NUCLEAR MEDICINE - METHODS AND DIAGNOSTICS	
GENERAL INFORMATIONS	
Course coordinator	Prof. Ivica Mihaljević, MD, PhD
Assistant/Associate	Assoc. Prof. Mario Štefanić, MD, PhD Asst. Prof. Tomislav Kizivat, MD, PhD Katica Mijatović, MD Ivana Marić, MD, PhD Vlado Wagenhofer, MD, PhD
Study Programme	Undergraduate University Study of Medical Laboratory Diagnostics
Status of the course	mandatory
Year of study, semester	2nd year, 4th semester
ECTS	**2**
Workload (hours)	Lectures 15; clinical exercises: 15
Expected number of students	30-35
COURSE DESCRIPTION	
Course objectives	
Acquiring knowledge and skills in applying nuclear medicine diagnostic and therapeutic procedures falling within the clinical branch of Nuclear Medicine.	
Enrolment requirements and entry competencies	
Passed 1st year exams and enrolled in 2nd year of study	
Learning outcomes at programme level	
1.1., 2.2, 2.3, 2.6., 3.1	
Learning outcomes at the course level	
After completing lectures, seminars and exercises, following independent studying and passing the exam, students will be able to: 1. Explain the principles and methods of nuclear medicine 2. Explain the biokinetics of certain radionuclides and radiopharmaceuticals 3. Apply the procedure of *in vitro* radiochemical analysis 4. Prepare radiopharmaceuticals 5. Explain the application of radionuclides and radiopharmaceuticals in *in vivo* diagnostics of metabolic disorders and functional disorders of individual organs and organ systems	
Course content	
Lectures: *Radioactive markers in biology and medicine: relationship of morphology and function***.** Nuclear medicine and its specificities. Nuclear reactor and cyclotron production of radionuclides. Isotopes used in medicine. *In vivo* radiomarker application. Use of open radionuclides for *in vivo* and *in vitro* diagnostics and treatment. Production of radioactive compounds (radiopharmaceuticals). Behaviour of radioactive substances in the body. Scintigrams. Simultaneous testing of morphology and function of organs and organ systems. Definition of radionuclides and radiopharmaceuticals, mechanism of their distribution in the body. Molecular nuclear medicine: marking of complex compounds, receptors, specific monoclonal antibodies, precursors, metabolites and medicine. *Scintigraphy: devices, gamma camera, SPECT, computer-assisted scintigraphy and PET/CT. Radiopharmaceuticals: production and preparations of radiopharmaceuticals and radionuclides. Mechanisms of biodistribution.* Definition, classification and selection of radiopharmaceuticals. Characteristics of ideal radiopharmaceuticals and radionuclides. Radiopharmaceutical quality control. Radiopharmaceutical applications and mechanisms of distribution. Radionuclide production and radionuclide generators (^{99}Mo/^{99m}Tc): synthesis and elution. Yield calculation and yield tables. Physical properties of most commonly used isotopes in nuclear medicine. Radiolabelling, standard operating	

procedures in radiopharmaceutical preparation. Radiopharmaceutical synthesis. Technetium-99m labelled radiopharmaceuticals. Iodine-131 labelled radiopharmaceuticals. Radiopharmaceuticals labelled with other radionuclides. Eluate and radiopharmaceutical quality control, chromatography. Protective equipment, dose calibrator. Laminar air flow hood for radiopharmaceutical preparation. Purchase and use permits, required documentation, conditions for conducting that activity and training requirements for working with open sources of ionizing radiation. Radioactive waste management. Therapeutic radionuclides and radioimmunotherapy. *Diagnostics and treatment of thyroid disease: measurement of radioiodine accumulation, scintigraphy, ultrasound, cytology and radioiodine treatment.* Radiopharmaceutical accumulation measurement devices: structure, selection and administering of radionuclides and indications. Imaging radionuclide diagnostic methods: role and position of ^{99m}Tc and ^{131}I scintigraphy and accumulation measurement in diagnostics and therapy of benign and malignant thyroid disease. Laboratory analysis: FT4, FT3, TSH and TRH Autoimmune antibodies and tumour markers. Cytodiagnostics. Iodine 131 therapeutic activity monitoring methods in benign and malignant thyroid disease. *Immunoanalysis and non-radioimmunoassay - non-RIA in determining hormone concentration, antibodies and thyroid tumour markers***.** Classification of radioimmunoassay (RIA) methods. Competitive and non-competitive RIA with derivatives and comparison with competing methods. Sources of variability and quality control. Reference ranges and medical report interpretation. Thyroid hormones: biosynthesis, serum transport, distribution and hypothalamic-pituitary axis. Total and free T3 and T4. Thyroid autoantibodies (TPOAt, TRAb, TgAt): epidemiology, functional, clinical and pathological significance, their role in diagnostics and prognostics of thyroid disease. Tumour markers in thyroidology: thyroglobulin, calcitonin and their role in follow up. Rational use of laboratory hormone analysis, antibodies and tumour markers in diagnosing thyroid disease.

*Nuclear medicine in cardiology and pulmonology: myocardial perfusion scintigraphy, radionuclide ventriculography and shunt detection. Perfusion and ventilation pulmonary scintigraphy. Nuclear medicine in gastroenterology and haematology: scintigraphy of the oesophagus, Meckel's diverticulum, liver, spleen, biliary tree, stomach and bleeding. Radiopharmaceuticals. Nuclear medicine diagnostics of infection/inflammation***.** Radiopharmaceuticals. **N***uclear medicine in nephrology and urology.* Radiopharmaceuticals. *Nuclear medicine in neurology: brain scintigraphy, radionuclide cisternography, brain SPECT and PET/CT. Radiation safety: fundamentals of dosimetry, biological effects of ionizing radiation, effects of excessive radiation on the body and medical treatment in case of excessive radiation.* Exposure to radiation. *Nuclear medicine in examining the skeletal system and oncology: bone and joint scintigraphy, bone marrow scintigraphy. Role of functional and fusion imaging in individualized medicine, therapy and prognostics.*

Exercises: Collimator: types, role and design Planar and single-photon emission tomography, single-head and dual-head cameras Radionuclide generator (^{99}Mo/^{99m}Tc): generation and elution Eluate and radiopharmaceutical quality control, chromatography. Protective equipment, dose calibrator. Digestor, radioactive waste management. Measuring points, measuring demonstration and radioiodine accumulation measurement Thyroid scintigraphy using ^{131}I and ^{99m}Tc-pertechnetate: indications, contraindications, image acquisition and dosimetry. Thyroid ultrasound with guided cytological punction: device demonstration and examination technique. Iodine 131 therapeutic activity monitoring methods in benign and malignant thyroid disease. Administration technique, standard operating procedure in radionuclide therapy and hospital discharge requirements. Principles and execution of radioimmunoassay and non-RIA specimen analysis. Reference ranges and medical report interpretation. Technetium Tc 99m tetrofosmin and MIBI: preparations, activities, application and dosimetry aspects. Planar, SPECT and g-SPECT scintigraphy. Fundamentals of scintigram analysis. Erythrocyte marking using *in vivo* and *in vitro* techniques. Pulmonary perfusion scintigraphy with ^{99m}Tc-MAA and microspheres. Radioactive gases (^{133}Xe, ^{81m}Kr) and aerosols for lung scintigraphy (ventilation-perfusion (V/Q) scan). ^{99m}Tc-IDA derivatives and colloids. *In vivo* method of erythrocyte labelling with

Sn-PYP. Presentation of medication report diagnosing Meckel's diverticulum and gastrointestinal bleeding. Radiopharmaceuticals ^{99m}Tc-DTPA, MAG3 and DMSA. Renogram and clearances. Representative lipophilic radiopharmaceuticals in regional cerebral blood flow analysis (^{99m}Tc-HMPAO). Diagnosing brain death and extrapyramidal motor disorders (DAT). PET/CT radiopharmaceuticals. Work with monitors, contamination control and surface decontamination. Personnel radiation protection. Wound decontamination and injured person decontamination. Treatment procedures for over-irradiated and contaminated persons. Types of radiation injuries, acute local injuries and treatment. ARS (acute radiation syndrome). Radiopharmaceuticals – diphosphonate preparations, ^{99m}Tc-HMPAO-labelled leukocytes, colloids. Three-phase bone and joint scintigraphy.

Course delivery methods

Lectures and exercises.

Students' responsibilities

Student is required to regularly attend and actively participate in all course delivery forms. In order to be able to successfully perform exercises, the student is required to prepare by reviewing the relevant chapter in the course textbook.

Monitoring students' work (Connecting learning outcomes, teaching methods and evaluation)

Examination: written exam.

Teaching activity	ECTS	Learning outcome	Student activity	Assessment methods	Grade points	
					Min.	Max.
Attending classes (lectures, exercises)	1	1,2,5 3,4	Class attendance, active participation Exercise completed and study report accepted	Attendance records	1 13	5 35
Final exam	1	1-5	Preparation for the final exam	Written exam	36	60
Total	**2**				**50**	**100**

Evaluation of written part of final exam:

Percentage of correct answers (%)	Grade points
60.00-64.99	36
65.00-69.99	40
70.00/-74.99	44
75.00-79.99	47
80.00-84.99	51
85.00-89.99	54
90.00-94.99	57
95.00-100	60

Calculation of the final grade:

Grade points earned in the final exam are added to the grade points earned in course classes. Grading is done by absolute distribution, i.e. based on overall result. Grades are numerically expressed as follows:
A – excellent (5): 80-100 grade points ; B – very good (4): 70-79.99 grade points; C – good (3): 60-69.99 grade points; D – sufficient (2): 50-59.99 grade points

Required reading (available in the library and through other media)		
Title	Number of copies in the library	Availability through other media
1. Dodig D, Kusić Z. Klinička nuklearna medicina. Second revised and amended edition. Course textbook. Zagreb, Medicinska naklada, 2012.	4	
Further reading		
1. Solter M. Bolesti štitnjače - klinička tireoidologija. Course textbook. Zagreb: Medicinska naklada; 2007. 2. Težak S, Ivančević D, Dodig D, Čikeš I. Nuklearna kardiologija i pulmologija. Course textbook. Zagreb: Medicinska naklada, 2005. 3. Dodig D, Ivančević D, Popović S. Radijacijske ozljede: dijagnostika i liječenje. Course textbook. Zagreb: Medicinska naklada, 2002. 4. Dodig D, Huić D, Poropat M, Težak S. Nuklearna medicina u dijagnostici i liječenju bolesti kostiju i zglobova. Zagreb: Medicinska naklada; 2009		
Course evaluation procedures		
Anonymous, quantitative, standardised student survey on the course and the teacher's work implemented by the Quality Improvement Office of the Faculty of Medicine Osijek.		