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

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


Lecturers: Dr. Michael Beierlein (3 hrs), Dr. Jack Byrne (1 hr), Dr. Valentin Dragoi (26 hrs), Dr. Dan Felleman (11 hrs), Dr. Harel Shouval (8 hrs), Dr. Fabricio Do Monte (5 hrs), Dr. Christophe Ribelayga (2 hrs), Dr. Shin Nagayama (2 hrs), Dr. Patrick Dougherty (1 hr).

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 (11 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. Cell types – 1 hr, Beierlein
   f. Cortical circuits (feedforward circuits) – 1 hr, Beierlein
   g. Cortical circuits (recurrent circuits, canonical microcircuits) – 2hrs, Dragoi
   h. Long-range intracortical connections – 1 hr, Dragoi
   i. Inter-areal cortical connections (feedforward, feedback, corticofugal, cortico-cortical connections, etc) – 1 hr, Felleman
   j. Functional architecture of the cerebral cortex – 1 hr, Felleman

EXAM 1

2. Neural circuits and information processing (11 hrs)
   a. Receptive fields – 1 hr, Dragoi
   b. Signal detection theory – 1 hr, Shouval
   c. Cortical processing (non-linear properties of cortical responses) – 1 hr, Dragoi
   d. Cortical processing: Extra-classical receptive field influences – 1 hr, Dragoi
   e. Neuronal response properties revealed by imaging techniques – 1 hr, Felleman
f. Cortical processing: Top-down modulation – 1 hr, Dragoi

g. Multiple-electrode recording (multiple single units, LFPs, EEG) – 2 hrs, Dragoi

h. Neuronal synchronization – 1 hr, Shouval

i. Signal and noise correlations – 1 hr, Dragoi

j. Introduction to population coding and decoding – 1 hr, Shouval

3. From neural circuits to systems (11 hrs)
   a. Visual pathways – 1 hr, Dragoi
   b. Auditory pathways – 1 hr, Dragoi
   c. Somatic sensory system – 1 hr, Dougherty
   d. Olfactory system – 1 hr, Nagayama
   e. Motor control – 1 hr, Beierlein
   f. Association cortex (parietal, temporal, prefrontal, etc) – 2 hrs, Dragoi
   g. Sensory motor integration (eye movements, motor planning) – 1 hr, Dragoi
   h. Space representation (hippocampus, entorhinal cortex) – 2 hrs, Shouval
   i. Representation of reward – 1 hr, Shouval

EXAM 2

4. Plasticity and development of neural circuits (10 hrs)
   a. Synaptic plasticity – 1 hr, Byrne
   b. Consequences of synaptic plasticity – 2 hrs, Shouval
   c. Adaptation-induced plasticity – 1 hr, Dragoi
   d. Learning-induced plasticity – 2 hrs, Dragoi
   e. Development of cortical circuits – 3 hrs, Felleman
   f. Recovery from neural injury – 2 hrs, Felleman

5. Brain state (8 hrs)
   a. Impact of brain state on neural responses – 1 hr, Dragoi
   b. Circadian rhythms, arousal, and sleep – 2 hrs, Ribelayga
   c. Stress – 1 hr, Do Monte
   d. Fear and anxiety – 2 hrs, Do Monte
   e. Reward and motivation – 2 hrs, Do Monte

EXAM 3