Course: Systems Neuroscience – GS14 1024 – Spring 2020  
Course Director: Valentin Dragoi

Basics: 4 credit course meeting Tues/Thurs from 10:45-12:45


Lecturers: Dr. Michael Beierlein (2 hrs), Dr. Jack Byrne (1 hr), Dr. Valentin Dragoi (31 hrs), Dr. Dan Felleman (14 hrs), Dr. Harel Shouval (8 hrs), Dr. Shin Nagayama (2 hrs).

Evaluation: Three take-home examinations will be used to assess the student’s acquisition of presented information. Grades, A, B, C, F will be assigned based on exam performance and student participation in class.

Lecture outline

0. **Introduction to Systems Neuroscience** – 2 hrs, Dragoi

1. **Functional neuroanatomy (12 hrs)**
   a. Brain anatomy – 1 hr, Felleman
   b. Ascending and descending pathways – 1 hr, Felleman
   c. Functional imaging techniques I (intrinsic signal imaging, voltage-sensitive dye imaging) – 1 hr, Felleman
   d. Functional imaging techniques II (two-photon imaging) – 1 hr, Nagayama
   e. Functional architecture of the cerebral cortex – 2 hrs, Felleman
   f. Cell types – 1 hr, Beierlein
   g. Cortical circuits (feedforward circuits) – 1 hr, Beierlein
   h. Cortical circuits (recurrent circuits, canonical microcircuits) – 2 hrs, Dragoi
   i. Long-range intracortical connections – 1 hr, Dragoi
   j. Inter-areal cortical connections (feedforward, feedback, corticofugal, cortico-cortical connections, etc) – 1 hr, Felleman

EXAM 1

2. **Neural circuits and information processing (12 hrs)**
   a. Receptive fields – 1 hr, Dragoi
   b. Signal detection theory – 1 hr, Shouval
   c. Subcortical processing (retinal circuits and thalamus) – 1 hr, Dragoi
   d. Cortical processing (non-linear properties of cortical responses) – 1 hr, Dragoi
   e. Cortical processing: Extra-classical receptive field influences – 1 hr, Dragoi
   f. Neuronal response properties revealed by imaging techniques – 1 hr, Felleman
g. Cortical processing: Top-down modulation – 1 hr, Dragoi
h. Multiple-electrode recording (multiple single units, LFPs, EEG) – 2 hrs, Dragoi
i. Neuronal synchronization – 1 hr, Shouval
j. Signal and noise correlations – 1 hr, Dragoi
k. Introduction to population coding and decoding – 1 hr, Shouval

EXAM 2

3. From neural circuits to systems (12 hrs)
a. Visual pathways – 1 hr, Dragoi
b. Auditory pathways – 1 hr, Dragoi
c. Somatic sensory system – 1 hr, Felleman
d. Olfactory system – 1 hr, Nagayama
e. Motor control – 1 hr, Felleman
f. Association cortex (overview: parietal, temporal, prefrontal, etc) – 2 hrs, Dragoi
g. Sensory motor integration (eye movements, motor planning) – 2 hrs, Dragoi
h. Space representation (hippocampus, entorhinal cortex) – 2 hrs, Shouval
i. Representation of reward – 1 hr, Shouval
j. Student presentations – 2 hrs, TBD

4. Development and plasticity of neuronal circuits (11 hrs)
a. Population matching: retino-tectal, spont activity vs experience dependent retino-thalamic-thalamo-cortical, postnatal maturation of circuits and properties – 1 hr, Felleman
b. Mechanisms of short-term synaptic plasticity – 1 hr, Byrne
c. Mechanisms of long-term synaptic plasticity – 2 hrs, Shouval
d. Development of cortical circuits – 2 hrs, Felleman
e. Adaptation-induced plasticity – 2 hrs, Dragoi
f. Learning-induced plasticity – 2 hrs, Dragoi
g. Recovery from neural injury – 2 hrs, Felleman
h. Student presentation – 2 hrs, TBD

EXAM 3

5. General discussion and conclusions – 2 hrs, Dragoi