COURSE OF STUDY: Medicine and Surgery – Medicina e Chirurgia (corso in inglese) - Bari English Medical Curriculum LM-41

ACADEMIC YEAR: 2023/2024

ACADEMIC SUBJECT: Medical Physics (6 CFU), module of the integrated course Medical Physics Medical Statistics (11 CFU)

General information	
Year of the course	1st
Academic calendar (starting and ending date)	1st semester (13/11/2023 - 22/02/2024)
Credits (CFU/ETCS):	6
SSD	FIS/07 - Applied Physics
Language	English
Attendance	Mandatory

Professor/Lecturer	
Name and Surname	Loredana Bellantuono
E-mail	loredana.bellantuono@uniba.it
Department and address	Nuovo Complesso delle Scienze Biomediche – Policlinico – Piazza G. Cesare 11, 70124 Bari
Virtual room (Microsoft Teams code)	qcr0nfi
Office Hours (and modalities: e.g., by appointment, on line, etc.)	Mon—Fri, by appointment

Work schedule			
Hours			
Total	Lectures	Hands on (Laboratory, working groups, seminars, field trips)	Out-of-class study hours / Self-study hours
150	60		90
CFU/ETCS			
6	6		

Learning objectives	**Medical Physics** Provide the student with a basic knowledge of general physics and illustrate its applications to the fields of biology and medicine. At the end of the course, the student will be able to understand the physical concepts and quantities useful to describe human physiology and pathology. Moreover, the student will acquire the competence to apply the scientific method in the description and interpretation of simple natural phenomena.
Course prerequisites	High-school mathematics.

Teaching strategy	Lectures as the main teaching tool, also with the use of free and interactive simulations available online.

Expected learning outcomes ***specified for each Dublin Descriptor (DD)*** ***DD1*** **Knowledge and understanding** ***DD2*** **Applying knowledge and understanding** ***DD3*** **Making informed judgments and choices** ***DD4*** **Communicating knowledge and understanding** ***DD5*** **Capacities to continue learning**	**Medical Physics** - **DD1**: acquiring the theoretical and experimental basis of classical Physics, understanding the scientific method and the procedures of research in Physics. - **DD2**: identifying the most relevant features in the description of a physical phenomenon, in terms of order of magnitude and level of approximation, applying physical laws and theories to practical situations. - **DD3**: using autonomous reasoning to recognize the physical laws that determine the observed phenomena and to solve standard and non-standard problems. - **DD4**: using scientifically accurate terminology and being able to communicate scientific knowledge. - **DD5**: strengthening logical and scientific attitudes useful to further studies.
Syllabus	
Content knowledge	**Medical Physics** **UNITS OF MEASURE:** Physical quantities and laws. The scientific method. Fundamental and derived units of measure. Dimensional equations. Systems of units of measure: SI, CGS, British. Multiples and submultiples of units of measure. Measurement errors. Representation of physical laws. **VECTORS**: Scalar and vector quantities. Displacement vector. Addition and subtraction of vectors. Multiplication and division of a vector by a scalar. Composition and decomposition of a vector. Scalar and vector product of two vectors. **KINEMATICS:** Vector radius and displacement vector. Mean and instantaneous vector velocity. Mean and instantaneous vector acceleration. Uniform rectilinear motion and uniformly accelerated motion. Motion in the gravity field. Uniform circular motion: angular velocity, period, frequency, centripetal acceleration. Harmonic motion: pulsation, period, frequency. Velocity and acceleration in the harmonic motion. Reference systems in relative motion. **DYNAMICS:** The fundamental laws of dynamics. Mass, forces and momentum. Universal gravitation law and weight force. Measure of forces: scales and dynamometer. Contact forces. The inclined plane. Support reactions and thread tension. Sliding friction and medium resistance. Centripetal force. Inertial forces and centrifugal force. **STATICS:** Statics and equilibrium of levers. **ENERGY AND WORK**: Work of a force. Kinetic energy and kinetic energy theorem. Conservative forces and potential energy. Energy conservation and transformation. Power. **ELASTICITY:** Elasticity. Hooke's law and Young's module. Elastic force and harmonic motion. Elastic energy. **WAVE PROPAGATION:** Propagation of an elastic wave. Sinusoidal waves: frequency, wavelength and velocity. Longitudinal and transverse waves. Sound waves and features of sound. Hearing sensation and Fechner's law. Ultrasounds and their application in medicine. **DOPPLER EFFECT:** Doppler effect and its applications in medicine. **FLUID STATICS**: States of aggregation of matter Pressure. Pascal's principle. Hydraulic jack. Stevin's law. Communicating vessels. Buoyant forces. Atmospheric pressure. Units of measure for pressure. Instruments for pressure measurement. **FLUID DYNAMICS:** Flow rate. Bernoulli's theorem and its applications. Viscosity.

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	Hagen-Poiseuille law. Laminar and turbulent motion. Stokes' formula and sedimentation velocity. Ultracentrifuges. Surface tension. Capillarity. Laplace law. Elastic tension of vessel walls. Alveoli of the lungs. **CARDIOVASCULAR SYSTEM:** Physical properties of blood. General features of the cardiovascular system. Vessel pressures and resistances. Resistances in series and in parallel. Embolism. Arterial pressure measurement. Hydrostatic and acceleration effects. Work of the cardiac cycle. **TEMPERATURE:** Temperature. Thermometers and thermometric scales. Thermal dilation. Anomalous behavior of water. **GAS THEORY:** Laws of perfect gases. Absolute temperature. Dalton's partial pressures law. Kinetic model of perfect gases and Joule-Clausius equation. Absolute temperature and mean molecular kinetic energy. **HEAT:** Heat and energy. Specific heat. Thermal equilibrium. Phase transitions and latent heat. Vaporization and sublimation. Saturated vapor pressure. Real gases. Heat propagation. Thermoregulation of the human body. **THERMODYNAMICS:** Thermodynamic heat. Thermodynamic transformation. First law of thermodynamics. Specific heat of a perfect gas. Adiabatic transformation. Carnot cycle and conversion of heat into work. Refrigerating machines. Second law of thermodynamics. Entropy. Calorific value of food and metabolism. **ELECTROSTATICS**: Electric phenomena and electric charge. Coulomb's law. Atomic structure. Electric charge quantization. Conductors and insulators. Electric field and electrostatic potential. Electric energy measured in eV. Electric capacity and capacitors. Capacitors connected in series and in parallel. **ELECTRIC CURRENT:** Electric current. Ohm's law. Resistances connected in series and in parallel. Joule effect. Electrolysis and Faraday's laws. Electrophoresis. **MAGNETISM:** Magnetic phenomena and magnetic field. Charges in a magnetic field. Mass spectrometer. Origin of the magnetic field and Biot-Savart's law. Magnetoencephalography. **ELECTROMAGNETISM:** Electromagnetic induction: Faraday's and Lenz's laws. Origin of electromagnetic waves. Features of electromagnetic waves. Electromagnetic spectrum and visible light. **GEOMETRICAL OPTICS:** Geometrical optics. Reflection and refraction. Refraction index. Total reflection and limit angle. Optical fibers. Plane mirrors. Spherical mirrors. **THIN LENSES:** Centered optical system and spherical diopter. Object and image. Thin lenses and optical power. Focal points and image construction. Aberrations. **VISION OPTICS:** Optical scheme of the eye. Eye adjustment. Visual acuity. Visual defects: Schematizzazione ottica dell'occhio. Accomodamento dell'occhio. Acuità visiva. Difetti visivi: myopia, hyperopia, presbyopia, astigmatism, daltonism. Simple and composed micrscopes. **X RAYS:** Spectrophotometry and Lambert-Beer's law. Ionizing radiations. X rays and applications in medicine. Computerized axial tomography (CAT). **NUCLEAR PHYSICS:** Structure of the atomic nucleus. Nuclides and isotopes. Radioactivity. Alpha, beta and gamma decay. Radioactive decay law. Mean lifetime and half-life. Activity. Scintigraphy. SPECT. Elements of radioprotection rules.
Texts and readings	• A. Bacchetta, D. Scannicchio, Introduction to Medical Physics, CEA – Casa Editrice Ambrosiana, Zanichelli • L. Nitti, R. Tommasi, Fisica – 2000 quiz a scelta multipla per le scienze biomediche, CEA – Casa Editrice Ambrosiana, Zanichelli + a free software for translation (e.g. https://www.collinsdictionary.com/translator)
Notes, additional materials	**Medical Physics:** lecture slides
Repository	**Medical Physics:** Microsoft Teams (code: qcr0nfi)

Assessment	
Assessment methods	The final exam of the integrated course is composed of the partial tests of Medical Physics and Medical Statistics.

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	Medical Physics The test is aimed at assessing both the student's theoretical knowledge of the course contents and ability to apply theory to the solution of exercises. The test is written, made of 30 multiple-choice questions, and lasts 60 minutes. A scientific calculator is allowed. The number of questions can be proportionally reduced for students who have their CFU/ECTS obtained in other degree courses recognized.
Assessment criteria	*Knowledge and understanding*: the student should demonstrate knowledge of the main physical laws, related to the topics covered by the lectures. *Applying knowledge and understanding*: the student should be able to solve simple physical problems by using the acquired knowledge. *Making judgments*: the student should be able to follow autonomous reasoning in solving problems. *Communication skills*: the student should master scientific related to the course contents *Learning skills*: the student should learn to autonomously investigate problems in which the application of physical laws is required.
Final exam and grading criteria	**Medical Physics** The partial test consists of 30 multiple-choice questions. Each right answer is awarded 1.05 points, while a penalty of 0.25 points is given for each wrong answer; unanswered questions give no contribution to the score. The number of questions can be proportionally reduced for students who have their CFU/ECTS obtained in other degree courses recognized. In this case, the final score is computed as an average, weighted by CFU/ECTS, of the scores obtained in the recognized exam and in the Medical Physics partial test. The test is passed with a score of at least 18 points (rounded). The test is passed cum laude with a score greater than 30 points. The final marks of the integrated course are computed as an average, weighted by CFU/ECTS, of the scores obtained in the two partial tests.
Further information	
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COURSE OF STUDY: Medicine and Surgery – Medicina e Chirurgia (corso in inglese) - Bari English Medical Curriculum LM-41

ACADEMIC YEAR: 2023/2024

ACADEMIC SUBJECT: Medical Statistics (5 CFU/ECTS), module of the integrated course Medical Physics Medical Statistics (11 CFU/ECTS)

General information	
Year of the course	I year
Accademic calendar	I semester (oct - jan)
Credits (CFU/ETCS):	5
SSD	MED/01 – Medical Statistics
Language	Italian
Mode of attendance	Mandatory

Professor	
Name and Surname	Paolo Trerotoli
E-mail	paolo.trerotoli@uniba.it
Telephone	0805478478
Department and address	Department of Interdisciplinary Medicine, Istituto of Hygiene, third floor Biology Istitutes
Virtual room	Teams "MED STAT BEMC (access code: 421qocc)" The meeting should be planned by e-mail
Office Hours	By appointment to plan by e-mail

Work schedule			
Hours			
Total	Lectures	Hands-on	Out-of-class/self-study hours
125	50		75
CFU/ETCS			
5	5		

Learning Objectives	Provide the basic elements of descriptive and inferential statistics, as well as elements of probability useful for main applications in the field of biomedical research and for the interpretation and critical evaluation of biomedical literature.
Course prerequisites	Basics of mats at secondary degree.

Teaching strategies	Lessons with practical cases, solved using Excel and free applications available on the web and which use the R software for calculation (https://www.statskingdom.com/).

Expected learning outcomes ***specified for each Dublin Descriptor (DD)*** ***DD1*** **Knowledge and understanding** ***DD2*** **Applying knowledge and understanding**	- **Dublin 1 descriptor (knowledge and understanding):** Knowledge of the methods of data synthesis from clinical studies, knowledge of principles of probability useful for understanding the results of data analyses, knowledge of the main data analysis methods. **- Dublin 2 descriptor (ability to apply knowledge and understanding):** Ability to choose the correct methods for different data analysis conditions and assumptions, ability to recognize the types of clinical studies and interpret their limitations and strengths. **- Dublin 3 descriptor (critical and judgment skills):**

***DD3* Making informed judgments and choices** ***DD4* Communicating knowledge and understanding** ***DD5* Capacities to continue learning**	Development of critical thinking to read the results of clinical studies, and to identify main information that guide professional choices based on scientific evidence **- Dublin 4 descriptor (ability to communicate what has been learned):** Development of the ability to get the essential elements in data analysis procedures to produce effective reporting and illustrate the results of clinical studies. **- Dublin 5 descriptor (ability to continue studying independently throughout life):** Ability to go into details of the main topics for the purpose of planning clinical studies, systematic reviews, reading and promoting guidelines.
Content knowledge (Programma)	• **How to conduct a clinical study, Sources of data** • **Basic concepts**. Measurement, variable, scale of measurement. • **Population and Sample**. Simple random sample. Randomization. • **The frequency distribution**. The Sturges rule. Histograms. • **Descriptive statistics**: measure of central tendency; measure of dispersion. Count and percentages. Graphical methods: the box-plot, the pie chart, the bar plot, the scatter plot, the choropleth map. • **Basic Concepts of probability**: classical and frequentist probability, elementary properties of probabilities. Bayes theorem, application on screening tests, sensitivity, specificity, predictive values. • **Probability distributions**: Binomial distribution, Poisson distribution, Normal distribution. The standard Normal distribution. Sampling distributions. • **Inference: Estimation**. Confidence intervals. Confidence interval for a population mean with known and unknown population variance. Confidence interval for the difference of two population mean. Confidence interval for a proportion. Confidence interval for the difference of two proportions. Confidence interval for Odds ratio. Determination of the sample size. • **Hypothesis testing**. Type I error and Type II error, power of the test. • **Statistical tests to compare means**. A single population mean. The difference between two population means. • **Analysis of Variance**. Completely randomized design. Notes on other design of the study. Interaction. Multiple comparison methods (Bonferroni, LSD, Duncan) • **Distribution free methods to compare groups**: Wilcoxon test for paired and unpaired data. Kruskal Wallis test. • **Analysis of frequency data.** A single proportion. The difference between two proportions. The ratio of two population variance (F-statistic). The r*c table. The chi-square test. The Mantel Haenszel statistic. McNemar test; the Cohen's K. The Fisher exact test. Chi-square for trend. • **Correlation**. Pearson correlation coefficient. T-test for independence. • **Distribution free methods for correlation**: Spearman Correlation Coefficient. • **Simple linear regression**. Ordinary Least Square, slope, ANOVA to evaluate significance of slope, Coefficient of determination. Confidence interval for slope and intercept; notes on residual analysis. Notes on multiple regression. • **Logistic regression**. • **Survival analysis**. The Kaplan Meier curve. The log-rank test. Notes on Cox regression and hazard ratio. • **Diagnostic accuracy and screening**. Sensitivity, specificity and predictive values of a diagnostic test. ROC curves. Measure of efficacy and effectiveness of a screening. • **Introduction to Machine Learning** • **Statistical Methods for Epidemiology**. Incidence, prevalence, rates, Risk, relative risk, absolute risk, attributable risk. Odd and Odds ratio. Standardization of rates (direct and indirect). Confounding and interaction. • **Experimental and Observational studies** • **Clinical Trials**

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	• **Critical evaluation of a research paper**
Texts and readings	• Daniel W., Cross C., Biostatistics, Wiley, 2009 • Motulsky H., Intuitive biostatistic – a non mathematical guide, Piccin, 2021
Notes, additional materials	
Repository	Web page of the professor, to access by "Search people (index book)" (www.manageweb.ict.uniba.it/it/docenti/trerotoli-paolo)

Assessment	
Assessment methods	The exam for the assessment of medical statistic is a written test made by multiple choice questions and open text to evaluate knowledge of basics of statistics, the acquired skill to choose the correct application for the main clinical study conditions, the skill to interpret results of a published paper. The exam has a duration of 1 hour. If the student has the right to hold a partial exam because of previous curriculum studiorum, the test will be composed by questions on selected arguments on which the student will be informed. The professor should evaluate the contents of previous exams.
Assessment criteria	Knowledge and understanding: the student should demonstrate knowledge of the different descriptive and inferential methods, as well as their theoretical foundations. Applied knowledge and understanding: the student should be able to set up and solve common data analysis problems and know how to interpret the results. Autonomy of judgment: the student should be able to understand the transferability of the results to clinical practice, as well as to lay the methodological premises for any further developments of the research. Communication skills: the student should demonstrate the ability to correctly use the specific terminology of the discipline and must communicate the results of their analyses. Ability to learn: the student should demonstrate the ability to use the basic principles of description and statistical inference to be able to critically evaluate the biomedical scientific literature and propose analytical alternatives suited to the clinical objectives.
Final exam and grading criteria	The final score of the Medical Statistics test is attributed based on the number of correct answers to the multiple-choice questions (1 point for each correct answer) and the evaluation of the open-ended questions. The latter are formulated in such a way as to require answers that use the technical language learned during the lessons and exercises, to allow the teacher to identify in the answers the key words whose presence leads to the attribution of the score; In addition to the presence of keywords, presentation and synthesis are also evaluated. The total for the test is 31, honors are awarded to those who achieve this score. Passing is achieved with 18 points. Points will not be deducted for answers incorrectly or not given. The final grade is the weighted mean of both tests (Physics and Statistics). The weights are the CFU of each discipline of the C.I.
Further Information	
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