1. Course title: Neuroscience Core Course	
2. Instructor(s): Jonas, Csicsvari, Jösch	
3. Track(s): Neuroscience	**4. Track segments:** relevant for all neuroscience segments
5. Semester: Spring 1+2	**6. Duration:** full-semester
7. Course type: track course	**8. Teaching assistant(s):** tbd
9. Minimum attendance:	**11. Preferred schedule** (if applicable): ◻ Mon/Wed x Tue/Thu ◻ other: ◻ morning ◻ afternoon ◻ no preference
10. Maximum attendance:	
12. Course is expected to be offered **a) every year** x **b) every second year** ◻ **c) only this year / recurrence cannot be foreseen** ◻	**13. Course website:** Typo 3 template ◻ yes x no
	14. Specific class room requirements:

The goal of the neuroscience core course is to teach students basic concept of neuroscience and provide them a general overview of the structures, functions and building blocks of the brain - from molecules to systems. Students will experience conceptual ideas behind classic and novel discoveries and get a general understanding of the essential methodological strategies required for those breakthroughs. The aim here as well to develop critical thinking, practical basic data analysis skills and try out their abilities in tasks that they need in the future as scientists such as reviewing a research manuscript or developing a research project for grant or fellowship applications. The contents provided in this course are selected to provide a general neuroscience backbone that is required for all fields in neuroscience and thus, will be a constant in the neuroscience track.

Students will be asked in each module to solve different assignments, some of which will require basic skills in data analysis (basic knowledge in e.g. Matlab, Python or R are required). In addition, students will have to present a publication in short Journal Club-style presentation, write a review report of a selected paper and formulate a research proposal. Faculty and/or course assistants will give direct feedback to the presentations and reviews. These exercises will (i) test their critical reading and (ii) challenge their interpretation skills.

To finalize the course, each student will have to write an essay from a list of provided topics. The topics are selected from the course content form to test their critical thinking, methodological knowledge and writing skills. Thus, our course is designed not only to provide a core knowledge in basic neuroscience, but also to foster critical thinking.

Topics for 2018/2019 (order to be determined based on scheduling)

- **Module 1: From Molecules to Single Cells (8 lectures, Jonas).**
  Topics covered: General introduction into neuroscience.

  Block 1: Channels, excitability, and axons. Ion channels in lipid membranes, squid giant axon, Na+ channels, K+ channels, diversity in action potential phenotype. Action potential propagation in myelinated axons. Hodgkin-Huxley models of excitability.

Block 2: Synapses and exocytosis. Model synapses (neuromuscular junction, squid giant synapse, central synapses). Mechanisms of transmitter release (SNARE proteins, presynaptic Ca2+ channels, Ca2+ sensors, synaptotagmins). Mechanisms of receptor activation (acetylcholine receptors, glutamate receptors, GABA receptors). Electrical synapses and metabotropic transmission.

Block 3: Dendrites and dendritic integration. Structure and cable properties of dendrites. EPSPs, IPSPs, synaptic integration (hyperpolarizing inhibition, shunting inhibition). Active properties of dendrites, action potential initiation and backpropagation. Passive and active cable models of dendrites.

Block 4: Synaptic plasticity, learning, and memory. Classical conditioning in Aplysia and underlying cellular mechanisms. Long-term potentiation in mammalian synapses. Spike timing-dependent (Hebbian) plasticity. Homeostatic plasticity, structural plasticity.

The course will present both textbook knowledge and data from classical and recent scientific papers. The primary focus will be on experimental findings, but simple computational models will be also developed (“build it, and you understand it”). Students will be judged on the basis of attendance, successful completion if homework (including questions and reading list), and an “essay” written on one of the papers in the reading list.

- **Module 2: From Circuits to Behaviour (8 lectures, Jösch).**
  Topic covered: Sensory and motor systems

  The **first half** of this module will cover sensory systems with an emphasis on vision. We will discuss vision in different organisms, ranging from flies and locust to mouse and primates. Subtopics will include: optics, phototransduction, adaptation, optimization, information, circuit computation and implementations (color, motion, looming), optomotor behaviors, retina, visual streams and the role of different visual areas of the brain for the process of seeing (visual cortex, thalamus, superior colliculus, etc.). The selection of topics aims to use the visual system as a platform to discuss general principles of computations that are applicable across systems. Therefore, after this first half, students will be asked to choose a different sensory system (Olfaction, Audition, Touch, Somatosensory) and apply the acquired knowledge by discussing similarities and differences to the once learned in a journal club style presentation.

  In the **second half** of this module, we will cover general principles of motor control by discussing the spinal cord, reflexes, central pattern generators, and the role of areas involved in motor control, e.g., basal ganglia, cerebellum and motor cortex, and the pathophysiology of motor systems. At the end of this section, students will have to write one review on a selected list of papers .

- **Module 3: Systems Neuroscience (8 lectures, Csicsvari).**
  Topic covered: Functional anatomy of global brain systems

  Systems neuroscience approaches to study somatosensory, auditory and olfactory systems; brain circuits involved in learning and memory; place cells; role of sleep in learning; oscillations in the brain, the circuit mechanism behind them and their functional role.

Both general textbox knowledge and research articles are discussed in an interactive form. Students need to design a research project and present the research proposal of the project. The talks describing the research proposal will be brief, in a similar format researchers require to prepare for interviews for research fellowships and grants such as ERC or Wellcome trust interviews.

16. Target audience: Students planning to affiliate in a neuroscience research group.

17. Prerequisites: Basic knowledge in data analysis is required (e.g. beginner skills in Matlab, Python or R). For students with no background in life-sciences certain aspects of the course will require further reading.

18. Teaching format(s): Lectures

19. Evaluation:

Two assignments:
- First term write a preview article about a paper
- Second term write referee report about a paper

AND
- Final exam essay

(Final exam essay 50% plus assignments 50%)