



# Degree Program Documentation

Master's degree program

*Radiation Biology*

TUM School of Medicine

Technical University of Munich

Name	Radiation Biology
Administrative responsibility	TUM School of Medicine / Department of Radiation Oncology
Degree	Master of Science (M.Sc.)
Standard Duration of Study & Credits	4 semesters and 120 ECTS
Form of study	Full time
Admission	Aptitude assessment (EFV/EV)
Start	WS 2015/2016
Language(s) of Instruction	English
Degree program coordinator	Directors: Prof. Dr. Michael J. Atkinson/ Prof. Dr. Stephanie E. Combs  Coordinator: Carmen Kessel
Additional information for special degree programs	In Cooperation with Helmholtz Zentrum München, Department of Radiation Sciences
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Dean of Studies	Signature

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# 1 Degree Program Objectives

## 1.1 Purpose of the Degree Program

People are exposed to ionising radiation for a variety of reasons. The sources of ionizing radiation are manifold and can be both natural and artificial, including diagnostic or therapeutic medical applications. The general population is mainly exposed through diagnostic radiological examinations such as CT scans and exposure has steadily increased over the past few decades. The number of people who have been treated with therapeutic doses of ionizing radiation in the course of cancer treatment has also been growing steadily. There is an estimated number of about 3 million cancer patients that have been subjected to radiation therapy in Germany at present.

Radiobiological research of the effects of ionising radiation on the human body is therefore an increasingly important concern of health policy. Radiation affects the human body in many different ways. This includes hereditary defects, developmental disorders *in utero*, induction of cancer and delayed and slowly developing degenerative diseases. Despite its undeniable benefits, the use of ionising radiation also harbours many risks, depending on many different factors, such as the individual amount of radiation absorbed (which can differ greatly), the dose distribution in the body or organ (which is mainly determined by physical and medical prerequisites) and many other biological factors and other medical conditions and illnesses. The assessment of the health risks associated with radiation exposure in each individual case can only be based on the current physical, biological and medical knowledge.

The risk of a radiation-induced tumour and the chances of recovery very much depend on the physical radiation dose at the target site and its temporal and anatomical distribution. Therefore to gain a basic knowledge of radiation physics and dosimetry is absolutely necessary, including prospective and retrospective dose calculation. This entails both external irradiation and by incorporated radionuclides, as well as their behaviour in the environment (radioecology). Radiation biology research is highly interdisciplinary as it includes both the biological fundamentals of therapeutic applications (especially in the treatment of cancer) and the risks associated the use of ionising radiation in medicine and technology. The academic foundations for the Master's programme *Radiation Biology* at the Technical University of Munich (TUM) are better than anywhere else in Germany or Europe, especially thanks to the strong cooperation with the Helmholtz Zentrum München, the Federal Office for Radiation Protection and the Bundeswehr Institute of Radiobiology. It is therefore easily comprehensible that doctors, biologists and physicists of the TUM have come together to develop this Master's programme. This programme promotes cooperation between the TUM School of Medicine, Department of Physics, Research Neutron Source Heinz Maier-Leibnitz (FRM II), Department of Chemistry and TUM School of Life Sciences.

## 1.2 Strategic Significance of the Program

The goal of this Master's programme is to achieve scientific Excellency by teaching basic interdisciplinary contents and methods, for a later specialisation with focus on research

and practical relevance, using the core competencies of various faculties of the Technical University of Munich. The TUM is in the perfect situation to strengthen and further develop Radiation Biology as a focus of training and research. Due to its central role as a bridge between medicine, biology and physics, the Master's programme Radiation Biology has a significant integrative function in both in strengthening the role of the School of Medicine within the TUM and in promoting cooperation with other technical, physical and molecular-biological radiation research institutions in Munich, such as the Helmholtz Zentrum München, the Federal Office for Radiation Protection and the Bundeswehr Institute of Radiobiology.

The Master's programme in Radiation Biology is characterised by its connection to the clinical unit of the Rechts der Isar Hospital and consequentially the teaching has a strongly emphasises on research. The programme and the Department of Radiation Sciences at Helmholtz Zentrum München are closely connected with a number of shared staff. This programme is attractive in its teaching, internationally competitive and aims to develop and maintain radiobiological Excellency and the promotion of young talents. The acquired professional and interdisciplinary knowledge of the graduates is an important driving force for further developments in the preclinical research of innovative methods in nuclear medicine, radiology and radio-oncology and also a common basis for a dialogue between science and society on current topics.

## 2 Qualification Profile

You can independently carry out complex tasks in research and development in radiation biology and physics. You are able to actively do basic research in Radiation Biology, the molecular mechanisms of radiation effects, translational radiation oncology, nuclear medicine imaging techniques and radiology. You are also able to independently evaluate research results and participate in the scientific and social discussion. More precisely, you have the expertise to assess health risks after radiation exposure in medicine, industry and the environment. You are competent in the methods to design, prepare and perform experiments suitable for researching specific problems and evaluate different possible approaches. You are familiar with the principles of good scientific practice, which will be deepened by many practical units, including two six-week internships and a one-semester research project. You are able to present your results appropriately in written and oral form, to place them within current international research and to present them at national and international conferences.

The specialist knowledge acquired in methods and techniques of modern radiobiological research will qualify you to connect to current international research in all fields of radiation biology, to successfully apply for research positions and to make significant contributions to the further increase in the knowledge of radiation biology.

Particularly through research internships, but also through seminars and tutorials, the graduate of the Master's programme *Radiation Biology* will gain key qualifications such as skills in communication, conflict management, cooperation and networking, as well as in independent project planning. You can deal with unforeseen difficulties and failures in

research activities outside predefined standards and are able to evaluate different research strategies (in vitro, in vivo, ex vivo), that are used to clarify the biological effects of exposure to radiation on humans and to change the strategy when problems arise. With the knowledge, skills and competences acquired you will be an extensively trained and qualified radiation biologist, who will be able to evaluate and communicate problems of radiation and environmental protection as well as provide competent and partnerly advice to radio-oncologists and medical physicists on questions concerning the optimisation of therapy planning.

Due to the combination of scientific and social competences thought, you will be able to work as a flexible and prepared employee in a variety of related occupational fields such as environmental protection, cancer research, or as a technical expert in government institutions and others. The research competencies acquired qualifies you for medical studies.

## 3 Target Groups

### 3.1 Target Groups

The Master's programme *Radiation Biology* is primarily aimed at excellent graduates of national and international scientific universities that are seriously interested in and prepared to commit to radiation biology. A Bachelor of Science or an equivalent degree in physics, biology, chemistry, environmental sciences or medicine recognised in Germany is required for admission. Since the lessons are exclusively held in English, a good command of the English language is absolutely essential.

### 3.2 Program Prerequisites

Candidates for the Master's programme *Radiation Biology* must demonstrate a desire to acquire complementary competencies beyond the subject-specific contents of their Bachelor's study that will enable them to archive the interdisciplinary educational aims of this programme. Applicants should have a strong interest in radiobiological research and interdisciplinary learning. They need a high level of motivation and discipline for practical work in scientific laboratories and for self-study.

### 3.3 Target Numbers

For the next three years in the Master's programme in *Radiation Biology* (from winter semester 19/20), we are aiming for 20 new MSc students per year (table 2). There are no plans to introduce a Numerus clausus. On the ground of our own experiences, as well as to the growing reputation of the programme and our limited resources we only plan to increase the numbers slowly in the foreseeable future. As there has not been a comparable programme in Europe in recent years, future planning will only be carried out carefully and in close cooperation with the relevant European scientific societies (such as ESTRO, ERR, ESR, EANM, EURADOS).

Table 1 Recruitment scheme

<b>MSc Studenten</b>	<b>WS 2019/20</b>	<b>WS 2020/21</b>	<b>WS 2021/22</b>
<b>1. Jahr</b>	20	20	20
<b>2. Jahr</b>	15	20	20
<b>jährliche Einschreibungen, insgesamt</b>	35	40	40
<b>jährliche Absolventen</b>			20

#### 4 Analysis of Need

For the further development of radiation therapy and radiation protection, there is an ever increasing demand for young scientists with a good technical training in the field of radiation biology. The expected continuous increase in the number of cancer survivors, several million people alone in Germany at present, will cause a huge rise in the demand for radiobiologists trained in translational radio-oncology in future, which is not adequately covered by the universities in Germany and other European countries at the moment. Radiation protection plays a prominent role not only in clinical medicine, technology and industry, but also increasingly in politics and public health. In these fields, too, there is an ever increasing demand in well-trained radiation biologists. Politicians and scientists regularly criticise the existing lack of scientists with a radiobiological training and call for a systematic promotion of training in this important field for society, for example the German Commission on Radiological Protection (Strahlenschutzkommission – SSK) or the position paper of the European Commission (High Level Expert Group, HLEG, [www.hleg.de/fr.pdf](http://www.hleg.de/fr.pdf)). The prospects of radiation research in Germany were discussed in 2008 at the symposium of the Academy of Sciences Leopoldina and published in the *Nova Acta Leopoldina* (Volume 96, Number 355).

Due to the plans of the Federal Government for the Energy transition, an increase in the demand for experts with radiobiological competencies is to be expected, e.g. for the deconstruction of nuclear power plants, the "rehabilitation" of the Asse II mine etc. This and the constantly increasing demand for qualified specialists in facilities specialised in radiation diagnostics or therapy demonstrate the necessity of providing a Master's programme in *Radiation Biology*. Throughout Europe, there are hardly any comparable Master's courses with a specialisation on *Radiation Biology* that could meet this demand.

## 5 Competition Analysis

### 5.1 External Competition Analysis

#### **national**

In Germany, there are currently two listed Master's degree programmes with a radiobiological content. Both Master's programmes are titled *Medical Radiation Sciences Master* and focus clearly on radiation physics and the qualification of experts in medical physics. They only have one module on tumour and radiation biology.

The Master's programme in *Radiation Biology* to be introduced at the TUM School of Medicine, on the other hand, offers an attractive programme for applicants which is characterised by an in-depth scientific as well as research-oriented training in equal proportions in all aspects important for the future of radiobiological research. There will not be a direct competition with the two Master's programmes mentioned above, which are much more specialised.

The programme is in English in order to attract international applicants with the prerequisite scientific or medical qualifications. The compact module structure (by blocks) also promotes the mobility of future Master students, since acquired academic credits in individual modules are recognised elsewhere within the framework of the European Credit Transfer System (ECTS).

It should therefore be emphasised that the conceptual design of the Master's programme *Radiation Biology* nationally has some uniquely distinguishing features.

Comparable Master's programmes, with modules or partial modules with radiobiological topics, are offered in Germany and Austria for the following Master's courses:

- Medical Physics (TU Dresden, Uni Düsseldorf, Uni Gießen, Uni Halle-Wittenberg, Uni Heidelberg, TU Kaiserslautern, LMU Munich as part of the Master's programme in Physics, Uni Vienna). In Dresden and Heidelberg there is taught in English.
- Biophysics (Uni Berlin, Uni Bielefeld, Uni Frankfurt, Uni Freiburg, Uni Homburg, Uni Linz, TU Munich as part of the Master's programme in Physics, Uni Münster).

#### **international**

A Master's programme in *Radiation Biology* has been offered by the Oxford University for several years now (MSCRB European Master of Science Course in *Radiation Biology*, coordinated by Gray Laboratory, U.K.). However, it concentrates entirely on the molecular mechanisms of radiation resistance in tumours. There is little to no overlap with our programme's objectives. Currently there is neither in the USA nor in an Asian country a comparable Master's programme offered or, as far as we know, planned.

There are no Master's programmes in Germany or Austria that are exclusively devoted to radiation protection in research and practice.

Radiation protection is only offered as a Master's programme in France and England:



- The European Masters in *Radiation Protection* (EMRP) Project in French in the framework of an Erasmus programme led by the University of Grenoble.
- A Master of Science programme in *Radiation Protection* from the University of Surrey in Guildford (UK), in English.

Within the framework of the *CONCERT-European Joint Programme for the Integration of Radiation Protection Research*, it's Education and Training Committee (with which we are in close contact to) is currently exploring possibilities for an Europe-wide cooperation with the aim of increasing the mobility of Master students in *Radiation Biology* within the Bologna Principles and teaching modules or partial modules in collaboration.

## 5.2 Internal Competition Analysis

There is no similar or related Master's programme at the Technical University of Munich. The Master's programme in *Radiation Biology* is unique and there is no displacement.

## 6 Structure of the Degree Program

This Master's programme comprises of 4 semesters. In semesters 1 and 2 the basics of radiation biology are taught. Due to the very heterogeneous qualifications of the students who aspire the Master in *Radiation Biology* (Bachelor's in Biology, Physics, Chemistry, Environmental Sciences and state examined Physicians), the first semester focuses on basic biomedical knowledge, which is indispensable for achieving the objectives. In the 2<sup>nd</sup> semester the physical, cell and molecular biological basics of radiation biology are paramount. Lectures, practical laboratory course, seminars, tutorials and exercises are supplemented by practical research work in the fields of cell biology, medical physics, radiation protection and clinical research alternatively. (Two research work placements over a period of six weeks in semesters 1 and 2, whereby both topic and method differ between the two placements).

In Semester 3, three modules are offered, two of which have to be chosen in order to focus on the desired competencies for later research. In addition to seminars and internships, a special module on research management will be offered in preparation for the thesis. All modules are comprised of lectures, seminars, tutorials and exercises or internships, in addition some modules include excursions and demonstrations. The research internships each last 6 weeks, during which the students are individually assigned to a researcher working in the field of radiation research in Munich. After the internship is completed, a paper is prepared in which the methods used are critically described and questioned in relation to the desired goals. Research internships will take place at the same time for all students during the semester breaks. After successfully completing semesters 1 to 3, all students have to prepare a Master's thesis in the fourth semester which will be based on their own, independently accomplished research work within their chosen research project. The student chooses a topic, an institute or laboratory and a supervisor together with whom they develop their research project. In addition, each student is assigned a personal mentor

by the programme manager for their respective research project, who is a member of the teaching staff of the TUM. After the supervisor and the scientist responsible for the module *Research Management* (module 12) have approved of the research project, the student independently carries out their research project they have planned themselves. The personal mentor supervises the writing of the Master's thesis, which must be submitted 6 months after the start of the research project.

Worldwide and in Europe there are only very few opportunities to do a Master's degree in *Radiation Biology*. Nevertheless students are encouraged to do modules of related Master's programmes at home and abroad. If this is the case, however, it cannot be guaranteed that the TUM Master's course in *Radiation Biology* will be completed without delay.

The Master's programme in *Radiation Biology* is planned in such a way that it can be completed within 2 years (4 semesters). Attendance time for the students is planned so that in the course of a week they still have enough time for self-study.

In order to achieve the objective of a comprehensive knowledge in all fields of radiobiological research, theoretical lectures, tutorials, exercises and seminars as well as practical laboratory courses are offered equally. The courses take place either in the rooms of the Rechts der Isar Hospital or in the laboratories and rooms of the Helmholtz Zentrum München. As a rule the timetable is planned in such a way that, that no journeys between the various course locations are required on one day.

Table 2 Curriculum master's degree program Radiation Biology

Semester	Module				Credits
1.	Human Anatomy/Pathology and Physiology/Pathophysiology for Radiobiologists (Pflicht) Written Exam 6 CP	Principles of Radiation Protection and Medical Applications (Pflicht) Written Exam 6 CP	Molecular Biology of the Cell (Pflicht) Oral Exam 6 CP	Research Practical (Wahl) Report 12 CP	30
2.	Radiation Physics and Dosimetry (Pflicht) Oral Exam 6 CP	Mechanisms of Radiation Effects on Cells and Tissue (Pflicht) Written Exam 6 CP	Molecular Radiation Biology (Pflicht) Oral Exam 6 CP	Research Practical (Wahl) Report 12 CP	30
3.	Clinical and Experimental Radiation Oncology	Advanced Molecular Radiation Biology (Wahl)	Advanced Radiation Protection Research	Research Management (Pflicht) Written Proposal	30

	(Wahl) Written Exam 12 CP	Oral Exam 12 CP	(Wahl) Written Exam 12 CP	6 CP	
4.	Master's Thesis 30 CP				30
Legende:	dunkelblau = Abschlussarbeit/Praktikum hellblau = Wahlmodulbereich grau = Pflichtmodulbereich				

## 7 Organization and Coordination

This Master's programme is offered and organized by the TUM School of Medicine. The general responsibility for this Master's programme lies with the TUM School of Medicine.

The following institutions are involved:

Participating Departments:	Radiation Biology, Radio-Oncology and Radiation Therapy
Responsible Department:	Radiation Biology
External Cooperation:	Helmholtz Zentrum München Bundeswehr Institute of Radiobiology Federal Office for Radiation Protection

The Technical University of Munich is responsible for advice, application, admission procedure, matriculation, student and examination management. General student guidance is provided by the central administration of the TUM, while guidance for this Master's programme is provided by three members of the faculty, appointed by the Dean of Studies, whose names you may find listed on the homepage of this programme. The members of the commission for the Master's programme in *Radiation Biology* are as follows:

Prof. Pascal Berberat (Dean of Studies), Prof. Dr. Mike Atkinson, Prof. Dr. Stephanie E. Combs, Prof. Dr. Gabriele Multhoff, Prof. Dr. Thomas Schmid, Mrs Carmen Kessel (secretary) as well as a representative of the Master students, who is elected from among the students of the respective year as their representative.

## 8 Resources

### 8.1 Staffing Resources

Table 3 Resources spreadsheet

Degree program moduls						Staffing resources available			
Module title/Module number			Courses of the module			Personnel category	Lecturer		
Module title	Module number	Module type	Course name	Type	SWS		Name	Chair	School/Dep.
Human Anatomy/Pathology and Physiology/Pathophysiology for Radiobiologists	MEMA-STRB001	P	Physiology / Pathophysiology	VO	2	Prof.	Prof. Dr. Peter Vaupel	Department of Radiation Oncology	ME
			Anatomy / Pathology	VO	2	Prof.	PD Dr. Frauke Neff	-	ME
			Physiology / Pathophysiology	SE	0,5	Prof.	Prof. Dr. Peter Vaupel	Department of Radiation Oncology (teaching assignment)	ME
			Anatomy / Pathology	SE	0,5	Prof.	PD Dr. Frauke Neff	-	ME
Principles of Radiation Protection and Medical Applications	MEMA-STRB002	P	Radiation Protection	VO	1	Prof.	Prof. Dr. Thomas Schmid	Department of Radiation Oncology / IRM Helmholtz Zentrum München	ME
			Radiation Oncology	VO	0,15	WiMI	Dr. Christoph Straube	Department of Radiation Oncology	ME
					0,15	WiMi	Dr. Michal Devecka	Department of Radiation Oncology	ME
					0,15	WiMi	Dr. Steffi Pigorsch	Department of Radiation Oncology	ME
					0,15	WiMI	Dr. Stefan Münch	Department of Radiation Oncology	ME

				0,15	Prof.	Prof. Dr. Thomas Schmid	Department of Radiation Oncology / IRM Helmholtz Zentrum München	ME
				0,25	WiMi	Dr. Stefan Bartzsch	Department of Radiation Oncology / IRM Helmholtz Zentrum München	ME
		Nuclear Medicine	VO	0,15	Prof.	PD. Dr. Johannes Notni	Chair of Pharmaceutical Radiochemistry	CH
				0,15	Prof.	Prof. Dr. Margret Schotelius	Chair of Pharmaceutical Radiochemistry	CH
				0,25	WiMI	Dr. Mona Mustafa	Department of Nuclear Medicine	ME
				0,25	Prof.	PD Dr. Peter Nekolla	Department of Nuclear Medicine	ME
				0,1	Prof.	PD Dr. Matthias Eiber	Department of Nuclear Medicine	ME
				0,1	WiMi	Anne Allmann	Department of Nuclear Medicine	ME
		Radiology	VO	0,4	Prof.	PD Dr. Daniela Pfeiffer	Department of Radiology	ME
				0,3	Prof.	PD. Dr. Dimitrios Karampinos	Department of Radiology	ME
				0,3	Prof.	PD Dr. Carl-Robert Ganter	Department of Radiology	ME
		Radiation Protection	SE	0,15	Prof.	Prof. Dr. Thomas Schmid	Department of Radiation Oncology / IRM Helmholtz Zentrum München	ME
				0,1	Prof.	Prof. Dr. Klaus-Rüdiger Trott	Department of Radiation Oncology (teaching assignment)	ME
		Radiation Oncology	SE	0,125	WiMI	Dr. Sophie Dobiasch	Department of Radiation Oncology	ME
				0,125	WiMi	Dr. Stefan Münch	Department of Radiation Oncology	ME
		Nuclear Medicine	SE	0,25	WiMi	Dr. Behrooz Yousefi	Department of Nuclear Medicine	ME
		Radiology	SE	0,25	Prof.	PD Dr. Daniela Pfeiffer	Department of Radiology	ME

Molecular Biology of the Cell	MEMA-STRB003	P	Cell Biology	VO	1	Prof.	Prof. Dr. Mike Atkinson	Chair of Radiation Biology / ISB Helmholtz Zentrum München	ME
					0,6	Prof.	PD Dr. Soile Tapio	Chair of Radiation Biology / ISB Helmholtz Zentrum München	ME
					0,6	WiMi	Dr. Omid Azimzadeh	Chair of Radiation Biology / ISB Helmholtz Zentrum München	ME
					0,6	WiMi	PD Dr. Simone Mörtl	Chair of Radiation Biology / ISB Helmholtz Zentrum München	ME
					0,6	WiMi	Dr. Michael Rosemann	Chair of Radiation Biology / ISB Helmholtz Zentrum München	ME
					0,6	WiMi	Dr. Natasa Anastasov	Chair of Radiation Biology / ISB Helmholtz Zentrum München	ME
			Cell Biology	SE	0,25	WiMi	Dr. Omid Azimzadeh	Chair of Radiation Biology / ISB Helmholtz Zentrum München	ME
					0,25	WiMi	PD Dr. Simone Mörtl	Chair of Radiation Biology / ISB Helmholtz Zentrum München	ME
					0,25	WiMi	Dr. Michael Rosemann	Chair of Radiation Biology / ISB Helmholtz Zentrum München	ME
					0,25	WiMi	Dr. Natasa Anastasov	Chair of Radiation Biology / ISB Helmholtz Zentrum München	ME
			Lab Practical: Cell Biology	PR	0,5	WiMi	Dr. Omid Azimzadeh	Chair of Radiation Biology / ISB Helmholtz Zentrum München	ME
					0,5	WiMi	PD Dr. Simone Mörtl	Chair of Radiation Biology / ISB Helmholtz Zentrum München	ME

					0,5	WiMi	Dr. Michael Rosemann	Chair of Radiation Biology / ISB Helmholtz Zentrum München	ME
					0,5	WiMi	Dr. Natasa Anastasov	Chair of Radiation Biology / ISB Helmholtz Zentrum München	ME
Radiation Physics and Dosimetry	MEMA-STRB004	P	Radiation Physics and Dosimetry	VO	0,4	Prof.	Prof. Dr. Jan Wilkens	Department of Radiation Oncology / Chair of Radiation Physics	ME / PH
					0,3	WiMi	Dr. Markus Oechsner	Department of Radiation Oncology	ME
					0,3	WiMi	Dr. Stefan Bartzsch	Department of Radiation Oncology / IRM Helmholtz Zentrum München	ME
			Radiation Physics and Dosimetry	SE	1	Prof.	Prof. Dr. Jan Wilkens	Chair of Radiation Physics	ME / PH
			Radiation Physics and Dosimetry	PR	1	Prof.	Prof. Dr. Jan Wilkens	Chair of Radiation Physics	ME / PH
Mechanisms of Radiation Effects on Cells and Tissue	MEMA-STRB005	P	Mechanisms of Radiation Effects on Cells and Tissue	VO	1	Prof.	Prof. Dr. Thomas Schmid	Department of Radiation Oncology / IRM Helmholtz Zentrum München	ME
					0,5	Prof.	Prof. Dr. Klaus-Rüdiger Trott	Department of Radiation Oncology (teaching assignment)	ME
					0,25	Prof.	Prof. Dr. Gabriele Multhoff	Department of Radiation Oncology	ME
					0,25	Prof.	Dr. Mathias Gehrman	Department of Radiation Oncology	ME
			Mechanisms of Radiation Effects on Cells and Tissue	SE	1	Prof.	Prof. Dr. Thomas Schmid	Department of Radiation Oncology / IRM Helmholtz Zentrum München	ME
			Lab Practical Cytogenetics	PR	1	WiMi	Dr. Christina Beinke	Department of Radiation Oncology (teaching assignment) / Habil	ME
			Lab Practical Tumour Cells	PR	2	Prof.	Prof. Dr. Thomas Schmid	Department of Radiation Oncology / IRM Helmholtz Zentrum München	ME

Molecular Radiation Biology	MEMA-STRB006	P	Molecular Radiation Biology	VO	0,5	Prof.	Prof. Dr. Mike Atkinson	Chair of Radiation Biology / ISB Helmholtz Zentrum München	ME
					0,5	Prof.	PD Dr. Soile Tapio	Chair of Radiation Biology / ISB Helmholtz Zentrum München	ME
					0,5	WiMi	Dr. Omid Azimzadeh	Chair of Radiation Biology / ISB Helmholtz Zentrum München	ME
					0,5	WiMi	PD Dr. Simone Mörtl	Chair of Radiation Biology / ISB Helmholtz Zentrum München	ME
					0,5	WiMi	Dr. Michael Rosemann	Chair of Radiation Biology / ISB Helmholtz Zentrum München	ME
					0,5	WiMi	Dr. Natasa Anastasov	Chair of Radiation Biology / ISB Helmholtz Zentrum München	ME
			Lab Practical	PR	0,5	WiMi	Dr. Omid Azimzadeh	Chair of Radiation Biology / ISB Helmholtz Zentrum München	ME
					0,5	WiMi	PD Dr. Simone Mörtl	Chair of Radiation Biology / ISB Helmholtz Zentrum München	ME
					0,5	WiMi	Dr. Michael Rosemann	Chair of Radiation Biology / ISB Helmholtz Zentrum München	ME
					0,5	WiMi	Dr. Natasa Anastasov	Chair of Radiation Biology / ISB Helmholtz Zentrum München	ME
Research Management	MEMA-STRB007	P	Research Management	SE	1	WiMi	Dr. Kerstin Kessel	Department of Radiation Oncology	ME
Master's Thesis	MEMA-STRB008	P							
	MEMA-STRB009	W	Clinical and Experimental Radiation Oncology	VO	0,5	WiMI	Dr. Christoph Straube	Department of Radiation Oncology	WiMI



Clinical and Experimental Radiation Oncology			0,5	WiMi	Dr. Michal Devecká	Department of Radiation Oncology	WiMi
			0,5	WiMi	Dr. Steffi Pigorsch	Department of Radiation Oncology	WiMi
			0,25	WiMi	Dr. Markus Oechsner	Department of Radiation Oncology	ME
			1	Prof.	Prof. Dr. Klaus-Rüdiger Trott	Department of Radiation Oncology (teaching assignment)	ME
			1	Prof.	Prof. Dr. Thomas Schmid	Department of Radiation Oncology / IRM Helmholtz Zentrum München	ME
			0,5	WiMi	Dr. Stefan Münch	Department of Radiation Oncology	ME
			0,25	WiMi	Dr. Lars Schüttrumpf	Department of Radiation Oncology	ME
			0,25	Prof.	Prof. Dr. Gabriele Muthhoff	Department of Radiation Oncology	ME
			0,25	Prof.	Dr. Mathias Gehrmann	Department of Radiation Oncology	ME
	Clinical Conference	VI	0,5	WiMi	Dr. Christoph Straube	Department of Radiation Oncology	ME
			0,5	WiMi	Dr. Michal Devecká	Department of Radiation Oncology	ME
			0,5	WiMi	Dr. Stefan Münch	Department of Radiation Oncology	ME
			0,5	WiMi	Dr. Thomas Pyka	Department of Neuroradiology	ME
	Clinical and Experimental Radiation Oncology	SE	1	WiMi	Dr. Kerstin Kessel	Department of Radiation Oncology	ME
			0,5	Prof.	Prof. Dr. Klaus-Rüdiger Trott	Department of Radiation Oncology (teaching assignment)	ME
		0,5	Prof.	Prof. Dr. Thomas Schmid	Department of Radiation Oncology / IRM Helmholtz Zentrum München	ME	

Advanced Molecular Radiation Biology	MEMA-STRB010	W	Advanced Molecular Radiation Biology	VO	1	Prof.	Prof. Dr. Mike Atkinson	Department of Radiation Oncology / IRM Helmholtz Zentrum München	ME
					0,6	Prof.	PD Dr. Soile Tapio	Department of Radiation Oncology / IRM Helmholtz Zentrum München	ME
					0,6	WiMi	Dr. Omid Azimzadeh	Department of Radiation Oncology / IRM Helmholtz Zentrum München	ME
					0,6	WiMi	PD Dr. Simone Mörtl	Department of Radiation Oncology / IRM Helmholtz Zentrum München	ME
					0,6	WiMi	Dr. Michael Rosemann	Department of Radiation Oncology / IRM Helmholtz Zentrum München	ME
					0,6	WiMi	Dr. Natasa Anastasov	Department of Radiation Oncology / IRM Helmholtz Zentrum München	ME
			Lab Practical: Advanced Molecular Radiation Biology	PR /UE	1	WiMi	Dr. Omid Azimzadeh	Department of Radiation Oncology / IRM Helmholtz Zentrum München	ME
					1	WiMi	PD Dr. Simone Mörtl	Department of Radiation Oncology / IRM Helmholtz Zentrum München	ME
					1	WiMi	Dr. Michael Rosemann	Department of Radiation Oncology / IRM Helmholtz Zentrum München	ME
		1	WiMi	Dr. Natasa Anastasov	Department of Radiation Oncology / IRM Helmholtz Zentrum München	ME			
Advanced Radiation Protection Research	MEMA-STRB011	W	Advanced Radiation Protection Research	VO	1	Prof.	Prof. Dr. Thomas Schmid	Department of Radiation Oncology / IRM Helmholtz Zentrum München	ME
					2	Prof.	Prof. Dr. Klaus-Rüdiger Trott	Department of Radiation Oncology (teaching assignment)	ME
					1	Prof.	Prof. Dr. Michael Abend	Bundeswehr Institute of Radiobiology	(ME)

					1	Prof.	Prof. Dr. Werner Rühm	IRM HelmHoltz Zentrum München (teaching assignment)	ME
			Advanced Radiation Protection Research	SE	1	Prof.	Prof. Dr. Klaus-Rüdiger Trott	Department of Radiation Oncology (teaching assignment)	ME
					1	Prof.	Prof. Dr. Michael Abend	Bundeswehr Institute of Radiobiology	(ME)
					1	Prof.	Prof. Dr. Werner Rühm	IRM HelmHoltz Zentrum München (teaching assignment)	ME
			Advanced Radiation Protection Research	UE	2	Prof.	Prof. Dr. Klaus-Rüdiger Trott	RadioOnkologie und Strahlentherapie (teaching assignment)	ME
						Prof.	Prof. Dr. Michael Abend	Bundeswehr Institute of Radiobiology	(ME)
						Prof.	Prof. Dr. Werner Rühm	IRM HelmHoltz Zentrum München (teaching assignment)	ME
Research Practical: Cell Biology	MEMA-STRB012	W	Betreuung Practical	PR	3,75	WiMi	divers	Department of Radiation Oncology / Helmholtz Zentrum München / Bundeswehr Institute of Radiobiology / Bundesamt für Strahlenschutz	ME / -
Research Practical: Radiation Protection	MEMA-STRB013	W	Betreuung Practical	PR	3,75	WiMi	divers	Department of Radiation Oncology / Helmholtz Zentrum München / Bundeswehr Institute of Radiobiology / Bundesamt für Strahlenschutz	ME / -
Research Practical: Clinical Research	MEMA-STRB014	W	Betreuung Practical	PR	3,75	WiMi	divers	Department of Radiation Oncology / Nuclear Medicine / Radiology	ME
Research Practical: Medical Physics	MEMA-STRB015	W	Betreuung Practical	PR	3,75	WiMi	divers	Department of Radiation Oncology / Chair of Radiation Physics	ME / PH

## 8.2 Material Resources/Rooms

The Rechts der Isar Hospital and the TUM Medical Education Center provide rooms for lectures, seminars and tutorials. Further rooms are provided by the clinical institutions, where specialist courses and demonstrations are held. The Institute for Radiation Biology and the Institute of Radiation Medicine of the Helmholtz Zentrum München also provide rooms for lectures, seminars and tutorials for the modules planned at the Helmholtz Zentrum München. Practical laboratory course will be given in the laboratories of the Institute for Radiation Biology and the Institute of Radiation Medicine at Helmholtz Zentrum München, Rechts der Isar Hospital, the Federal Office for Radiation Protection and the Bundeswehr Institute of Radiobiology.

## 9 Advancements to the Degree Program

On April 1<sup>st</sup>, 2016, the first modified statutes of the professional examination and study regulations were issued. The modifications concerned the terms of the English language qualifications in the qualification requirements in § 36. Furthermore, errors in the overview of the examination modules were corrected and the possibility to apply for a compensation for disadvantages after a rejection in the first stage of the aptitude test was added. On April 12<sup>th</sup>, 2017, the second modified statutes of the professional examination and study regulations were issued. In all compulsory and optional modules, examinations were reduced to one. In addition, the weighting of the Master's thesis and the colloquium was changed. Based on the results of the evaluation and feedback interviews, the module *External Courses* was deleted and the ECTS points of the research internships were increased. In addition, the research internships were divided into elective modules and changed from an academic achievement to an examination achievement.

## 10 Appendix to the Degree Program Documentation