documentation |
| **Credit points** | 15 |
| **Content** | Laboratory Research includes an intensive period of laboratory work including documentation, self-study/homework and discussion about methods and results. Participants choose from the participating faculties either one lab for the entire period, or several labs for four weeks each, where they experimentally work on a defined research project to get data, which are then analyzed and documented and finally presented in the form of a 20 min oral seminar (hybrid format) (DAS exam). The goal of this module is to learn as many techniques and methods possible, to accurately mine data at the bench using the right controls and a correct statistical analysis, to critically assess own data and the data of their lab mates, to participate in lab seminars to discuss science, to read and present the relevant literature and present the progress of the laboratory research in seminars in front of the research group or the institute. In most cases the research topic is continued in the same lab(s) for the subsequent master thesis. However, the students can change the topic and/or the research lab after the lab research and start with something entirely new for the master thesis. |
| **Learning Outcomes** | ■ Participants learn in-depth about methods and documentation during hands-on<br>■ They should be able to adapt methods to specific questions<br>■ They understand all principles of laboratory work in the chosen laboratories |
| **Exam (PL) Study performance (SL)** | PL: Each student has to submit a written lab report of max. 20 pages about the experiments performed during the lab rotation. The report is graded by the module leader for the parts introduction, analysis and data presentation, discussion and conclusion, writing style and English language.<br>The arithmetic average grade accounts for 12% of the final master grade.<br>SL: Each student gives a 15 min Powerpoint presentation in a hybrid format on the lab rotation and his/her master thesis plan at the Diploma of Advanced Study (DAS) exam in the end of April. The presentation is graded and accounts for the DAS certificate, which is a separate certificate from the master certificate. For the master certificate, the presentation is a SL which means that the grade does not count.<br>Participation at the practical work: 85% |

## 5.7 Elective Modules

| Elective module | Decellularization of the cornea |
|---|---|
| Lecturers | Dr. Naresh Polisetti |
| Duration | 2 days |
| Type of course | Practical work, lectures, self-study/homework |
| Workload | **Total workload: 15,5 h**<br>**Presence: 11,5 h/week**<br>Session 1, day 1, 4 h (12.00 – 16.00): Lecture and practice<br>Session 2, day 2, 4 h (08.00 – 12.00): Practice<br>Session 3, day 2, 3.5 h (12:30 – 16:00): Practice<br>**Self-study/homework: 4 h/week**<br>2 h/day: reading, data analysis & documentation |
| Credit points | 0,5 |
| Content | This module is focusing on the decellularization of human corneal tissue. Decellularization is a process used in tissue engineering to isolate the extracellular matrix (ECM) of a tissue from its inhabiting cells, leaving an ECM scaffold of the original tissue, which can be used in tissue regeneration. Decellularization of tissue or organs is a promising experimental approach to solve the clinical problem of donor shortage by generating biomimetic natural scaffolds. In this module, the participants learn about the purpose and different types of decellularization. They practice how to isolate the ECM of human corneal tissue from its inhabiting cells. They practice in three different sessions in a two-day time period. In the first session, the corneal tissue will be dissected, rinsed, and then decellularized by incubating it in detergent, followed by nuclease digestion overnight. On the second day (session 2), the samples will be rinsed and frozen. In the final session, the frozen samples will be sectioned on a cryostat in preparation for histological examination. The samples will be stained for H&E to visually determine the effectiveness of the decellularization protocol. |
| Learning Outcomes | ▪ Participants define and describe the purpose, types, and application of decellularization of tissues<br>▪ Participants perform the decellularization of human corneal tissue and interpret the effectiveness of decellularization protocol. |
| Study performance (SL) | The participants have to submit a detailed protocol containing the results of the experiments |

| Elective module | Cell and Gene Therapy |
|---|---|
| **Lecturers** | Prof. Dr. Toni Cathomen, Dr. Claudio Mussolino, Dr. Anika Schmith and other lecturers |
| **Duration** | Entire winter semester (end of Oct to beginning of Feb), 1 x per week |
| **Type of course** | Seminars, paper presentations |
| **Workload** | **Total workload: 29 h**<br><br>**Presence: 1.5 h /week**<br>1.5 h once a week:<br>1 h: seminar<br>0.5 h: presentation of papers<br><br>**Self-study/homework: 8 h/ semester**<br>Study of publication and preparation time for presentation |
| **Credit points** | 1 |
| **Content** | This module focuses on current topics in cell and gene therapy. The participants will learn about rare hereditary disorders and particular malignancies, as well as the clinical application of cell and gene therapies to treat those diseases. Participating students get to know various therapeutic strategies that involve the employment of advanced therapy medicinal products (ATMPs), including gene therapies to treat immune disorders, CAR T cell therapy to treat cancer, and the use of induced pluripotent stem cells (iPSCs) in regenerative medicine. Furthermore, the students practice the presentation and critical analysis of scientific publications. |
| **Learning Outcomes** | ■ Participants have a basic knowledge of distinct rare inherited diseases and certain types of cancer.<br>■ Participants understand the basic concepts and methodologies used in cell and gene therapy.<br>■ Participants gain entry into specific topics of cell and gene therapy by reading and understanding current publications.<br>■ Participants are able to present scientific publications, and to interpret and discuss scientific data. |
| **Study performance (SL)** | Each student has to present one topic of the module in a 30 min powerpoint presentation |

| Elective module | Flow Cytometry, Image Cytometry and Confocal Microscopy |
|---|---|
| **Lecturers** | Dr. Marie Follo, PD Dr. Franck Ditengou |
| **Duration** | 3 days |
| **Type of course** | Lecture, lab work |
| **Workload** | **Total workload: 28 h**<br>**Presence: 3 days**<br>1,5 h / day: lecture<br>6,5 h / day: labwork<br>**Self-study/homework: 6 h**<br>2 h /day preparation time, data analysis |
| **Credit points** | 1 |
| **Content** | This module focuses on the practical use of flow cytometry, image cytometry/automated microscopy, and confocal microscopy in biological experiments. Similarities and differences between the above approaches will be demonstrated with guidance given as to where and when it is best to use the different approaches. Strengths and weaknesses of these methods will be explained and demonstrated, taking away some of the “mystery” behind them, allowing participants to gain confidence in their abilities and understanding thereof.<br>Experiments will be carried out on state-of-the-art equipment using both fixed and living specimens, allowing participants to learn about the challenges and limitations of these approaches. The goal is to help the participants increase the scientific validity and reproducibility of their experiments in these areas. |
| **Learning Outcomes** | ▪ Participants will perform and interpret a multicolor FACS experiment, including antibody labelling and titration, the selection and proper use of compensation and gating controls, as well as steps required for basic data analysis.<br>▪ They will study samples using automated fluorescence microscopy or image cytometry, learning how to generate microscopy images and then analyse these to generate statistically relevant data.<br>▪ Participants will use high-resolution confocal microscopy to examine and analyse labelled samples in 2D, 3D and 4D. They will learn about some of the typical pitfalls involved with the method and steps that they can take to minimize them. |
| **Study performance (SL)** | The participants have to submit a detailed protocol containing the results of the experiment |

# 6. Part III: Research Project and Master Thesis

The master thesis takes place from July to February each year. Usually, Argentinian students go back to UBA because they are part of an integrated master/PhD program where the topic of the master thesis continues into the PhD. Others can choose their topic at any research lab at the Faculties of Biology, Medicine, Engineering, Chemistry and Pharmacy at UFR or Medicine, Pharmacy and Biochemistry at UBA. In rare occasions the master thesis can also be performed in a renowned lab of another university. However, the IMBS directors have to approve this request and the professor who grades the master thesis has to a member of UFR or UBA.

Each master project in the IMBS program is co-supervised by a professor from UFR and a professor from UBA (this also accounts for master projects outside UFR or UBA). The team accompanies the master student throughout his/her thesis and is regularly contacted by him/her for advice, reorientation of the project and other problems, which may arise during the thesis. The co-supervising team grades the written document of the master thesis and eventually asks for corrections or additions if not satisfactory. The jury of the master thesis defense consists of a faculty member of UFR and a faculty member of UBA, who are not the same as the thesis co-supervisors The third jury member is an external not belonging to either university. This ensures an independent assessment of the written thesis work and the oral presentation (defense) and is therefore a crucial in-built quality control of our IMBS program. Thanks to the co-supervision principle of the master theses, we have established intense collaborations between the research groups at both universities. Every two months, the master students present the progress of their experimental work in a 15 min oral rehearsal in front of UFR and UBA professors, supervisors, directors and co-directors (in a hybrid format). This allows the master students to learn how to present their work and to get input from the IMBS professors about the stage of their master thesis. At this occasion, the master thesis plan can be adjusted or changed and the data can be critically analyzed and improved so that the master students can submit their thesis in time.

After completing their master thesis, the IMBS students defend their work in a 30 minute presentation followed by a 30 minute discussion (after a total of 24 months). The defense either takes place at UFR or UBA depending on where the master thesis was performed and is given in a hybrid format. It always involves the evaluation by professors from both universities and external jury members who join the master thesis defense by video conference. After successful completion of the defense, two master's degrees, a Master of Science from UBA and a Master of Science from UFR (involving the same number of ECTS points mutually accredited to each degree) are be provided.

| Nr | MODULES | Type of course | Credit points | Semester | Type of exam or Study performance |
|---|---|---|---|---|---|
| | **University of Freiburg or University of Buenos Aires (30 ECTS)** | | | | |
| | Master Module | | 30 | 3 und 4 | SL: lab protocol<br>PL: written master thesis<br>PL: oral master thesis defense |
| | **Subtotal** | | **30** | | |
| | **Total credit points** | | **120** | | |

## 6.1 Master Module

| Master Thesis Research, Master Thesis and Defense | |
|---|---|
| **Lecturer** | All UBA and UFR Faculty |
| **Duration** | 8 months (32 weeks) |
| **Academic performance** | Practical work, self-study/homework |
| **Workload** | **Total workload: 750 h**<br><br>**Presence for the first 6 months (24 weeks): 25 h/week**<br>20 h/week laboratory research<br>5 h /week lab protocol<br>**Self-study/homework for the remaining 2 months (8 weeks): 18,75 h/week**<br>15 h/week master thesis writing<br>3,75 h/week preparation for the master thesis defense |
| **Credit points** | 30 |
| **Content** | For the first 6 months, the student practically works on a biomedical project in any of the research groups associated with the IMBS program. The project has to be designed in a way that the student learns a great variety of different methods. Moreover, it has to be based on preliminary data on which the student builds his/her experiments to get own results, which he/she can wrap up into a master thesis. During the practical work, the master student has to regularly present progress reports within the group and/or at the institute, is obliged to read the relevant literature and to regularly present research papers and participate at literature seminars. The master thesis has to be supervised by a professor of the master program who regularly meets the student for progress updates. In addition, a co-supervisor of the partner university is assigned for each master thesis project who can be contacted by the master student on demand and gets informed about the state of the experiments after 3 months in form of a written report and a teleconference between the student, the supervisor and the co-supervisor. At this time, all master students also need to present their progress to the IMBS professor team of the respective university. Moreover, a senior PhD student or postdoc shall supervise the practical work of the master student on a daily basis. He/she merely provides technical and methodological input and support and ensures that the master student uses the right controls and statistical analysis in his/her experiments. In the last 2 months of the thesis, the master student assembles the data and writes the master thesis in English. If possible, part or all of the data shall be published in a scientific journal. The supervisor and the co-supervisor of the partner university have to read the thesis in advance to make sure that it is formally correct and can be submitted. In the end both write a report about the written master thesis, which is graded (written exam). The master student then defends the thesis in a 60 min final colloquium (30 minute presentation and 30 minute discussion) at either UFR or UBA (oral exam) |

| | |
|---|---|
| **Learning Outcomes** | ■ Acquisition of skills and experience in biomedical research, analysis, presentation and publication<br>■ Acquisition of skills and experience in biomedical research, analysis, presentation and publication |
| **Exam (PL)<br>Study performance (SL)** | SL: All students have to write lab protocols of all the experiments which they perform during their master thesis (either on paper or digitally as e-lab book)<br><br>PL: The written master thesis has to be submitted as PDF file to the study dean's office six weeks before the defence. It is graded by the director and the co-director. The oral master thesis defence takes place at hybrid event (presence and online) and lasts for 60 minutes (30 minutes presentation, 30 minutes discussion). It is graded by a jury consisting of a professor from UFR, a professor from UBA and an external professor not belonging to either university. The director and co-director of the thesis cannot function as jury members.<br><br>The grade of the master module accounts for 40% of the final master grade (75% written master thesis, 25% oral defence). |

# Annex: IMBS Teachers

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