# 1. Module Overview

The Master of Science degree program comprises the blocks *Adjustment*, *Fundamentals*, *Specialization*, *Practical training* and the master thesis.

| 1st semester<br>Adjustment & Fundamentals | 30 CP | 2nd semester<br>Adjustment & Fundamentals | 30 CP | 3rd semester<br>Specialization & Research | 30 CP | 4th semester<br>Research | 30 CP |
|---|---|---|---|---|---|---|---|

Legend :

compulsory courses

M = course is compulsory for students having a bachelor degree in biological sciences or having completed the basic studies in medicine

C = course is compulsory for students having a bachelor degree in chemical sciences

P = course is compulsory for students having a bachelor degree in physical sciences

| Adjustment | 16 CP | | 8 CP |
|---|---|---|---|
| Mathematical Methods (M/C)<br>Precourse (3 weeks) | A0.1 | | |
| Mathematical Methods (M/C)<br>2L +2E | A1.1<br>4 CP | Physical Optics (M/C)<br>2L + 1E | A2.1<br>4 CP |
| Optical Engineering (M/C)<br>2L + 1E | A1.2<br>4 CP | | |
| Physical Chemistry (M/P)<br>4L + 2E | A1.3<br>8 CP | Light Matter Interaction (M/P)<br>2L + 1E | A2.2<br>4 CP |
| Human Biology I (C/P)<br>4L + 2E | A1.4<br>8 CP | Human Biology II (C/P)<br>2L + 1E | A2.3<br>4 CP |

| Fundamentals | 8 CP | | 8 CP |
|---|---|---|---|
| Image Processing I (M/C/P)<br>2L + 1E | F1.1<br>4 CP | Image Processing II (M/C/P)<br>2L + 1E | F2.1<br>4 CP |
| Biomedical Imaging I (M/C/P)<br>2L + 1E | F1.2<br>4 CP | Biomedical Statistics (M/C/P)<br>2L + 2E | F2.2<br>4 CP |

| Specialization | 8 CP | | 12 CP |
|---|---|---|---|
| Basic techniques | | Specialization towards microscopy | |
| Advanced mathematics<br>2L + 2E | S2.1<br>4 CP | Biological microscopy<br>2L + 1E | S3.1<br>4 CP |
| Biomedical Imaging II<br>2L + 1E | S2.2<br>4 CP | Single-molecule microscopy<br>2L + 1E | S3.2<br>4 CP |
| Microscopy<br>2L + 1E | S2.3<br>4 CP | Electron microscopy<br>2L + 1E | S3.3<br>4 CP |
| Lables (Dyes, Nanoparticles, etc.)<br>2L | S2.4<br>4 CP | Nanooptics<br>2L + 1E | S3.4<br>4 CP |
| Lasers in medicine<br>2L + 1E | S2.5<br>4 CP | Specialization towards clinical applications | |
| Fiber optics<br>2L + 1E | S2.6<br>4 CP | Ophthalmoscopy<br>2L + 1E | S3.5<br>4 CP |
| Image understanding<br>2L + 1E | S2.7<br>4 CP | Medical diagnosis and therapy<br>2L + 1E | S3.6<br>4 CP |
| Visual recognition and analysis<br>1L + 2E | S2.8<br>4 CP | Theranostics<br>2L + 1E | S3.7<br>4 CP |
| Management of scientific data<br>2L + 2E | S2.9<br>4 CP | Biomaterials<br>2L + 1E | S3.8<br>4 CP |
| | | Specialization towards spectroscopy / diagnostics | |
| | | Chemometrics<br>2L + 1E | S3.9<br>4 CP |
| | | Microspectroscopy<br>3L | S3.10<br>4 CP |
| | | Mass Spectrometry Imaging<br>2L + 1E | S3.11<br>4 CP |
| | | Optical Sensors, Microfluidics<br>2L + 1E | S3.12<br>4 CP |

| Practical Training | | | | |
|---|---|---|---|---|
| Practical Course | P1<br>12 CP | Research Labworks | P2<br>18 CP | Master Thesis | M<br>30 CP |

# 2. Block Adjustment

## 2.1. Block A: Adjustment (1st and 2nd semester)

| Block number | MedPho – A |
|---|---|
| Block name | Adjustment |
| Coordinators | Christoph BISKUP, Michael SCHMITT, N.N. (PAF) |
| Learning objectives | This module block provides students with the necessary background knowledge in natural sciences (with focus on optics and physical chemistry) and basic knowledge in biology and medicine (with focus on human anatomy and physiology). Courses in this module are to be taken depending on the background of the student. Not all modules need to be chosen. |
| Content | Since students with different background are accepted to this Master program, different modules are advised. Students are supposed to take 2 out of 3 modules.<br>The following modules are offered within this block:<br>• Mathematical concepts (A1.1): The course (A1.1) focuses on basic mathematical concepts and methods that are important to analyze problems in optics or physical chemistry. To get prepared, students have the opportunity to attend an additional pre-semester-course (A0.1). Pre-course and course are strongly advised for students not having a Bachelor degree in mathematics or physics. Students of physics having passed the corresponding modules during their studies do not need to participate in this course.<br>• Optics (Module A2.1): This Module provides an introduction into the fundamentals of optics and photonics. The module is mandatory for students not having a Bachelor degree in physics. Students of physics having passed the corresponding modules during their studies do not need to participate in this course.<br>• Physical Chemistry (Module A1.2) + Light Matter Interaction (Module A2.2): These modules provide an introduction into the fundamentals of physical chemistry. Topics of module A1.2 include equilibrium thermodynamics, chemical kinetics and an introduction into molecular quantum mechanics (techniques of approximation).<br>Topics of module A.2.2 include an introduction into molecular transitions, UV/Vis absorption spectroscopy, fluorescence spectroscopy, basic concepts of vibrational and rotational spectroscopy.<br>These modules are mandatory for students not having a Bachelor degree in chemistry or physics. Students of chemistry or physics having passed the corresponding modules during their studies do not need to participate in this course.<br>• Human biology (Modules A1.3 + A2.3): This course provides an introduction into the human anatomy and physiology. The medical histology part of the module will cover the microscopic structure of cells and tissues that make up the organ systems. In the macroscopic anatomy and physiology part of the course students will explore the major organ systems of the human body.<br>These modules are mandatory for students not having a Bachelor degree in biomedical sciences. The modules may be advised to students having a Bachelor degree in biology. Students of medicine having passed the corresponding module during their studies do not need to participate at this course. |
| Course type | Lectures and exercises organized as 4 individual modules in 2 semesters, which have to be chosen depending on the knowledge of the student. |
| ECTS credits | 16 ECTS credits in the 1st semester, 8 ECTS credits in the 2nd semester,<br>24 ECTS credits in total |
| Category | Based on the previous knowledge the modules will be advised to each student. The decision will be based on the student's transcript and a personal interview. |
| Usability | Basic module in the 1st and 2nd semester. |
| Frequency of offer | winter semester (1st part) + summer semester (2nd part) |
| Duration | 2 semester |
| Work load | lectures: 180 h<br>exercises: 90 h<br>self study: 450 h<br>total work load: 720 h |
| Language | English |
| Prerequisites | none |
| Exam prerequisites | specifically defined in the description of the individual modules |
| Requirements to complete this block | specifically defined in the description of the individual modules |

| Block number | MedPho – A |
|---|---|
| Used media | specifically defined in the description of the individual modules |
| Literature | specifically defined in the description of the individual modules |

# 3. Block Fundamentals

## 3.1. Block F: Fundamentals (1st and 2nd semester)

| Block number | MedPho – F |
|---|---|
| Block name | Fundamentals |
| Coordinators | Christoph BISKUP, Rainer HEINTZMANN, N.N. (PAF) |
| Learning objectives | In this block the necessary fundamental knowledge in essential fields of optics and image processing is taught. The modules provide the students with the basics needed for the more specialized courses in the following semesters. |
| Content | Courses within this block provide an introduction into basic principles of data and image analysis:<br>• Programming and Image Processing (Modules F1.2 + F2.1)<br>• Statistics (Module F2.2)<br>The following courses provides an introduction into basic biomedical imaging techniques:<br>• Biomedical imaging I (Module F1.2) |
| Course type | lectures: 4h/week during the 1st semester, 4h/week during the 2nd semester<br>exercises: 2h/week during the 1st semester, 2h/week during the 2nd semester<br>organized as 4 individual modules in 2 semesters |
| ECTS credits | 8 ECTS credits in the 1st semester, 8 ECTS credits in the 2nd semester |
| Category | The modules of this block are mandatory. |
| Usability | Basic module in the 1st and 2nd semester. |
| Frequency of offer | winter semester (1st part) + summer semester (2nd part) |
| Duration | 2 semester |
| Work load | lectures: 120 h<br>exercises: 60 h<br>self study: 360 h<br>total work load: 480 h |
| Language | English |
| Prerequisites | none |
| Exam prerequisites | specifically defined in the description of the individual modules |
| Requirements to complete this block | The successful completion of 2 modules/semester (4 modules in total) is required. |
| Used media | specifically defined in the description of the individual modules |
| Literature | specifically defined in the description of the individual modules |

# 4. Block Specialization

## 4.1. Block S: Specialization (2nd and 3rd semester)

| Block number | MedPho – S |
|---|---|
| Block name | Specialization |
| Coordinators | Christoph BISKUP, N.N. |
| Learning objectives | The specialization block allows the student to choose 2 modules in the 2nd semester and 3 modules in the 3rd semester according to his/her focus of interest. |
| Content | Courses of the 2nd semester provide an introduction the following techniques:<br>• Biomedical Imaging II (non-ionizing radiation) (module S2.1)<br>• Microscopy (Module S2.2)<br>• Labelling techniques (Module S2.3)<br>• Lasers (Module S2.4)<br>• Fiber optics (Module S2.5)<br>2 out of the 9 modules offered need to be chosen.<br><br>In the 3rd semester the student can specialize in the following fields:<br>• Microscopy (Modules S3.1-S3.4)<br>• Clinical Applications (Modules S3.5-S3.8)<br>• Spectroscopic Applications (Modules S3.9-S3.12)<br>3 out of the 12 modules offered need to be chosen; at least two of the research fields should be covered. |
| Course type | Lectures and exercises organized as 5 individual modules in 2 semesters |
| ECTS credits | 8 ECTS credits in the 1st semester, 12 ECTS credits in the 2nd semester,<br>20 ECTS credits in total |
| Category | The student has to choose 2 modules in the 2nd semester and 3 modules in the 3rd semester according to his/her focus of interest. |
| Usability | block of the 2nd and 3rd semester. |
| Frequency of offer | summer semester (1st part) + winter semester (2nd part) |
| Duration | 2 semester |
| Work load | lectures: 150 h<br>exercises: 75 h<br>self study: 375 h<br>total work load: 600 h |
| Language | English |
| Prerequisites | specifically defined in the description of the individual modules |
| Exam prerequisites | specifically defined in the description of the individual modules |
| Requirements to complete this module | The successful completion of 2 modules in the 2nd semester and of 3 modules in the 3rd semester (5 modules in total) is required. |
| Used media | specifically defined in the description of the individual modules |
| Literature | specifically defined in the description of the individual modules |

# 5. Practical courses / Research Labwork

## 5.1. Module P 1: Practical Course (1st and 2nd semester)

| Module number | MedPho – P 1 |
|---|---|
| Module name | Practical Course |
| Coordinators | • Optics: N.N. (PAF)<br>• Physical chemistry: Jürgen POPP, Michael SCHMITT<br>• Physiology: Christoph BISKUP |
| Learning objectives | The course provides an introduction to experimental techniques in optics, physical chemistry and medicine. The students gain experience in planning, preparing and executing experiments. Students are expected to analyze the data generated in the experiments and to present the results in a written report. |
| Content | Experiments of this practical course cover a broad range of topics, including:<br>• Optics: basic optical phenomena, optical elements, laser fundamentals<br>• Physical Chemistry with special focus on light matter interaction: UV/Vis-absorption spectroscopy, fluorescence spectroscopy and vibrational spectroscopy<br>• Physiology: selected experiments introducing into the of physiology and pharmacology |
| Course type | Practical course |
| ECTS credits | 12 |
| Category | Compulsory module |
| Usability | Module in the 1st and 2nd semester of the Medical Photonics program. |
| Frequency of offer | winter semester / summer semester |
| Duration | 2 semesters |
| Work load | Total work load: 360 h |
| Language | English |
| Prerequisites | none |
| Exam prerequisites | regular labwork |
| Requirements to complete this module | Every student has to carry out 8 of the 9 experiments offered in the module and submit a written report.<br>Similar experiments performed during the bachelor course can be recognized. The decision will be based on the student's transcript and a personal interview. |
| Used media | specified by the instructor |
| Literature | Prepared electronic material describing the labs and experiments. The material can be downloaded from the Medical Photonics homepage. |