

**מבוא לנוירוביולוגיה מערכתית (1501.1005)**  
**System Neuroscience**

**Dr. Pablo Blinder**  
**Dr. Yuval Nir**  
**Dr. Segev Barak**

סמסטר א', שלישי 13:00-16:00 תשע"ה  
נפתלי, 001

| Week | Date  | Lecture                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |
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| 1    | 28.10 | <p><b>Block 1: System Neuroscience principles</b><br/><b>- Dr. Pablo Blinder</b></p> <p><b>Lesson 1 – Systems, systems everywhere!</b><br/><b>Key concepts in system biology and their usage in system neuroscience</b></p> <ol style="list-style-type: none"> <li>1. The concept of “system”</li> <li>2. An overview of regulatory networks and their outputs                             <ol style="list-style-type: none"> <li>(a) Feedforward excitation/inhibition</li> <li>(b) Recurrent excitation/inhibition</li> <li>(c) Convergence/Divergence</li> <li>(d) Feedback inhibition</li> </ol> </li> <li>3. Brain organization from the network perspective</li> </ol> |
| 2    | 4.11  | <p><b>Lesson 2 – What are the bits of neuronal information?</b><br/><b>Neuronal coding</b></p> <ol style="list-style-type: none"> <li>1. Rate coding</li> <li>2. Temporal coding</li> <li>3. Population coding</li> <li>4. Pattern generation</li> </ol>                                                                                                                                                                                                                                                                                                                                                                                                                     |
| 3    | 11.11 | <p><b>Lesson 3 – Motor output within a whisker of sensory processing</b><br/><b>Scaling from local circuits to a sensory system - the whisker system</b></p> <ol style="list-style-type: none"> <li>1. The cortical column micro-circuit</li> <li>2. Pathways of sensory information processing</li> <li>3. Tight link between sensor and motor areas</li> <li>4. Active sensation</li> </ol>                                                                                                                                                                                                                                                                                |

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| 4 | 18.11 | <p><b>Lesson 4 – I want to ride my bicycle!</b></p> <p><b>Motor Systems</b></p> <ol style="list-style-type: none"> <li>1. Fundamentals of motor systems and interaction with our environment</li> <li>2. Spinal and Peripheral motorics</li> <li>3. Motor planning and execution</li> <li>4. Motor output modulation</li> </ol>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |
| 5 | 25.11 | <p><b>Block 2: Learning, memory and cognition - Dr. Segev Barak</b></p> <p><b>Lesson 5 – How do we learn new tricks?</b></p> <p><b>Terminology and measurement of psychological variables</b></p> <ol style="list-style-type: none"> <li>1. What are learning, memory and cognition</li> <li>2. What are we measuring? Performance and its interpretation</li> </ol> <p><b>Neural substrates of learning</b></p> <ol style="list-style-type: none"> <li>1. Role of Basal ganglia-thalamocortical circuits, amygdaloid nuclei, hippocampal formation and mesolimbic system in: <ol style="list-style-type: none"> <li>(a) Classical (Pavlovian) conditioning</li> <li>(b) Operant (instrumental) conditioning</li> <li>(c) Spatial learning</li> <li>(d) Motivations, drives and learning: modulation of brain systems</li> </ol> </li> <li>2. Summary: From molecules to systems</li> </ol> |
| 6 | 2.12  | <p><b>Lesson 6 – Don't forget me on Valentine's day</b></p> <p><b>Neural substrates of memory</b></p> <ol style="list-style-type: none"> <li>1. In search of the Engram: Brain systems and circuits involved in memory processes (e.g., afferents and efferents of hippocampus, cortex, amygdala)</li> <li>2. Classifications of memory: memory stores (iconic, STM, LTM), working memory, procedural vs. declarative (episodic, semantic).</li> <li>3. Memory processes: encoding, storage, retrieval, consolidation, reconsolidation, forgetting?</li> <li>4. Summary: From molecules to systems</li> </ol>                                                                                                                                                                                                                                                                               |
| 7 | 9.12  | <p><b>Lesson 7 – Cogito ergo sum</b></p> <p><b>Neural substrates of higher cognitive functions</b></p> <ol style="list-style-type: none"> <li>1. Cortical control, basal ganglia-thalamocortical circuits</li> <li>2. Executive functions (mental flexibility, selective attention, integrative thinking etc.)</li> <li>3. The elusive search for cognition enhancing drugs</li> <li>4. Summary: From molecules to systems</li> </ol>                                                                                                                                                                                                                                                                                                                                                                                                                                                       |
| 8 | 16.12 | <p><b>Lesson 8 – Loosing your nerve?</b></p> <p><b>Dysfunctions in learning and memory: neuropsychiatric disorders and brain injuries</b></p> <ol style="list-style-type: none"> <li>1. Dementias and Alzheimer's disease</li> </ol>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |

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|    |       | <p>2. Compulsive disorders and addiction</p> <p>3. Strokes and brain injuries</p>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |
| 9  | 23.12 | <p><b>Block 3 : Vision and sensory systems - Dr. Yuval Nir</b></p> <p><b>Lesson 9 – To see or not to see</b></p> <p><b>What are visual stimuli?</b></p> <p><b>The eye and retina (quick re-iteration depending on prior courses/knowledge)</b></p> <ol style="list-style-type: none"> <li>1. Sensory transduction: transforming physical sensory stimuli into electrical pulses, i.e. photoreception: rods &amp; cones, adaptation</li> <li>2. Basis of color vision, selectivity and tuning curves</li> <li>3. Ganglion cells and retinal output: ON/OFF, receptive fields / center-surround, detection of contrast/changes</li> </ol> <p><b>Visual pathways – from the retina to the brain</b></p> <ol style="list-style-type: none"> <li>1. Blind spot</li> <li>2. Optic nerve &amp; optic chiasm</li> <li>3. Superior colliculus, tectum / saccades, fixations</li> <li>4. Thalamic relay: LGN, Magnocellular, Parvocellular</li> <li>5. Optic radiation</li> </ol>                                                                                                                                                                                                                                                                                                                                                                                            |
| 10 | 30.12 | <p><b>Lesson 10 – More than meets the eye</b></p> <p><b>Primary visual cortex (specialization within regions)</b></p> <ol style="list-style-type: none"> <li>1. Simple and complex cells, receptive fields, invariance</li> <li>2. Spatial frequency</li> <li>3. Retinal disparity</li> <li>4. Color</li> <li>5. Retinotopy, eccentricity, foveal magnification</li> <li>6. Ocular dominance</li> <li>7. Orientation selectivity</li> <li>8. Cortical layers and signal propagation</li> <li>9. Cortical columns, hypercolumns / blobs, modular organization, horizontal connections</li> </ol> <p><b>Extrastriate visual cortex</b></p> <ol style="list-style-type: none"> <li>1. Hierarchy/abstraction</li> <li>2. Specialization across regions: <ol style="list-style-type: none"> <li>(a) Dorsal and ventral streams</li> <li>(b) Motion perception, MT</li> <li>(c) Face/place object recognition</li> <li>(d) Perception as an 'all or none' non-linear process</li> <li>(e) Color vision <ol style="list-style-type: none"> <li>(a) Prediction, 'filling-in', meshing incoming input with prior knowledge</li> <li>(b) Attention (to spatial location , to specific features)</li> <li>(c) Free viewing conditions</li> <li>(d) Lesions and corresponding deficits (agnosias)</li> </ol> </li> </ol> </li> </ol> <p>- moved out due to lack of lessons</p> |

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| 11 | 6.1  | <p><b>Block 4: Neurobiology of sleep, waking and consciousness - Dr. Yuval Nir</b></p> <p><b>Lesson 11 – Wake up and smell the coffee</b></p> <p><b>States of sleep and wakefulness</b></p> <ol style="list-style-type: none"> <li>1. Sleep as a distinct behavior</li> <li>2. Sleep stages and EEG rhythms</li> <li>3. Passive sleep vs. active sleep</li> <li>4. Variability of sleep (across the animal kingdom, across the life span)</li> </ol> <p><b>Brain centers (and neuromodulators) regulating wakefulness and sleep</b></p> <ol style="list-style-type: none"> <li>1. Wakefulness <ol style="list-style-type: none"> <li>(a) The Ascending Reticular Activating System (ARAS)</li> <li>(b) The cholinergic system, basal forebrain and arousal</li> <li>(c) Locus Coeruleus and noradrenergic system</li> <li>(d) Other neuromodulatory systems (Serotonin, Histamine, Hypocretin / Orexin, Dopamine)</li> </ol> </li> <li>2. NREM sleep <ol style="list-style-type: none"> <li>(a) Hypothalamic sleep promoting system (VLPO area)</li> </ol> </li> <li>3. REM sleep <ol style="list-style-type: none"> <li>(a) REM generating system / pons</li> </ol> </li> </ol> |
| 12 | 13.1 | <p><b>Lesson 12 – Sleeping beauty</b></p> <p><b>Spontaneous neuronal activity in sleep</b></p> <ol style="list-style-type: none"> <li>1. Unit studies in animals: wakefulness, NREM sleep, REM sleep</li> <li>2. Metabolism and brain imaging (PET, EEG-fMRI) in humans</li> <li>3. Intracranial studies</li> </ol> <p><b>Circadian Rhythms</b></p> <ol style="list-style-type: none"> <li>1. The Suprachiasmatic nucleus</li> <li>2. Pineal gland and melatonin</li> </ol> <p><b>Why do we sleep?</b></p> <ol style="list-style-type: none"> <li>1. Sleep homeostasis</li> <li>2. Acute and chronic sleep deprivation in animals and humans, effects on specific brain circuits and behavior</li> <li>3. Possible function(s) of sleep: sleep as a time filler / memory enhancer / brain restitution</li> </ol>                                                                                                                                                                                                                                                                                                                                                                 |
| 13 | 20.1 | <p><b>Lesson 13 – Beyond your wildest dreams</b></p> <p><b>Sleep, learning and memory</b></p> <ol style="list-style-type: none"> <li>1. Reactivation (replay) of circuits during sleep</li> <li>2. Sleep and non-declarative memories: perceptual and motor learning</li> <li>3. Sleep and declarative memories</li> <li>4. Potential mechanisms: hippocampus, cortex and their "dialogue"</li> </ol> <p><b>Sleep and consciousness</b></p>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |

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|  | <ol style="list-style-type: none"><li>1. Dreaming and related brain activity</li><li>2. Processing of external sensory stimuli</li><li>3. Loss of consciousness in sleep and anesthesia</li></ol> <p><b>Highlights of sleep disorders and their brain substrates</b></p> <ol style="list-style-type: none"><li>1. Insomnia</li><li>2. Sleep apnea</li><li>3. Narcolepsy / Cataplexy</li><li>4. Sleep paralysis</li><li>5. Sleep walking</li><li>6. REM sleep behavior disorder</li></ol> |
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הרכב הציון הסופי :  
מבחן 100%