Plan of the course
Fundamentals of Neuroscience

Academic year 2012/2013

Course coordinator:
Goran Šimić, M.D., D.Sc.
I. COURSE AIMS:

This course introduces students to all aspects of the nervous system structure and function, in health and in disease. It includes the anatomy, physiology, chemistry, pharmacology, and pathology of nerve cells, as well as the behavioural and psychological features that depend on the function of the nervous system and the clinical disciplines that deal with them, such as neurology, neurosurgery, and psychiatry. Traditionally neuroscience is seen as a branch of biological sciences. However, recently there has been a convergence of interest from many allied disciplines, including medicine, psychology, physics, computer science, statistics and many others. The scope of neuroscience has now broadened to include any systematic scientific experimental and theoretical investigation of the central and peripheral nervous system of biological organisms. The methodologies employed by neuroscientists have been enormously expanded, from biochemical and genetic analysis of dynamics of individual nerve cells and their molecular constituents to imaging representations of perceptual, motor and cognitive tasks in the brain. Neuroscience is at the frontier of investigation of the brain and mind. The study of the brain is becoming the cornerstone in understanding how we perceive and interact with the external world and, in particular, how human experience and human biology influence each other. Neuroscience is the most rapidly growing field of science.

II. COURSE STRUCTURE

The course Fundamentals of Neuroscience will last for five weeks (14th May 2012 – 15th June 2012). It will consist of lectures (65 hrs), seminars/tutorials (approximately 45 hrs), and practicals (dissections, computer simulations, examination of microscopical preparations, EEG recordings and readings, etc. - approx. 20 hrs), totaling 130 hrs.

Lectures (L) : 65 hours

Seminars (S) : 45 hours

Practicals (P) : 20 hours

Total: 130 hours

III. PLAN OF THE COURSE AND COURSE SCHEDULE
The Neurobiology of Behavior

1. The Brain and Behavior (IK)  Mon 20 May 9.00 – 10.45 h
2. Nerve Cells and Behavior (MJ)  Mon 20 May 11.00 – 12.45 h
3. Genes and Behavior (ŽK)  Mon 20 May 13.00 – 14.45 h

Cell and Molecular Biology of the Neuron

4. The Cytology of Neurons (MB)  Tue 21 May 9.00 – 10.45 h
5. Synthesis and Trafficking of Neuronal Protein (ŽK)  Tue 21 May 11.00 – 12.45 h
6. Ion Channels (VC)  Tue 21 May 13.00 – 14.45 h
7. Membrane Potential (MR)  Wed 22 May 9.00 – 10.45 h

Elementary Interactions Between Neurons: Synaptic Transmission

10. Overview of Synaptic Transmission (ZP)  Thu 23 May 9.00 – 10.45 h
11. Signaling at the Nerve-Muscle Synapse: Directly Gated Transmission (HB)  Thu 23 May 11.00 – 12.45 h
12. Synaptic Integration (GŠ)  Thu 23 May 13.00 – 14.45 h
13. Modulation of Synaptic Transmission: Second Messengers (HB)  Fri 24 May 9.00 – 10.45 h
14. Transmitter Release (GŠ)  Fri 24 May 11.00 – 12.45 h
15. Neurotransmitters (ŽK)  Fri 24 May 13.00 – 14.45 h
16. Diseases of Chemical Transmission at the Nerve-Muscle Synapse: Myasthenia Gravis (VC)  Mon 27 May 9.00 – 10.45 h

Neural Basis of Cognition

17. The Anatomical Organization of the Central Nervous System (ŽK)  Mon 27 May 11.00 – 12.45 h
18. The Functional Organization of Perception and Movement (GŠ)  Mon 27 May 13.00 – 14.45 h
19. Integration of Sensory and Motor Function: The Association Areas of the Cerebral Cortex and the Cognitive Capabilities of the Brain (GŠ)  Tue 28 May 9.00 – 10.45 h
20. From Nerve Cells to Cognition: The Internal Cellular Representations Required for Perception and Action (ZP)  Tue 28 May 11.00 – 12.45 h

Perception

21. Coding of Sensory Information (ZP)  Wed 29 May 9.00 – 10.45 h
22. The Bodily Senses (GS)  Wed 29 May 11.00 – 12.45 h
<table>
<thead>
<tr>
<th>Course</th>
<th>Date</th>
<th>Time</th>
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<tbody>
<tr>
<td>Touch (VLŠ)</td>
<td>Thu 30 May</td>
<td>9.00 – 10.45 h</td>
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<tr>
<td>The Perception of Pain (GŠ)</td>
<td>Thu 30 May</td>
<td>11.00 – 12.45 h</td>
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<tr>
<td>Constructing the Visual Image (ZP)</td>
<td>Thu 30 May</td>
<td>13.00 – 14.45 h</td>
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<tr>
<td>Visual Processing by the Retina (ZP)</td>
<td>Fri 31 May</td>
<td>9.00 – 10.45 h</td>
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<tr>
<td>Central Visual Pathways (GŠ)</td>
<td>Fri 31 May</td>
<td>11.00 – 12.45 h</td>
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<tr>
<td>Perception of Motion, Depth, and Form (ZP)</td>
<td>Mon 3 June</td>
<td>9.00 – 10.45 h</td>
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<tr>
<td>Color Vision (GŠ)</td>
<td>Mon 3 June</td>
<td>11.00 – 12.45 h</td>
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<tr>
<td>Hearing (VC)</td>
<td>Mon 3 June</td>
<td>13.00 – 14.45 h</td>
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<tr>
<td>Sensory Transduction in the Ear (VC)</td>
<td>Tue 4 June</td>
<td>9.00 – 10.45 h</td>
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<tr>
<td>Smell and Taste: The Chemical Senses (VC)</td>
<td>Tue 4 June</td>
<td>11.00 – 12.45 h</td>
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**Movement**

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<thead>
<tr>
<th>Course</th>
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<tbody>
<tr>
<td>The Organization of Movement (HB)</td>
<td>Tue 4 June</td>
<td>13.00 – 14.45 h</td>
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<tr>
<td>The Motor Unit and Muscle Action (HB)</td>
<td>Wed 5 June</td>
<td>9.00 – 10.45 h</td>
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<tr>
<td>Diseases of the Motor Unit (GŠ)</td>
<td>Wed 5 June</td>
<td>11.00 – 12.45 h</td>
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<tr>
<td>Spinal Reflexes (VLŠ)</td>
<td>Wed 5 June</td>
<td>13.00 – 14.45 h</td>
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<tr>
<td>Locomotion (ZP)</td>
<td>Thu 6 June</td>
<td>9.00 – 10.45 h</td>
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<tr>
<td>Voluntary Movement (GŠ)</td>
<td>Thu 6 June</td>
<td>11.00 – 12.45 h</td>
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<tr>
<td>The Control of Gaze (MR)</td>
<td>Thu 6 June</td>
<td>13.00 – 14.45 h</td>
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<tr>
<td>The Vestibular System (VLŠ)</td>
<td>Fri 7 June</td>
<td>9.00 – 10.45 h</td>
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<tr>
<td>Posture (MR)</td>
<td>Fri 7 June</td>
<td>11.00 – 12.45 h</td>
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<tr>
<td>The Cerebellum (MV)</td>
<td>Fri 7 June</td>
<td>13.00 – 14.45 h</td>
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<tr>
<td>The Basal Ganglia (GI)</td>
<td>Mon 10 June</td>
<td>9.00 – 10.45 h</td>
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**Arousal, Emotion, and Behavioral Homeostasis**

<table>
<thead>
<tr>
<th>Course</th>
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<tbody>
<tr>
<td>Brain Stem, Reflexive Behavior, and the Cranial Nerves (ZP)</td>
<td>Mon 10 June</td>
<td>11.00 – 12.45 h</td>
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<tr>
<td>Brain Stem Modulation of Sensation, Movement, and Consciousness (GI)</td>
<td>Mon 10 June</td>
<td>13.00 – 14.45 h</td>
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<tr>
<td>Seizures and Epilepsy (GI)</td>
<td>Tue 11 June</td>
<td>9.00 – 10.45 h</td>
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<tr>
<td>Sleep and Dreaming (GI)</td>
<td>Tue 11 June</td>
<td>11.00 – 12.45 h</td>
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<tr>
<td>Disorders of Sleep and Wakefulness (GI)</td>
<td>Tue 11 June</td>
<td>13.00 – 14.45 h</td>
</tr>
<tr>
<td>The Autonomic Nervous System and the Hypothalamus (GŠ)</td>
<td>Wed 12 June</td>
<td>9.00 – 10.45 h</td>
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<tr>
<td>Emotional States and Feelings (ER)</td>
<td>Wed 12 June</td>
<td>11.00 – 12.45 h</td>
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<tr>
<td>Motivational and Addictive States (ER)</td>
<td>Wed 12 June</td>
<td>13.00 – 14.45 h</td>
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**The Development of the Nervous System**

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<thead>
<tr>
<th>Course</th>
<th>Date</th>
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<tbody>
<tr>
<td>The Induction and Patterning of the Nervous System (ŽK)</td>
<td>Thu 13 June</td>
<td>9.00 – 10.45 h</td>
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<tr>
<td>The Generation and Survival of Nerve Cells (ŽK)</td>
<td>Thu 13 June</td>
<td>11.00 – 12.45 h</td>
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<tr>
<td>The Guidance of Axons to Their Targets (NJM)</td>
<td>Thu 13 June</td>
<td>13.00 – 14.45 h</td>
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<tr>
<td>The Formation and Regeneration of Synapses (GŠ)</td>
<td>Fri 14 June</td>
<td>9.00 – 10.45 h</td>
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<tr>
<td>Sensory Experience and Fine-Tuning of Synaptic Connections (MV)</td>
<td>Fri 14 June</td>
<td>11.00 – 12.45 h</td>
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</tbody>
</table>
57. Sexual Differentiation of the Nervous System (ŽK)  Mon 17 June 9.00 – 10.45 h
58. Aging of the Brain and Alzheimer’s Disease (GŠ)  Mon 17 June 11.00 – 12.45 h

Language, Thought, Mood, and Learning, and Memory

59. Language and the Aphasias (GŠ)  Mon 17 June 13.00 – 14.45 h
60. Disorders of the Thought and Volition: Schizophrenia (ER)  Tue 18 June 9.00 – 10.45 h
61. Disorders of Mood: Depression, Mania, and Anxiety Disorders (ER)  Tue 18 June 11.00 – 12.45 h
62. Learning and Memory (GŠ)  Tue 18 June 11.00 – 12.45 h
63. Cellular Mechanisms of Learning and the Biological Basis of Individuality (MR)  Wed 19 June 11.00 – 12.45 h
64. Ventricular Organization of Cerebrospinal Fluid: Circulation of the Brain and Blood-Brain Barrier, Brain Edema, and Hydrocephalus (MK)  Thu 14 June 11.00 – 12.45 h
65. Consciousness and the Neurobiology of the Twenty-First Century (IK)  Fri 15 June 11.00 – 12.45 h

Faculty

Professor Ivica Kostović, MD, DSc (Director, Croatian Institute for Brain Research)
Professor Hrvoje Banfić, MD, DSc
Professor Miloš Judaš, MD, DSc
Professor Marijan Klarića, MD, DSc
Professor Srećko Gajović, MD, DSc
Professor Zdravko Petanjek, MD, DSc
Professor Goran Šimić, MD, DSc (Head, Dept. of Neuroscience, co-ordinator of the course)
Professor Svjetlana Kalanj-Bognar, MD, DSc
Associate Professor Mario Vukšić, MD, DSc
Associate Professor Nataša Jovanov-Milošević, DVM, DSc
Assistant Professor Vladana Cržen, MD, DSc
Assistant Professor Milan Radoš, MD, DSc
Assistant Professor Vesna Lukinović-Škudar, MD, DSc
Elizabeta Radonić, MD, BA, DSc
Goran Ivkić, MD
Goran Sedmak, MD
Željka Kršnik, BBSc, DSc
Mirkana Babić, BBSc

All lectures, seminars and practicals will take place in Croatian Institute for Brain Research building (Šalata 12) – www.hiim.hr.

IV. EXAMINATIONS

The written exam consists of 50 multiple choice questions. There will be two summer examination terms (27th of June and 11th of July) and two examination terms in the fall (5th and 19th of September).
Scoring system: 39-50 points = excellent (5), 34-38 = very good (4), 29-33 = good (3), 26-28 = satisfactory, less than 26 = 1 (fail).

Catalog of knowledge for the oral examination

1. Types of nervous cells
2. Types of glial cells
3. Neuronal cytoskeleton
4. Fast and slow axonal transport
5. Potassium, sodium and calcium ion channels
6. Resting membrane potential
7. Passive electrical properties of the neuron
8. Action potential
9. Neuromuscular synapse and its disorders
10. Excitatory synapses
11. Inhibitory synapses
12. Temporal and spatial synaptic integration
13. Ionotropic receptors
14. Metabotropic receptors
15. Transmitter synthesis and synaptic vesicles
16. Transmitter release and uptake
17. Acetylcholine
18. Biogenic amine transmitters
19. Amino acid transmitters
20. Neuroactive peptides
21. Anatomical organization of the spinal cord
22. Anatomical organization of the medulla
23. Anatomical organization of the midbrain
24. Anatomical organization of the cerebellum
25. Anatomical organization of the diencephalon
26. Anatomical organization of the cerebral hemispheres
27. Laminar organization of the cerebral cortex
28. Columnar organization of the cerebral cortex
29. Localization of cognitive functions within the cerebral cortex
30. Functional imaging of cognitive functions
31. Mechanoreceptors, proprioceptors and thermal receptors
32. Nociceptors and hyperalgesia
33. Dorsal column – medial lemniscal system
34. Anterolateral spinothalamic system
35. Gate-control theory, opioid peptides and the endogenous pain control
36. Thalamic syndrome and central pain
37. Photoreceptors and phototransduction cascade
38. Retinal visual processing
39. Visual field and lesions in the retino-geniculo-cortical visual pathways
40. Magnocellular and parvocellular central visual pathways
41. Functional modules of the visual cortex
42. Motion processing in the dorsal visual pathway
43. Visual attention
44. Object processing in the ventral visual pathway
45. Stereoscopic perception
46. Color vision
47. Conscious awareness and the binding problem in the visual cortex
48. Sensory transduction in the ear
49. Functional anatomy of the cochlea
50. Neural processing of auditory information
51. Sensorineural hearing loss
52. Encoding of odorant information
53. Olfactory pathways
54. Pheromones
55. Taste cells and qualities
56. Organization of the motor system
57. The motor unit
58. Neurogenic diseases of the motor unit
59. Myopathic diseases of the motor unit
60. Diseases of the peripheral nerves
61. The stretch reflex
62. Alterations in reflex responses and muscle tone
63. Locomotion patterns within the spinal cord
64. Voluntary movements
65. Gaze control
66. Anatomical organization of the vestibular apparatus
67. Vestibular reflexes and central vestibular pathways
68. Posture control
69. Vestibulocerebellar circuits and disorders
70. Spino cerebellar circuits and disorders
71. Cerebrocerebellar circuits and disorders
72. Direct and indirect pathways in the basal ganglia
73. Movement disorders (Parkinson’s disease, Huntington’s disease)
74. Roles of basal ganglia in the cognition and learning
75. Brain stem reticular formation and cranial nerves
76. Brain stem modulation of sensation, movement and consciousness
77. Classification of the seizures and the epilepsies
78. Disorders of sleep and wakefulness
79. Hypothalamic control of the endocrine system
80. The roles of amygdaloid complex in emotional states and feelings
81. Depression, mania and anxiety disorders
82. Addictive states and drug abuse
83. Induction and patterning of the nervous system
84. Generation and survival of nerve cells
85. Guidance of axons to their targets
86. Formation and regeneration of synapses
87. Sensory experience and fine tuning of synaptic connections
88. Single genes that have profound effects on behavior
89. Sexual differentiation of the nervous system
90. Hormone-induced modifications in the brain structure
91. Aging of the brain and dementia
92. Alzheimer’s disease
93. Language development and organization of the brain areas related to language
94. Types of aphasias and other language-related disorders
95. Schizophrenia
96. Explicit and implicit memory
97. Habituation, sensitisation and conditioning
98. Long-term potentiation and long-term depression
99. Blood-brain barrier, brain edema and hydrocephalus
100. Brain circulation and stroke

The *oral examination* will consist of 5 randomly chosen questions from the list above, for example:
1. Action potential
2. Anatomical organization of the midbrain
3. Anterolateral spinothalamic system
4. Addictive states and drug abuse
5. Alzheimer’s disease

<table>
<thead>
<tr>
<th>Regular terms</th>
<th>Date</th>
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<tbody>
<tr>
<td>Winter</td>
<td>27th June 2013</td>
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<tr>
<td></td>
<td>11th July 2013</td>
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<tr>
<td>Summer</td>
<td>5th Sept 2013</td>
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<td>19th Sept 2013</td>
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</tbody>
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**V.I. LIST OF LECTURERS AND TEACHING STAFF**
1. Professor Ivica Kostović, MD, DSc (Director, Croatian Institute for Brain Research)
2. Professor Hrvoje Banfić, MD, DSc
3. Professor Miloš Judaš, MD, DSc
4. Professor Marijan Klarića, MD, DSc
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12. Assistant Professor Milan Radoš, MD, DSc
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15. Goran Ivkić, MD
16. Goran Sedmak, MD
17. Željka Kršnik, BBSc, DSc
18. Mirjana Babić, BBSc

**VI. LIST OF EXAMINERS**
1. Professor Ivica Kostović, MD, DSc (Director, Croatian Institute for Brain Research)
2. Professor Hrvoje Banfić, MD, DSc
3. Professor Miloš Judaš, MD, DSc
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11. Assistant Professor Milan Radoš, MD, DSc  
12. Assistant Professor Vesna Lukinović-Škudar, MD, DSc

VII. LITERATURE

A. Obligatory


B. Additional


NOTE: The use of online multimedia resources is highly recommended.