SGSMP SSRPM SSRFM
Schweizerische Gesellschaft für Strahlenbiologie und Medizinische Physik
Société Suisse de Radiobiologie et de Physique Médicale
Società Svizzera di Radiobiologia e di Fisica Medica
Swiss Society of Radiobiology and Medical Physics

Member of the European Federation of Organisations for Medical Physics (EFOMP) and the International Organization for Medical Physics (IOMP)

Annexe II: List of knowledge, competencies and skills

Guidelines for obtaining the specialist recognition SSRMP for medical physics

SSRMP Board

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1 Scope

This document lists the required knowledge, competence and skills for attaining the SSRMP certification in medical physics and for maintaining this through continuous education. As defined in the SSRPM guidelines on medical physics certification in Switzerland, specialty fields in medical physics are classified into two directions and medical physicists attain certification in one of the two subject area of medical physics:

A. **Medical Radiation Physics (MRP)**, which includes the specialty fields of:
   - Radiation Oncology (RO)
   - Nuclear Medicine (NM)
   - Diagnostic Radiology with ionizing radiation (DR-X)

B. **Medical Imaging (MI)**, which includes the specialty fields of:
   - Nuclear Medicine (NM)
   - Diagnostic Radiology with ionizing radiation (DR-X)
   - Diagnostic Radiology without ionizing radiation (DR)

For the examination for the attainment of the SSRMP certification in medical physics in Switzerland, candidates are examined in one of the two subjects area of medical physics listed above and define their primary specialty field of expertise in their chosen direction.

The knowledge and competencies listed in this document are grouped according to the specialty fields. The levels A, B and C assigned next to these indicate the required level of expertise an individual examined and/or working in one of the two directions of medical physics (MRP or MI) must have to attain and maintain the specialist recognition SSRMP in medical physics.

The levels of competence of the medical physics professional are based on a simplified classification as compared to the one provided by the Swiss Ordinance on Trainings and Permitted Activities in Radiation Protection SR 814.501.261. The competence have been classified in the three categories:

Competences		**Performance**
according to this document	**according to Ordinance**	
A. Knowledge	1: Knowledge	Enumerate, sketch, name, describe, depict
	2: Comprehension	Interpret ,explain, clarify, formulate, present
B: Ability	3:Application	Apply, set up, solve, perform, calculate, design, configure
	4: Interpretation	Select, categorise, analyse, compare
C: Responsibility	5: Evaluation and decision	Assess, decide, judge, classify, evaluate

It should be noted that the highest classification, level C (or 5), in the table above, does not indicate equivalence to the level of experience and expertise of a medical physics expert with extended expertise in the field of medical physics (MPE).

2 Competencies in background knowledge - MRP and MI areas of medical physics

Topic	Content	Competence	
		Certification direction	
		MRP	MI
2.1 Anatomy and physiology	• Medical terminology	A	A
	• Basic concepts of cellular biology	A	A
	• Basic knowledge of human anatomy	A	A
	• General knowledge of physiology of main systems: e.g. heart, circulation, breathing, digestion, nervous and endocrine systems, skeleton and muscular system	A	A
	• General knowledge of pathology, diseases	A	A
	• Sensory organs and skin	A	A
	• Appearance of anatomy and pathology in medical images	A	A
2.2 Biophysics and biochemistry	• Fundamentals of molecular biology	A	A
	• Structure and properties of biological macromolecules	A	A
	• Concepts from biophysics and biochemistry	A	A
	• Biophysics of the cell	A	A
	• Physics of the sensory organs	A	A
	• Transmission of biological signals	A	A

Topic	Content	Competence	
		Certification direction	
		MRP	MI
2.3 Biomedical technology	• Registration of biological signals	A	A
	• Biomechanics	A	A
	• Physiological measurement (e.g.: endoscopy, blood flow measurements, mineralometry biomagnetism)	A	A
	• Medical technology (e.g.: pacemakers, diathermy, prosthesis, lithotripsy)	A	A
	• Electromagnetic compatibility	A	A
	• Safety regulations	A	A
2.4 Information and communication technology (ICT)	• Data management and data warehouses		
	○ Databases	B	B
	○ Picture archiving and communications systems (PACS)	B	B
	○ Standards for the communication and management of medical imaging information (DICOM) and DICOM-RT	B	B
	○ Semantic and interoperability: Health Level 7 (HL7), Fast Healthcare Interoperability Resources (FHIR)	A	A
	○ Data management regulations	A	A
	• Data protection regulations		
	○ Data sharing with third parties (clinics and commercial parties)	C	C
	○ Data safety (integrity and privacy)	C	C

Topic	Content	Competence	
		Certification direction	
		MRP	MI
	○ Data anonymization and pseudo-anonymization	C	C
	• Medical device regulation (regarding use of software and data in networks)	B	B
	• Quality assurance on data transfer and integrity	B	B
	• Hospital Information Systems (HIS) and electronic patient records	B	B
	• Basics and principles of ICT: OSI-Layer and network, operating systems, batch-coding, user management, data exchange within HIS and interfacing	A	A
	• IT-Security: risks and counter measures	A	A
	• Telemedicine	A	A
	• Statistics in medical physics		
	○ Study design and power analysis	C	C
	○ Analysis, interpretation and reporting of data	C	C
	○ Uncertainty analysis and reporting	C	C
	• Fundamentals in programming		
	○ Image processing	B	C
	○ Non-commercial software tools and scripting in the clinic	B	B
	• Basics of data modelling and use of AI		
	○ Radiomics	B	B

Topic	Content	Competence	
		Certification direction	
		MRP	MI
	○ Machine learning: supervised/unsupervised; lin. and log. Regression, random forest	B	B
	○ Deep learning: Convolutional neural networks, back-propagation, GANS,	B	B
	○ Model training, testing and validation	B	B
2.5 Organization and legislation in healthcare	• Structure of healthcare	A	A
	• Organization in hospitals	B	B
	• Medical device regulations, device procurement and tender process	C	C
	• Guidelines and recommendations related to clinical care from national and international organisations	A	A
	• Health care professions, medical specialities and their main tasks	A	A
2.6 Society and medical physics	• Principles and terminology of ethics and corresponding legislation	B	B
	• Responsibilities and the position of the medical physicist in the clinical environment	C	C
	• Training in medical physics; roles of mentors and trainees	C	C
	• Communication (e.g. of risks) with patients and other healthcare professionals	B	B
2.7 Basic concepts in a Quality	• Definitions: Quality Management, Quality Assurance, Quality Control, Quality Standards, Quality Audit, Quality Objectives	C	C
	• Implementation of a QMS, internal directives, Standard Operating Procedures (SOPs) and standardized processes	C	C

Topic	Content	Competence	
		Certification direction	
		MRP	MI
Management System (QMS)	• Clinical and technical audits in healthcare	C	C
2.8 Radiation physics	• Particle and molecular physics in medical physics	C	C
	• Ionising radiation, types and sources	C	C
	• Radioactive decay	C	C
	• Principles of X-ray generation and the X-ray spectrum	C	C
	• Physical quantities for the characterisation of radiation fields	C	C
	• Interactions of ionising radiation with matter, attenuation of ionising radiation	C	C
	• Radiation transport: the Boltzmann transport equation and the Monte Carlo method	C	C
2.9 The physics of the x-ray beam	• Generation of x-ray beam	C	C
	• X-ray tube technology	C	C
	• Characteristics of the X-ray beam	C	C
	• Interaction between radiation and patient	C	C
	• Radiation detection systems	C	C
2.10 Concept of radiation dose	• Effect of the microscopic distribution of the absorbed energy	C	C
	• Dosimetric quantities: e.g. Absorbed dose, Kerma, Terma, Exposure?	C	C
	• Operational dosimetric quantities	C	C

Topic	Content	Competence	
		Certification direction	
		MRP	MI
	• Dose measurements, working principles of dose measurement devices and systems	C	C
	• Phantoms for dosimetry	C	C
	• Metrology, calibration methods and calibration chain	C	C
2.11 Radiobiology	• Direct and indirect radiation effects		
	○ Effects of radiation at the cellular level	B	B
	○ Effect of the microscopic distribution of the absorbed energy	B	B
	○ Radiation effect on DNA	B	B
	○ Repair of radiogenic radiation damage	B	B
	○ Cell death after irradiation	B	B
	○ Factors influencing cell survival after irradiation	B	B
	○ Oxygen effect	B	B
	○ Fractionation and dose rate	C	B
	○ Cellular radiation sensitivity	C	C
	○ Influence on cell cycle	B	B
	○ Relative Biological Effectiveness (RBE)	C	B
	○ Linear Energy Transfer (LET)	C	B

Topic	Content	Competence	
		Certification direction	
		MRP	MI
	○ Radiosensitizers, radioprotectors	B	B
	○ Bystander effect, abscopal effect	B	B
	• Effect on organs and tissues		
	○ Potentially lethal damage	B	B
	○ Sub-lethal damage	B	B
	○ Early and chronic reactions to radiation	B	B
	○ Factors influencing tissue sensitivity to radiation	B	B
	○ Cataract and skin reactions	B	B
	○ Radiation effects on the embryo and foetus	C	C
	• Late effects: carcinogenesis and genetic effects	C	C
	• Radiation-related developmental disorders	B	B
	• Effects of ionizing radiation on generative organs	B	B
	• Acute radiation syndrome	C	C
	• Biological dose indicators	B	B
	• Deterministic radiation effects (tissue reactions)	C	C
	• Stochastic radiation effects	C	C

Topic	Content	Competence	
		Certification direction	
		MRP	MI
2.12 Radiation protection theoretical background	• Basic concepts		
	○ Equivalent dose	C	C
	○ Effective dose	C	C
	○ Dose indicators and concepts for staff dosimetry including dosimetry methods	C	C
	• Principles of radiation protection	C	C
	• Instrumentation for measuring and monitoring radiation exposure		
	○ Radiation detectors	C	C
	○ Electronic instrumentation for radiation detection systems	B	B
	• Natural and industrial exposure to radiation		
	○ Exposure of the population	C	C
	○ Limits of effective dose for the different population groups	C	C
	• Risk estimation and management	C	C
2.13 Radiation protection regulations	• Regulatory framework: Swiss Radiation Protection Act and Ordinances and guidelines, international recommendations (ICRP framework)	C	C
	• Training in radiation protection in accordance with Supplement I of "Concept for the acquisition of the evidence of radiation protection expertise for SSRMP certified Medical Physicists in Switzerland".	C	C

Topic	Content	Competence	
		Certification direction	
		MRP	MI
	• Role and responsibilities of radiological protection experts and medical physicists in the framework of the radiation protection ordinance	C	C
	• Protection of staff, patient and public	C	C
	• Diagnostic reference levels	B	C
	• Classification of working areas	C	C
	• Administration of radioactive substances: transport, storage, disposal	C	C
	• Medical radiation incidents, failures, Critical Incident Reporting System (CIRS)	C	C
	• Occupational dosimetry	C	C
	• Regulatory licenses for equipment and staff	C	C
	• Personal protective equipment	C	C
	• Topics listed in the radiation protection ordinance (814.501.261)	See RP ordinance	
2.14 Physical basics of nuclear medicine	• Principles of nuclear medicine		
	○ Basics of internal dosimetry and instrumentation	C	C
	○ Radioisotopes used in nuclear medicine	C	C
	○ Parameters relevant to nuclear medicine		
	– Production of radioisotopes through neutron activation	B	C
	– Production of radioisotopes by activation with charged particles	B	C

Topic	Content	Competence	
		Certification direction	
		MRP	MI
	– Isotope generator	B	C
	– Measurement methods in nuclear medicine	B	C
	– Procedure for a nuclear medicine examination	B	C
	○ Typical examination and radiation doses in nuclear medicine	B	C
	○ Principles of nuclear medicine	B	C
	• Tasks and responsibilities of the medical physicist	C	C
2.15 Medical physics for imaging	• Imaging detector systems		
	○ X-ray and fluoroscopy imaging in conventional X-ray diagnostics	B	C
	○ Computerised Tomography (CT)	C	C
	○ Ultrasound imaging	A	B
	○ Magnetic resonance imaging (MRI)	B	C
	○ Imaging in nuclear medicine (SPECT, PET, SPECT-CT, PET-CT)	B	C
	• Magnetic resonance imaging (MRI)		
	○ Basic principle of MRI	B	C
	○ Basic sequences (spin eco, gradient eco, eco planar image, flair, diffusion tensor imaging, perfusion weighed imaging)	B	C
	○ Artefacts	B	C

Topic	Content	Competence	
		Certification direction	
		MRP	MI
	• Medical image acquisition, processing and reconstruction		
	○ Hardware for image display and image processing	B	C
	○ Software for image display and image processing	B	C
	• Image quality		
	○ Fourier transform - space of local frequencies	B	C
	○ ROC curves and human observers study	B	C
	○ Measurement with test objects	C	C
	○ Assessment of image quality (SNR, spatial resolution, contrast, DQE, NEQ)	B	C
	• Deformable image registration	B	B
	• Use of contrast agents	B	B
	• Tasks and responsibilities of the medical physicist	C	C
	• Typical examinations and associated radiation doses	C	C

3 Competencies specific to radiation oncology – MRP direction only

Topic	Content	Competence	
		Specialisation	
		RO	NM / DR-X
3.1 Basics of medical oncology	• Fundamentals on epidemiology	A	A
	• TNM classification	A	A
	• Tumour locations	A	A
	• Metastases (frequency, location)	A	A
	• Oncological terminology related to clinical outcome and complications		
	○ Overall survival	A	A
	○ Relapse	A	A
	○ Regression	A	A
	• Oncological treatments and treatment concepts	B	A
	• Clinical studies: data collection, evaluation and publications	B	B
	• Quality assurance from a medical point of view	A	A
3.2 Basics of radiation oncology	• Organization of a radiotherapy department	C	B
	• Radiation effects on tumours and healthy tissues	C	B
	• Anatomical and functional imaging	B	C

Topic	Content	Competence	
		Specialisation	
		RO	NM / DR-X
	• Therapeutic window	B	A
	• Dose escalation	B	A
	• Fractionation schemes: Hyper-fractionation, hypo-fractionation, acceleration	B	A
	• Local tumour control	B	A
	• Factors influencing local tumour control	B	A
	• Side effects of radiation treatments	B	A
	• New modalities	B	A
3.3 Application of external beam (percutaneous) radiation therapy (EBRT)	• Beam production (photons, particles)	C	C
	• Conventional photon and electron treatment devices		
	○ Conventional C-arm linear accelerator	C	B
	○ Co-60 irradiation unit	A	A
	○ Kilovolt (kV) unit	C	B
	• Specialised treatment and other devices		
	○ Neutron, proton and heavy ion units	B	B
	○ Gamma Knife	A	A
	○ Linac-based systems: Tomotherapy, Cyberknife, MR-Linac, ZAP	C	B

Topic	Content	Competence	
		Specialisation	
		RO	NM / DR-X
	• Treatment planning systems	C	B
	• Imaging modalities for radiation therapy planning		
	○ Planar kV-images	C	B
	○ CT scanner / CBCT	C	B
	○ Magnetic Resonance Imager	C	B
	○ PET-CT scanner	C	B
3.4 Dosimetry in radiation therapy	• Cavity theory	C	C
	• Measurement of ionizing radiation	C	C
	• Dosimeters in radiation therapy		
	○ Ionization chamber dosimetry	C	C
	○ 1D dosimetry with other detectors (solid-state, TLDs, MOSFET, OSL, scintillator etc.)	C	B
	○ 2D dosimetry with films, electronic portal imager (EPID), detector arrays	C	B
	○ 3D dosimetry: gel dosimetry	B	B
	• Dosimetry protocols (all modalities; including. recommendations of the SSRMP)		
	○ Determination of radiation beam quality	C	B
	○ Constancy checks for measurement instruments	C	B

Topic	Content	Competence	
		Specialisation	
		RO	NM / DR-X
	○ Calibration of reference instruments dosimeters	C	B
	○ Cross calibration of field instruments in the clinic	C	B
	• Dose determination through measurement and calculation		
	○ Absolute, reference, relative and in-vivo dosimetry	C	B
	○ Formalisms for dose and monitor unit/ treatment time calculations	C	B
	• Common experimental quantities and concepts used in dose determination in the patent		
	○ Line doses: Percentage depth dose (PDD), Tissue-Phantom Ratio (TPR), Tissue-Phantom Ratio (TMP), Off-Axis Ratios (OAR)	C	B
	○ Scatter factors: output ratio/output factors, head-scatter factor / in-air output ratio, phantom-scatter factor, wedge factors	C	B
3.5 Patient positioning and target localisation for treatment	• Patient immobilisation for planning and treatment: devices and methods	B	A
	• Beam modelling and dose calculation		

Topic	Content	Competence	
		Specialisation	
		RO	NM / DR-X
3.6 Treatment planning for EBRT with MV photons	○ Terminology: fluence, energy fluence, TERMA, dose, flux?	C	B
	○ Modelling the source or radiation: energy fluence engines	C	B
	○ Modelling of dose in the patient		
	– Dose calculation engines: kernel-based approaches, Monte Carlo and deterministic solution to the Boltzmann transport equation	C	B
	– Dose to water and dose to the medium calculations	C	B
	– Factor-based approaches: isocentric and fixed SSD formalisms (ESTRO, AAPM TG formalisms)	C	B
	– Methods to correct for irregular field shape (e.g. Clarkson-integration method), surface obliquity, extended SSD, inhomogeneity	C	B
	• Treatment planning and delivery techniques		
	○ Forward planning with standard beam arrangements: isocentric and non-isocentric arrangements; single fields, wedged fields, parallel-opposed fields, multiple field plans, non-coplanar fields, planning for breast, pelvis, thorax, extremities	C	B
	○ Field shaping and modulation: margins, blocks, cones, MLCs, wedges, compensators	C	B
	○ Forward-planned intensity modulated RT: field-in-field IMRT, EDW	C	B
	○ Inverse planning		

Topic	Content	Competence	
		Specialisation	
		RO	NM / DR-X
	– Plan optimisation methods	C	B
	– IMRT with static gantry and dynamic MLC motion	C	B
	– IMAT: intensity modulated arc therapy (Tomotherapy, volumetric arcs (VMAT)); dynamic arc, hybrid arc, lattice?	C	B
	○ Total Body Irradiation (TBI)	B	B
	○ Stereotaxic ablative radiotherapy (SABR)		
	– SRT/SRS to the brain, Stereotactic Body Radiotherapy (SBRT)	C	B
	– SABR on gantry mounted delivery systems	C	B
	– SRT/SRS on specialised delivery systems (Gamma-Knife, Cyberknife, ZAP etc.)	B	B
	• Dose prescription and reporting: ICRU Reports, 50, 62, 83, 91	C	B
3.7 Treatment planning for EBRT with Electrons	• Characteristics in electron beams		
	○ Energy and depth dose	C	B
	○ Penumbra	C	B
	○ Build-up region and the use of bolus	C	B
	○ Virtual source distance and the change of output with SSD	C	B
	• Dose calculation engines for electrons: Pencil beam and Monte Carlo approaches	C	B

Topic	Content	Competence	
		Specialisation	
		RO	NM / DR-X
	• Specialised techniques with electrons		
	○ Total Skin Electron Irradiation (TSEI)	B	A
	○ Arching electron treatments	B	A
	○ Intraoperative radiotherapy with electrons (IORT)	B	A
	• Dose prescription and reporting: ICRU Report 71	C	B
3.8 Treatment planning for EBRT with kV photons	• Characteristics in kV-photon beams	C	B
	• MU/treatment time calculations under non-reference conditions	C	B
3.9 Treatment planning for EBRT with protons and ions	• Characteristics of clinical proton beams	B	A
	• Beam delivery methods:		
	○ Passive scattering	B	A
	○ Particle beam scanning	B	A
	• Dose calculation engines for protons	B	A
	• Treatment planning techniques		
	○ Single fields, Spread-Out Bragg-Peak	B	A
	○ Scanned beams	B	A

Topic	Content	Competence	
		Specialisation	
		RO	NM / DR-X
	○ Intensity modulated proton therapy (IMPT)	B	A
3.10 Treatment plan evaluation for EBRT	• dose distributions	C	B
	• Plan geometry (Beam's eye view etc.)	C	B
	• Dose volume histograms (DVH); dosimetric indices	C	B
	• Tumour Control Probability (TCP) and Normal Tissue Complication Probability (NTCP), robustness	C	B
	• Plan robustness	C	B
3.11 Verification of patient position prior and during treatment	• Image guided RT (IGRT)		
	○ 2D imaging: kV and MV imagers (incl. stereoscopic kV imaging)	C	B
	○ 3D imaging: Cone-Beam CT (kV-CBCT ad MV-CBCT)	C	B
	• Motion management during treatment; Gating, tracking and surface guidance (SGRT)	C	B
3.12 Brachytherapy sources and equipment	• Radiation sources for brachytherapy	C	B
	• Specification of brachytherapy source strength / activity	C	B
	• Calibration of brachytherapy sources	C	B
	• Afterloading equipment		
	○ Manual afterloading (intracavitary and interstitial techniques)	C	B

Topic	Content	Competence	
		Specialisation	
		RO	NM / DR-X
	○ Remote-controlled afterloading (LDR, MDR)	C	B
	○ Remote-controlled afterloading: high dose rate (HDR and PDR)	C	B
	• Quality assurance for afterloading systems	C	B
3.13 Brachytherapy: dose calculation methods and treatment techniques	• Dose calculation for brachytherapy sources:		
	○ Dose from a point source	C	B
	○ Dose from a line source	C	B
	○ The AAPM TG formalisms: TG-43, TG-43U1, TG-43U1S1, TG-186	C	B
	• Brachytherapy treatment planning		
	○ Interstitial implants	B	A
	○ Gynaecological intracavitary treatments	C	B
	○ HDR for non-gynaecological sites (bronchus, oesophagus, nasopharynx, breast, special moulds and applicators)	C	B
	○ Prostate brachytherapy	B	A
	○ Optimisation in afterloading brachytherapy: surface, volume, DVH analysis	B	A
	• Radiobiology considerations for brachytherapy	B	A
3.14 Practical radiation	• Design of external beam treatment facilities	C	B
	• Design of facilities for sealed and unsealed source therapy	C	B

Topic	Content	Competence	
		Specialisation	
		RO	NM / DR-X
protection in radiation oncology	• Equipment and source handling	C	B
	• Management of patient treatments	C	B
	• Risk associated with radiotherapy treatment	C	B
3.15 Quality Assurance (QA) in radiation oncology	• Basic concepts: tolerance limits, accuracy, precision, reproducibility, uncertainties, errors	C	B
	• Equipment QA: treatment planning and delivery systems: acceptance testing, commissioning and periodic quality control	C	B
	• QA of the treatment planning process		
	○ End-to-end testing	C	B
	○ Patient / plan specific QA (PSQA): calculation and measurement approaches	C	B
	• QA in dosimetry equipment: detector systems stability checks	C	B
3.16 Radiation oncology information systems (ROKIS)	• Oncology management information systems (OIS)	B	A
	• Record and verify systems on therapy equipment (R&V)	C	A
	• Treatment planning systems (TPS)		
	○ Configuration, commissioning, QA	C	A
	○ Interfaces and data transfer	B	A
	• Operation and management of software tools for patient related dosimetry		

Topic	Content	Competence	
		Specialisation	
		RO	NM / DR-X
	○ Radiation field analyser (RFA), detector and software systems for PSQA	C	A
	• Data management for clinical studies	B	A

4 Competencies specific to nuclear medicine - MRP and MI directions

Topic	Content	Competence	
		Specialisation	
		NM	Others
4.1 Biological kinetics	• Compartment theory	C	B
	• ICRP model of inhalation and ingestion	C	B
	• Bio-distribution of radiopharmaceuticals	C	B
4.2 Basics of radiopharmacy	• Role of the radiopharmaceutical (bifunctional molecules)	C	B
	• Marking technique	B	B
	• Purity control (chemical, radiochemical, radioisotope, radionuclide)	B	A
	• Control of sterility and freedom from pyrogens	B	A
	• Activity measurement in practice	C	C
4.3 Devices in nuclear medicine	• Pinhole camera	C	B
	• Gamma camera(Anger camera)	C	B
	• SPECT / CTs		
	○ Devices	C	B
	○ The SPECT process	C	B
	• PET / CT		

Topic	Content	Competence	
		Specialisation	
		NM	Others
	○ Devices	C	B
	○ The PET process	C	B
	• In vitro measurement technique	C	B
	• Whole body counter	C	B
	• PET / MR	C	B
	• Photon counting detectors	C	B
4.4 Dosimetry in nuclear medicine	• General model of calculation according to ICRP	C	B
	• Calculation of the accumulated activity	C	B
	• Calculation of the specific energy	C	B
	• Influence of the patient's (age, gender etc.)	C	B
	• Knowledge of the doses in the most important examinations in nuclear medicine	C	B
4.5 Radiation protection in nuclear medicine	• Protection through structures (classification of laboratories, requirements for laboratories)	C	B
	• Handling of open radiation sources	C	B
	• Protection of personnel from external radiation	C	B
	• Protection of personnel from contamination	C	B
	• Methods of dosimetric controls (external irradiation and contamination)	C	B

Topic	Content	Competence	
		Specialisation	
		NM	Others
	• Radioactive waste management	C	B
	• Radiation protection devices	C	B
	• Methods of protecting the patient	C	B
	• Special case of therapy with open radiation sources	C	B
	• Diagnostic reference values	C	B
	• Risk assessment, estimation and management	C	B
4.6 Therapy in nuclear medicine	• Nuclear medicine therapies ()	C	B
	• Personalised patient Dosimetry	C	B
4.7 Image reconstruction	• Approaches for image reconstruction in nuclear medicine	C	B

5 Competencies specific to diagnostic radiology with use of ionising radiation - MRP and MI directions

Topic	Content	Competence	
		Specialisation	
		DR-X	Others
5.1 Radiography	• Detector systems: screen film radiography, computed radiography and digital radiography	C	B
	• Imaging systems: various devices and their configuration for clinical applications	C	B
	• Grid effect	C	B
	• Acquisition parameters: tube voltage, filtration, tube current, exposure time and their influence on image quality and imaging dose	C	B
	• Pre- and post- processing of digital images	C	B
	• Dual energy imaging; including dual energy X-ray absorptiometry (DXA)	C	B
5.2 Angiography and fluoroscopy systems	• Fluoroscopy imaging systems	C	B
	• Detector design for fluoroscopy imaging systems (image intensifiers, flat panel detectors)	C	B
	• Modes of operation of fluoroscopy systems (continuous, pulsed, cine, DSA, radiography, CBCT 3D)	C	B
	• Acquisition parameters (tube voltage, filtration, tube current, exposure time, pulse rate, collimation, magnification) and their influence on dose and image quality	C	B

Topic	Content	Competence	
		Specialisation	
		DR-X	Others
	• Digital image pre- and post-processing	C	B
5.3 Mammography & Tomosynthesis	• Mammography imaging systems (mammography, tomosynthesis)	C	A
	• Requirements on x-ray tubes and filters for mammography	C	A
	• Detector design for mammography imaging systems	C	A
	• Acquisition parameters (tube voltage, filtration, tube current, exposure time, automatic exposure control, collimation, magnification, projection mammography and tomosynthesis) and their influence on dose and image quality	C	A
	• Modes of operation (e.g. 2D-mammography, 3D-tomosynthesis, biopsy, compression, magnification)	C	A
	• Digital image pre- and post-processing, reconstruction of tomosynthesis acquisitions	C	A
5.4 Computed Tomograpy	• Computed tomography imaging systems (general CT systems, DECT, Spectral CT, CBCT, Photon counting CT and others still to come)	C	B
	• Modes of operation (localizer, axial, helical, dynamic acquisition, CT interventions, bolus tracking, prospective triggering (ECG), retrospective gating (ECG), quantitative imaging)	C	B
	• Acquisition and reconstruction parameters (tube voltage, tube current, rotation time, pitch, beam collimation, slice thickness, reconstruction kernel, FOV) and their influence on dose and image quality	C	B
	• CT image reconstruction: FBP, iterative reconstruction, Deep learning algorithm	C	B

Topic	Content	Competence	
		Specialisation	
		DR-X	Others
	• Contrast enhancement in computed tomography	C	B
	• CT number scale (in Hounsfield units)	C	B
5.5 Radiation protection in x-ray diagnostics	• Dosimetric quantities and dose indicators for each specialty including the respective measurement and calculation methods (e.g. CTDI, DAP, MGD, etc.)	C	C
	• Patient dose documentation, dose management systems	C	B
	• Determination of organ doses and effective doses, fetal dose, peak skin dose	C	C
	• Risks due to x-ray examinations and interventions	C	C
	• Justification of examinations, referral guidelines for imaging	B	B
	• Application of ALARA principle (optimisation of radiation exposure for patients, staff and general public)	C	C
	• High risks procedures (e.g. Interventional radiology; CT; Health screening programmes; Irradiation of children, pregnant patients, neonates or the fetus)	C	C
	• Protection of the patient in X-ray imaging	C	B
	• Protection of the staff in X-ray imaging	C	C
	• Classification of modalities (low dose, moderate dose and high dose)	C	B
	• Shielding calculations and assessment of shielding	C	B
	• Basics of clinical image guided diagnostic examination types and interventional procedures, for example in surgery, interventional radiology, cardiology, radiology. Clinical tasks and techniques.	C	B

Topic	Content	Competence	
		Specialisation	
		DR-X	Others
	• Parameters to be checked (following national ordinances, national and international guidelines and recommendations)	C	B
5.6 Quality controls in xray imaging devices	• Methodology of checks (recommendations of the SGSMP)	C	B
	• Frequency and tolerances in quality checks	C	B
	• Risk assessment, estimation and management?	C	B

6 Competencies specific to diagnostic radiology without the use of ionising radiation - MI direction only

Topic	Content	Competence	
		Specialisation	
		DR	Others
6.1 Fundamentals of biomedical imaging	• Principles of imaging methods	C	B
	• Detection and recording of the signals	C	A
	• Digitization of the signals	C	A
	• Mathematical methods of image transformation	C	A
	• Digital filtering	C	A
	• Recognition of the shapes	C	A
	• Image reconstruction methods	C	A
	• Methods of representation	C	A
	• Measures of image quality	C	A
	• Deformations and artefacts	C	A
6.2 Magnetic resonance imaging (MRI)	• Principles on the formation of the MR signal	C	B
	• Importance of the relaxation times	C	B
	• Sequences in MRI (spin echo, gradient echo)	C	B
	• Spatial encoding in MRI	C	B

Topic	Content	Competence	
		Specialisation	
		DR	Others
	• Acceleration techniques		
	○ Fast spin echo sequences	C	B
	○ Fast gradient echo sequences	C	B
	○ Parallel imaging	C	A
	○ Compressed sensing	C	A
	• Sequences in angiography	C	A
	• Magnetic resonance spectroscopy	C	A
	• Functional MRI	C	A
	• Movement and flow artefact and their mitigation strategies	C	B
	• Perfusion, diffusion weighted imaging	C	A
6.3 MRI devices	• Static magnetic field generation and shimming techniques	C	A
	• Gradient coils	C	A
	• Transmitter coils and radiofrequency pulses	C	A
	• Receiving coils and detection techniques	C	A
	• Image quality and artefacts	C	B
	• Contrast and signal-to-noise ratio	C	B
	• Physical properties of the ultrasonic wave	A	A

Topic	Content	Competence	
		Specialisation	
		DR	Others
6.4 Imaging with ultrasound	• Generation and detection of the ultrasound	A	A
	• Sonography by reflection	A	A
	• Continuous Doppler ultrasound	A	A
	• Pulsed Doppler ultrasound	A	A
6.5 Sonography equipment	• Ultrasonic probes	A	A
	• Associated electronics	A	A
	• Image quality	A	A
	• Artefacts on ultrasound	A	A
	• Quality control	A	A
6.6 Other diagnostic techniques	• Fundamentals on encephalography	A	A
	• Fundamentals on echocardiography	A	A
	• Fundamentals on bio-magnetism	A	A
	• Fundamentals of endoscopy	A	A
	• Basic concepts on thermography	A	A
6.7 Safety and protection in the field of non-	• Effects of electromagnetic fields and radiation (EM) on cells and tissues	C	A
	• Measured quantities used for protection against EM	C	A
	• Legal regulation and exposure limit values for EM	C	A

Topic	Content	Competence	
		Specialisation	
		DR	Others
radiological imaging	• Security at MRI	C	A
	• Effect of ultrasound on the organism	A	A
	• Measured variables used for protection against ultrasound	A	A
	• Legal regulation and exposure limit values for ultrasound	A	A
	• Safety with ultrasound	A	A

7 Appendix: Relevant resources

Federal Office of Public Health (FOPH)
https://www.bag.admin.ch/bag/de/home/gesund-leben/umwelt-und-gesundheit/strahlung-radioaktivitaet-schall/ausbildung-im-strahlenschutz/strahlenschutzausbildung-in-der-medizinphysik.html

Swiss of Radiobiology and Medical Physics (SSRMP)
https://ssrpm.ch/publications-and-communication/recommendations-and-reports/

European Federation of Organisations for Medical Physics (EFOMP)
https://www.efomp.org/index.php?r=fc&id=core-curricula

IAEA Human Health Campus – Medical Physics
https://humanhealth.iaea.org/hhw/medicalphysics/index.html

American Association of Physicists in Medicine (AAPM)
https://www.aapm.org/education/default.asp

Institute of Physics and Engineering in Medicine (IPEM)
https://www.ipem.ac.uk/resources/

Deutsche Gesellschaft für Medizinische Physik (DGMP)
https://www.dgmp.de/de-DE/59/ausbildung/

Österreichische Gesellschaft für Medizinische Physik (ÖGMP)
https://www.oegmp.at/fachanerkennung/