# Fundamentals of Neurobiology and Genetics

## Prof. Daniela Tavian

***COURSE AIMS AND INTENDED LEARNING OUTCOMES***

The course aims to guide students towards a general understanding of the properties of living material, the biological structure and meaning of the macro-molecules of life, of metabolism and cellular organisation, while placing particular emphasis on the structure and workings of neuronal cells. Students will discuss the laws of transmission of hereditary characters and connected molecular mechanisms, as well as the neurobiological basis of some human diseases and normal and pathological behaviour. Lastly, the course will introduce students to a rudimentary understanding of human neuroanatomy, while providing the necessary basis for understanding detailed information later in other courses.

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

* Identify and understand the biochemical bases of biological systems and processes;
* Understand and describe the relationship between structure and function within informational macro-molecules (nucleic acids, proteins);
* Identify and describe the main laws of transmission of hereditary characters in man;
* Learn the ability to solve biological problems inherent to the analysis of the metabolism and genetic heritage;
* Identify and describe the workings of neurons and the main neuroanatomical structures;
* Correctly contextualise notions of biology and human genetics and critically assess neuro-cognitive and genetic studies;
* Implement and update personal knowledge by independently referring to scientific texts, articles and online platforms;
* Describe/communicate neuro-biological and genetic knowledge accurately, also to non-experts using scientifically correct language and terminology.

***COURSE CONTENT***

1. The study of living nature

- The experimental method: development, needs and limits

- Living organisms: the life cycle, reproduction, homeostasis, and

interaction with the environment

2. The molecular bases of life

- The principal elements and classes of compounds found in living matter

- The informational macromolecules: DNA, RNA and protein, the structure-function relationship

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

3. The cell

- 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

4. Cell cycle and division

- Mitosis and meiosis

- Control of the cell cycle: restriction points

- The molecular mechanisms of tumour onset and invasiveness

5. Transmission of hereditary characteristics

- Mendel's laws and modern genetics

- Gender determination, heterosomal inheritance

- Mutations and genetic variability

- Regulation of gene activity

6. 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

- Deletions of chromosomal tracts: Cri-du-chat syndrome

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

7. The autistic spectrum

- Neurobiological and genetic bases

- The new "broken mirror" theory

- Classic autism, Asperger syndrome and Rett syndrome.

8. Genes and behaviour

- Single genes and basic behavioural traits

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

- Complex behavioural traits: polygenic model (examples: schizophrenia, bipolar disorders and borderline personality disorder)

9. Nature and transmission of nerve impulses

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

- Electrical transmission: membrane potentials, ionic channels

- Synaptic potential and action potential

- Depolarisation and repolarisation

- Synaptic transmission: synapses, neurotransmitters and neuromodulators

- Neurotransmitters and drugs

10. Anatomy and development of the nervous system

- Peripheral nervous system: sensory and motor division

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

- Basal nuclei

- Limbic System

- Elements of cognitive neuroscience:

From nerve cells to cognitive processes

Cognitive processes and the cerebral cortex

11. Mirror neurons

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

***READING LIST***

D. Sadava-D.M Hillis-H.C. Heller-M.R. Berenbaum-S. Hacker, *Life: the science of Biology, volume 1,* Sinaurer Associates Inc, 2011, 9th edition

E.R. Kandel-J. H. Schwartz-T.M. Jessell, *Fondamenti delle neuroscienze e del comportamento,* Ambrosiana, Prima edizione 1999, Ristampa 2005.

W.J. Hendelman, *Atlas of Functional Neuroanatomy, CRC Press, 2016,* 3th edition.

***TEACHING METHOD***

The course consists of lectures that will outline the approach to the subjects and indicate a method of study; examples of solutions to certain biological problems will also be illustrated, allowing the student to assess their own level of understanding of the material. Tutorials will provide integrated sessions of in-depth study and verification.

***ASSESSMENT METHOD AND CRITERIA***

There will be a written test composed of questions on the entire course program. The test will contain 27 closed questions and they will carry 1 mark. There will be two open-ended questions and the mark will range from 0 to 3 (3 for impeccable answers). Students can obtain marks ranging from 0 to 33 for the written test (zero: no correct answers; 33: all correct answers). Marks between 31 and 33 will receive honours. Students may also sit an oral test, it is optional and may be requested only if students have obtained a minimum of 18 marks on the written test.

***NOTES AND PREREQUISITES***

There are no prerequisites for attending the course.

In case the current Covid-19 health emergency does not allow frontal teaching, remote teaching will be carried out following procedures that will be promptly notified to students.

*Students’ reception*

Prof. Daniela Tavian will receive the students on Tuesday from 12.30 to 14.30, by appointment via email ([daniela.tavian@unicatt.it](mailto:daniela.tavian@unicatt.it))

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.