Testi del Syllabus

Resp. Did.	**BATTAGLINI PIERO PAOLO**	**Matricola: 003861**

Docenti	**BALLERINI LAURA, 2 CFU** **BATTAGLINI PIERO PAOLO, 3 CFU** **TORRE VINCENT, 2 CFU**

Anno offerta:	**2017/2018**
Insegnamento:	**898SM - NEUROFISIOLOGIA INTEGRATIVA**
Corso di studio:	**SM54 - NEUROSCIENZE**
Anno regolamento:	**2017**
CFU:	**7**
Settore:	**BIO/09**
Tipo Attività:	**B - Caratterizzante**
Anno corso:	**1**
Periodo:	**Secondo Semestre**
Sede:	**TRIESTE**

Testi in italiano

Lingua insegnamento	Inglese
Contenuti (Dipl.Sup.)	Overview. The course is aimed at providing wide information on different, but fundamental, aspects of neuronal integration at several levels in the central nervous system. Different aspects will be presented, from the integrative processes which are carried on by neuronal membranes to neuronal networks, main aspect of sensory-motor integration, such as reflex and voluntary movement, till to the more actual approaches to study the activity of the living brain. The course is organized in three independent modules, given by three different teachers, each of them expert in the particular topic. Part 1 (Prof. Torre): In this series of lectures, new experimental methods useful for integrative neurophysiology are reviewed. Particular emphasis is dedicated to imaging and the physical mechanisms of image acquisition in CCD cameras are examined. We then discuss a variety of optical dyes useful for imaging network properties and cellular functions: voltage sensitive dyes, calcium dyes. New approaches based on advanced microscopy as optical tweezers and atomic force microscopy are also illustrated and discussed. Part 2 (Prof.ssa Ballerini): The main aim of these lectures is to provide fundamentals in membrane biophysics and in the mechanisms characterizing cell excitability; to translate single cell knowledge towards rules governing small networks behavior in more complex systems. The focus will be on brain waves generation and neuronal mechanisms sustaining such activities: from neuronal membrane to neuronal networks The course will provide a sound basis of membrane biophysics and synaptic transmission to allow an analysis of more complex systems which involve the organization of neural networks. Oscillatory mechanisms: cellular and network analysis of oscillatory neural systems. Thalamo-cortical rhythms, spindle waves and delta waves, contribution of thalamic neuron properties and circuits. Recent published experimental

	evidences will be presented within the framework of theoretical concepts sustaining brain waves mechanisms. At a cellular level experimental evidence supporting the role of particular membrane properties, such as voltage dependent ion channels, or synaptic properties, such as microcircuit organization enabling oscillating activities in cortical networks reflected in EEG activities will be addressed and presented. Part 3 (Prof. Battaglini): Spinal reflexes: monosynaptic, disynaptic and polysynaptic reflexes, H reflex. Brainstem reflexes: vestibular reflexes, optocinetic nystagmus, orienting reflex, stability of visual perception. Somaesthesia: sensory transduction, cutaneous mechanoceptors, receptive field, coding of stimulus intensity and duration, tactile acuity, lemniscal and spino-thalamic pathways, primary sensory area, coding of stimulus location and modality. Cerebral cortex: functional subdivisions, Brodman's areas, cortical columns, maturation of the cerebral cortex, cortical plasticity, primary areas, association areas. Voluntary movement: kinds of movement and their control, pyramidal tract, primary motor cortex, premotor areas, functional streams. Basal ganglia and cerebellum: relation of basal ganglia with the cerebral cortex, direct and indirect pathways, functional organization of the cerebellum, input and output pathways.
Testi di riferimento	Kandel, Principles of Neuronal Science, Mc Graw-Hill Hille "Ionic channels of excitable membranes" Sinauer ass.editors [second or third edition]. In particular from chapter 1 to 5. Other reviews and papers: Annu. Rev. Neurosci. 1997. 20:185–215. J. Physiol. 1995;483;641-663. J. Physiol. 1993;468;669-691. J. Physiol. 1990;431;291-318 Physiol Rev 89: 847–885, 2009; Neuron, Vol. 20, 553–563, March, 1998. Neuron, Vol. 21, 9–12, July, 1998. Annu Rev. Phyiol. 1996 58:299-327. PNAS 2004 vol. 101 no. 52 18195–18199. The Journal of Neuroscience, 1993, 13(8): 3284-3299. Cell Calcium 40 (2006) 97–114. Trends in Neurosciences, 2013, Vol. 36, No. 12 pp 738. Additional Selected scientific papers or other didactical material could be provided. The presentation of the lectures and a collection of papers are provided
Obiettivi formativi	As stated in the overview of the contents of the course, students will learn different, but fundamental, aspects of neuronal integration at several levels of the central nervous system. These will comprise different aspects, from the integrative processes which are carried on by neuronal membranes to neuronal networks, main aspect of sensory-motor integration, such as reflex and voluntary movement, till to the more actual approaches to study the activity of the living brain.
Prerequisiti	Basic knowledge of physics, chemistry and elementary mathematics. Good knowledge of neuroanatomy Knowledge in cell physiology Good knowledge of basic neurobiology
Metodi didattici	Lectures
Modalità di verifica dell'apprendimento	Students are required to take a final written examination (parts 1 and 2) and an oral one (part 3). The written examination consists in a multiple choices test (true/false) and 2 open questions on the topic of the courses. The oral examination consists in a discussion of 20-30 min, during which the student is invited to describe and comment on topics covered in the course.
Programma esteso	Overview. The course is organized in three independent modules, given by three different teachers, each of them expert in the particular topic. The program is aimed at providing wide information on fundamental aspects of neuronal integration at several levels in the central nervous system, from the integrative processes which are carried on by neuronal membranes to neuronal networks, to sensory-motor integration and movement production, till to the more actual approaches to study the activity of the living brain Part 1: (prof. Torre). Basic properties of Imaging: spatial and temporal resolution. Number of pixels in a CCD camera and physical properties of pixels in high performance CCD cameras. A/D processing at 8, 12 and 16 bits and its implication for the detection of fluorescence signals (DF/F).

Acquisition rates for different biological phenomena.
Basic properties of optical trapping and manipulation. Introduction to Mechanobiology: forces exerted by filopodia, lamellipodia and neurons. Introduction to mechanosensitivity of cells and neurons.

Part 2: (prof. Ballerini). The main aim of these Lectures is to provide fundamentals in membrane biophysics and in the mechanisms characterizing cell excitability; to translate single cell knowledge towards rules governing small networks behavior in more complex systems. The focus will be on brain waves generation and neuronal mechanisms sustaining such activities, from neuronal membrane to neuronal networks. Oscillatory mechanisms: cellular and network analysis of oscillatory neural systems. Thalamo-cortical rhythms, spindle waves and delta waves, contribution of thalamic neuron properties and circuits. Recent published experimental evidences will be presented within the framework of theoretical concepts sustaining brain waves mechanisms. At a cellular level experimental evidence supporting the role of particular membrane properties, such as voltage dependent ion channels, or synaptic properties, such as microcircuit organization enabling oscillating activities in cortical networks reflected in EEG activities will be addressed and presented. In particular the following systems will be addressed: Oscillatory mechanisms: cellular and synaptic contributions (network driven rhythmicity vs pacemaker driven one). Voltage dependent ion channels: calcium channels (HVA and LVA) with particular attention to It; IKCa; ICAN; Ih; IIR; IAHP (BK and SK) and others Thalamo-cortical rhythm.
Part 3: (prof. Battaglini). Spinal reflexes: monosynaptic reflex and general organization of the spinal cord. Brainstem reflexes: vestibular reflexes, orienting reflex. Stability of visual perception. Somaesthesia: overview of sensory modalities and receptors, sensory transduction, cutaneous mechanoceptors, receptive field, coding of stimulus intensity and duration, tactile acuity, lemniscal and spino-thalamic pathways; primary sensory area, coding of stimulus location and modality. Cerebral cortex: functional subdivisions, Brodman’s areas, cortical columns, maturation of the cerebral cortex, cortical plasticity, primary and association areas. Voluntary movement: kinds of movement and their control, motor equivalence, overall organization of the motor systems, pyramidal tract, primary motor cortex, premotor areas, working memory, mirror neurons, functional streams, action and perception, timing for motor production. Basal ganglia and cerebellum: relation 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.

Testi in inglese

English

Overview.
The course is aimed at providing wide information on different, but fundamental, aspects of neuronal integration at several levels in the central nervous system. Different aspects will be presented, from the integrative processes which are carried on by neuronal membranes to neuronal networks, main aspect of sensory-motor integration, such as reflex and voluntary movement, till to the more actual approaches to study the activity of the living brain. The course is organized in three independent modules, given by three different teachers, each of them expert in the particular topic.
Part 1 (Prof. Torre): In this series of lectures, new experimental methods useful for integrative neurophysiology are reviewed. Particular emphasis is dedicated to imaging and the physical mechanisms of image acquisition in CCD cameras are examined. We then discuss a variety of optical dyes useful for imaging network properties and cellular functions:

	voltage sensitive dyes, calcium dyes. New approaches based on advanced microscopy as optical tweezers and atomic force microscopy are also illustrated and discussed. Part 2 (Prof.ssa Ballerini): The main aim of these lectures is to provide fundamentals in membrane biophysics and in the mechanisms characterizing cell excitability; to translate single cell knowledge towards rules governing small networks behavior in more complex systems. The focus will be on brain waves generation and neuronal mechanisms sustaining such activities: from neuronal membrane to neuronal networks The course will provide a sound basis of membrane biophysics and synaptic transmission to allow an analysis of more complex systems which involve the organization of neural networks. Oscillatory mechanisms: cellular and network analysis of oscillatory neural systems. Thalamo-cortical rhythms, spindle waves and delta waves, contribution of thalamic neuron properties and circuits. Recent published experimental evidences will be presented within the framework of theoretical concepts sustaining brain waves mechanisms. At a cellular level experimental evidence supporting the role of particular membrane properties, such as voltage dependent ion channels, or synaptic properties, such as microcircuit organization enabling oscillating activities in cortical networks reflected in EEG activities will be addressed and presented. Part 3 (Prof. Battaglini): Spinal reflexes: monosynaptic, disynaptic and polysynaptic reflexes, H reflex. Brainstem reflexes: vestibular reflexes, optocinetic nystagmus, orienting reflex, stability of visual perception. Somaesthesia: sensory transduction, cutaneous mechanoceptors, receptive field, coding of stimulus intensity and duration, tactile acuity, lemniscal and spino-thalamic pathways, primary sensory area, coding of stimulus location and modality. Cerebral cortex: functional subdivisions, Brodman's areas, cortical columns, maturation of the cerebral cortex, cortical plasticity, primary areas, association areas. Voluntary movement: kinds of movement and their control, pyramidal tract, primary motor cortex, premotor areas, functional streams. Basal ganglia and cerebellum: relation of basal ganglia with the cerebral cortex, direct and indirect pathways, functional organization of the cerebellum, input and output pathways.
	Kandel, Principles of Neuronal Science, Mc Graw-Hill Hille "Ionic channels of excitable membranes" Sinauer ass.editors [second or third edition]. In particular from chapter 1 to 5. Other reviews and papers: Annu. Rev. Neurosci. 1997. 20:185–215. J. Physiol. 1995;483;641-663. J. Physiol. 1993;468;669-691. J. Physiol. 1990;431;291-318 Physiol Rev 89: 847–885, 2009; Neuron, Vol. 20, 553–563, March, 1998. Neuron, Vol. 21, 9–12, July, 1998. Annu Rev. Phyiol. 1996 58:299-327. PNAS 2004 vol. 101 no. 52 18195–18199. The Journal of Neuroscience, 1993, 13(8): 3284-3299. Cell Calcium 40 (2006) 97–114. Trends in Neurosciences, 2013, Vol. 36, No. 12 pp 738. Additional Selected scientific papers or other didactical material could be provided. The presentation of the lectures and a collection of papers are provided
	As stated in the overview of the contents of the course, students will learn different, but fundamental, aspects of neuronal integration at several levels of the central nervous system. These will comprise different aspects, from the integrative processes which are carried on by neuronal membranes to neuronal networks, main aspect of sensory-motor integration, such as reflex and voluntary movement, till to the more actual approaches to study the activity of the living brain.
	Basic knowledge of physics, chemistry and elementary mathematics. Good knowledge of neuroanatomy Knowledge in cell physiology Good knowledge of basic neurobiology
	Lectures
	Students are required to take a final written examination (parts 1 and 2) and an oral one (part 3). The written examination consists in a multiple choices test (true/false) and 2 open questions on the topic of the courses.

The oral examination consists in a discussion of 20-30 min, during which the student is invited to describe and comment on topics covered in the course.

Overview. The course is organized in three independent modules, given by three different teachers, each of them expert in the particular topic. The program is aimed at providing wide information on fundamental aspects of neuronal integration at several levels in the central nervous system, from the integrative processes which are carried on by neuronal membranes to neuronal networks, to sensory-motor integration and movement production, till to the more actual approaches to study the activity of the living brain

Part 1: (prof. Torre). Basic properties of Imaging: spatial and temporal resolution. Number of pixels in a CCD camera and physical properties of pixels in high performance CCD cameras. A/D processing at 8, 12 and 16 bits and its implication for the detection of fluorescence signals (DF/F). Acquisition rates for different biological phenomena.

Basic properties of optical trapping and manipulation. Introduction to Mechanobiology: forces exerted by filopodia, lamellipodia and neurons. Introduction to mechanosensitivity of cells and neurons.

Part 2: (prof. Ballerini). The main aim of these Lectures is to provide fundamentals in membrane biophysics and in the mechanisms characterizing cell excitability; to translate single cell knowledge towards rules governing small networks behavior in more complex systems. The focus will be on brain waves generation and neuronal mechanisms sustaining such activities, from neuronal membrane to neuronal networks. Oscillatory mechanisms: cellular and network analysis of oscillatory neural systems. Thalamo-cortical rhythms, spindle waves and delta waves, contribution of thalamic neuron properties and circuits. Recent published experimental evidences will be presented within the framework of theoretical concepts sustaining brain waves mechanisms. At a cellular level experimental evidence supporting the role of particular membrane properties, such as voltage dependent ion channels, or synaptic properties, such as microcircuit organization enabling oscillating activities in cortical networks reflected in EEG activities will be addressed and presented. In particular the following systems will be addressed: Oscillatory mechanisms: cellular and synaptic contributions (network driven rhythmicity vs pacemaker driven one). Voltage dependent ion channels: calcium channels (HVA and LVA) with particular attention to It; IKCa; ICAN; Ih; IIR; IAHP (BK and SK) and others Thalamo-cortical rhythm.

Part 3: (prof. Battaglini). Spinal reflexes: monosynaptic reflex and general organization of the spinal cord. Brainstem reflexes: vestibular reflexes, orienting reflex. Stability of visual perception. Somaesthesia: overview of sensory modalities and receptors, sensory transduction, cutaneous mechanoceptors, receptive field, coding of stimulus intensity and duration, tactile acuity, lemniscal and spino-thalamic pathways; primary sensory area, coding of stimulus location and modality. Cerebral cortex: functional subdivisions, Brodman’s areas, cortical columns, maturation of the cerebral cortex, cortical plasticity, primary and association areas. Voluntary movement: kinds of movement and their control, motor equivalence, overall organization of the motor systems, pyramidal tract, primary motor cortex, premotor areas, working memory, mirror neurons, functional streams, action and perception, timing for motor production. Basal ganglia and cerebellum: relation 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.