# Neurobiological and Genetic Bases of Mental Activity

## Prof. Sara Missaglia

***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 meaning of the macromolecules of life, and metabolism and cellular organisation, paying particular attention to the structure and function of neuronal cells. The laws of hereditary trait transmission and the molecular mechanisms governing it, as well as the neurobiological basis of some human diseases and normal and pathological behaviour will be discussed. Lastly, the course will introduce students to a rudimentary understanding of human neuroanatomy, providing the bases for understanding detailed information they will receive in other courses.

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 within 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 and the main neuroanatomical structures;
* 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: life cycle, reproduction, homeostasis, interaction with the environment

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

*-*  The cell: the basic unit of living organisms

- Cell theory: its origin and development, prokaryotic and eukaryotic cells

- The principal cellular organelles: structure and function

- Cell cycle and division: mitosis and meiosis

- Control of the cell cycle: restriction points

- The molecular mechanisms of tumour onset and invasiveness

Unit 3. *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 traits*

- Mendel's laws and modern genetics

- Gender determination, heterosomal heredity

- 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 from chromosomal aberrations, neurocognitive and genetic aspects*

- The normal and pathological human karyotype

- Autosomal aneuploidies: Down syndrome, Edwards syndrome and Patau syndrome

- Heterosomal aneuploidies: Turner syndrome, Klinefelter syndrome

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

Unit 6. *The autistic spectrum*

*-* Neurobiological and genetic bases

- The new "broken mirrors" theory

- Classic autism, Asperger syndrome and Rett syndrome

Unit 7. *Genes and behaviour*

- Single genes and basic behavioural traits

- Mutations in single genes: motor and cognitive deficits (example: Huntigton's Chorea)

- Complex behavioural traits: polygenic model (example: schizophrenia, bipolar disorders and borderline disorders)

Unit 8. *Anatomy and development of the nervous system*

- The peripheral nervous system: sensory and motor division

- Organisation of the central nervous system: spinal cord, bulb, pons, mesencephalon, cerebellum, diencephalon, cerebral hemispheres

- Basal nuclei

- The limbic system

Unit 9. *Elements of cognitive neurosciences*

*-* From nerve cells to cognitive processes

- Cognitive processes and the cerebral cortex

Unit 10. *Nature and transmission of the nerve impulse*

*-* The cells of the nervous system: neurons and glial cells

- Electrical transmission: membrane potential, ionic channels

- Synaptic potential and action potential

- Depolarisation and repolarisation

- Synaptic transmission: synapses, neurotransmitters and neuromodulators

- Neurotransmitters and drugs

Unit 11. *Mirror neurons*

- Their discovery, theoretical implications and possible practical consequences (examples: autistic syndrome and post-stroke rehabilitation).

***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.
3. Hendelman, *Atlante di Neuroanatomia funzionale,* *con considerazioni cliniche*, Ambrosiana, second edition 2016.

***TEACHING METHOD***

The course consists of lectures that will outline the approach to the course subjects and indicate a study method; examples of solutions to certain biological problems will also be illustrated, allowing students to assess their own level of understanding of the subject. Practical classes correlated to the course will provide sessions of in-depth study and evaluation.

***ASSESSMENT METHOD AND CRITERIA***

A written exam, with the possibility, at the request of the Examination Committee and/or the student, of an in-depth supplementary oral exam to be carried out according to the procedures established by the Committee. 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 - 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.

***NOTES AND PREREQUISITES***

Being an introduction to the neurobiological and genetic foundations, there are no prerequisites for attending the course.

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.