Dépt des neurosciences cliniques
Bâtiment hospitalier
Rue du Bugnon 46
CH-1011 Lausanne

Laboratoire de Recherche en Neuro-Imagerie

Clinical neuroscience course:

The human brain in health and disease

The course will provide a comprehensive overview over the most common brain disorders including all relevant diagnostic, therapeutic and prognostic characteristics to then make the link with ongoing research in the field – both locally and beyond. Students will also benefit from participation in the clinical case presentations at the neurology service of the CHUV on Wednesday mornings. Upon successful completion of the course, students will have developed a broad knowledge about the pathophysiology underlying most common brain disorders and the affected anatomical circuitry. In particular they will:

- Have a good basic knowledge of brain anatomy / function and corresponding characteristic changes in neurological diseases.
- Be aware of the major recent developments in research in the area of clinical reserach.

Proposed schedule (6x4h= 2 ECTS; to be discussed): Wednesday mornings

Topic 1: Introduction to Neuroanatomy and Physiology (B. Draganski)

Topic 2: Paroxysmal brain disorders – stroke and epilepsy (L.Hirt & J. Novy)

Topic 3: Chronic brain disorders – neurodegenerative and movement disorders (O. Rouaud & B. Draganski)

Topic 4: Disorders of consciousness and sleep (F. Siclari & M. De Lucia)

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Topic 5: Pain perception, pain sensation and brain ageing from the gender perspective (C. Berna-Renella & AM de Lange)

Topic 6: The Immune System & the Brain – neuroinflammation & neurooncology (C. Pot & A. Hottinger)

Topic 1: Introduction to Neuroanatomy and Physiology

Content Summary

Neuroanatomy (NA) The cortex; Basal ganglia; Vasculature
Physiology & Function (PF) CNS physiology; Functional systems

Learning Outcomes

Neuroanatomy (N)

At the end of this module students will be able to identify the important anatomic structures of the brain and its vascular supply. The students should gain anatomical knowledge of the neural systems subserving different functions.

Physiology & Function (PF)

At the end of this module students will be able to understand the physiology of the CNS and the fundamentals of brain's functional systems.

Topic 2: Paroxysmal brain disorders – stroke and epilepsy

Content Summary

Pathophysiology (PA) Pathophysiology of ischemic/haemorrhagic stroke and epilepsy; small vessel disease, arteriosclerosis, electrical activity of cortex and subcortical structures

Brain diseases (BD) Stroke, Small vessel disease; Treatment of ischaemic & haemorrhagic stroke; Epilepsy - clinical presentation and diagnostic, pharmacological and surgical treatment

Learning Outcomes

Neuroanatomy & function (NA&F)

Brief recapitulation on basic principles of brain anatomy and function emphasizing on the particular topic of interest.

Pathophysiology (PA)

Focusing on small/medium vessel pathology the students will understand the main causes of ischaemic and haemorrhagic stroke in adults and be able to differentiate between ischaemic and haemorrhagic stroke and their relative frequency. They will also be familiar with the time course of the radiological appearance of ischaemic stroke on MRI with particular emphasis on diffusion weighted MRI. They will have an understanding of the mechanisms, epidemiology & prevention, and treatment of stroke, and have had an introduction to neurological rehabilitation and neurological outcome measurement.

Similarly, we will present and discuss different forms of primary and secondary causes for epilepsy, putting an emphasis on the link between seizure semiology and anatomical localization of potential

epileptogenic focus. The students will get insight into well-established and novel methods for diagnosis and treatment of epileptic disorders with focus on pharmacology.

Brain diseases (BD)

After the lecture the students should be able to name epileptogenic and vascular pathology processes that commonly involve the brain (ischaemia, haemorrhage) and be familiar with the clinical syndromes caused by lesions in particular locations. Students will be able to describe and explain the clinical presentation of paroxysmal acute brain disorders in terms of function disruption within the nervous system.

Topic 3: Chronic brain disorders – neurodegenerative and movement disorders

Content Summary

Pathology (PA) Cognitive decline – differentiation between "healthy ageing" and pathological conditions with progressive loss of cognitive abilities

Movement disorders - clinical presentation and diagnostic, pharmacological and surgical treatment; Motor control

Brain Disorders (BD) Subjective, minor and major cognitive impairment – differential diagnosis and potentially treatable conditions; Memory system; Alzheimer's disease; Amyloid cascade hypothesis; Multisystem Atrophy (MSA), Progressive Supranuclear Palsy (PSP), and Fronto-Temporal Lobar Degeneration (FTLD)

Parkinson's disease, Tourette's syndrome, Huntington's disease

Learning Outcomes

Neuroanatomy & function (NA&F)

Brief recapitulation on basic principles of brain anatomy and function emphasizing on the motor system and networks supporting episodic memory.

Pathology (PA)

At the end of the module students will have been introduced to the motor system, and motor control theories; the use of MRI and PET/SPECT, for assessment of motor function and an understanding of the physiology & functional organization of the basal ganglia, the neuropathological basis of movement disorders, the pathogenesis and treatment of Parkinson's disease, akinetic-rigid syndromes and choreiform disorders. Finally, the students will be able to differentiate and explain the root cause for

variable clinical patterns and temporal evolution of pathological processes within the sensorimotor system.

The main aim of this module is to differentiate between processes governing cognitive decline in "healthy ageing" from progressive loss of cognitive abilities due to neurodegeneration. Here, we put emphasis on diagnostic and ethical aspects of cognitive impairment and current developments for biomarkers-based diagnosis and innovative treatment. The students will be able to demonstrate an understanding of the cellular mechanisms in predominantly affected brain regions in Alzheimer's Disease (AD), Multisystem Atrophy (MSA), Motor Neuron Disease (MND) Progressive Supranuclear Palsy (PSP), and Fronto-Temporal Lobar Degeneration (FTLD). They will also become familiar with the age of onset and long-term prognosis for each of the above diseases.

Brain Disorders (BD)

At the end of this presentation the students will have acquired knowledge about the circuitry affected in motor disorders and in cognitive decline on the exemplary basis of Parkinson's disease, Huntington's disease, Tourette's syndrome and Alzheimer's disease.

After this topic students will acquire knowledge about the link between neuroimaging biomarkers of neurodegeneration and age- or disease- related cognitive decline. They will learn about the impact of amyloid burden, white matter hyper-intensities and local brain atrophy on cognition, particularly on episodic and working memory – most vulnerable domains in "normal ageing" and Alzheimer's disease. Finally, students will be able to challenge the concept of cognitive reserve in "supernormal ageing" by evidence for preservation of neurochemical, structural and functional brain integrity in old age rather than recruitment of "reserves" for maintaining cognitive abilities.

Topic 4: Disorders of consciousness and sleep

Content Summary

Brain anatomy and Function (PA) The arousal system; interaction between body and brain – interoceptive system; sleep and dreams

Brain Disorders (BD) Sleep, pathological sleep conditions, coma

Learning Outcomes

Neuroanatomy & physiology (N&PF)

Brief recapitulation on basic principles of brain anatomy and function emphasizing on the brain's arousal system and networks supporting consciousness, dreaming and interoception.

Brain Disorders (BD)

At the end of the module students will also have an understanding of physiological and pathophysiological processes related to consciousness, sleep and dreaming. They should be able to describe the corresponding networks both in terms of anatomical location and function.

Focusing on pathology within the arousal system the student will gain familiarity with the clinical forms of loss of consciousness, pathological sleep and should be able to name a number of anatomical/ electro-physiological findings encountered in patient with coma. At the end of the module the students will have an understanding of disorders of consciousness and sleep focusing on their pathophysiology and treatment.

Interoception (PL)

At the end of this presentation students will have acquired knowledge about current concepts of functional organisation of the brain's arousal system in health and disease supported by empirical studies. They will be able to grasp recent evidence for conscious and subconscious interoceptive perception in the human brain. Novel ideas about treatment of dysfunction in these systems will be debated.

Topic 5: Pain perception, pain sensation and brain ageing from the gender perspective

Content Summary

Pathology (PA) Different forms of pain perception, endogenous opioid system, placebo effects Neuroscience and gender; epidemiology of brain disorders from the gender perspective

Brain disorders (BD) Chronic Pain and related conditions; pharmacological and non-pharmacological treatment of pain

Learning Outcomes

Neuroanatomy & function (NA&F)

Brief recapitulation on basic principles of brain anatomy and function emphasizing on the particular topic of interest.

Pathology (PA)

Students will be able to understand the anatomy and function of the neural networks for pain perception and the endogenous opioid system. They will also have an understanding of cognitive processes including pain perception, chronicity of pain and their impact on mood and cognition.
Along another line of research, the students will be confronted with the gender bias existing in neuroscience with implication on our understanding of women's brain in health and disease.

Therapy (Th)

The students will get familiarised with pharmacological and non-pharmacological treatment options in acute and chronic pain. We will present relevant data about the cognitive bias on pain perception and

the importance of cognitive health to counteract chronic pain. The students will be confronted with the concept of maladaptive plasticity in the case of chronic pain.

On the example of cardio-vascular health the students will get an overview on gender-specific risk factors related to brain ageing. There will be a discussion around hormonal changes across the lifespan and potential link to brain disorders.

Topic 6: The Immune System & the Brain

Content Summary

Pathology (PA) Demyelination; White matter lesions; Multiple Sclerosis

Brain tumours

Brain Disorders (BD) Immuno-modulatory treatment, personalised medicine in neuro-oncology

Learning Outcomes

Neuroanatomy & physiology (N&PF)

Brief recapitulation on basic principles of brain anatomy and function emphasizing on the particular topic of interest.

Pathology (PA)

At the end of this module students will be familiar with the clinical forms of multiple sclerosis (MS) and typical imaging appearance (McDonald criteria). They will be able to identify infectious and immunological factors that can cause MS. At the end of this module students will be able to understand the role of diagnostic and therapy for assessment of cognitive and motor decline in MS.

We will provide a comprehensive overview on the most common primary malignancies affecting the brain. Students will learn the role of diagnostic means (neuroimaging, genetics, biopsy etc) for personalised medicine in the case of primary brain tumours.

Therapy (Th)

At the end of this topic students will have acquired knowledge about current concepts of the interaction between chronic inflammation and neurodegeneration in MS supported by neuroimaging studies.

They will be able to discuss controversial aspects of immuno-modulatory treatment in MS and its impact on function recovery as assessed by sophisticated MRI techniques.

Along the same lines, the students will learn about novel non-invasive pharmacological and non-pharmacological treatment options in neuro-oncology.