Courses for Erasmus Students

Courses at the Bachelor Level:

Two semester courses: You could take these courses if you will stay in Tübingen for the whole academic year.

1. Cell Biology 1 and 2: 9 ECTS (Molecular Medicine B. Sc., Semester 3 and 4)

General principals of signal transduction

Protein processing, trafficking, and degradation

The role of the cytoskeleton in vesicular transport and cell motility

Interactions between cells and their environment

 Cell fate (proliferation, differentiation, apoptosis, regeneration)

2. Scientific literature Critical analysis & Effective writing: 5 ECTS (Molecular Medicine B. Sc., Semester 3 and 4)

A*) The types, content, and critical analysis of scientific manuscripts. This section is designed for students to get an appreciation for the role of scientific publications in science, as well as develop their ability to critically evaluate the primary literature.*

Didactic modalities: Lectures and journal club sessions (group discussions of scientific manuscripts).

B) Effective scientific writing. This section focuses on the structure and style of primary research articles, emphasizing on the notions of intellectual property (i.e.,

citing and referencing, paraphrasing).

Winter Term Courses (Middle of October – End of February)

3. Virology: Lecture 3 ECTS

Introduction to the field of virology and definitions of terms in virology. Replication strategies. Viral pathogenesis, entry points for viruses, and the spread of viruses in the body. Cell-intrinsic antiviral immunity. Vaccinations against viral infections. Introduction to individual virus families and species in detail:- Retroviruses (exogenous and endogenous)- Flaviviruses- Papillomaviruses, Polyomaviruses- Influenza viruses- Polioviruses- Coronaviruses- Hepatitis viruses (HAV, HBV, HCV, HDV, HEV)- Herpesviruses.

4. Python-Course (6 ECTS):

The Python Programming Fundamentals is an immersive and comprehensive course designed to equip students with a strong foundation in Python, one of the most popular and versatile programming languages. Throughout this course, students will embark on a journey that takes them from the basics of Python syntax to advanced concepts, enabling them to become proficient Python programmers. The main covered topics are data structures, operators and control structures, functions, I/O operations, object-oriented programming and several advanced libraries for tasks such as data analysis. The course is designed for students with little or no programming background.

Summer Term Courses

5. Special Microbiology: Microbial Pathogenicity: Lecture and Seminar: 3 ECTS

The following topics are covered:

B1. Basics and B2. adhesion

B5. Metabolism and regulation

B3. Bacterial protein secretion

B4. Bacterial toxins

C. Microbiom

D1. Antimicrobial effectors

D2. Recognition of microbial molecules

D3. Detection of microbes by serum components

D4. Elimination of microbes by phagocytes

E1. E2. Adaptive immune system I

E3. E4. Adaptive immune system II

6. Oral Communication: scientific English: 3 ECTS

You will learn basic vocabulary for communication with English-Speaking colleagues in the lab, Lab jargon in English, basic vocabulary for discussing scientific texts from molecular biology / cell biology / immunology (specific vocabulary), conducting presentations, writing texts (e.g., resumes and cover letters)

7. Bioinformatics: 3 ECTS

This module provides an overview of the field of bioinformatics as well as elementary skills in sequence analysis and structural bioinformatics. Both, the theoretical foundations and the practical applications of key bioinformatics methods will be conveyed in a blended learning approach. Core contents of the course are: introduction and overview of bioinformatics, basics of computer systems, key concepts of computer science, programming in Python, sequences, strings, pairwise alignments, dynamic programming, multiple alignments sequence databases, database search (BLAST, PSI-BLAST), protein structure and related databases, prediction of protein secondary structure, threading and homology modeling, ab initio prediction of protein structure.

8. Special Virology: Lecture 3 ECTS (

Adenoviruses, Parvoviruses, Emerging Viruses, Measles, Replication Strategies of DNA Viruses, Structural Virology, Antiviral Therapy, Hemorrhagic Fever, Prions

9. Fundamentals and Ethical-Legal Dimensions of AI in Medicine (3 ECTS):

course *aims to develop a cross-faculty curriculum on AI in medicine, integrating elements from medicine, life sciences, mathematics, statistics, and computer science. This curriculum will also address ethical, legal, and societal dimensions of AI. Participants can choose courses based on their prior knowledge, with a focus on the use of machine learning in medical research and practice. Additionally, workshops on visual science communication will be offered, teaching skills to create visual abstracts. Learning materials are provided through an online platform, featuring videos, quizzes, and exercises.*

10. Chosen Topics in Oncology (3 ECTS)

Immunopeptidomics; Bioinformatics, sequencing; short-read/long-read next-generation sequencing or tumor sequencing within the framework of MTBs for advanced tumor diseases; T cells + immunomonitoring; cloning; CAR-T cells; Peptide vaccines; genome sequencing, clinical application; GMP / GCP

11. Neuromodulation and Neuroplasticity (6 ECTS)

- Fundamentals of Anatomy and Physiology of the Sensorimotor Nervous System

- Basic theories and models of neural plasticity (spike timing dependent plasticity; Hebbian plasticity; entrainment)

- Application, advantages and disadvantages of transcranial neuromodulation: ◦ transcranial current stimulation ◦ transcranial magnetic stimulation

- Application, advantages and disadvantages of peripheral neuromodulation: ◦ peripheral nerve stimulation ◦ neuromuscular electrical stimulation ◦ robot-based tactile and proprioceptive stimulation

- Clinical application examples

12. Tissue Engineering (Practical Block Course 12 ECTS)

Medical fundamentals of vital implants• Cell culture techniques/methods for tissue cultivation• Carrier systems and cell colonizations• Coating of technical materials with bioactive capturing molecules• Coating of biodegradable biomaterials with biologically active factors• Extra- and intracorporeal bioartificial organs and bioreactors for organ replacement

Courses during Semester Break in March suitable for Master and Bachelor Level

13. STATISTICS (3 ECTS):

Scales, Descriptive Statistics (Graphics, Tables, Parameters), Correlation and Regression, Diagnostic Tests, Confidenceintervals, Kaplan Meier Analysis of Survival Data Examples and Principles of statistical tests, Tests for independent samples, Tests for dependent Samples, Assessment of Normal Distribution, one factorial analysis of variance, Multiple Testing, Principles of sample size estimation

14. ANOVA (3 ECTS):

One factorial analysis of variance, analysis of covariance, two factorial analysis of variance without interaction, two factorial analysis of variance with interaction, two factorial analysis of variance with one between and one within factor, multiple comparisons, mixed models and generalized estimating equations

15. Statistics of Clinical Studies (3 ECTS):

Statistical methods for clinicial studies, sample size estimation, sequential and adaptive designs, diagnostic studies, studies with censored data

Master Level Courses offered in Winter Term

Exchange Students of the undergraduate level are eligible to take part at this course if they fulfill the prerequisites

16. Advanced Immunology: 3 – 6 ECTS

Lecture (3 ECTS), Elective Seminar (3 ECTS): *The specialist field of immunology imparts knowledge of the complex processes involved in the regulation of cellular and immunological processes in both human and animals. The immunological processes are thus examined in association with disease-induced malfunctions, for example in the case of immune defects or tumor immunology.*

The lectures in the series "Advanced Immunology" cover the detailed mechanisms of the immune system. This includes an examination of the recent discoveries made in cellular and molecular immunology. The major topics include the evolution of immune systems, therapeutic antibodies, computational immunobiology, antigen processing, cellular communication, negative and positive regulatory mechanisms in immunity, the interaction between immune systems, and pathogens and pathomechanisms. The course provides important and up-to-date knowledge of cellular and molecular immunology.

After completion of this module, students will be able to understand the state-of-the-art strategies, modern methodologies, and open questions in selected fields of immunology

After completion of this module, students will have acquired a specialized knowledge and understanding of innate and adaptive immunology.

Thematic focus: Introduction and evolution of immune systems, Therapeutic antibodies. Computational immunology, T-cell populations, Cell-cell-communication and signal transduction in immune systems, Immunity in the intestine, Immunodeficiency – strategies/mechanisms of pathogens, Function of neutrophil granulocytes, MHC and antigen processing, Immunopathology, Pattern-recognition receptors in immune response: Recognition and regulation.

Prerequisite*: Basic Knowledge in Immunology*

17. Advanced Neurosciences (3-12 ECTS), Choose one or several courses in Neuroscience, 3 ECTS each:

- *Genetic and Molecular Basis of Neural Diseases I*
- *Methods in Molecular Neurobiology*
- *Human Neurogenetics*
- *Neurochemistry and Neurotransmitters*
- *Cellular and Molecular Biology of Neurons and Glia*

- *Sensory Systems 1 (Auditory System)*

Prerequisit*e: Basic Knowledge in Neurobiology*

18. Advanced Oncology Lecture (3 ECTS):

The Advanced Oncology lecture intends to provide deep knowledge on the molecular basis of tumor development, the modern molecular approaches of tumor diagnostics, and state-of-the-art cancer therapy strategies. Advanced experimental models to study several aspects of tumorigenesis will also be addressed. The students will acquire deep insight into molecular and translational oncology with respect to

- *Molecular mechanisms of cancer development*
    - *Cancer stem cells*
    - *Chemokine signaling and Cancer*
    - *Intravital microscopy for understanding microenvironmental control of tumor progression and therapy resistance*
- *Molecular diagnostics*
    - *Molecular Imaging in Oncology*
- *Experimental models of cancer*
    - *Dissecting the tumor microenvironment by highly multiplexed single-cell technologies*
    - *Current progress in cancer disease modeling using iPSCs, organoids, gene editing with CRISPR nucleases*
- *Molecular strategies in cancer therapies*
    - *Current approaches in pediatric cancer immunotherapy*
    - *RNA-Based Medicines in Hematology/Oncology and Beyond*
    - *De novo design of protein-based therapeutics*

In addition to the theoretical backgrounds provided during the lecture series, current research projects and cutting-edge experiments will be presented. This will give the students a better insight into the experimental field of oncology.

Prerequisite*: Basic Knowledge in Oncology*

19. **Advanced Infection Biology Lecture (3 ECTS):** *The lecture on Advanced Infection Biology is intended to provide further knowledge on the molecular basis of*

- Viral control of translation

- trafficking of viral components

- reverse transcription and integration

- evolution and emergence of viruses

- Bacteria-phagocyte interaction

- In vivo infection models

- DNA sequencing techniques, protein expression systems

- Flow cytometry

- Malaria vaccines

- Drug resistance of Plasmodium falciparum

- Reverse genetics in Plasmodium falciparum

- Helminths and allergies

In addition to the theoretical backgrounds provided during the lecture current research projects and key experiments are supposed to be presented. This gives the students a better insight into the research area of the chosen field of specialization.

Prerequisite*: Basic Knowledge in Oncology*

20. Seminar Meet the Expert (3 ECTS):

Part A:

The module comprises

- *weekly lectures that are organized in the framework of the focus area research centers and various institutes,*
- *colloquia (expert meetings with guest speakers)*
- *journal clubs and*
- *Participation in scientific congresses/symposia/etc.*

Some formats require registration (e.g. journal clubs) and students need to attend on a regular basis. Attendance is monitored via the coordinator (e.g. Seminar Meet the Expert Cell Biology & Immunology).

Other formats do not need registration (e. g. progress seminars/colloquia), and students might decide on a weekly basis if they are interested in the topic or not. Students shall keep a record of their attendance and the different topics via an attendance sheet.

Part B: Interdisciplinary Seminar Molecular Medicine

*Each student has to present one of the two Laboratory Rotations in a 10-minute talk followed by a discussion with fellow *students and supervisors.*

21. Biomedical Technologies in Diagnostic and Therapy (6 ECTS):

The course provides important and up-to-date knowledge of different biomedical technologies:

Heart-lung machine, artificial respiration, anaesthetic technique, computer-assisted surgery, electromedical technique, electronic implants, rehabilitation technology, biocompatible prosthesis, biomedical laser applications.

22. Laboratory Techniques and Methods (3 ECTS):

The course provides important and up-to-date knowledge of different basic and state-of-the-art laboratory techniques. These techniques include general good scientific practice and statistical analysis, providing the base for every scientific work. Specific techniques covered in this program include, but are not limited to cell culture, xNA isolation, live cell imaging using advanced microscopic and spectroscopic techniques, lab-on-a-chip approaches and molecular interactions.

Thematic focus:

- *molecular biology, cell culture, DNA, RNA and protein isolation, molecular interactions, surface refinement, opt. spectroscopy, microsystems engineering, lab-on-a-chip, live cell imaging, FACS, electron microscopy*
- *research methodologies, experimental design*

good scientific practice

23. NanoBioAnalytics – Lecture and Seminar (6 ECTS):

- *Introduction to nanophysics, fundamentals of nanotechnology, statistical physics, soft matter and polymer physics, mechanics of cells and tissues, physics of the cytoskeleton, cellular forces, motor proteins, methods in nanobiophysics, high resolution microscopy techniques, micro- and nanofluidics, lab-on-a-chip technology*
- *Discussion of current research topics in the field of nanotechnology and nanoanalytics for medical applications*
- *Student prepare and present seminar talks with 30 minutes duration about selected topic and discuss them afterwards*

***Prerequisite**: Basic Knowledge in Physics and Biology*

24. Ethical and Social Aspects of Biomedical Technologies (3 ECTS):

Basics:

- *What makes and innovation a good innovation?*
- *What are ethical and social aspects of biomedical technologies?*
- *How to deal with those aspects?*

Joint case study of a particular biomedical technology:

- *What is the case?*
- *How can we detect ethical and social aspects of the case?*
- *How to deal with those aspects?*

Individual case studies of the technologies the students develop in their master thesis:

- *Which ethical and social aspects has my own work?*
- *How can I deal with them?*

Courses offered by the University of Tübingen

25. German Language Courses: 6 ECTS+

You need to register for the German Courses via ALMA (Course Catalogue. The Main Registration period takes place in Alma in October. You are an absolute beginner and an exchange student? Please write us an email to info@daf.uni-tuebingen.de Placement test for levels higher than A2 are required. It is an online test that takes place via zoom (multiple choice). Please check here for more information: https://uni-tuebingen.de/en/international/learning-languages/learn-german/

26. The Transdisciplinary Course Program *(https://uni-tuebingen.de/en/study/finding-a-course/transdisciplinary-competencies/transdisciplinary-course-program/)*

Summer Term

27. Biomedical Engineering – Lecture (3 ECTS)

Thematic focus:

- *Tissue engineering: cell biology, biomaterials, extracellular matrix (ECM), micropatterning*
- *Implants: ATMPs, cell-/material interface, host response, biostability, biocompatibility*
- *Bioengineered in vitro models: Spheroid, transwell models, hydrogels and bioprinting, organoids, organ-on-chip and multi-organ-chips*

Prerequisite: Basic Knowledge in Biology

28. NanoBioAnalytics – Lecture and Seminar (6 ECTS)

- *Introduction to nanophysics, fundamentals of nanotechnology, statistical physics, soft matter and polymer physics, mechanics of cells and tissues, physics of the cytoskeleton, cellular forces, motor proteins, methods in nanobiophysics, high resolution microscopy techniques, micro- and nanofluidics, lab-on-a-chip technology*
- *Discussion of current research topics in the field of nanotechnology and nanoanalytics for medical applications*
- *Student prepare and present seminar talks with 30 minutes duration about selected topic and discuss them afterwards*

Prerequisite: Basic Knowledge in Physics and Biology

29. Regulatory Affairs of Medical Devices - Lecture (3 ECTS)

Thematic focus:

- *regulatory affairs, patents, quality control, audits, startups*
- *quality, risk and project management*
- *incorporation of industry-based lectures*

The course provides important and up-to-date knowledge regarding regulatory affairs in the field of medical devices. The students will learn about the implemented mandatory safety strategies that ensure high quality materials and products in both academia and industry. These include, yet are not limited to, regulatory affairs, patenting and auditing. Additionally, measures to maintain quality will be highlighted by experts from academia and industry, including quality control and management. As universities are encouraging students to found spin-offs, students will gain insights on the objectives, hurdles and opportunities of creating their own startups from knowledgeable experts.

30. Clinical Cases and Consequences for Medical Devices- Seminar (6 ECTS)

Thematic focus:

The course provides up-to-date knowledge of different clinical cases (e.g., brain diseases), diagnostic and therapeutic procedures (e.g., neuromodulation), the potential, limitations and future perspectives of medical technology devices

31. MRI-applications for neuroscientific and clinical research- Lecture and Seminar (6 ECTS)

MRI has widely increased our knowledge about the structure and function of the human brain. The continuous development of new technologies and methods in this field allow investigations to be carried out at an ever-increasing level of detail. In this course, established and emerging methods that allow robust and reproducible quantification of physiologic and pathologic processes will be taught.

Topics include:

Non-invasive imaging of tissue

MR principles

Tissue structure and MRI of gray matter regions

White matter (WM) microstructure and diffusion weighting (DWI)

Mapping long-range connections, brain plasticity and neurodegeneration using DWI

MRI of WM using non-diffusion techniques

Mapping brain function, structure: connectome networks and radiomics

How structure and function modify local magnetic susceptibility

Contrast agents for cell-labelling and studies of the 'glymphatic' system

Neurochemistry and multi-nuclear magnetic resonance spectroscopy

MRI at high magnetic field strengths – Visit of the MRZ.