

## MEDICINE AND SURGERY

Course: **Clinical Neuroscience**

Year (1<sup>st</sup>-2<sup>nd</sup>-3<sup>rd</sup>-4<sup>th</sup>-5<sup>th</sup>-6<sup>th</sup>): 5<sup>th</sup> Period (1<sup>st</sup>-2<sup>nd</sup> semester – annual): 1<sup>st</sup> Credits: 9

### Objectives

*Knowledge in Clinical Neuroscience is expanding rapidly. We propose an integrated course designed to translate basic science into clinical practice. This interdisciplinary program will bridge different subspecialties into an integrated and comprehensive curriculum. Upon completion, students will have a solid knowledge of the main neurological diseases, including their pathophysiology, diagnosis, and treatment.*

*The Neurology module is divided into three comprehensive parts. The first part introduces students to clinical neuroanatomy, neurophysiology and neurological semiotics (phenomenology), providing essential tools for mastering neurological localization in diagnosis and interpreting historical medical data to formulate reasoned syndromic and etiological diagnostic hypotheses. The second part covers the major neurological disorders that are commonly encountered in clinical practice. It discusses their etiopathogenesis, clinical presentation, diagnostic modalities, differential diagnosis, and therapeutic approaches. The final part aims to equip students with practical skills for addressing the main neurological symptoms seen in clinical settings. It includes detailed discussions on differential diagnoses, diagnostic algorithms, and strategic diagnostic approaches, along with practical therapeutic insights. Moreover, this part features interactive lessons where students are encouraged to engage in logical reasoning and formulate diagnostic hypotheses based on discussed neurological clinical cases. The approach is symptom-based and patient-centered. Additionally, the module includes a practical training ("tirocinio pratico"), in small groups, where students will learn and practice the neurological physical examination and interpret its results.*

*The Neuroradiology module reviews the role diagnostic and interventional radiology applied to neurological diseases. This module instructs on some of the basic aspects of neurologic imaging, including anatomy of the brain and spinal cord as shown by CT and MRI, and diagnosis of diseases and abnormalities of the central nervous system.*

*The Neurosurgery module provides an overview of the surgical management of neurological diseases. It will integrate diagnostic procedures and technological advancements.*

### Prerequisites

*The course is dedicated to 5th year medical students who already master the fundamental knowledge required to approach the integrated field of Clinical Neuroscience. This includes passing courses of Body at work 1, and Mechanism of diseases 1 and 2 (2nd year).*

### Content

#### **"The ghost in the machine"** (Absinta) (2 hours)

Introduction by Prof. Fasano; presentation of the course by all the teachers.

Learning goals: to understand the relationship between clinical neurology and internal medicine; to understand the relationship between neurology, psychiatry and neuroscience; to understand the clinical methodology in neurology; to describe the initial clinical approach to the patient with neurological problems; to describe the main categories of neurological diseases and their frequency.

#### **The blueprint of the nervous system part 1: cranial nerves** (Nobile-Orazio) (2 hours)

Learning goals: to describe the symptoms due to impairment of cranial nerve; to learn the neurological examination of patients with cranial nerve impairment; to learn the main diseases causing cranial nerve impairment.

#### **The blueprint of the nervous system part 2: motor and sensory** (Nobile-Orazio) (2 hours)

Learning goals: to describe the symptoms of motor and sensory pathways impairment; to describe the clinical assessment of motor impairment; to describe the clinical assessment of sensory impairment; to describe the symptoms due to cerebellar dysfunction; to describe the symptoms due to meningeal involvement; to describe the clinical assessment of cerebellar dysfunction and meningeal involvement.

#### **"Locked-in" a small space: the brainstem** (Barajon) (6 hours)

Learning goals: to revise the macroscopic features of the brainstem; to revise the internal organization of the brainstem: tegmentum and base, position of nuclei and pathways; to revise the organization of the blood supply to the brainstem.

**Brain wiring and its dysfunction (Fesce) (2 hours)**

Learning goals: to review excitatory/inhibitory balance and the pathogenesis of seizures and epilepsy; to review genetic and environmental causes of neuronal dysfunction and neurodegenerative disorders; to review calcium overload (excitotoxicity), ROS and oxidative damage, mitochondrial derangement and mitophagy, UPR, proteasome impairment; to review non-cell-autonomous factors (microglia, astroglia, neural stem cells).

**“From activation to action”: ARAS, physiopathology of emotions and control of behavior (Fesce) (2 hours)**

Learning goals: to acquire a comprehensive perspective on the emotional and cognitive processes that contribute to regulating our cognitive and motor behavior.

This is a flipped class activity – the students will discuss this topic after having reviewed the activating reticular ascending aminergic pathways and their roles in affecting emotional and cognitive processing, the sensory-motor, motivational, learning and executive circuits that control motor and cognitive behavior.

**“Inside the battle”: cellular and molecular mechanisms in neurological diseases (Fesce) (4 hours)**

Learning goals: to identify the major cellular components involved in neurological diseases; to understand cell-specific mechanisms of neurodegeneration, inflammation, and repair; to interpret how cell–cell interactions drive disease progression; to review the etiopathogenesis of Parkinson's disease, Huntington's disease, Alzheimer's disease, Amyotrophic Lateral Sclerosis, Multiple Sclerosis.

**“Messages interrupted”: neurological syndromes (Doneddu) (4 hours)**

Learning goals: to understand transient and permanent neurological syndromes; to understand the anatomical-clinical syndromes of the brain; to understand the anatomical-clinical syndromes of the spinal cord and the peripheral nervous system.

**“Reading the electric code”: clinical neurophysiology (Doneddu) (2 hours)**

Learning goals: to learn the main neurophysiological tests (electroneurography, electromyography, electroencephalography, and evoked potentials) used for neurological diagnosis; to learn how they work, their indications, and their limitations.

**“Snapshots 1”: Introduction to Neuroimaging: basic tips on how to read a brain CT and MRI (Politi) (2 hours)**

Learning goals: to recognize the main imaging features of brain CT; to recognize the main imaging features of brain MRI.

**“Out of sync 1”: the slow and trembling patient (Parkinson's disease and parkinsonian syndromes) (Fasano) (2 hours)**

Learning goals: to recognize the clinical presentations of parkinsonian syndromes; to learn diagnostic criteria for Parkinson's disease and other parkinsonian syndromes; to review the different causes of parkinsonian syndromes; to learn how to manage a patient with Parkinson's disease.

**“Out of sync 2”: the patient with abnormal movement and incoordination (Fasano) (2 hours)**

Learning goals: to describe the different hyperkinetic movement disorders; to learn how to diagnose a patient with hyperkinetic movement disorder; to learn how to manage patients with hyperkinetic movement disorders; to describe ataxias; to learn how to diagnose a patient with cerebellar ataxia.

**“Electric storms”: the patient with acute loss of consciousness and jerking (epilepsy) (Nobile-Orazio) (2 hours)**

Learning goals: to describe the clinical presentation of a patient with acute loss of consciousness; to describe the main causes of acute loss of consciousness; to recognize the main seizure types; to learn what are the main forms and causes of epilepsy; to learn how to treat patients with epilepsy; to learn how to manage and treat patients with syncope.

Priority Presenting Problems Portfolio: Seizure, Loss of Consciousness

**“Brain blackout”: the patient with acute loss of consciousness (syncope) (Doneddu) (2 hours)**

Learning goals: to describe the clinical presentation of a patient with fainting and loss of consciousness; to describe the main causes of fainting and loss of consciousness; to learn what is the assessment of fainting and loss of consciousness; to learn how to treat patients with fainting and loss of consciousness; to learn how to manage and treat patients with fainting and loss of consciousness.

Priority Presenting Problems Portfolio: Transient Loss of Consciousness

**“The great disconnect”: the patient with persistent loss of consciousness (coma)** (Liberatore) (2 hours)

Learning goals: to describe the clinical presentation of a patient with persistent loss of consciousness; to explain the neurological mechanisms underlying coma; to differentiate between various coma states; to assess patients using standardized coma scales; to discuss clinical approaches to diagnosis and management.

**“The dreaming brain”: the patient with sleep disorders** (Absinta) (2 hours)

Learning goals: to describe the physiology of sleep and the main pathological conditions that alter the physiology of sleep; to learn how to identify these conditions based on medical history, physical examination, and second-level diagnostic tests. to learn the management and therapeutic strategies for treating sleep-related disorders; to learn how to handle these complex conditions in clinical settings.

**“Split brain”: lateralization, language physiology and aphasias** (Fesce) (2 hours)

Learning goals: to review the functions that sustain lexicon, semantics, comprehension, verbalization; to review Broca, Wernicke, conduction, transcortical motor and sensory aphasias; to review aphasias related to problems external to language areas.

**“Breaking the flow 1”: the patient with acute onset of neurological signs (stroke)** (Pensato) (2 hours)

Learning goals: to describe the different clinical presentations of a patient with stroke; to review the main stroke syndromes; to recognize transient ischemic attacks; to describe the main causes leading to stroke.

Priority Presenting Problems Portfolio: Stroke

**“Breaking the flow 2”: stroke management** (Pensato) (2 hours)

Learning goals: to describe the principal complication of stroke; to describe the prognosis of a patient with stroke; to describe the therapeutic approach to a patient with stroke; to describe the therapy in the acute phase of stroke; to describe the secondary prevention of stroke.

**“Breaking the flow 3”: Imaging and endovascular treatment of ischemic stroke** (Politi) (2 hours)

Learning goals: to learn to recognize an acute ischemic stroke on CT and MRI images; to learn timing and indication of the different neuroimaging modalities in the management of a patient with acute ischemic stroke; to gain familiarity with CT angiography; to learn to recognize normal vasculature and vessel occlusions; to understand the differences between cytotoxic and vasogenic edema; to understand the fundamentals of endovascular thrombectomy; to learn how to depict brain chronic ischemic lesions on CT and MRI.

**“Cognitive drift”: the patient with loss of memory and cognitive impairment** (Fasano) (4 hours)

Learning goals: to describe the varied clinical presentations of a patient with cognitive impairment; to learn how to investigate a patient with cognitive impairment; to learn how to distinguish age-related cognitive decay from dementia; to review the different causes of dementia; to learn how to manage a patient with dementia.

**“Drowning brain”: the patient with hydrocephalus** (Fasano, Pessina, Riva) (2 hours)

Learning goals: to describe the clinical presentation of a patient with hydrocephalus and learn the differential diagnosis with other dementia patients; to learn the diagnostic workout; to learn the surgical indications in these patients; to learn which are the main causes of hydrocephalus; to learn the different surgical approaches; to learn the clinical outcomes of surgery.

**“The clouded mind”: the patient with confusion and delirium** (Doneddu) (2 hours)

Learning goals: to describe the clinical presentation of a patient with confusion and delirium; to learn how to assess a patient with confusion and delirium; to describe the main causes of confusion and delirium; to learn how to treat patients with delirium.

Priority Presenting Problems Portfolio: Altered Mental Status, Substance Abuse

**Collaborative learning: Headache** (Barajon, Fesce, Pessina, Lalli, Fasano) (2 hours)

Learning goals: to describe the possible neuroanatomical sources of pain in the head region; to understand the role of the trigeminal ganglion and the trigeminovascular system in the pathogenesis of migraine; to learn how to treat patients with headache.

Priority Presenting Problems Portfolio: Headache

**“Wired painfully”: the patient with pain in the head (Absinta) (2 hours)**

Learning goals: to describe the clinical presentation of a patient with pain in the head; to learn what are the main causes of headache; to learn how to diagnose different types of headaches; to learn how to treat patients with headache.

**“Tight spaces”: the patient with headache and progressive neurological impairment (raised intracranial pressure) (Pessina, Riva) (2 hours)**

Learning goals: to describe the physiology and pathophysiology of the mechanisms underlying intracranial pressure (ICP) control; to learn causes of ICP alteration; to learn the clinical presentation of ICP hypertension and hypotension; to learn how to treat patients with ICP disorders.

**“Growing danger”: the patient with intracranial masses (brain tumors) (Pessina, Riva) (2 hours)**

Learning goals: to describe the pathophysiology of intracranial tumor formation and expansion; to describe the clinical presentation of a patient with brain tumor; to learn how to diagnose brain tumors; to learn how to treat patients with brain tumors.

**“Snapshots 2”: visualizing intracranial mass lesions (Politi) (2 hours)**

Learning goals: to learn how to distinguish intra- and extra-parenchymal mass lesions; to gain familiarity with imaging features of low and high-grade primary brain tumors; to learn how to identify complications arising from increased intracranial pressure; to understand the usefulness of advanced MRI techniques for tumor characterization and tumor grading; to understand the complexity of assessing brain tumor treatment response.

**“After the impact”: the patient with head trauma (Pessina, Riva) (2 hours)**

Learning goals: to describe the clinical presentation of a patient with head trauma; to describe the direct effects of head trauma; to describe the secondary effects of head trauma; to describe the neuroradiological approach to a patient with head trauma; to describe the management of a patient with head trauma; to describe the complication of head trauma. Priority Presenting Problems Portfolio: Trauma

**“Red alert”: the patient with brain hemorrhage (Pessina, Riva, Pensato) (2 hours)**

Learning: to describe the clinical presentation of a patient with different types of brain hemorrhage; to learn the diagnostic workout; to learn the surgical indications in these patients; to learn which are the main causes of brain hemorrhage; to learn the different surgical approaches; to learn the clinical outcomes of surgery of the brain hemorrhagic patients.

**“Snapshots 3”: the neuroradiology of head trauma and spontaneous intracranial hemorrhages (Politi) (2 hours)**

Learning goals: to learn how to recognize an acute intracranial hemorrhage on CT and MRI images; to learn to distinguish intraparenchymal hemorrhage from subarachnoid hemorrhage, and subdural hematoma from epidural hematoma; to understand the complication of intracranial hemorrhages and learn how to depict them; to discriminate between a skull fracture and a suture on CT images; to understand the basics of endovascular treatment options for brain aneurysms, arteriovenous malformations and dural arteriovenous fistulae.

**“The brain on fire”: the patient with relapsing neurological deficits (multiple sclerosis) (Absinta) (4 hours)**

Learning goals: to describe the clinical presentation of a young patient with relapsing neurological deficits; to describe the clinical presentation of a patient with sudden vision loss; to learn what is multiple sclerosis; learn how to diagnose multiple sclerosis and the main differential diagnosis (neuromyelitis optica spectrum disorder and MOG-associated disease); to learn how to treat patients with multiple sclerosis and mimicking disorders.

**“Intruders at the gate”: the patient with meningitis and encephalitis (Absinta) (2 hours)**

Learning goals: to learn what is meningitis and encephalitis (infectious, paraneoplastic and autoimmune); to learn how to approach patient with suspected meningitis and encephalitis; to learn how to establish the diagnosis of patient with suspected meningitis and encephalitis; to learn how to treat patients with suspected meningitis and encephalitis. Priority Presenting Problems Portfolio: Fever

**“The backbone of neurology”: the patient with spinal diseases (Pessina, Riva) (2 hours)**

Learning goals: to describe the clinical presentation of a patient with limb weakness and pain; to learn the diagnostic workout; to learn the surgical indications in these patients; to learn which are the main causes of surgery in the spine; to learn the different surgical approaches; to learn the clinical outcomes of surgery of the spine.

**“Snapshots 4”: Neuroimaging of demyelinating disorders and spine degenerative changes (Politi) (2 hours)**

Learning goals: to gain familiarity with the imaging features of the different demyelinating disorders; to understand the relevance of neuroimaging in assessing disease progression in demyelinating diseases; to gain familiarity with the imaging features of the different demyelinating disorders; to learn to recognize intervertebral disc bulging, protrusion and extrusion; to learn to depict spinal canal and neuroforaminal stenosis.

**“When motor neurons fail”: the patient with progressive muscle weakness and atrophy (motor neuron disease)**

(Doneddu)

(2 hours)

Learning goals: to describe the clinical presentations of a patient with motor neuron disease; to learn how to assess a patient with progressive muscle weakness and atrophy; to learn how to diagnose amyotrophic lateral sclerosis; to learn how to manage the patient with amyotrophic lateral sclerosis.

**“Stripped wires”: the patient with rapidly progressive palsy (polyradiculoneuritis) (Nobile-Orazio) (2 hours)**

Learning goals: to describe the clinical presentation of a patient with rapidly progressive palsy; to learn how to evaluate a patient with rapidly progressive palsy; to learn the main causes of rapidly progressive palsy; to learn how to distinguish peripheral from central rapidly progressive palsy; to learn what is acute demyelinating inflammatory polyradiculoneuritis (Guillain-Barré syndrome); to learn what is acute myelitis; to learn how to diagnose and treat Guillain-Barré syndrome.

**“Burning feet”: the patient with pain and weakness in the limbs (neuropathy) (Doneddu) (2 hours)**

Learning goals: to describe the clinical presentation of a patient with pain and weakness in the feet; to learn how to evaluate a patient with a suspected neuropathy; to learn what are the main causes of neuropathy; to learn how to distinguish the main causes of neuropathy; to learn what are the inflammatory neuropathies; to learn how to treat patients with neuropathy.

**“The final synapse”: the weak and fatigable patient (neuromuscular disorders) (Nobile-Orazio) (2 hours)**

Learning goals: to describe the clinical presentation of a patient with weakness or fatigability; to learn how to evaluate a

patient with a suspected myasthenia gravis; to learn how to diagnose and treat a patient with myasthenia gravis; to learn how to evaluate a patient with a suspected myopathy; to learn what are the main causes of myopathy; to learn how to distinguish the main causes of myopathy; to learn how to treat a patient with myopathy.

**“Muscle matters”: the patient with progressive muscle weakness (myopathies) (Liberatore) (2 hours)**

Learning goals: to learn the muscle diseases most frequently encountered in clinical practice; understand the differential diagnosis of myopathies and be familiar with the laboratory and instrumental tests necessary for diagnosis; to gain insights on therapeutic approaches.

**“Autopilot gone awry”: autonomic nervous system disorders (Pensato) (2 hours)**

Learning goals: to learn the main disorders that affect the autonomic nervous system; to learn to recognize the symptoms and signs of dysautonomia and formulate reasoned diagnostic hypotheses, choose appropriate laboratory and instrumental tests based on the clinical scenario, outlines of therapy.

**“A software bug in a normal hardware”: functional neurological disorders (Fasano) (2 hours)**

Learning goals: to define functional neurological disorders and to distinguish them from other neurological conditions; to identify and describe the common motor and sensory symptoms of functional neurological disorders, such as functional weakness, tremors, and non-epileptic attacks.

**“Now think like a neurologist”: reasoned approach to neurological symptoms, diagnostic algorithms and clinical cases**

(Doneddu, Liberatore, Pensato, Absinta, Politi) (4 hours)

Learning goals: to learn the correct approach to differential diagnosis and orientation for the most common neurological symptoms encountered in clinical practice; to learn diagnostic algorithms tailored for symptom-based diagnosis and gain skills in distinguishing and managing neurological symptoms or scenarios that necessitate timely diagnosis and treatment; to learn how to effectively address urgent neurological conditions; to appropriate choice of imaging test based on the clinical scenario and correct interpretation and clinical-instrumental correlation.

## Teaching methods

Lectures, clinical case discussions, teamwork. Lecture materials are provided to students only after the class to encourage their active participation in the clinical case-based lectures. Students are expected to acquire additional knowledge through the recommended textbooks, which will provide foundational and supplementary information essential for mastering the course.

Students are advised to consult UpToDate (<https://www.uptodate.com/>) for all the topics included in this syllabus.

### Main Textbook

- Adams & Victor's Principles of Neurology, 12th edition, by Ropper, Samuels, Klein, Prasad – McGraw-Hill Education 2023

### Suggested Textbooks

- Neuroanatomy through clinical cases by Hal Blumenfeld – Oxford University Press\_ 2021
- Learning Radiology, Recognizing the Basics, 3rd Edition, by William Herring – Elsevier 2015
- Neuroradiology: The Requisites, 4th Edition, by Rohini Nadgir, David Yousem – Elsevier 2016
- Handbook of Neurosurgery, 9th Edition, by Mark S. Greenberg – Thieme Medical Publishers 2019

## Verification of learning

The exam will assess students' knowledge of the topics covered during the course, their ability to diagnose and formulate differential diagnosis of common neurological symptoms, and their competence in conducting targeted anamneses based on clinical contexts. It will also test their ability to recognize and manage urgent neurological scenarios that threaten patient safety and require immediate attention. The exam will not solely focus on information presented in lectures via PowerPoint; students are expected to thoroughly study the lesson topics using recommended sources and textbooks and integrate this knowledge to deepen their understanding and enhance their clinical reasoning skills.

Written tests will assess the student's overall preparation and skills and will be preliminary to the final oral exam. The test will encompass 25 multiple-choice or open questions (5 each for Neurology, Neurosurgery, Neuroanatomy, Neurophysiology and Neuroimaging). Each correct answer will be assigned one point. The threshold for passing the test is  $\geq 60\%$  of correct answers in each module (at least 3/5 in the other modules). To access the oral exam, one (only one) of these sub-thresholds may be failed by 1 question.

The oral exam will consist of three main components: (1) localization of neurological symptoms; (2) discussion of a neurological disease, including its key pathological, clinical, diagnostic, and therapeutic features (e.g., motor neuron disease); (3) analysis of a neurological clinical case. The oral exam will adjust the written exam grade by a range of 3 to +8, depending on its outcome.