PRINCIPI DI INFORMATICA MATEMATICA E FISICA APPLICATI ALLE BIOTECNOLOGIE

12 CFU - 1° Semester

Teaching Staff

FRANCESCO PAPPALARDO - Module Mathematics and Computer Science: applications in biotechnology - INF/01 - 6 CFU
Email: francesco.pappalardo@unict.it
Office: Dipartimento di Scienze del Farmaco, Piano 2
Phone: 0957384223
Office Hours: Lunedì 12-14, studenti; Venerdì 12:30-13:30, tesisti e tirocinanti
LIVIO LAMIA - Module Physics - FIS/07 - 6 CFU
Email: llamia@lns.infn.it
Office: INFN-LNS, via Santa Sofia 62, 95123, Catania
Phone: 095/542547
Office Hours: Martedì, 14:00-15:00 Dipartimento di Fisica e Astronomia (DFA), Stanza 328

LEARNING OBJECTIVES

- **Mathematics and Computer Science: applications in biotechnology**
  To show basic mathematical concepts and how they can be used in the elaboration of simple models useful for the understanding of the biological phenomena; develop the ability to calculate and manipulate the most common mathematical objects; present with sufficient accuracy some simple but significant methods of proof of mathematics to refine the logical abilities; teach to communicate clearly the rigorous concepts. Knowing the fundamentals of computer science and possible applications in biology.

- **Physics**
  The student is required to achieve the following training objectives:

  - physical quantities and dimensional analysis;
  - vector calculation and applications;
  - static and dynamic of the material point and of the rigid body;
  - fluidostatic and fluid dynamics;
  - thermodynamics

COURSE STRUCTURE

- **Mathematics and Computer Science: applications in biotechnology**
  Through lessons and practical sessions at the end of each learning unit (when planned).

- **Physics**
  The teaching method is generally the most congenial to the teaching of Physics. In particular, the lecture will be given by means of slides prepared by the teacher according to the needs of the class. In addition, multimedia files (video and / or audio) will be used to facilitate the understanding of some topics. In addition to this, teaching in cooperative learning is privileged, in which the classroom becomes a moment of development and apprehension of knowledge. Brainstorming will also be considered (mainly for the resolution of exercises submitted by the teacher) and flipped-classroom in which the students will be directly called into question to explain or illustrate exercises or theoretical topics.

DETAILED COURSE CONTENT

- **Mathematics and Computer Science: applications in biotechnology**
  Mathematics Section

  Recalls on numerical sets and on arithmetic calculation, properties of real numbers and their consequences.
  Elementary theory of sets
  Elementary functions: n-th power and roots functions, exponential functions and logarithm functions: definitions, properties, graphs, applications.
  Use of exponentials and logarithms in the life sciences: models for the evolution of a population.
  Functions of a real variable: overview of definition domain, growth, decrescence, maximum and minimum (absolute), composition of elementary functions and their graph.
  Limits: definitions, properties, rules of calculation, order of infinity and infinitesimal, graphic aspects, oblique asymptotes.
  Continuous functions: definition, properties, zero theorem, approximation of the zeroes of a function (for example of the roots of a polynomial) with the bisection method.
  Continuous functions: existence of maximum and minimum over a closed and limited interval.
  Composition of elementary functions and their graph, considering definition domain, limits at the ends of the definition domain, crescenza and decrescence, maximums and minima.
  Derivatives.
  Integrals: definition, properties, area calculation, approximation with the trapezoidal method.
  Differential equations, notes on numerical methods of resolution. Enzymatic and molecular kinetics.

  Computer Section

  Basic concepts.

  Fundamental concepts of information theory; General concepts: Hardware, Software; Information technology; Types of computers; Main components of a PC; Performance of a computer. Hardware: Central processing unit; Memory; Input Devices; Output peripherals; Input / output devices; Memory devices. Software: Types of software; System software; Application software; Graphical User Interface; System development.

  Introduction to algorithms.

Algorithms; Properties of the Algorithms; Description; Constants and Variables; Propositions and Predicates; Block diagrams

Introduction to computational biomedicine.

Bioinformatics and computational modeling in biomedicine.

Applications Section

Usage and access of the most important genomic, proteinomic and bibliographic databases
Practical examples of classical bioinformatics: assembly of genomic fragments, analysis and alignment of biosequences
Protege and ontologies: outline
COPASI: molecular modeling
Agent models: netlogo and customs systems

- **Physics**

1) Physics quantities

Quantities in physics--International system-Dimensions and dimensional calculation-Measurement uncertainties

2) Vectors

Reference frame and euclidean axes; Geometrical meaning of vectors; Vectors in physics and their role in describing 2D and 3D space; Vector and scalar quantities; Vectors in the plane and their decomposition; Versors; Operation with vectors: sum, difference product

3) Kinematics

Position and displacement vector; Velocity and accelerations vectors; ; One dimensional motion with constant velocity; One dimensional motion with constant acceleration; Freely falling objects; Projectile motion; Uniform Circular motion; Centripetal acceleration

4) Dinamics

The concept of force; Newton's laws of motion; The force as a vector; Gravitational force; Forces of friction; The concept of work; Equilibrium condition and the inclined plane (with and without friction forces); Work done by a constant and a varying force; Conservative forces; Elastic forces and Hooke's law; The simple pendulum; Mass-spring system; Kinetic Energy and the wrok-kinetic energy theorem: Gravitaional force and gravitaional law; Conservation of energy; Potential energy; The isolated systems: conservation of mechanical energy; Linear momentum and its conservation; Impulse and momentum; Angular position, veolicity and acceleration; Rotational kinematics; Rigid body; Angular momentum and torque; Energy in rotational motion; Angular momentum conservation;

5) Fluid mechanics

Pressure; Variation of pressure with depth; Stevin's law; Pressure measurements; Pascal's law; Buoyant forces and Archimede's principle; Fluid dynamics; Bernoulli's equation

6) Thermodinamics

Temperature and the zeroth law of thermodynamics; Thermic contact; Thermometers; Absolute scale of temperatures; Thermic equilibrium; The heat; Thermal expansion of solids and liquids; Specific heat and calorimetry; Temperature of equiibrium; Latenet heat; The first law of thermodynamics; Work, heat and internal energy in thermodynamics; Transformation; Peferct gases; Transformations with constant temperature or volume or pressure; Molar specifi heat; The Mayer relation; Adiabatic transformations; The Carnot Cycle; The Carnot principle; The second law of thermodynamics; Entropy;

6) Electromagnetism

Point-like charges; The Coulomb law; Electric field and its sources; the Gauss law; Electric potential and energy; Capacity and Capacitors; Current, resistance and Ohm's laws; Magnetic field and its sources; Time-dependent magnetic fields; Introduction to the Maxwell equations; Electromagnetic waves and properties; Applications

---

TEXTBOOK INFORMATION

- **Mathematics and Computer Science: applications in biotechnology**
  Teacher's slides

- **Physics**
  1. D. Halliday, R. Resnick, J. Walker "Fondamenti di Fisica" (2015) Casa Ed. Ambrosiana;

  2. D. Scannicchio "Fisica Biomedica" (2009), Edises

  3. Mazzoldi, Nigro, Voci: “Elementi di Fisica Vol. 1 – Meccanica e Termodinamica. Seconda edizione.” (EdiSES)

  5. D. Halliday, R. Resnick, J. Walker "Fundamental of Physics" Casa Ed. Ambrosiana

---