# Fundamentals of Neurobiology and Genetics

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COURSE AIMS AND INTENDED LEARNING OUTCOMES

The course aims to provide students with a general understanding of the properties of living matter, the structure and biological significance of life's macromolecules, and metabolism and cellular organisation, paying particular attention to the structure and function of neuronal cells. Furthermore, the laws of hereditary trait transmission and the molecular mechanisms governing it, as well as the neurobiological basis of certain human diseases and normal and pathological behaviour will be discussed.

At the end of the course, students will be able to:

* know and understand the biochemical bases of biological systems and processes;
* understand and describe the structure-function relationship in informational macromolecules (nucleic acids, proteins);
* know and describe the main laws of hereditary trait transmission in humans;
* solve biological problems inherent in the analysis of metabolism and genetic inheritance;
* know and describe the functioning of neurons;
* correctly contextualise the notions of human biology and genetics, and critically evaluate neuro-cognitive and genetic studies;
* implement and update their knowledge, drawing independently from texts, scientific articles and online platforms;
* describe/communicate neurobiological and genetic knowledge even to non-expert interlocutors, with a command of the language and correct scientific terminology.

COURSE CONTENT

Unit 1. *The study of living nature*

– The experimental method: development, needs and limits;

– Living organisms: the life cycle, reproduction, homeostasis, interaction with the environment.

Unit 2. *The levels of organisation and fundamental processes of the living*

– The cell: the basic unit of living organisms;

– Cell theory: origin and development, prokaryotic and eukaryotic cells;

– The principal cellular organelles: structure and function;

– Cell cycle and division: mitosis and meiosis;

– Cell cycle control: restriction points;

– Molecular mechanisms of tumour onset and invasiveness.

Unit 3. *The molecular bases*

– The principal elements and classes of compounds found in living matter;

– The informational macromolecules: DNA, RNA and proteins, the structure-function relationship.

Unit 4. *Transmission of hereditary characteristics*

– Mendel's laws and modern genetics;

– Determination of sex, heterosomal inheritance;

– Molecular genetics: from the structure of nucleic acids to maps of the human genome;

– Mutations and genetic variability;

– Regulation of gene activity.

Unit 5. *Syndromes due to chromosomal aberrations, neurocognitive and genetic aspects*

– The normal and pathological human karyotype;

– Autosomal aneuploidy: Down, Edwards and Patau syndrome;

– Heterosomal aneuploidy: Turner syndrome, Klinefelter syndrome;

– Fragile X syndrome, an example of an "expansion"-related mutation.

Unit 6. *Autism spectrum*

– Neurobiological and genetic bases;

– The new "broken mirror" theory;

– Classic autism, Asperger syndrome and Rett syndrome.

Unit 7. *Genes and behaviour*

– Individual genes and elementary behavioural traits;

– Mutations in individual genes: motor and cognitive deficits (example: Huntington's Chorea);

– Complex behavioural traits: polygenic model (examples: schizophrenia and bipolar disorders).

Unit 8. *Nature and transmission of the nerve impulse*

– The cells of the nervous system: neurons and glial cells;

– Electrical transmission: membrane potentials, ion channels;

– Synaptic potential and action potential;

– Depolarisation and repolarisation;

– Synaptic transmission: synapses, neurotransmitters and neuromodulators;

– Neurotransmitters and drugs.

READING LIST

Main recommended texts:

1. David Sadava - David M. Hillis - H. Craig Heller - Sally Hacker, *Elementi di biologia e genetica,* Zanichelli, Fifth Italian Edition based on the eleventh American Edition.
2. E.R. Kandel-J. H. Schwartz-T.M. Jessell, *Fondamenti delle neuroscienze e del comportamento,* Ambrosiana, First Edition 1999, Reprint 2005.

TEACHING METHOD

The course will be divided into lectures that will outline the approach to the topics in the programme and indicate a method of study. The course, in addition to the frontal lectures, includes 10 hours of practical activities during which examples of solutions to certain biological problems will be illustrated, allowing the student to assess their own level of understanding of the subject.

ASSESSMENT METHOD AND CRITERIA

A written exam, with the possibility, at the request of the Exam Commission, of a more in-depth supplementary oral exam to be carried out according to the procedures established by the Commission. The written exam will comprise a series of test questions and some open-ended questions. The test will include 27 closed-ended questions, each worth 1 mark. There will be two open-ended questions, each of which will be given a mark from 0 to 3 (3 in the case of an exemplary answer). After completing the written exam (27 marks for the test questions and 6 marks for the open-ended questions) students will be given a mark from 0 to 33 (zero: no correct answers; 33: all correct answers). A distinction will be awarded for marks of 31 - 33. The results of the practical activities will be subject to a final assessment according to methods specified in class.

NOTES AND PREREQUISITES

As this is an introduction to the neurobiological and genetic foundations, there are no prerequisites for attending the course. However, intellectual interest and curiosity in the topics covered in the course are assumed.

Further information can be found on the lecturer's webpage at http://docenti.unicatt.it/web/searchByName.do?language=Eng or on the Faculty notice board.