



FISICA INFORMATICA E STATISTICA MEDICA - channel 4

10 CFU - 1° Semester

Teaching Staff

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LEARNING OBJECTIVES

▪ Physics

The aim of the course is the achievement by the student of descriptive and predictive ability of physics applied to biological systems. The review, in the medical field, of the scientific method in terms of language, models and representation of the mechanical, thermal, electromagnetic phenomena represents a specific objective as well as the knowledge of basic physical principles of the diagnostic and therapeutic techniques used in modern medicine.

The subjects that will be covered are: fluid mechanics and its implications in hemodynamic; wave mechanics with specific developments relating to sound and hearing; the use of ultrasounds in medicine; vision and optical instruments; interaction of radiation with matter; generation, use and biological effects of ionizing radiation; dosimetry and radiation protection.

The scientific field of reference is Applied Physics (FIS/07).

▪ **Bioinformatics**

Objective of the course is the acquisition of methods for the analysis of biological sequences and structures and the capability of searching in biological databases (eg. Genes, sequences, functional domains). Starting from primary sequences of nucleic acids or proteins can hypothesize the function, evolutionary history and structure. The tools used to achieve these objectives are the public databases and the tools for the analysis and visualization of such kind of data.

Knowledge and understanding: Students will gain knowledge on methods for the analysis of biological sequences and for searching in biological databases. In particular students will be able to search on database of sequences and domains. Also, public databases available on NCBI will be presented together with software for the analysis and visualization of biological data. Finally, students will acquire the basic tools for the analysis of the transcriptome.

Applying knowledge and understanding: identify the appropriate tools to manipulate data and extract knowledge underlying; solve problems through the use of appropriate software in bioinformatics.

Making judgments: Through guided exercises, the students will acquire the basic skills necessary to deal with the analysis of new biological sequences, hypothesizing the function, study the transcriptome.

Communication skills: the student will acquire the necessary communication skills and expressive appropriateness in the use of technical language within the general framework of the analysis of biological data.

Learning skills: The course aims, as the goal, to provide students with the necessary basic theoretical methods and practices in order to address and solve problems concerning the analysis of biological data.

▪ **Medical Statistics**

The course begins with basic knowledge of statistics, presenting methods for descriptive statistics of various kinds of data. The fundamental tests used in biomedical statistics will be presented. At the end of the course the student will be able to understand statistical results reported in biomedical literature, and to use simple techniques for statistical analysis and presentation of results.

COURSE STRUCTURE

▪ **Physics**

Lectures and tests (entrance, on going and end-of-course verification).

▪ **Bioinformatics**

Lectures

▪ **Medical Statistics**

Classes

DETAILED COURSE CONTENT

▪ **Physics**

Physical quantities and their measurement - Physical quantities, units and systems of measurement, dimensional analysis. Measurements and uncertainties. Instrument characteristics of instrument. Analytical and graphical representations. Scalar and vector quantities.

Elements of mechanics and concepts of Biomechanics - Kinematics. Circular and harmonic motion. Momentum. Principles of dynamics. Work. Energy. Power and efficiency. Statics. Elasticity. Physiological statics. Bone fractures.

Basics of fluids and applications in biological systems - Density. Viscosity. Hydrostatic pressure. Fluid statics. Drip. Dynamics of ideal fluids. Bernoulli's theorem. Aneurysm and stenosis. Real liquids. Poiseuille's relation. Hydraulic resistance. Sphygmomanometry.

Waves and radiations - Wave phenomena. Period and frequency. Amplitude and energy. Mechanical waves. Sound. Decibel. Isophonic curves. Phonendoscope. Ultrasonic waves. Electromagnetic waves. Electromagnetic spectrum. Eye and vision. Radiation for diagnostics and therapy. X ray imaging. Radioisotopes and nuclear medicine. Radiotherapy. Biological effects of ionizing radiation. Introduction to radiation protection dosimetry.

▪ **Bioinformatics**

The course is organized into lectures that provide a theoretical basis coupled with exercises for learning the use of bioinformatics tools in the field of medicine.

PROGRAM

1. Introduction
2. Pairwise and Multiple alignment
3. Biological Databases: General Databases (NCBI, EMBL), Specialized Databases (OMIM, CIVIC, Drugbank, KEGG Pathway)
4. Tools for the analysis of the transcriptome: Microarray, Next Generation Sequencing, Analysis of the transcriptome: Biomarkers

▪ **Medical Statistics**

Introduction to statistics:

- descriptive and inferential statistics; types of data: qualitative, ordinal, quantitative - discrete and continuous; data collection and presentation; tables; graphical representations

Descriptive Statistics:

- frequencies and proportions; frequency distributions; quantiles and percentiles; means and other central tendency measures; standard deviation and other statistical dispersion measures

Probability and statistical inference

- probability distributions and probability density functions; sampling, inference and hypothesis testing; confidence intervals; false-positive and false-negative errors; sensibility and specificity; predictive values.

Hypothesis testing

- "Student's" t-test for means; "chi squared" test for frequencies; correlation and regression; elements of ANOVA and non-parametric methods;

TEXTBOOK INFORMATION

▪ **Physics**

Scannicchio D., Fisica Biomedica, EdiSES, 2013

Davidson R.C., Metodi Matematici per un Corso introduttivo di Fisica - EdiSes, 2013

Lecture notes provided during the course

▪ **Bioinformatics**

- Jambeck, Gibas "Developing Bioinformatics Computer Skills", O'Reilly

▪ **Medical Statistics**

- Biostatistics for the Biological and Health Sciences, Marc M. Triola and Mario F. Triola, Wiley

or:

- Pagano, Gauvreau. "Principles of biostatistics". Duxbury Press

- Daniel WW and Cross CL. Biostatistics, 11th ed., Wiley
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