

COMPACT COURSE SUMMER SEMESTER 2009

Neurophysiology II - Electrophysiology in Living Brain Slices: Physiology of Neurons and Neuronal Networks

Date: 27.07.2009 – 14.08.2009, all day
Time: 9:15 h – 18:00 h
Place: Neurobiology and Biophysics, Inst. for biology, Lab AG Aertsen, 5th floor
Schänzlestr. 1

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Tutors: Csaba David, Jessica Koch, Samora Okujeni, Thomas Fucke

Links to the course scripts:

Introduction to the neuroanatomy of the hippocampus and neocortex:

http://material.brainworks.uni-freiburg.de/teaching/Neurophysiology_II/slicekurs_Einfuehrung_Anatomie.pdf

Synaptic plasticity and extracellular recordings:

de: http://material.brainworks.uni-freiburg.de/teaching/Neurophysiology_II/slicekurs_ss_script_LFP_de.pdf

en: http://material.brainworks.uni-freiburg.de/teaching/Neurophysiology_II/slicekurs_ss_script_LFP_en.pdf

Single-cell properties and patch-clamp recordings:

http://material.brainworks.uni-freiburg.de/teaching/Neurophysiology_II/Skript_slicekurs_patch_clamp_de.pdf

Link to participant list and presentation topics:

http://material.brainworks.uni-freiburg.de/teaching/Neurophysiology_II/ss09/teilnehmerliste09.pdf

Link to publications available as PDF files:

http://material.brainworks.uni-freiburg.de/teaching/Neurophysiology_II/literature/index.html

Link to this text:

http://material.brainworks.uni-freiburg.de/teaching/Neurophysiology_II/ss09/ablaufplan_slice09.pdf

Presentation topics and schedule

(with presenter and *tutor*)

- a) The structure of the neocortex (Johannes Ackermann; tutor: Csaba David)
[V. B. Mountcastle. Cells and local networks of the neocortex. In: Perceptual neuroscience: The cerebral cortex, edited by V. B. Mountcastle, Cambridge:Harvard University Press, 1998, p. 50-77.](#)

[J. DeFelipe, L. Alonso-Nanclares, and J. I. Arellano. Microstructure of the neocortex: comparative aspects. J Neurocytol. 31 \(3-5\):299-316, 2002](#)
- b) The structure of the hippocampus (Lukas Fiederer; tutor: Uli Egert)
[M. P. Witter and D. G. Amaral. Hippocampal formation. In: The rat nervous system, edited by G. Paxinos, \(3rd Ed.\) Elsevier \(USA\) 2004, p. 635-704](#)
- c) Ion channel properties during the initiation of action potentials: Basics and application of the voltage-clamp technique (Claudia Bachmann; tutor: Clemens Boucsein)
[C. M. Colbert and E. H. Pan. Ion channel properties underlying axonal action potential initiation in pyramidal neurons. Nat. Neurosci. 5 \(6\):533-538, 2002nd](#)

[Palmer LM, Stuart GJ. Site of action potential initiation in layer 5 pyramidal neurons. J Neurosci. 2006 Feb 8;26\(6\):1854-63](#)
- d) Synaptic plasticity (Carolin Nieder; tutor: Uli Egert)
[Synapses Cowan WM, Südhoff TC, and Stevens CF \(eds.\) Baltimore, London: The Johns Hopkins University Press, 2001. Ch. 3 & 9](#)
- e) The contribution of distal synapses to action potential generation (Lalitta Suriya; tutor: Thomas Fücke)
[Williams SR, Stuart GJ \(2002\) Dependence of EPSP efficacy on synapse location in neocortical pyramidal neurons. Science 295:1907-1910](#)

[Larkum ME, Zhu JJ, Sakmann B \(1999\) A new cellular mechanism for coupling inputs arriving at different cortical layers. Nature 398:338-341](#)
- f) Physiology of synaptic connections in the neocortex (Anika Lückhoff; tutor: Clemens Boucsein)
[Koester HJ, Johnston D \(2005\) Target cell-dependent normalization of transmitter release at neocortical synapses. Science 308: 863-866.](#)

[Markram H, Lubke J, Frotscher M, Roth A, Sakmann B \(1997\) Physiology and anatomy of synaptic connections between thick tufted pyramidal neurones in the developing rat neocortex. J Physiol 500 \(2\): 409-440.](#)

Experiments

a) Introduction to the neuroanatomy of the hippocampus and neocortex

Jochen Staiger, Institut für Anatomie und Zellbiologie, Abteilung für Neuroanatomie/ Zentrum für Neurowissenschaften

In this part of the course, we use immunohistochemical techniques to give an introduction to the distribution of various neuron types in the hippocampus and neocortex of rats. It will thus prepare an anatomical background that should help to interpret the electrophysiological data recorded in the subsequent experiments.

b) Patch Clamp recordings in slices of the neocortex

Clemens Boucsein, Neurobiologie und Biophysik, Inst. Biol. III

Here, students will get the opportunity to perform their own patch-clamp recordings from layer V pyramidal cells of rat neocortex. Basic current and voltage clamp protocols will be applied to study the passive electrical properties as well as voltage gated ion channels of those cells.

c) Investigation of the synaptic plasticity in the hippocampus with microelectrode arrays

Ulrich Egert, Samora Okujeni & Steffen Kandler, Neurobiologie und Biophysik, Inst. Biol. III

In this part students will get to know the following neurophysiological topics and methods:

- Paired-Pulse facilitation and Long-Term-Potentiation as examples of synaptic plasticity
- Temporal and spatial interaction in neuronal tissue
- Acute slices of the hippocampus as an experimental model
- Extracellular recording of population potentials
- Extracellular stimulation
- Quantitative analysis of local field potentials

As a general preparation please **read before the course**: Schmidt, R.F. und Thews, G. Physiologie des Menschen, 26.Aufl. Springer Vlg. Chapter 2: Informationsvermittlung durch elektrische Erregung; Chapter 3: Erregungsübertragung von Zelle zu Zelle; or any suitable introductory chapter on information transmission in neuronal systems

Schedule for the course Neurophysiology II

group	Mo	Tue	Wed	Thu	Fr		Mo	Tue	Wed	Thu	Fr		Mo	Tue	Wed	Thu	Fr
1	talks	anatomy					patch clamp exp.				syn.		plasticity exp.			data analy., talk prep.	talks
2				anatomy			syn. plasticity exp.				pat-		ch clamp exp.				

talks:

9:15, central seminar room, Lab AG Aertsen, 5th floor Schänzlestr. 1

anatomy (Jochen Staiger, Csaba Dávid, Anna Gross):

9:00, 2. floor, room 009 ZfN, Albertstrasse 23

Introduction to neuroanatomy and immunohistochemistry of the hippocampus and neocortex of the rat

synaptic plasticity experiments (Ulrich Egert, Steffen Kandler, Samora Okujeni)

9:15, Biomikrotechnik, Georges-Köhler-Allee 102, IMTEK, Fakultät für Angewandte Wissenschaften

1. day: Experiment 1: **Determine the stimulus/response function in acute slices of the hippocampus**

2. day: **Analysis of the data from experiment 1**

3. day: Experiment 2 & 3: **Time constants of the neuronal response to electrical stimulation in LFP recordings, Induction of long-term potentiation**

4. day: **Analysis of the data from experiments 2 & 3**

patch clamp experiments (Clemens Boucsein):

9:15, Lab AG Aertsen, 5th floor Schänzlestr. 1

1. day: **Introduction to the patch-clamp technique and first own experiments**

2. day: Experiment 1: **Determination of cell parameters to characterize pyramidal cell properties in current clamp mode**

3. day: Experiment 2: **Pharmacological separation of typical currents in pyramidal cells with the voltage-clamp-technique**

4. day: **Analysis of the data from both experiments**