SUBJECT OUTLINE

1. Programme of study description

1.1.	**THE "CAROL DAVILA" UNIVERSITY OF MEDICINE AND PHARMACY**
1.2.	**THE FACULTY OF MEDICINE / DEPARTMENT I FUNCTIONAL SCIENCES**
1.3.	**DISCIPLINE: BASICS OF PARACLINICAL INVESTIGATIONS**
1.4.	**DOMAIN OF STUDY: Healthcare – regulated sector within the EU**
1.5.	**CYCLE OF STUDIES: BACHELOR'S DEGREE**
1.6.	**PROGRAMME OF STUDY: MEDICINE**

2. Subject description

2.1.	**Name of the subject/compulsory subject/elective subject within the discipline: Basics of Paraclinical Investigations**						
2.2.	**Location of the discipline: Blvd. Eroii Sanitari, nr. 8, sector 5, București**						
2.3.	**Course tenured coordinator: Conf. Dr. Adrian Iftime**						
2.4.	**Practicals/clinical rotations tenured coordinator: Conf. Dr. Adrian Iftime**						
2.5. Year of study	I	**2.6. Semester**	II	**2.7. Type of assessment**	written	**2.8. Subject classification**	DOPT

3. Total estimated time (hours/semester of didactic activity) – teaching module

Number of hours per week	4	**Out of which: course**	2	**Clinical rotation**	2
Total number of hours from curriculum	56	**Out of which: course**	28	**Clinical rotation**	28
Distribution of allotted time					**Hours**
Study from textbooks, courses, bibliography, and student notes					
Additional library study, study on specialized online platforms and field study					
Preparing seminars / laboratories, assignments, reports, portfolios and essays					
Tutoring					
Examinations					
Other activities					
Total hours of individual study					
Number of credit points	2				

4. Prerequisites (where applicable)

4.1. of curriculum	Not applicable
4.2. of competencies	Not applicable

5. Requirements (where applicable)

5.1. for delivering the course	Requires a lecture hall with computer assisted video-projection and whiteboard with markers
5.2. for delivering the clinical rotation	Requires a lecture hall with computer assisted video-projection, laptop with specific software for medical simulations, laboratory equipment for demonstrations

6. Acquired specific competencies

Professional competencies (expressed through knowledge and skills)	- Knowledge of physics laws involved in common medical and biological phenomena (correct measurement of arterial blood pressure through manual and automated methods, direct and indirect methods; bio-electrical phenomena and the ways these can be evaluated in clinical vs. research

	setting; the response of living tissues to ultrasounds - mechanical stress index and thermal stress index. - Knowledge of physical and mathematical limitations of ultrasound imaging techniques (resolution limit; differences between B-mode (morphologic), M-mode (motion), pulsed, Doppler and echo-contrast); the causes of imaging artifacts. - Knowledge of physical and mathematical limitations of X-Ray 2D and 3D imaging (projection problems; tomographic reconstruction algorithms; relationship between these and the total ionizing radiation dose; relationship between the resolution and the radiation dose. - Knowledge of the physical principles and usage of relatively new medical devices used in clinical practice (pulseoximeters, infrared thermometers, transcutaneous bilirubinometers), with an emphasis on understanding the limits and error domains of these devices. - Knowledge of corelation between the human body energy intake (expressed in kilocalories) and the corresponding ability to energy expenditure (expressed in kilojoules) – the mechanical equivalent of the kilocalories, with applications in most common metabolic diseases.
Transversal competencies (of role, of professional and personal development)	- The development of critical thinking applied to medical sciences, through engaging in solving simple medical problems (appropriate for 1st year medical students): selecting an appropriate imaging method for particular conditions of the case. - The ability to correctly interpret results of blood pressure monitoring methods and the ability to spot and correct the sources of errors. - The ability to self-check the validity of properties of electrical vector of the heart (found on ECG through geometrical vector analysis methods) - Applied critical thinking: - the ability to identify imaging artifacts arising due to reconstruction algorithms in a variety of physical imaging techniques (echography, digital radiography, tomography) - the ability to identify the sources of errors in the discussed paraclinical methods and the possible strategies to mitigate them.

7. Subject learning objectives (based on the scale of acquired specific competencies)

7.1. General learning objective	Para-clinical examinations are branches of laboratory medical sciences, which provide services for patients without direct involvement in care. This lecture offers a quick introduction in para-clinical methods that use Physics (pressure, ultrasound, bio-electricity, x-rays, gamma-rays, magnetic resonance). The lecture is designed to especially help the students that did not study Physics before enrolling in the medical faculty, providing concise definitions and explanations of the laws of physics involved in each lecture chapter. Lecture content was designed to answer most common questions addressed to Biophysics Department by the students in preclinical years (1...3), questions that are related to medical physics but are not present in the curricula of the main Biophysics Lecture.
7.2. Specific learning objectives	- Brings a simplified and clear understanding of key Physics concepts used by medical sciences. - The lecture was designed to be accessible and useful to the students that did not studied physics before the university; - Designed to develop the ability to self check the validity of some common measurements performed in medical practice. - Ability to perform a basic risk/benefit analysis of common paraclinical investigations.

8. Content

8.1. Course	Teaching methods	Observations
Course 1: Hemodynamics and objective measurements of its parameters (I)	Lectures are taught in amphitheaters and halls which are technically equipped for this purpose: laptop, video-projector. All lectures have an electronic support and are brought up to date from the point of view of the information, according to treatises, research journals and books. The lecture has an extensive additional multimedia support, available through UMFCD platform (medical animations, software for simulations, online access to educational resources).	The educational materials, according to the curriculum, are presented interactively using multimedia methods, power-point presentations, teaching videos, simulations. We use dedicated software simulators for CT reconstruction algorithms and 3D image generation.
Course 2: Hemodynamics and objective measurements of its parameters (II)		
Course 3: Recording of electrical signals from biological tissues		
Course 4: Electrical conduction in the body and in the heart		
Course 5: Ultrasounds and their medical applications		
Course 6: Medical ultrasound imaging methods (Physical principles, types, theoretical limits, artifacts)		
Course 7: Basic physics of 2D X-Ray imaging		
Course 8: Imaging in 3D (tomographic imaging)		
Course 9: Photometric measurements in clinical practice (I: pulseoximetry)		
Course 10: Photometric measuremets in clinical practice (II: infrared thermometry, transcutaneous bilirubinometry)		
Course 11. Direct and indirect methods for measuring the metabolic rate		
Course 12. Measurement of plasma osmolarity (direct, indirect methods); clinical applications of osmolarity.		
Course 13. Common physicochemical methods in clinical laboratory (centrifugation, HPLC, electrophoresis)		
Course 14. Measurement errors in medical practice (types, causes, identification, mitigation)		

8.2. Clinical rotation /Seminar (Sem)	Teaching methods	Observations
Sem1: Introductive seminar (including work security). Standard and derived units for pressure used in medical practice (mmHg, cmH2O, torr, bar, psi, atm); problem solving: conversion between units.	Frontal teaching with the entire group; interactive method, systematic presentation, conversation, problem-solving exercises, debate. The seminars is augmented with an extensive multimedia support (medical animations, access online to educational materials) and the use of dedicated software for medical simulations such as: - PhET Interactive Simulations (University of Colorado, Boulder); - KiG (KDE foundation Interactive Geometry); - CTSim (Open Source Computed Tomography Simulator); - Blender (Blender Foundation); - R (R Foundation for Statistical Computing)	
Sem2: Frequent errors in sphygmomanometric pressure measurements (examples, problems).		
Sem3: Measuring of membrane electrical potential (with digital simulation of the electrical field; patch-clamp simulation).		
Sem4: Finding the electrical vector of a tissue (heart, etc) from the scalar recordings (I: digital simulation with KiG software).		
Sem5: Finding the electrical vector of a tissue (heart, etc) from the scalar recordings (II: problem solving).		
Sem6: Demonstration of image reconstruction in echography using an ultrasound ranging probe.		
Sem7: Identification of common image artifacts		

in 2D imaging. Software simulations and examples.	Practical demonstrations can be performed during the seminars by the teaching staff using devices already in the inventory of the discipline: sphygmomanometers, pulseoximeters, ultrasound telemeters, portable ultrasound probe (these portable devices do not require special handling requirements) and in the future with other dedicated devices purchased for teaching activities.	
Sem8: From 2D to 3D: Basic physics and elementary maths. Demonstration with CTSim simulation software.		
Sem9: Finding pulse rate and peripheral blood oxygenation level with a pulseoximeter (demonstration with a portable device).		
Sem10: Measurement units for metabolic rate : kilocalorie, kilojoule; problem solving: converting, use.		
Sem11: Calculation of metabolic efficiency, rate; problem solving (calculations for a healthy person, hypo and hyper metabolic states).		
Sem12: Calculation of plasma osmolarity (direct, indirect, osmolar gap); examples, problem solving exercises.		
Sem13: Error finding in laboratory data (normal distribution, outlier data); application in Excel and statistical programs.		
Sem14: Self evaluation; recapitulation of main topics via complex problems.		

Bibliography for course and clinical rotation

1. Alberts, B. *et al.*, ***Molecular Biology of the Cell***, 6th Edition, Garland Science **2020**, ISBN: 978-0-393-87094-7
2. Băran I, O. Călinescu, D. Ionescu, A. Iftime, C. Ganea, ***Curs de Biofizică***, Editura Universitară "Carol Davila" Bucureşti, ISBN: 978-973-708-994-6, **2017**
3. Badea R., Dudea S., Mircea P., Stamatian F., ***Tratat de Ultrasonografie Clinică***, Ed.Medicală Buc., **2000**
4. Glasser R, ***Biophysics – An Introduction***, Springer, ISBN: 978-3642252112, **2012**
5. Goldberger A.L., *Basic principles of electrocardiographic interpretation*, UpToDate, Wolters Kluwer, 2022
6. Holmes, R.J., ***Gamma ray and Neutron sources***, International Atomic Energy Agency, URL http://www.iaea.org/inis/collection/NCLCollectionStore/_Public/14/792/14792880.pdf, **2012**
7. Kaddoura S., ***Echo Made Eas***y, Elsevier, ISBN: 978-0702066566, **2016**
8. Kak A.C. and Malcolm Slaney, *Principles of Computerized Tomographic Imaging,* Society of Industrial and Applied Mathematics, **2001**
9. ***Lucrări practice de Biofizica si Fizica medicala***, coordonator A. Iftime, autori I. Băran, O. Călinescu, D. Ionescu și alții, Ed. Universitară Carol Davila, ISBN 978-973-708-710-2, **2013**
10. Malmivuo J., R. Plonsey, Bioelectromagnetism – Principles and applications of Bioelectric and Biomagnetic Fields, https://www.bem.fi/book/, Oxford University Press, 1995, updated **2014**
11. Nölting, B., ***Methods in Modern Biophysics***, 3rd Edition, Springer **2010**, ISBN 978-3-642-03022-2
12. *R*, R Core Team, R Foundation for Statistical Computing, Vienna, Austria, **2023**
13. Suslick, K.S., in Kirk-Othmer ***Encyclopedia of Chemical Technology***; 4th Ed. J. Wiley & Sons: New York, **1998**
14. United Nations Scientific Committee on the Effects of Atomic Radiation, ***Sources and Effects of Ionizing Radiation***, UNSCEAR 2019 Report to the General Assembly, with scientific annexes, actualizare **2022**
15. Prutkin J.M., *ECG Tutorial, Electrical components of the ECG*, UpToDate, Wolters Kluwer, **2022**

9. Corroboration of the subject content with the expectations of the representatives of the epistemic community, professional associations, and major employers in the field of the programme of study

This optional (elective) lecture encourages students to develop basic analytical skills and critical thinking applied to common medical investigations, by clarifying key physics notions required in several branches of medical sciences; these notions are very often not known by the students, due to the fact that these are not presented in the high-school/college curricula (basic hydrodynamics; basic acoustics; vector approach to electrical fields; discrete analysis method applied to ionizing radiation interaction with matter; photometric-based measurements; metabolic energy calculation; osmotic calculation). Only the notions with direct and relevant clinical impact are discussed, typically in a clinical case based approach; care was taken to select only

cases that involve anatomical and physiological notions that are easily recognized and understood by 1st year medical students. The content of the lectures is continuously updated, improved and completed in accordance with the new scientific discoveries in the field and correlated with the feedback from the students that completed the lecture.

10. Assessment

Type of activity	**Assessment criteria**	**Assessment methods**	**Assessment weighting within the final grade**
Course	- The following will be graded: the exactness, accuracy and integrity of the knowledge; logical coherency; the degree of assimilation of the specialty terms; the capacity to operate with principles taught at the lecture.	Written exam: - The written exam consists of solving a **multiple choice test** made up of 30 questions, that are chosen to uniformly cover the topic studied. Approx. 60% of the questions are from the lecture topics and 40% are problems from the seminars. - The test is identical in content for all the students, but the order of the questions is randomly varied. The written exam is scheduled at the same time for all the students in a semester. - The exam is considered to be passed if the student has correctly solved a minimum of 7 questions (the equivalent of grade "5"). The grading system is fully detailed below.	100%
Clinical rotation / Seminar	The seminar activities (problem solving skills) are evaluated during the final written exam (above). At the given problems, only the correct answers are considered in the evaluation.	Additionally to the final written exam, there will be at least 3 home-works for auto-evaluation during the semester (to be used during the individual self study time). These will be evaluated, but not graded (they do not impact final grade). The students will receive feedback to improve their academic performance (if needed) during the semester, based on these home-works.	
	The final grade is computed from the table below:		
	Final grade	**Number of correct answers at written test (from 30 maximum possible)**	
	10 (ten)	26 … 30 correct answers	
	9 (nine)	21 … 25 correct answers	
	8 (eight)	16 … 20 correct answers	
	7 (seven)	11 … 15 correct answers	
	6 (six)	8 … 10 correct answers	
	5 (five)	7 correct answers	
	4 (four, exam failed)	Less than 7 correct answers out of 30 maximum possible (i.e.20% or less from possible maximum)	

Minimum performance standard
The written exam is considered passed if the student correctly answers at least 7 questions out of 30

(i.e. ~23% out of maximum); this means that the student is able to at least recognize and minimally describe the phenomena studied during the lecture and seminar activities.

Date of filing: **22.09.2023**	**Signature of the course tenured coordinator:** **Conf. Univ. Dr. Adrian Iftime**	**Signature of the seminar tenured coordinator** **Conf. Univ. Dr. Adrian Iftime**

Date of approval in the Council of the Department:

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Signature of the Head of the Department

Prof. Univ. Dr. Ion Fulga