Testi del Syllabus

Resp. Did.	**FORNASIERO EUGENIO**	**Matricola: 040787**

Docenti	**CELLOT GIADA, 2 CFU** **FORNASIERO EUGENIO, 5 CFU**
Anno offerta:	**2023/2024**
Insegnamento:	**973SV - INTEGRATIVE NEUROPHYSIOLOGY**
Corso di studio:	**SM75 - NEUROSCIENCE**
Anno regolamento:	**2023**
CFU:	**7**
Settore:	**BIO/09**
Tipo Attività:	**B - Caratterizzante**
Anno corso:	**1**
Periodo:	**Secondo Semestre**
Sede:	**TRIESTE**

Testi in italiano

Lingua insegnamento	English
Contenuti (Dipl.Sup.)	The course consists of two modules led by two faculty members, Dr. Fornasiero and Dr. Cellot, which are interdependent. Its objective is to provide an up-to-date overview of the integration of neuronal activity in various neural systems of mammals and vertebrates. The course will explore a range of integrative processes starting from fundamental neurophysiological functions of basic neuronal networks, and progressing to advanced topics like sensorimotor integration and movement production. Key topics to be covered include: Part 1 (Fornasiero): membrane biophysics and cell excitability; membrane properties; neuronal channel functions; EEG and brain waves generation; oscillatory mechanisms; thalamo-cortical rhythms, different EEG waves; general organization of the spinal cord and spinal reflexes; brainstem reflexes; function of the superior colliculus; coding of sensory information; physiological basis of perception; general organization of the cerebral cortex; primary and associative areas; function and organization of motor systems. Part 2 (Cellot); Long term plasticity (LTP): from Hebb's postulate to electrophysiological and behavioral evidence; NMDA receptor- dependent LTP; spike timing dependent plasticity; anti-Hebbian LTP; Depolarizing GABA in early development and its implication for synaptic plasticity; functional implications of hippocampal synaptic plasticity: memory and learning; plastic changes in the amygdala circuitry; an example of associative learning: the fear conditioning paradigm; cellular mechanism underlying fear extinction; zebrafish as alternative model to study synaptic plasticity in whole organism.
Testi di riferimento	Kandel, Principles of Neuronal Science, Mc Graw-Hill Other reviews and papers: doi: 10.1515/nf-2017-A059 – doi: 10.1101/lm.045690.117. - doi:10.1113/jphysiol.2007.148064 - doi:10.1038/nrn2207- doi:10.1101/lm.30901 - doi: 10.3389/fnana.2022.837527 -

	/nrn3945 Other didactical material could be provided.
Obiettivi formativi	The course aims to ensure that students achieve the following learning outcomes: 1) Knowledge and Understanding: Students will gain a comprehensive understanding of the basic principles of neuronal integration at different levels of the central nervous system. This includes the integrative processes performed by neuronal membranes, neuronal networks, sensorimotor integration (such as reflexes and voluntary movement), and contemporary approaches to the study of brain activity. 2) Application of Knowledge and Understanding: Students will acquire the theoretical foundation to understand the basic procedures involved in extracting sophisticated biological information from the living brain. 3) Judgment: Students will develop a correct understanding of how the nervous system functions, with particular emphasis on the basic processes of integration at the cellular and systemic levels. 4) Communication Skills: Students will become adept at presenting concepts in a stimulating and interactive classroom setting. They will be encouraged to maintain scientific rigor in their communication with peers and the general public. Emphasis is placed on expressing ideas in clear and concise language. 5) Study Skills: By the end of the course, students will have the knowledge and critical reading skills necessary for independent learning. They will be able to adapt to new knowledge and technologies in the field of integrative processes in the brain.
Prerequisiti	Knowledge of fundamental cell biology and cell physiology.
Metodi didattici	Lectures and integrative teaching seminars.
Altre informazioni	Any change to the methods described, will be communicated on the web sites of the Department and of the Study Program or provided by the faculty at the beginning of the course.
Modalità di verifica dell'apprendimento	Both modules will utilize written assessments, which may consist of multiple-choice (true or false) questions or open-ended written questions with concise answers. The grading system will span from 18/30 to 30/30 cum laude. To successfully pass the exam, students are required to demonstrate a satisfactory comprehension of all the topics covered in the course. Additional information regarding the exam format will be provided by the faculty at the commencement of the course.
Programma esteso	The course consists of two modules led by Dr. Fornasiero and Dr. Cellot, which are interdependent. Part 1 (Fornasiero): 1. Fundamentals in integrative neurophysiology: - Introduction to neurophysiology and its principles 2. Neuronal anatomy and physiology: - Types of neurons - Basic neuroanatomical aspects - Membrane biophysics and cell excitability mechanisms 3. Neural networks and systems: - Rules governing small network behavior - Behavior in simple and complex systems 4. Motor control and reflexes: - Neuronal control of muscles - Proprioception and spinal reflexes - Monosynaptic reflexes - General organization of the spinal cord - Locomotion - Vestibular apparatus and vestibular reflexes 5. Sensory systems: - Overview of sensory modalities and receptors - Sensory transduction - Cutaneous mechanoceptors - Receptive field and coding of stimulus intensity and duration - Tactile acuity - Lemniscal and spino-thalamic pathways - Primary sensory area and coding of stimulus location and modality - Basic anatomy of the eye and structure of the retina - Visual processing, visual hypercolumns, and visual impairment

	6. Cerebral cortex: - Functional subdivisions and Brodmann's areas - Cortical columns and maturation of the cerebral cortex - Cortical plasticity and primary/association areas 7. Voluntary movement and motor systems: - Types of movement and their control - Motor equivalence - Overall organization of motor systems - Pyramidal tract and primary motor cortex - Premotor areas and working memory - Functional streams, action, and perception - Timing for motor production 8. Electroencephalography (EEG): - EEG basics - Brain wave generation and underlying neuronal mechanisms - Oscillatory mechanisms and thalamo-cortical rhythms - Different wave types - EEG and sleep 9. Basal ganglia and cerebellum: - Relationship of basal ganglia with the cerebral cortex - Direct and indirect pathways - Disorders of the basal ganglia - Functional organization of the cerebellum - Input and output pathways - Disorders of the cerebellum 10. Pain and emotions: - Peripheral mechanisms of pain - Central pain pathways and cortical localization - Central control of pain - Mirror neurons - Emotions and decision-making Part 2 (Cellot): The focus of these lectures is to explore the long-term plasticity (LTP), from the theory (Hebb's postulate) to the experimental strategies that can be used for its investigation, including electrophysiology and behavioral analysis. In detail, some forms of plasticity will be described: the NMDA receptor- dependent LTP (with its properties and mechanisms: input specificity, associativity and cooperativity), the spike timing dependent plasticity and the anti-Hebbian LTP. Depolarizing GABA in early development and its implication for synaptic plasticity will be described. The functional implications of hippocampal synaptic plasticity, that are memory and learning, will be presented. The second part of the lectures will focus on the amygdala, the brain structure involved in emotion processing. Plastic changes in the amygdala circuitry are the neuronal substrate for an example of associative learning, that is the fear conditioning. The cellular mechanisms underlying fear extinction will be explored. Different behavioral/optogenetic tools used for modelling fear and anxiety responses will be presented. Finally, zebrafish will be introduced as alternative model for studies of integrated neurophysiology, with a focus on investigating synaptic plasticity in a whole organism.
Obiettivi Agenda 2030 per lo sviluppo sostenibile	This course explores topics closely related to one or more goals of the United Nations 2030 Agenda for Sustainable Development (SDGs). Specifically, N.3 Health and wellbeing N.4 Education of quality

Obiettivi per lo sviluppo sostenibile

Codice	Descrizione
3	Salute e benessere
4	Istruzione di qualità

Testi in inglese

	English
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	and progressing to advanced topics like sensorimotor integration and movement production. Key topics to be covered include: Part 1 (Fornasiero): membrane biophysics and cell excitability; membrane properties; neuronal channel functions; EEG and brain waves generation; oscillatory mechanisms; thalamo-cortical rhythms, different EEG waves; general organization of the spinal cord and spinal reflexes; brainstem reflexes; function of the superior colliculus; coding of sensory information; physiological basis of perception; general organization of the cerebral cortex; primary and associative areas; function and organization of motor systems. Part 2 (Cellot); Long term plasticity (LTP): from Hebb's postulate to electrophysiological and behavioral evidence; NMDA receptor- dependent LTP; spike timing dependent plasticity; anti-Hebbian LTP; Depolarizing GABA in early development and its implication for synaptic plasticity; functional implications of hippocampal synaptic plasticity: memory and learning; plastic changes in the amygdala circuitry; an example of associative learning: the fear conditioning paradigm; cellular mechanism underlying fear extinction; zebrafish as alternative model to study synaptic plasticity in whole organism.
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	Lectures and integrative teaching seminars.
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satisfactory comprehension of all the topics covered in the course. Additional information regarding the exam format will be provided by the faculty at the commencement of the course.

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N.3 Health and wellbeing
N.4 Education of quality

Obiettivi per lo sviluppo sostenibile

Codice	Descrizione
3	Good health and well-being
4	Quality education