



Module Description

TUM Master's Program Radiation Biology

Module 1: Human Anatomy/Pathology and Physiology/Pathophysiology for Radiobiologists.	2
Module 2: Principles of Radiation Protection and Medical Applications	4
Module 3: Molecular Biology of the Cell.....	6
Module 4: Radiation Physics and Dosimetry.....	9
Module 5: Mechanisms of Radiation Effects on Cells and Tissue	11
Module 6: Molecular Radiation Biology.....	14
Module 7: Research Management.....	16
Module 8: Master's Thesis.....	18
Module 9: Clinical and Experimental Radiation Oncology.....	20
Module 10: Advanced Molecular Radiation Biology	23
Module 11: Advanced Radiation Protection Research	25
Module 12: Research Practical: Cell Biology	27
Module 13: Research Practical: Radiation Protection	29
Module 14: Research Practical: Clinical Research	31
Module 15: Research Practical: Medical Physics.....	33

Module 1: Human Anatomy/Pathology and Physiology/Pathophysiology for Radiobiologists

Module number: STRB001

Medical Faculty TUM

Module level: Master

Duration: 1 Semester

Frequency: only WS

Language: English

ECTS: 6

Time spent on the module: Total time: 180 hours

Lectures: 60 hours (4SWS) split in 30 hours in Anatomy/Pathology (2SWS) and 30 hours Physiology/Pathophysiology (2SWS)

Seminars: 15 hours

Self study: 105 hours

Requirements: No requirements.

Competence to be acquired in the module

After participating in module 1 of the TUM MSc Radiation Biology students acquire the competence

- to understand the anatomical, pathological and pathophysiological features of the different morbidities which may occur weeks, months or years after radiotherapy in the radiation exposed organs,
- to characterize the anatomical, pathological and pathophysiological features of the different manifestations of radiation diseases which may occur after accidental radiation exposures,
- to describe the anatomical, pathological and pathophysiological features of the late and very late morbidities such as cancer and non-cancer diseases which may occur after low and intermediate doses from occupational or radiological exposures.

Teaching and learning methods

Stand, 02.05.2017

The module consists of lectures, seminars and tutorials in which the interactions of the anatomical, pathological and pathophysiological manifestations of specific diseases and their clinical symptoms are discussed as an integrated program of organ specific blocks. Students are supposed to be encouraged to study textbooks, which are intended for students from Medicine in (Pre-)clinic or for the apprenticeship in medical assistant jobs, to deepen the knowledge of the lectures.

Syllabus of teaching

- Fundamentals of general and special anatomy and histology of tissues
- Fundamentals of special anatomy of organs
- Fundamentals of topographical anatomy and roentgen anatomy
- Fundamentals of general and special pathology of diseases
- Fundamentals of physiology and pathophysiology of organs and organ systems
- Radiation exposure and effect on the human body
- Aftermath and consequences onto the functions of the human body

Module examination

Mark: 100% written examination

The written module examination tests whether the competences described above have been achieved by requesting the answer to questions in free text which demands the combination of anatomical, pathological, physiological and pathophysiological knowledge to describe the radiation-induced transformations in the anatomy of the human, as well as the physiological functions of the human body. Duration: 90 min.

If failed, the student may repeat the examination at the end of the semester.

In agreement with §12 (8) APSO an oral examination can be held, in this case the guiding value for the duration of the examination is 25 minutes.

Module leader: Prof. Dr. med. S.E. Combs

Lecturer: PD Dr. med. F. Neff

Prof. Dr. med. P. Vaupel

Module 2: Principles of Radiation Protection and Medical Applications

Module number: STRB002

Medical Faculty TUM

Module level: Master

Duration: 1 Semester

Frequency: only WS

Language: English

ECTS: 6

Time spent on the module: Total time: 180 hours

Lectures: 60 hours as ring lectures with demonstrations (4SWS)

Seminars: 15 hours

Self study: 105 hours

Requirements: No requirements.

Competence to be acquired in the module

After participating in module 2 of the TUM MSc Radiation Biology students acquire the competence

- to understand the indications of the different radiological imaging methods and the associated radiation exposures of the patients and the technical and anatomical factors which influence exposure,
- to understand and apply the rules and regulations of occupational radiation protection and of radiation protection of the general population and patients undergoing diagnostic or interventional procedures involving radiation.

Teaching and learning methods

The module consists of lectures, demonstrations, seminars and tutorials. Teaching is performed as an integrated program of organ specific blocks. 15 hours will be dedicated to radiation protection, 45 hours will be dedicated to diagnostic radiology, nuclear medicine and radiation oncology, 15 hours to seminars. The fundamentals of radiation protection (historical and current), the effect of radiation and the use of radiation in medicine (Nuclear medicine, Radiology and Radiooncology) will be taught in a constitutive block of lectures of 1-2 weeks. The lectures with focus on medicine will be supplemented by demonstrations in clinical diagnostics and therapy to clarify the useful application of radiation. In the seminars, both examples of radiation protection and medical applications of radiation will be presented and discussed.

Syllabus of teaching

- Epidemiological evidence of long-term health effects in population cohorts exposed to radiation in medicine, occupation and nuclear accidents and in particular the Japanese Atom-bomb survivors.
- History of radiation protection and the international organizations involved in setting standards of radiation protection
- Introduction into concepts, dose specification and risk/benefit balance. Legal regulations of radiation protection
- Introduction into radiological procedures in the diagnosis and therapy of diseases and the associated radiation exposures. Risk/benefit in radiation therapy and diagnosis.
- Applications of reactor neutrons in medicine and biomedical research
- Demonstrations of the function of hardware used in diagnostic radiology, nuclear medicine and radiation therapy.
- Diagnostic concepts in nuclear medicine based on the tracer method and its application in oncological and non-oncological questions

Module examination

Mark: 100% written examination

The written module examination tests whether the competences described above have been achieved by requesting the answer in free text to questions related to radiation protection issues in specific aspects of diagnostic and therapeutic radiology. Duration: 120 min.

If failed, the student may repeat the examination at the end of the semester.

In agreement with §12 (8) APSO an oral examination can be held, in this case the guiding value for the duration of the examination is 25 minutes.

Module leader: Prof. Dr. med. S.E. Combs

Lecturers: Prof. Dr. med. S.E. Combs

Prof. Dr. W. Petry

Prof. Dr. med. E. Rummeny

PD Dr. rer. nat. T.E. Schmid

Prof. Dr. med. M. Schwaiger

Prof. Dr. med. K. R. Trott

Prof. Dr. rer. nat. H. J. Wester

Module 3: Molecular Biology of the Cell

Module number: STRB003

Medical Faculty TUM

Module level: Master

Duration: 1 semester

Frequency: only in WS

Language: English

ECTS: 6

Time spent on the module: Total time: 180 hours

Lectures: 30 hours (4 SWS)

Seminars: 15 hours (1 SWS)

Laboratory practicals: 30 hours (2 SWS)

Self study: 105 hours

Requirements: No requirements.

Competence to be acquired in the module

After participating in module 3 of the TUM MSc Radiation Biology students acquire the competence

- To describe the molecular organization and regulation of cells
- To describe the structure and function of DNA and the molecular mechanisms leading to DNA damage
- To describe the molecular processes of the cell cycle, mitosis and meiosis
- To understand the different experimental methods used in molecular cell biology research
- To describe the molecular processes involved in carcinogenesis

Teaching and learning methods

The module consists of 30 hours of lectures and 15 hours of seminars complemented by a 1-week laboratory practical in which methods used in molecular cell biology research are taught and practiced. The theoretical basics are taught in the lectures. In the constitutive seminars, these fundamentals are discussed in different scenarios. In the laboratory practical, the fundamentals are practiced. The results must be recorded, documented and scientifically assessed.

Syllabus of teaching

Topics of lectures are:

- The molecular organization of cells
- Structure and function of the genome
- DNA replication, genetic recombination, transcription, translation
- DNA damage and repair
- Cell membrane
- Cytoplasm, cytoskeleton, cell organelles
- Molecular biology of the cell cycle, mitosis, meiosis, cell differentiation
- Methods of molecular cell biology
- General pathogenesis of late radiation damage, carcinogenesis.
- Mathematical modelling of carcinogenesis.
- Biological dosimetry

Module examination

Mark: 100% written examination

The written module examination tests whether the competences described above have been achieved by requesting the answer to questions related to the molecular biology of cells, such as the role of experimental design in the exploration of radiation-induced alterations in the molecular biology of cells in vitro. Duration: 120 min.

If failed, the student may repeat the examination at the end of the semester.

In agreement with §12 (8) APSO an oral examination can be held, in this case the guiding value for the duration of the examination is 25 minutes.

Module leader: Prof. Dr. M. Atkinson

Lecturers: Prof. Dr. M. Atkinson
Prof. Dr. J. Graw
PD Dr. S. Tapio
Prof. Dr. Hrabé d'Angelis
Prof. Dr. Wurst

Module 4: Radiation Physics and Dosimetry

Module number: STRB004

Medical Faculty TUM

Module level: Master

Duration: 1 Semester

Frequency: only in SS

Language: English

ECTS: 6

Time spent on the module: Total time: 180 hours

Lectures: 30 hours (2 SWS)

Seminars: 15 hours (1 SWS)

Practicals: 15 hours (1 SWS)

Self study: 125 hours

Requirements: Module 001, 002, 003 of the TUM MSc Radiation Biology or equivalent modules of other Master courses

Competence to be acquired in the module

After participating in module 4 of the TUM MSc Radiation Biology students acquire the competence

- To understand the physical basis of medical applications of radiations in medicine,
- To understand the interactions of radiations with matter and the resulting doses,
- To understand the different methods of dosimetry
- To understand the physical methods of treatment planning in radiotherapy

Syllabus of teaching

Introduction into the physics basis of radiation biology and medical applications of radiations:

- Introduction in fundamentals of radiation physics within radiation biology and medical applications
- Generation of ionizing radiations, radioactivity, interactions of radiations with matter, radiation sources in medicine and research
- Principles of physical treatment planning in radiotherapy.
- Fundamentals in medical imaging

Teaching and learning methods

The module consists of lectures, exercises to apply the taught topics, practicals to practice the taught methods and seminars with presentations by the students, e.g. on methods of dosimetry. Students prepare a report on the practicals.

Module examination

Mark: 100% oral examination

The oral module examination (20 minutes) tests whether the competences described above have been achieved. It tests the understanding of applying radiation physics in medical treatments as well as the physical and clinical aspects in diagnostics and therapy. The mark exclusively accounts from the oral examination.

If failed, the student may repeat the examination at the end of the semester.

Module leader: Prof. Dr. J. Wilkens

Lecturers: Prof. Dr. J. Wilkens
Prof. Dr. F. Pfeiffer

Module 5: Mechanisms of Radiation Effects on Cells and Tissue

Module number: STRB005

Medical Faculty TUM

Module level: Master

Duration: 1 Semester

Frequency: only in SS

Language: English

ECTS: 6

Time spent on the module: Total time: 180 hours

Lectures: 30 hours (2 SWS)

Exercises: 15 hours

Practicals: 45 hours

Self study: 90 hours

Requirements: Module 001, 002, 003 of the TUM MSc Radiation Biology or equivalent modules of other Master courses

Competence to be acquired in the module

After participating in module 5 of the TUM MSc Radiation Biology students acquire the competence

- To analyse the chain of molecular radiation responses from initial interactions with molecules to DNA, chromosomes and cell function,
- To analyse the radiation effects on the function of clonogenic cells and stem cells
- To interpret the cellular pathogenesis of early and late clinical radiation injury in tissues and organs,
- To understand the development of radiation-induced immune defects
- To develop and interpret models of radiation-induced morbidities on the basis of functional radiation damage in cells.

Syllabus of teaching

- The development of cellular radiation damage from structural DNA damage via consequential chromosomal damages to functional deficits in cells.
- The dose dependence of radiation-induced impairment of proliferative and functional injury in cells *in vitro* and *in vivo*
- The dependence of different types of radiation injury in cells *in vitro* and *in vivo* on dose-rate, dose fractionation, radiation quality, microenvironment and underlying molecular mechanisms
- The role of the different types of functional radiation injuries in cells in the pathogenesis of the different early, late and very delayed radiation-induced morbidities in different organs and tissues
- The role of radiation effects on cells of the immune system

Teaching and learning methods

The module consists of lectures and exercises to apply the taught topics. Central to teaching this module are two major practicals on radiation effects on cells *in vitro*. The practicals conduce for analyzing the effect of ionizing radiation on the function clonogenic cells and stem cells. Since the different cellular radiation responses develop over many days and weeks, the overall duration of the practicals extends over 6 weeks.

In part 1 (2 weeks), the development of stable and unstable chromosome aberrations in human lymphocytes are evaluated after different radiation doses.

In part 2 (4 weeks) different effects of radiation are analyzed in different tumor cell lines with different radiation sensitivity after application of different radiation doses. Students will write a detailed report on methods and results of these practicals.

Module examination

Mark: 100% written examination

The written module examination tests whether the competences described above have been achieved by requesting the answer to questions related to radiation effects in cells and their role in the pathogenesis of early and late normal tissue injury. Duration: 120 min.

If failed, the student may repeat the examination at the end of the semester.

In agreement with §12 (8) APSO an oral examination can be held, in this case the guiding value for the duration of the examination is 25 minutes.

Module leader: PD Dr. T. E. Schmid

Lecturer: Prof. Dr. G. Multhoff
PD Dr. T. E. Schmid
Prof. Dr. K. R. Trott

Module 6: Molecular Radiation Biology

Module number: STRB006

Medical Faculty TUM

Module level: Master

Duration: 1 Semester

Frequency: only in SS

Language: English

ECTS: 6

Time spent on the module: Total time: 180 hours

Lectures: 45 hours (3 SWS)

Practicals: 30 hours (2 SWS)

Self study: 105 hours

Requirements: Module 001, 002, 003 of the TUM MSc Radiation Biology or equivalent modules of other Master courses

Competence to be acquired in the module

After participating in module 6 of the TUM MSc Radiation Biology acquire the competence

The evaluate the mechanisms of elicit radiation-induced malignant diseases

To analyse the molecular mechanisms which induce and repair DNA damages

To analyse the molecular mechanisms which induce functional injury in irradiated cells

To evaluate critically experiments using molecular biology methods and concept in vitro and in vivo performed in order to analyse the molecular mechanisms which underly the pathogenesis of radiation induced health effects

Syllabus

Molecular mechanisms involved in the pathogenesis or radiation-induced malignant diseases

Molecular mechanisms involved in the induction and repair of DNA damages

The role of molecular signaling pathways in the induction of functional and structural radiation injury in irradiated cells

In vitro-, in vivo- and *in silico*- models used in molecular radiation biology research

Teaching methods

Lectures supplemented by seminars of the journal club style in which selected recent articles in international journals will be presented and discussed. A joint laboratory practical will teach and practice common techniques used in radiation biology research.

Module examination

Mark: 100% written examination

The written module examination tests whether the competences described above have been achieved by requesting the answer to questions related to molecular radiation biology of cells. The knowledge on molecular reactions in different cellular structures induced by radiation and the resulting changes in function are tested.

Duration: 90 min.

If failed, the student may repeat the examination at the end of the semester.

In agreement with §12 (8) APSO an oral examination can be held, in this case the guiding value for the duration of the examination is 25 minutes.

Module leader: Prof. Dr. M. Atkinson

Lecturer: Prof. Dr. M. Atkinson
Prof. J. Graw
Prof. N. Hrabé d'Angelis
Prof. N. Wurst
PD Dr. S. Tapio
Dr. M. Rosemann
Prof. Dr. G. Multhoff

Module 7: Research Management

Module number: STRB007

Medical Faculty TUM

Module level: Master

Duration: 1 Semester

Frequency: only in WS

Language: English

ECTS: 6

Time spent on the module: Total time: 180 hours

Seminars and Exercise: 15 hours (1 SWS)

Self study: 150 hours

Requirements: Module 001 - 006 of the TUM MSc Radiation Biology or equivalent modules of other Master courses

Competence to be acquired in the module

After participating in module 7 of the TUM MSc Radiation Biology students acquire the competence

- To develop a research program of their own
- To develop the scientific basis and a hypothesis for their Master research program,
- to design the experimental plan,
- choose the appropriate materials and methods

Teaching and learning methods

In seminars, students learn to develop a research program and practices the handling of research data, literature search, project management, and time management. In close collaboration with the external supervisor and support by the teaching staff, students develop their own project which they will perform in the external laboratory, including a detailed literature search

Syllabus of teaching:

- literature search
- Development of a Hypothesis
- Experimental design, choice of material and methods

Module examination**Mark: 100% written elaboration**

Students submit a research plan which includes introduction, state of knowledge from literature, hypothesis to be tested, materials and experimental methods to be used. This research must contain a detailed plan considering time management and funding.

Module leader: Prof. Dr. S. E. Combs, Prof. Dr. M. Atkinson

Lecturers: Dr. K. Kessel

Module 8: Master's Thesis

Module number: STRB008

Medical Faculty TUM

Module level: Master

Duration: 1 Semester

Frequency: generally in SS

Language: English

ECTS: 30

Time spent on the module: Total time: 900 hours

Writing the thesis: 810 hours

Preparation of the colloquium: 90 hours

Requirements: Module 001 – 013 of TUM MSc Radiation Biology

Competence to be acquired in the module

After participating in module 8 of the TUM MSc Radiation Biology students acquire the competence

- To develop and perform a research project of their own
- To analyse and interpret the results of the own Master research project
- To write a Thesis with comprehensive literature review, presentation of results in tabulated and graphic form and discussion of the relationship of the results to the original hypothesis, plans for future research based on the project.
- To defend the thesis in front of a group of experts

Teaching and learning methods

The research projects may cover the whole range of current radiobiological research. On the basis of the research plan developed in module 7, students will to some extent, independently but under daily supervision by the external supervisor perform, if possible, all planned experimental work. The internal supervisor will support the external local supervisor, in particular during the period of writing up. The thesis has to be submitted at the latest 6 months after the start of the practical work on the research project.

Syllabus

- Perform a research project of their own which has been developed by the student
- Analyse and interpret the results of the own Master research project
- Write a Thesis with comprehensive literature review, presentation of results in tabulated and graphic form and discussion of the relationship of the results to the original hypothesis, plans for future research based on the project.
- Defend the thesis in front of a group of experts

Module examination

Mark: 90% Master Thesis, 10% Colloquium

The student submits a Master Thesis not later than 6 months after the start of the research project. The colloquium follows the passes Thesis not later than 2 months after announcement of the results and lasts 60 min. Based on the colloquium it is tested if the student is able to present the content of the Thesis clear and precisely. The colloquium consists of a presentation by the students (30 minutes) and an adjacent discussion with the examination board chosen by the Dean of Studies of the School of Medicine of TUM.

The Master Thesis can be repeated once with a new research topic.

Module 9: Clinical and Experimental Radiation Oncology

Obligatory elective module 1

Module number: STRB009

Medical Faculty TUM

Module level: Master

Duration: 1 Semester

Frequency: only in WS

Language: English

ECTS: 12

Time spent on the module: Total time: 360 hours

Lectures: 75 hours (5 SWS)

Seminars: 45 hours (2 SWS)

Clinical Conferences: 15 hours (1 SWS)

Self study: 225 hours

Requirements: Module 004, 005, 006 of the TUM MSc Radiation Biology or equivalent modules of other Master courses

Competence to be acquired in the module

After participating in module 9 of the TUM MSc Radiation Biology students acquire the competence

- To analyse the radiobiological mechanisms which underlie the various therapeutic effects of radiotherapy in the irradiated malignant diseases
- To analyse the radiobiological mechanisms which underlie the various morbidities which may occur in the different organs close to the treated tumors weeks, months or years after radiotherapy
- To evaluate and score the clinical manifestations and symptoms of early and late morbidities in organs and tissues close to the treated tumors.

- To evaluate and interpret the influence of the various factors inherent in the treatment plans such as anatomical dose distribution, treated volume, fractionation and overall treatment time on the response of tumors and normal tissues
- To interpret the different clinical responses of the tumors and the normal tissues and organs in the individual patient
- To develop strategies of translational research to investigate the possible causes to individual radiation responses of tumors and normal tissues in individual patients
- To develop hypotheses on possible improvement of clinical outcome of radiotherapy and plan experimental project to test such hypotheses in vitro or in experimental animals
- To present fundamental issues of modern translational radiation oncology research in an oral presentation and discuss conclusions and controversies.

Syllabus of teaching

- Radiobiological basis of radiation oncology. Methods and aims of Translational Research in Radiation Oncology
- The biology of tumor stem cells in vivo, tumor biology, radiation effects on tumor stem cells in vivo and in vitro
- The radio sensitivity of different tumors, palliative and curative radiotherapy, tumor responses, metastasis, interactions of radiotherapy and chemotherapy
- The development of early and late morbidities in the different irradiated organs after radiotherapy: clinical manifestations, dose-volume relationships, pathogenesis, therapy, prognosis.
- Clinical problems in planning and follow-up of patients treated for different primary tumors such as cancer of the breast, prostate, head and neck, pediatric etc.
- Planning, performing and analysing animal experiments on radiation effects in tumors
- Planning, performing and analysing animal experiments on radiation in critical normal tissues: clinical endpoints, molecular and pathological studies, interventional studies
- Animal protection in translational radiation oncology research
- Long-term follow-up of radiotherapy patients. Second primary malignancies after chemotherapy or/and radiotherapy

Teaching and learning methods

The module consists of lectures, seminars and exercises. Some seminars will be in the form of “clinical conferences” in which problems of treatment planning in individual (anonymized) patients will be discussed as in real clinical conferences. In other seminars, students will give

a presentation on particular problems of translational radiation oncology research of their choice. Exercises deal with real results of animal experiments and will train the student in the quantification and analysis of experimental results.

Module examination

Mark: 100% written examination

The written module examination tests whether the competences described above have been achieved by requesting the answer to questions related to the relationship between planned dose distribution and probability of cure, failure, early morbidity, late morbidity and risk of second cancer induction. In some questions, the ability to plan translational experiments for the investigation of set hypotheses on the relationship between radiation treatment and treatment outcome is tested. Duration: 120 min.

If failed, the student may repeat the examination at the end of the semester.

In agreement with §12 (8) APSO an oral examination can be held, in this case the guiding value for the duration of the examination is 25 minutes.

Module leader: Prof. Dr. S.E. Combs

Lecturers: Prof. Dr. S.E. Combs
Prof. Dr. M. Schwaiger
Prof. Dr. J. Wilkens
Prof. Dr. K. R. Trott
Prof. Dr. G. Multhoff
Dr. M, Rosemann
PD Dr. T. E. Schmid
PD Dr. Habermehl
Dr. G. Habl
Dr. N. M. Duma
Dr. Hanno Specht
Dr. S. Pigorsch
Dr. C. Straube

Module 10: Advanced Molecular Radiation Biology

Obligatory elective module 2

Module number: STRB010

Medical Faculty TUM

Module level: Master

Duration: 1 Semester

Frequency: only in WS

Language: English

ECTS: 12

Time spent on the module: Total time: 360 hours

Lectures and Seminars: 60 hours (4 SWS)

Practicals and Exercises: 60 hours (4 SWS)

Self study: 240 hours

Requirements: Module 004, 005, 006 of the TUM MSc Radiation Biology or equivalent modules of other Master courses

Competence to be acquired in the module:

After participating in module 10 of the TUM MSc Radiation Biology students acquire the competence

To evaluate the design and the results of molecular studies on the development of radiation-induced late normal tissue damage

To develop research projects on the molecular pathogenesis of radiation-induced early and late morbidities after radiotherapy

To evaluate the design and results on the molecular epidemiology and bio-mathematical modelling of radiation-induced late effects and their impact on risk analysis

Syllabus

The design and results of molecular studies on radiation-induced health effect after exposure to low radiation doses

Stand, 02.05.2017

The molecular pathogenesis of radiation-induced early and late morbidities after radiotherapy

Molecular epidemiology

Biomathematical modelling for risk analysis

Molecular radiation genetics

Ethical aspects of molecular radiation research

Teaching methods

The module consists of lectures and seminars including presentations by students on specific topics related to molecular epidemiology and molecular radiation pathogenesis. In the practicals and exercises, experiments are planned, conducted and documented. The results will be presented and discussed.

Module examination

Mark: 100% oral examination

The oral examination (30 min) tests whether the competences described above have been achieved by requesting the answer to questions related to molecular radiation biology of late radiation-induced cancer and non-cancer morbidities. Students prove the knowledge on specific problems of molecular pathogenesis due to radiation effects after low therapeutical doses and try to find solutions.

If failed, the student may repeat the examination at the end of the semester.

Module leader: Prof. Dr. M. Atkinson

Lecturers: Prof. Dr. M. Atkinson

PD Dr. S. Tapio

Dr. M. Rosemann

Module 11: Advanced Radiation Protection Research

Obligatory elective module 3

Module number: STRB011

Medical Faculty TUM

Module level: Master

Duration: 1 Semester

Frequency: only in WS

Language: English

ECTS: 12

Time spent on the module: Total time: 360 hours

Lectures: 75 hours (5 SWS)

Exercises: 30 hours

Seminars: 45 hours

Self study: 210 hours

Requirements: Module 004, 005, 006 of the TUM MSc Radiation Biology or equivalent modules of other Master courses

Competence to be acquired in the module

After participating in module 11 of the TUM MSc Radiation Biology students acquire the competence

- To evaluate the risks of radiation-induced morbidities in exposed people and in their progeny
- Analyze the uncertainties of risk analysis and develop research projects to further improve the scientific basis of radiation protection.
- To determine radiation doses from external exposures and those from incorporated radionuclides in different organs and tissues and evaluate their health impact.
- Evaluate the medical and organizational measures to protect the population in severe nuclear accidents.
- To present to the public the current status of evidence of radiation risks from environmental radiation exposures and those from nuclear accidents and from medical exposures.

Syllabus of lectures

- Epidemiological methods in radiation risk research

- Follow-up studies of patients exposed through medical procedures in therapy and diagnostics. Results and importance for radiation protection
- Radiation exposures from nuclear power plants in normal operation and accidents and from disposal and storage of nuclear waste and disposal of military hardware.
- Epidemiological studies on occupationally exposed populations
- Fundamentals of Radiation Ecology
- Radiation exposure from natural sources, in particular radon, doses and effects
- Heritable radiation effects, human radiation genetics
- Developmental defects after in utero exposure
- Accident preparedness in the vicinity of nuclear power plants and medical care in radiation accidents. Ethical and societal aspects.

Teaching and learning methods

The module consists of lectures, seminars and exercises as well as of excursions such as to a radon spa or a nuclear plant with taking environmental samples which will be measured later in the lab. In seminars, students will give a presentation on particular problems of epidemiological or radioecological research of their choice. Exercises deal with real results of epidemiological studies and will train the student in the quantification and interpretation of epidemiological studies and clinical follow-up data.

Module examination

Mark: 100% written examination

The written module examination tests whether the competences described above have been achieved by requesting the answer to questions related to the design of epidemiological studies on long-term morbidity or mortality in cohorts exposed to radiations from different sources. Particular emphasis will be given to the relationship between dose estimation and effect characterization and quantification. Duration: 120 min.

If failed, the student may repeat the examination at the end of the semester.

In agreement with §12 (8) APSO an oral examination can be held, in this case the guiding value for the duration of the examination is 25 minutes.

Module leader: Prof. Dr. M. Atkinson

Lecturers: Prof. Dr. M. Atkinson
 Prof. Dr. W. Rühm
 Prof. Dr. K. R. Trott.

Module 12: Research Practical: Cell Biology

Obligatory elective module 1

Module number: STRB 012

Medical Faculty TUM

Module level: Master

Duration: 1 Semester

Frequency: WS and SS

Language: English

ECTS: 12

Time spent on each module: Total time: 360 hours

Time working in the lab: 225 hours

Self study and writing the report on the laboratory practical: 135 hours

Requirements: No requirements

Competence to be acquired in the module 12

After participating in module 12 of the TUM MSc Radiation Biology students acquire the competence

- To perform radiobiological experiments under close individual supervision.
- To apply experimental techniques
- To document the experimental results
- To describe in detail the applied experimental methods in a report
- To describe in detail and critically interpret the obtained results.

Syllabus of teaching

The research practical Cell Biology lasts 6 weeks. Students work full-time in a radiobiological research group. They will be integrated into a research project to practice their methods and techniques. At the end of the practical a scientific report must be written. Methods and results must be critically discussed and evaluated. The research practical Cell Biology is one of four options to choose from. Students must choose two according to their individual interests.

Content

- Hypothesis and methods of translational radiation biological research

- Cell and tissue culture methods including primary cultures, 3-D cultures; transplantation of tumour cells into animals and following tumour growth and radiation responses; precisely localized irradiation of cell and tissue cultures, of tumours and of individual organs in vivo.
- Quantification of radiation responses in the applied biological objects, from DNA damage and clonogenic cell inactivation to tumour growth delay and tumour cure as well as functional and morphometric quantification of early and late normal tissue damage
- Isolation of cells, DNA and other cellular constituents from irradiated cells and organs
- Histopathology
- Proteomics and other –omics.

Module examination

Marl: 100% Report

The students write a report considering relevant literature and comparable research publication to demonstrate comprehension of Hypothesis and applied Methods. Results must be presented understandably.

Module leader: Prof. Dr. M. Atkinson

Module 13: Research Practical: Radiation Protection

Obligatory elective module 2

Module number: STRB 013

Medical Faculty TUM

Module level: Master

Duration: 1 Semester

Frequency: WS and SS

Language: English

ECTS: 12

Time spent on each module: Total time: 360 hours

Time working in the lab: 225 hours

Self study and writing the report on the laboratory practical: 135 hours

Requirements: No requirements

Competence to be acquired in the module 13

After participating in module 13 of the TUM MSc Radiation Biology students acquire the competence

- To perform radiobiological experiments under close individual supervision.
- To apply experimental techniques
- To document the experimental results
- To describe in detail the applied experimental methods in a report
- To describe in detail and critically interpret the obtained results.

Syllabus of teaching

The research practical Radiation Protection lasts 6 weeks. Students work full-time in a research group which works on radiation protection. They will be integrated into a research project to practice their methods and techniques. At the end of the practical a scientific report must be written. Methods and results must be critically discussed and evaluated. The research practical Radiation Protection is one of four options to choose from. Students must choose two according to their individual interests.

Content

- Hypothesis and methods of radiation protection

- Isolation of Lymphocytes from peripheral human blood, culturing and radiation of lymphocytes, Dosimetry
- Quantification DNA double strand breaks, Apoptosis and Micronuclei in lymphocytes
- Biological dosimetry with help of the chromosome aberration test, micronuclei test and gammaH2AX focus test
- Fluorescence in-situ Hybridization (FISH) for detection of translocations

Module examination

Marl: 100% Report

The students write a report considering relevant literature and comparable research publication to demonstrate comprehension of Hypothesis and applied Methods. Results must be presented understandably.

Module leader: PD. Dr. T. Schmid

Module 14: Research Practical: Clinical Research

Obligatory elective module 3

Module number: STRB 014

Medical Faculty TUM

Module level: Master

Duration: 1 Semester

Frequency: WS and SS

Language: English

ECTS: 12

Time spent on each module: Total time: 360 hours

Time working in the lab: 225 hours

Self study and writing the report on the laboratory practical: 135 hours

Requirements: No requirements

Competence to be acquired in the module 14

After participating in module 14 of the TUM MSc Radiation Biology students acquire the competence

- To understand treatment plans
- To know indications for Radiation Therapy
- To explain different techniques and their use in Radiation Therapy
- To identify the effectiveness and side effects of Radiation Therapy on the basis of the treatment plan
- To understand methods of retrospective prospective clinical research
- To apply methods of retrospective clinical research
- To critically analyse the results of a retrospective research project
- To describe in detail and present the prospective clinical research projects

Syllabus of teaching

The research practical Clinical Research lasts 6 weeks. Students work full-time in treatment planning and clinical research. If possible, they will be integrated into a project or they will work on an isolated project on their own. At the end of the practical a scientific report must be written. Methods and results must be critically discussed and evaluated. The research practical Clinical Research is one of four options to choose from. Students must choose two according to their individual interests.

Content

- Participation in tumor boards
- Participation in meetings of the doctors from the Clinic of RadioOncology and Radiation Therapy
- Introduction into practical treatment planning
- Introduction in current clinical trials
- Working on a retrospective research project
- Integration into research meetings and participation in groupmeetings

Module examination

Marl: 100% Report

The students write a report considering relevant literature and comparable research publication to demonstrate comprehension of Hypothesis and applied Methods. Results must be presented understandably.

Module leader: Prof. Dr. S. E. Combs

Module 15: Research Practical: Medical Physics

Obligatory elective module 4

Module number: STRB 015

Medical Faculty TUM

Module level: Master

Duration: 1 Semester

Frequency: SS

Language: English

ECTS: 12

Time spent on each module: Total time: 360 hours

Time working in the lab: 225 hours

Self study and writing the report on the laboratory practical: 135 hours

Requirements: Module 004 of TUM MSc Radiation Biology or equivalent modules of other master courses

Competence to be acquired in the module 15

After participating in module 15 of the TUM MSc Radiation Biology students acquire the competence

- To assist on the physical part of clinical treatment planning under close supervision
- To analyse quality assuring measurements on clinical and/or pre-clinical irradiation units
- To understand methods of physical research projects
- To apply special techniques of physical research projects
- To describe critically interpret methods and results of physical research projects

Syllabus of teaching

The research practical Medical Physics lasts 6 weeks. Students work full-time in a medical radiation physics research group. They will be integrated into clinical processes of medical

physics and work on a research project to practice their methods and techniques. At the end of the practical a scientific report must be written. Methods and results must be critically discussed and evaluated. The research practical Medical Physics is one of four options to choose from. Students must choose two according to their individual interests.

Content

- Physical treatment planning in the clinic for radiation therapy and radiooncology: Data transfer of image data, fundamentals of contouring, plan development, evaluation of dose distribution and verification
- Measurements on clinical and/or pre-clinical radiation devices: Quality assurance considering the devices as well as the patients, Use of different detector systems
- Depending on research project: computer simulation of radiation effect, dose-calculation algorithm, evaluation of new techniques in the clinical or pre-clinical area, Use of MRI for patients and small animals, special problems in dosimetry

Module examination

Marl: 100% Report

The students write a report considering relevant literature and comparable research publication to demonstrate comprehension of Hypothesis and applied Methods. Results must be presented understandably.

Module leader: Prof. Dr. J. Wilkens