MASTER BIOLOGIE SANTE option **BIOLOGIE** **S2**

TITRE DE L'ENSEIGNEMENT A CHOIX :

EC5. HUMAN NEUROSCIENCE IN HEALTH AND PATHOLOGY

UE 2.2 - APPROCHES TRANSLATIONNELLES DES PATHOLOGIES

BCC2 : Intégrer les avancées récentes en biologie-santé dans un ou plusieurs domaines de spécialité pour interpréter des données et développer son expertise.

Enseignement **Choix**
Modalité d'enseignement : **Présentiel**
Langue de l'enseignement : Anglais

Responsables de l'enseignement :
. Henrique SEQUEIRA et Julien CHAPUIS,
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volume horaire	CM	C-TD	TD	TP	A distance	Total
Heures d'enseignement encadrées	**18**		**18**			**36**

Required background and competencies:

Theoretical and practical knowledge and skills acquired during the general Biology degree course:

- Genetic and cellular mechanisms
- Neurochemical and anatomical bases of the nervous system
- Functional bases of ageing, cognition and emotion functions
- Experimental behavioral analysis of normal and pathological behaviors
- Global knowledge of computational models of behavior and mental functions

In addition:

- Analysis and integration of recent scientific papers
- Oral expression skills to discuss inside the class innovative data and strategies
- Interest in physiopathological, electromagnetic and behavioral procedures and techniques to remediate brain pathologies.

Syllabus :

Abstract:

For some years now, neurological and psychiatric diseases have played a central role in public health issues. Moreover, with the general ageing of the population, it has become urgent to gain a better understanding of the major pathologies of cerebral neurodegeneration. With a view to identifying and remedying the pathophysiological mechanisms of these pathologies, this course takes a three-pronged approach: molecular and cellular, neurobehavioral and computational.

Aims:

This teaching unit (TU) offers a specific training allowing to understand physiopathological mechanisms and cognitive and affective functions that may be associated with the major pathologies of cerebral neurodegeneration such as Alzheimer's and Parkinson's diseases. The acquisition of this knowledge will follow a three-stage learning dynamic: 1/analysis of mechanisms at the cellular and sub-cellular levels, 2/ an integrated analysis of the brain networks involved in cognitive and affective processes, 3/ then an evaluation of neuromorphic models aimed at future neuronal prostheses.

Description:

Theoretical and methodological training will bring qualified information about genetics, cellular and sub-cellular models, cerebral networks and next generation neural protheses. Data obtained in human and non-human animals, from brain lesions, and from neurodevelopmental and neurodegenerative states, will be analyzed in order to understand functional models of psychiatric, neurological and behavioral disorders (dementia, Parkinson's disease, epilepsy, multiple sclerosis, clinical depression, anxiety and autism).

Teaching will be organized as follows:

1/ Courses (18 h)

- ***Basic mechanisms of neurodegeneration***

. From genetic to physiopathology of neurodegenerative diseases (1.5 h)
. Amyloid and tauopathy in Alzheimer's disease (AD) (1.5 h)
. Synucleinopathy in Parkinson's disease (PD) (1.5 h)

- ***Models for studying neurodegenerative diseases***

. Mammalian models for AD and PD (1.5 h)
. Non-mammalian models for AD and PD (1.5 h)
. Cellular models for AD and PD (1.5 h)

- ***Integrated processes: from cognition and emotion to behaviour***

. Behavioral analyses: theory and applications (1.5 h)
. Neurodynamics of Cognition (1.5 h)
. Cerebral Networks of Emotion (1.5 h)
. Neurofunctional Bases of Memory (1.5 h)

- ***Artificial neuronal networks and perspectives for pathology***

. Advanced neuromorphic technologies (1.5 h)
. Towards next- generation neural protheses (1.5 h)

2/ **Tutorials (18 h)**: experimental or clinical papers, experimental figures or other kind of exercises related to main topics, to be presented by students, and being discussed under the professor supervision:

- **Tutorials related to neurodegeneration and neurodegenerative diseases**
- From genetic to physiopathology of neurodegenerative diseases (1.5 h)
- Amyloid and tauopathy in Alzheimer's disease (AD) (1.5 h)
- Synucleinopathy in Parkinson's disease (PD) (1.5 h)
- Mammalian models for AD and PD (1.5 h)
- Non-mammalian models for AD and PD (1.5 h)
- Cellular models for AD and PD (1.5 h)
- **Tutorials related to cerebral processes, artificial neuronal networks and pathology**
- Electromagnetic Coding of Mental Activity (1.5 h)
- Emotional Regulation: Neural Basis and Applications (1.5 h)
- Virtual Reality and Emotional Exploration (1.5 h)
- Building material/hardware-based artificial neurons from living neurons (1.5 h)
- Closed-loop Deep Brain Stimulation (1.5 h)
- Challenges and ethics of AI-enhanced Implantable Medical Devices (1.5 h)

Compétences travaillées :

Skills to be acquired:

This UT will give to students broad and pragmatic competences needed for future work on mental and behavioral remediation activities; competences will be related to: **1**/Pharmacological and neurocognitive (e.g. deep neurostimulation, transcranial magnetic stimulation, neurofeedback, electromagnetic recordings) techniques; **2**/affectivo-behavioral therapies (biofeedback. cognitive and affective bias remediation).

This UT also helps to provide the skills needed to contribute to a research activity in Biology-Health, by preparing students to: **1**/identify the challenges of research in Biology-Health; **2**/organise a bibliographic survey of international scientific literature; **3**/exploit theoretical knowledge by understanding and interpret results from the main experimental models; **4**/ master the formal knowledge of the fundamental mechanisms of neurodegenerative diseases; **5**/understand the main therapeutic strategies currently being developed.

Modalités d'évaluation

Knowledge assessment:

A final written examination (duration: 2 h; this corresponds to **70 %** of final required scores) and an intermediate examination corresponding to an individual or in pairs presentation of a scientific paper, experimental figures, or *ad hoc* exercises during a specific Tutorial (this corresponds to **30 %** of final required scores).

Descriptifs des enseignements

Intitulé de l'enseignement	Nature : CM / CM-TD/ TD / TP	Nom de l'enseignant	Volume Horaire (heure)
From genetic to physiopathology of neurodegenerative diseases	CM	*Julien Chapuis*	*1.5*
Amyloid and tauopathy in Alzheimer's disease	CM	*Julien Chapuis*	*1.5*
Cellular models	CM	*Julien Chapuis*	*1.5*
From genetic to physiopathology of neurodegenerative …	TD	*Julien Chapuis*	*1.5*
Amyloid and tauopathy in Alzheimer's disease	TD	*Julien Chapuis*	*1.5*
Cellular models for AD and PD	TD	*Julien Chapuis*	*1.5*
Synucleinopathy in Parkinson's disease	CM	Jean-Marc Taymans	1.5
Synucleinopathy in Parkinson's disease	TD	Jean-Marc Taymans	1.5
Mammalian models for AD and PD	CM	Sophie Halliez	1.5
Mammalian models for AD and PD	TD	Sophie Halliez	1.5
Non-mammalian models for AD and PD	CM	Pierre Dourlen	1.5
Non-mammalian models for AD and PD	TD	Pierre Dourlen	1.5
Behavioral analyses: theory and applications	TD	Laurent de Doncker	1.5
Virtual Reality and Emotional Exploration	TD	Laurent de Doncker	1.5
Electromagnetic Coding of Mental Activity	CM	Henrique Sequeira	1.5
Cerebral Networks od Emotion	CM	Henrique Sequeira	1.5
Neurodynamics of Cognition	CM	Henrique Sequeira	1.5
Emotional Regulation: Neural Bais and Applications	TD	Henrique Sequeira	1.5
Neurofunctional Bases of Memory	CM	Christel Van Besien	1.5
Advanced neuromorphic technologies	CM	Christel Van Besien	1.5
Towards next- generation neural protheses	CM	Christel Van Besien	1.5
Building material/hardware-based artificial neurons …	TD	Christel Van Besien	1.5
Closed-loop Deep Brain Stimulation	TD	Christel Van Besien	1.5
Challenges and ethics of AI-enhanced Implantable Medical …	TD	Christel Van Besien	1.5
Volume Horaire CM (Total)			**18 h**
Volume Horaire TD (Total)			**18 h**
Volume Horaire TP (Total)			**0 h**