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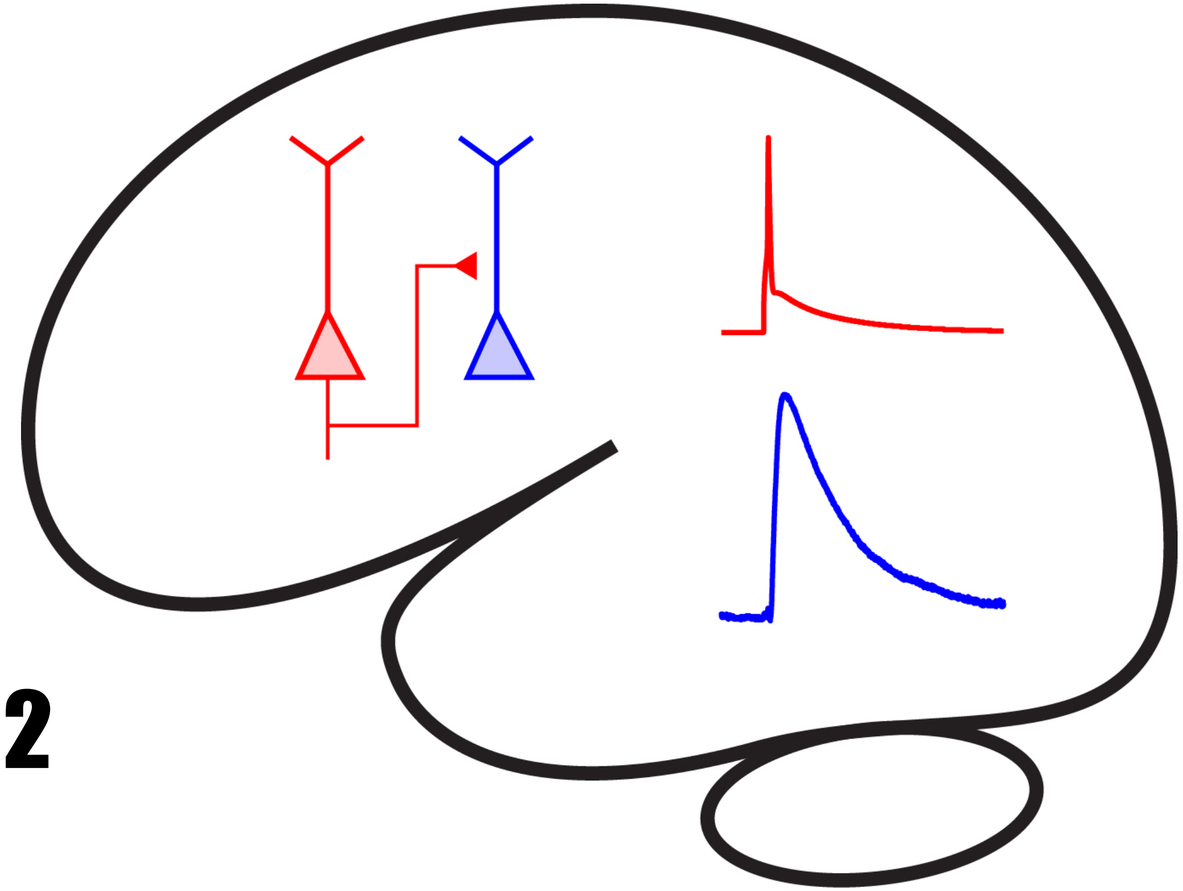

Neuroscience – BIO-482

Cellular and Circuit Mechanisms of Brain Function

Sylvain Crochet and Carl Petersen

Course overview

In this course we will take a ‘bottom-up’ approach.

We will start with the components of the brain and then gradually try to see how they work together.

We aim for a causal understanding of the biophysical mechanisms of brain function.

Course overview

The course is divided into two major parts:

a) Massive Open Online Course (MOOC) in the form of video lectures, questions and discussion (Weeks 1-9).

b) Mini-project to enhance quantitative understanding of neuronal function, as well as providing transversal skills in computer coding and data analysis (Weeks 10-14).

Course overview

Teachers:	MOOC	Carl Petersen & Sylvain Crochet
	Mini-project	Sylvain Crochet
Teaching assistants (TAs):		Meriam Malekzadeh
		Nishant Jana
		Lana Smith
		Jinyun Wu

Course overview

Moodle

https://moodle.epfl.ch/course/BIO-482

Course overview

Two mandatory parts of the course:

1) Attend the written exam on **Wednesday 13 November**

2) Hand your individual mini-project report by **Friday 20 December midnight.**

Course overview

1) MOOC – Weeks 1-7

Each week in your own time:
You should watch the Videos (*edX, YouTube, Courseware*)
You can also read the Lecture notes.

Each week on Fridays:
You should go through the Questions (*Moodle*)
Friday Exercises with TAs 13:15-14:00 (*CE 1106*)
Friday Discussion with Sylvain 14:15-15:00 (*CE 1106*)

MOOC videos

The MOOC videos are available from 4 sources:

https://www.edx.org/course/cellular-mechanisms-of-brain-function

https://www.swissmooc.ch/courses/bio482/

https://www.epfl.ch/labs/lsens/mooc/

https://doi.org/10.5281/zenodo.3974482

Week 1 - Electrical properties of cell membranes

MOOC videos

1.1 Introduction
1.2 The cell membrane
1.3 Ion channels
1.4 Membrane potential
1.5 Cable properties

13 September, 13:15-14:00 – Exercises (TAs)
13 September, 14:15-15:00 – Discussion (Sylvain)

Week 2 – Excitability

MOOC videos

- 2.1 Voltage-gated channels
- 2.2 Voltage-gating kinetics
- 2.3 The action potential
- 2.4 Action potential propagation
- 2.5 Whole-cell recordings

20 September, 13:15-14:00 – Exercises (TAs)

20 September, 14:15-15:00 – Discussion (Sylvain)

Week 3 – Synaptic transmission

MOOC videos:

3.1 Synaptic transmission
3.2 Neurotransmitter release
3.3 Presynaptic dynamics
3.4 Presynaptic modulation
3.5 Electron microscopy

27 September, 13:15-14:00 – Exercises (TAs)
27 September, 14:15-15:00 – Discussion (Sylvain)

Week 4 - Glutamatergic excitation

MOOC videos:

- 4.1 Glutamate receptors
- 4.2 Postsynaptic potentials
- 4.3 Glutamatergic circuits
- 4.4 Synaptic plasticity
- 4.5 Dendritic spines

4 October, 13:15-14:00 – Exercises (TAs)

4 October, 14:15-15:00 – Discussion (Sylvain)

Week 5 – GABAergic inhibition

MOOC videos:

5.1 GABAergic inhibition
5.2 Inhibitory synaptic conductances
5.3 Benzodiazepines
5.4 GABAergic projections
5.5 Neocortical inhibition

11 October, 13:15-14:00 – Exercises (TAs)
11 October, 14:15-15:00 – Discussion (Sylvain)

Week 6 – Measuring and controlling brain function

MOOC videos:

6.1 Brain function and behavior
6.2 Man and mouse
6.3 Imaging the brain in action
6.4 In vivo electrophysiology
6.5 Controlling brain function

18 October, 13:15-14:00 – Exercises (TAs)
18 October, 14:15-15:00 – Discussion (Sylvain)

=> Fall break 21-27 October

Week 7 – Mechanisms of brain (dys)-function

MOOC videos:

- 7.1 Sensorimotor interactions
- 7.2 Sensory perception
- 7.3 Learning
- 7.4 Brain dysfunction
- 7.5 Concluding remarks

1 November, 13:15-14:00 – Exercises (TAs)

1 November, 14:15-15:00 – Discussion (Sylvain)

Week 8 – Mock Exam

6 November, 13:15-15:00 – Mock exam (TAs)

8 November, 13:15-15:00 – Answers to Mock exam (TAs)

Week 9 – Exam and Mini-project introduction

13 November, 13:15-16:00 in room XX – Written exam (Sylvain, TAs)

The written exam will count towards two-thirds of your final grade.

No document or electronic device allowed

15 November, 13:15-15:00 in room CE 1106 – Mini-project introduction (Sylvain)

Weeks 10-14 – Mini-project

In the mini-project, you will use Matlab/Python to analyse a database of *in vivo* recordings of membrane potential during mouse behavior. The data are published:

Kiritani T, Pala A, Gasselin C, Crochet S, Petersen CCH (2023) Membrane potential dynamics of excitatory and inhibitory neurons in mouse barrel cortex during active whisker sensing. PLOS ONE 18: e0287174. https://doi.org/10.1371/journal.pone.0287174

Kiritani T, Pala A, Gasselin C, Crochet S, Petersen CCH (2023) Data set for "Membrane potential dynamics of excitatory and inhibitory neurons in mouse barrel cortex during active whisker sensing." [Data set]. Zenodo. https://doi.org/10.5281/zenodo.7833080

Weeks 10-14 – Mini-project

* Please have Matlab/Python installed on your laptop before coming to class.

* Please download the dataset before coming to class.

Wednesday mini-project sessions will be in CM 1105.
Friday mini-project sessions will be in CE 1106.

Weeks 10-14 – Mini-project

20 November, 13:15-15:00 – Mini-project (Sylvain Crochet + TAs)
22 November, 13:15-15:00 – Mini-project (Sylvain Crochet + TAs)

27 November, 13:15-15:00 – Mini-project (Sylvain Crochet + TAs)
29 November, 13:15-15:00 – Mini-project (Sylvain Crochet + TAs)

4 December, 13:15-15:00 – Mini-project (Sylvain Crochet + TAs)
6 December, 13:15-15:00 – Mini-project (Sylvain Crochet + TAs)

11 December, 13:15-15:00 – Mini-project (Sylvain Crochet + TAs)
13 December, 13:15-15:00 – Mini-project (Sylvain Crochet + TAs)

18 December, 13:15-15:00 – Mini-project (Sylvain Crochet + TAs)
20 December, 13:15-15:00 – Mini-project (Sylvain Crochet + TAs)

Week 14 – Mini-project submission

20 December – Submit mini-project before midnight to:
sylvain.crochet@epfl.ch

The mini-project will count towards one-third of your final grade.

Course overview

Two mandatory parts of the course:

1) Attend the written exam on **Wednesday 13 November**

2) Hand your individual miniproject report by **Friday 20 December midnight.**