

Mathematical modeling of the human brain: from physiology to neurodegenerative disorders

La Prof.ssa Paola Antonietti (Politecnico di Milano) terrà un corso di 8 ore su **Mathematical modeling of the human brain: from physiology to neurodegenerative disorders**. Il corso si concentrerà sui modelli matematici delle malattie neurodegenerative del cervello. Prima delle lezioni della Prof.ssa Antonietti, il Prof. Nicola Mercuri e la Dott.ssa Caterina Motta, neurologi dell'Università di Tor Vergata, offriranno alcune lezioni introduttive, non specialistiche, per spiegare questi fenomeni dal punto di vista medico. A completamento del corso, il Dott. Ivan Fumagalli dimostrerà come applicare e studiare i modelli presentati, utilizzando simulazioni al computer basate su casi reali.

Il corso si terrà nei seguenti orari:

Settimana 7-10 gennaio 2025 (orari ancora da definire): Prof. Nicola Mercuri e Dott.ssa Caterina Motta
13 gennaio 2025 (Prof. Antonietti) 14:00-18:00 Aula Dal Passo
14 gennaio 2025 (Prof. Antonietti) 9:00-13:00 Aula Dal Passo
15 gennaio 2025 (dott. Ivan Fumagalli) 9:00-13:00 Aula Dal Passo

Programma del corso:

Neurodegenerative diseases (NDs) are complex disorders that primarily affect the neurons in the brain and nervous system, leading to progressive deterioration and loss of function over time. A common pathological hallmark of NDs is the accumulation of disease-specific misfolded aggregated proteins in different areas of the brain (e.g., A β and tau in Alzheimer disease, α -synuclein in Parkinson disease). This course aims to discuss mathematical modeling, numerical analysis, and high-performance scientific computing to model the physiological and pathological function of the human brain and central nervous system.

The following topics will be discussed:

- Mathematical and numerical modeling of the misfolding process in NDs. I will discuss suitable mathematical models of increasing complexity and their numerical discretization.
- Mathematical and numerical modelling of brain's waste clearance mechanism. I will present the mathematical and numerical modeling of the multiphysics flow of blood and Cerebrospinal Fluid in the brain describing the functioning of the brain's waste clearance mechanism. This model describes how the brain's waste clearance mechanism operates, a recently uncovered aspect that is crucial in understanding the development and advancement of neurodegenerative diseases.
- Mathematical and numerical modelling of epileptic seizures. We discuss models to mathematically describe seizure evolution in the grey and white matter, coupled with specific ionic models for neuronal modelling in which the different dynamics of the potential and ionic currents are considered