# Neurofunctional Techniques

**Lesson 1**

30 September 2026

**Course presentation**

UNIVERSITÀ DEGLI STUDI DI TRIESTE

Department of Life Sciences

Home | Department | Research | Teaching | Post Graduate Studies | Services and Equipment | Knowled

- Research Areas
  - Biomedicine
  - Environmental Biology
  - Psychology
- Research Centres
  - Alpine Center for Botanical Studies in Pura Pass
- Research Outcomes
  - Large International Projects
  - Software and databases
  - Monthly summary of Q1 publications
  - Top cited articles
  - ArTS research archive
- Publications of the Department
- Conferences

## Synaptic neurophysiology (Prof. Cingolani)

**Research Strand:** Neurosciences (Biomedicine)




**Lorenzo Cingolani**

Associate Professor in Physiology (BIO/09)

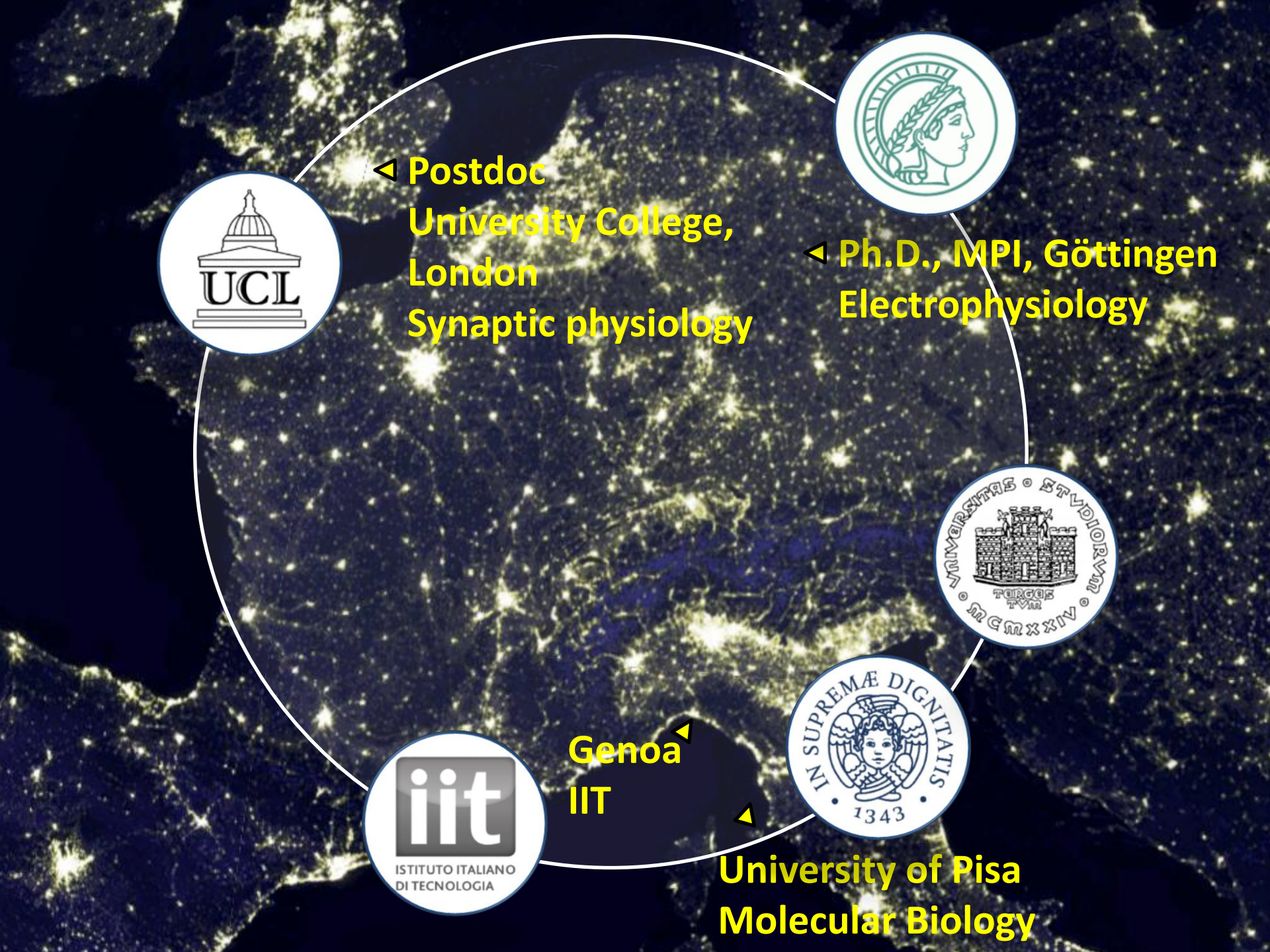
Phone: +39 040 5588728
Email: lcingolani@units.it
Skype: la.cingolani
Twitter: @CingolaniLab

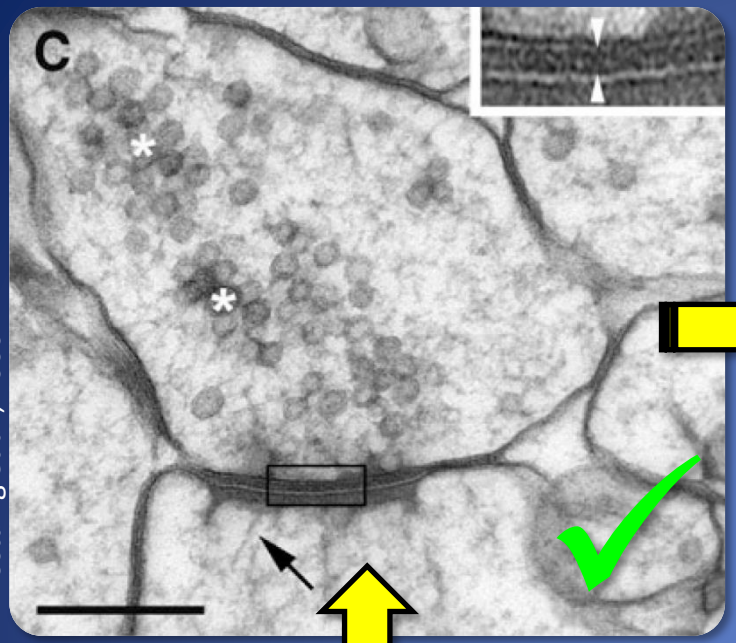

**Biosketch**

After graduating in Molecular Biology at the University of Pisa (Italy), I obtained a Ph.D. fellowship to work at the Max-Planck Institute for Experimental Medicine, Göttingen (Germany). Here, I specialized in

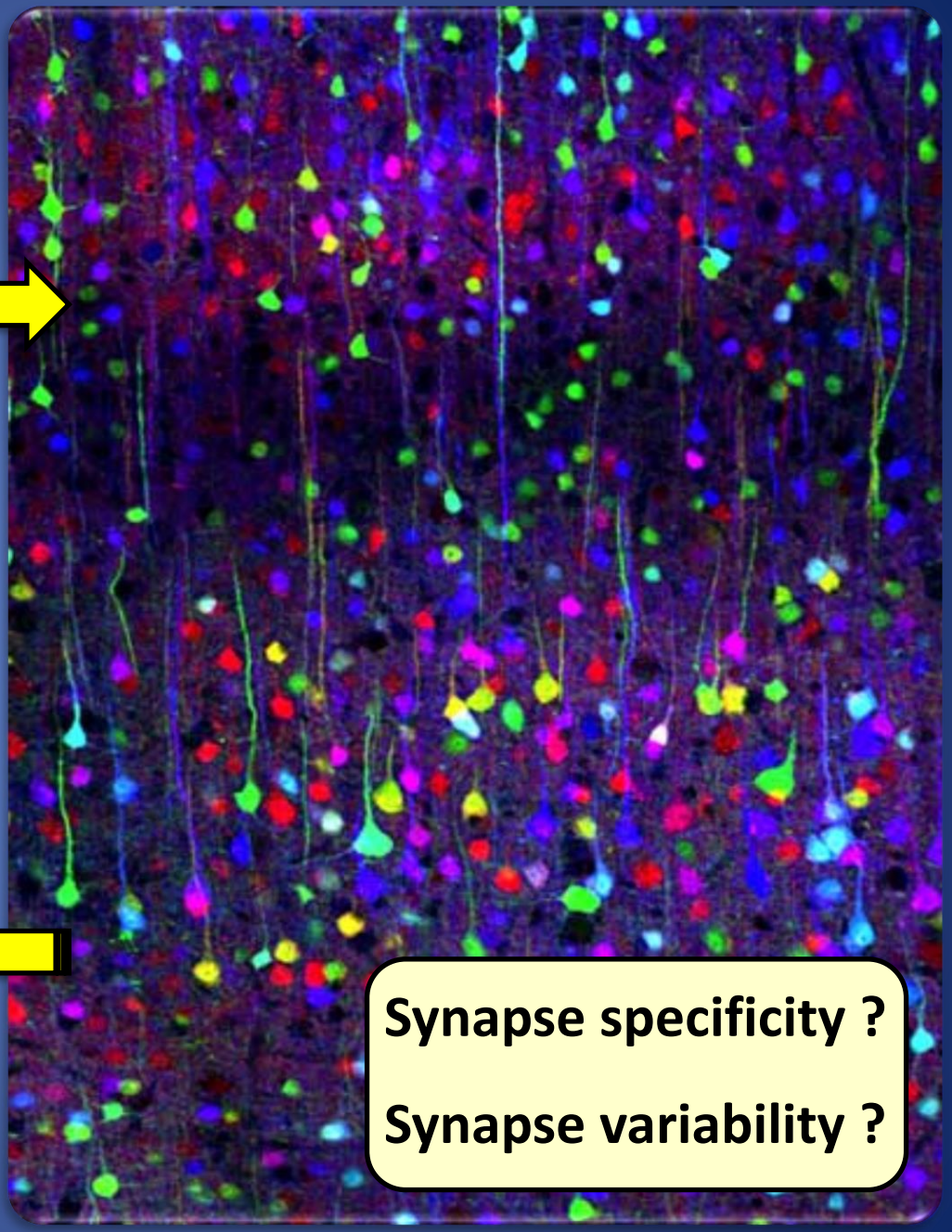
**Building Q - rooms 216 & 311**

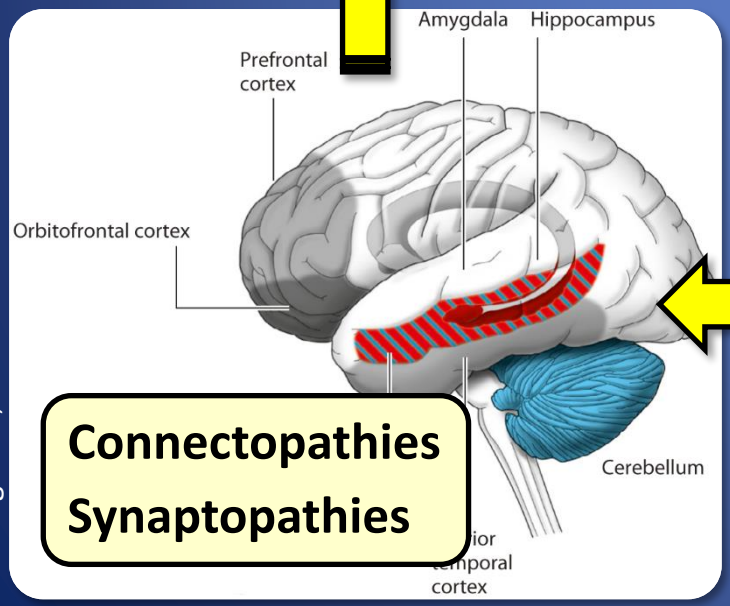



Postdoc
University College,
London
Synaptic physiology
Ph.D., MPI, Göttingen
Electrophysiology
Genoa
IIT
University of Pisa
Molecular Biology




Rostaing et al., 2006





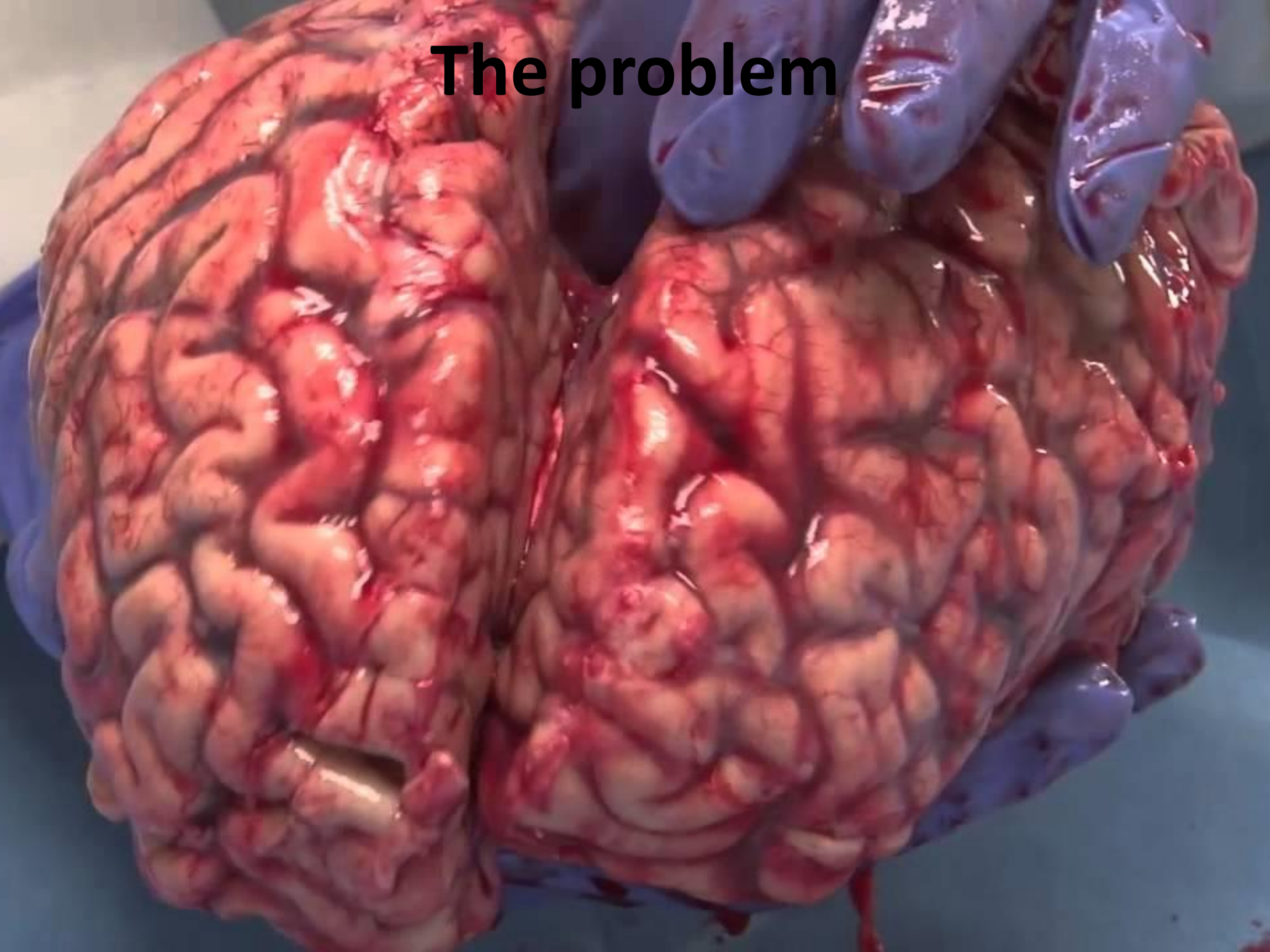

Wang et al., 2014

**Connectopathies**
**Synaptopathies**

**Synapse specificity ?**

**Synapse variability ?**

# The problem



# The problem

- **Human brain: 1 $dm^3$ = 1 l**

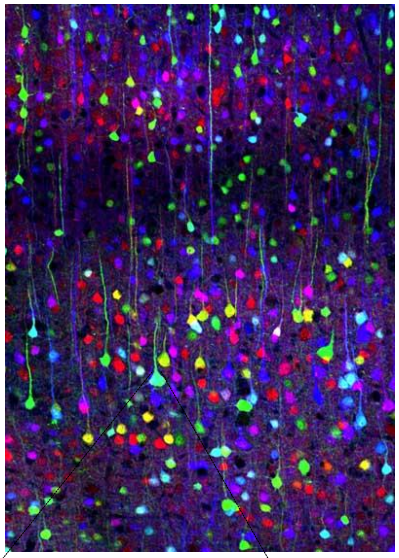


- **Rodent brain: 1 $cm^3$ = 1 ml**



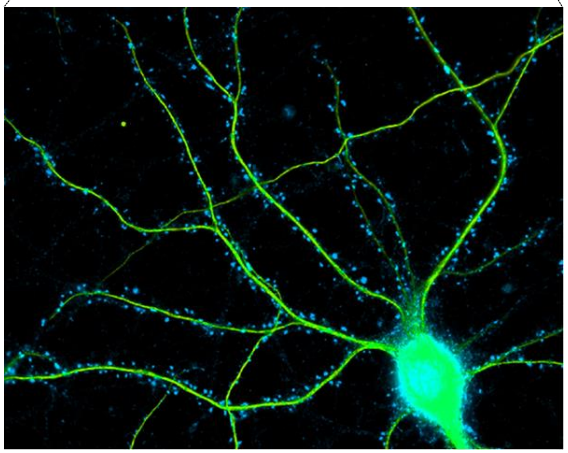
# The problem

- **1 $mm^3$ (= 1 µl) of mammalian cortex**



- **Number of synapses/neuron: $10^3$ - $10^4$**

- **Number of synapses in the human brain: $10^{15}$**



# An example: connectomics





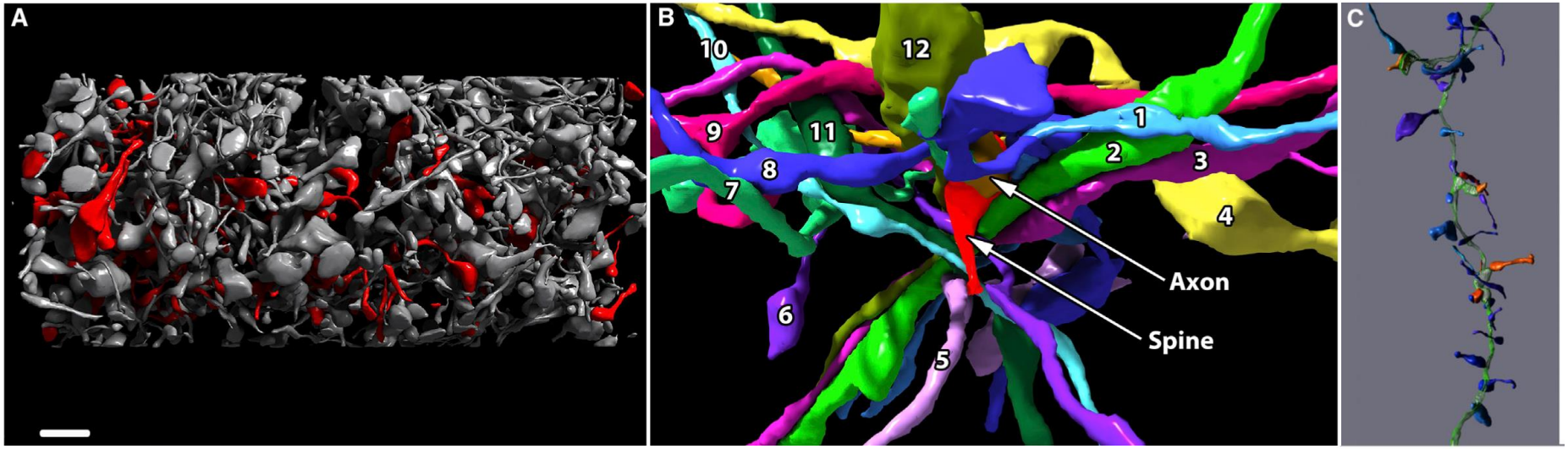


# An example: connectomics

**1500 $\mu m^3$**

**1700 synapses**

**1.13 synapses/$\mu m^3$**

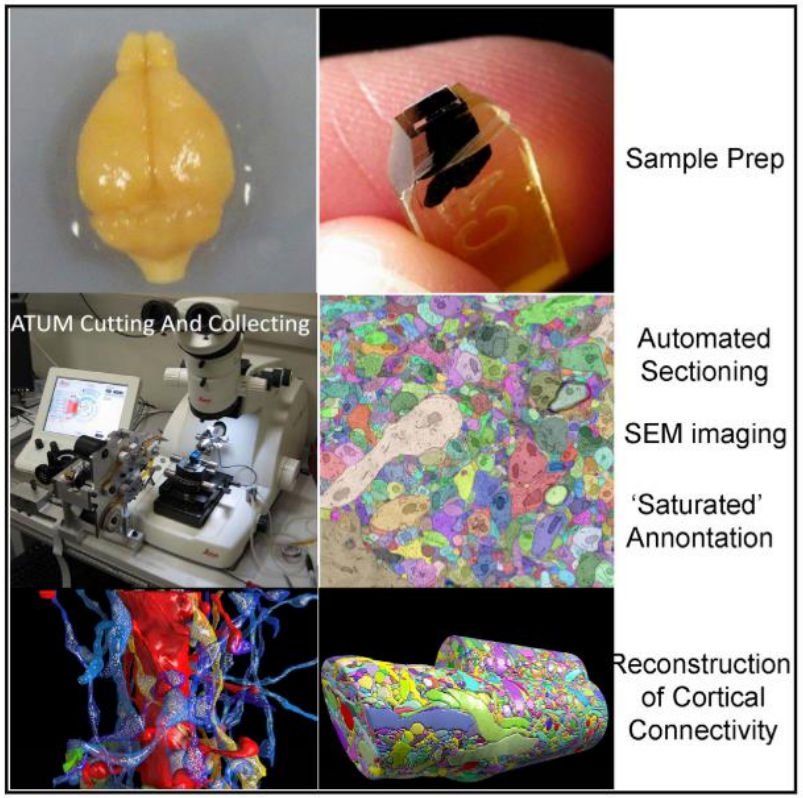


Cell



# Saturated Reconstruction of a Volume of Neocortex

## Graphical Abstract




## Authors

Narayanan Kasthuri, Kenneth Jeffrey Hayworth, Daniel Raimund Berger, ..., Carey Eldin Priebe, Hanspeter Pfister, Jeff William Lichtman

## Correspondence

bobby.kasthuri@gmail.com (N.K.), jeff@mcb.harvard.edu (J.W.L.)

## In Brief

Automated technologies probing the structure of neural tissue at nanometer resolution generate a saturated reconstruction of a sub-volume of mouse neocortex, refuting the idea that physical proximity is sufficient to predict excitatory synaptic connectivity.

## Highlights

- Tape-based pipeline for electron microscopic reconstruction of brain tissue
- Annotated database of 1,700 synapses from a saturated reconstruction of cortex
- Excitatory axon proximity to dendritic spines not sufficient to predict synapses

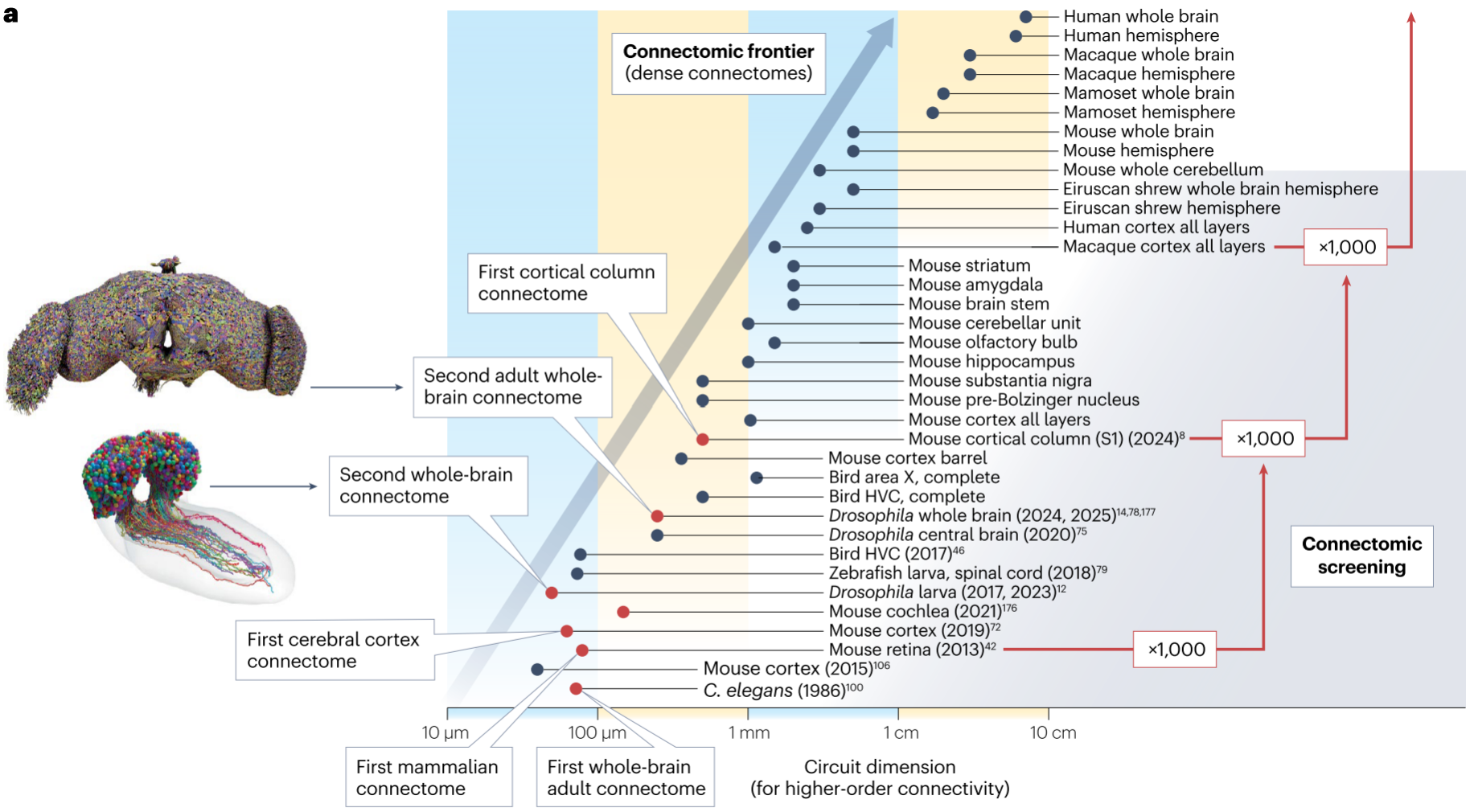
2015 Jul 30;162(3):648-61.
doi: 10.1016/j.cell.2015.06.054

nature reviews neuroscience
https://doi.org/10.1038/s41583-025-00998-z

Review article

Check for updates

# Synaptic-resolution connectomics: towards large brains and connectomic screening



# What can we learn from this example?

1) **The study of the brain poses special challenges**

2) **The development of new ‘cutting-edge’ techniques allows us to address long-standing questions**

# One major objective of the course

**Being able to understand a 2026 neuroscience paper**

1. **Understanding = doing**
2. **Which questions can I address?**

~~**Question → Technique I need**~~

**Technique I have → Question I can address**

# Structure of the course

**Lorenzo Cingolani** **6 CFU (48 hrs)**

**lcingolani@units.it** **Building Q - rooms 216**

| | | |
|---|---|---|
| **When :** | **Wednesday** | **14:00 - 16:00 (room L)** |
| | **Friday** | **14:00 - 18:00 (room L)** |

# Structure of the course

- **Face-to-face course**
- **In exceptional cases, you can follow in remote via Microsoft Teams (MT)**
- **Lessons will be recorded and available on MT (team code: dsu34v6)**
- **Materials (presentations, papers, articles, book chapters) loaded on Moodle before lessons**
- **Laboratory**

# How to study the brain:

1. How to 'watch' brain activity:
   A. Functional imaging
   B. Electrophysiology
   C. Behavior
2. How to 'tell' the brain what to do:
   A. Optogenetics
   B. X-genetics
3. How to repair the brain:
   A. Genome editing
   B. X-genetics

# Structure of the course

**For each technique:**

1. **Theory (book chapters + reviews)**
2. **Practice (exercises to understand theory)**
3. **Applications (milestone papers and key questions)**
4. **Laboratory (for selected techniques)**

# Structure of the exam

1. **Paper presentation in small groups (5 students 2 hours)**
   **Presentation + questioning: 20 points (+1 bonus)**

   a) **Presentation (10 min per student, total 50 min)**
      - **What was known?**
      - **What is the gap?**
      - **What are the main findings?**
      - **Are the techniques appropriate?**
      - **What are the broader implications?**

   b) **Questioning on individual figures and techniques used (14 min per student, total 70 min)**

2. **Questionnaire on the Moodle platform.**
   **10 multiple choice questions. 1 point each. Each question has only one correct answer**
   **Moodle questionnaire: 10 points.**

# Calendar

- **W 30 Sept:** Course introduction (14-16)
- **F 2 Oct:** Review neurophysiology + Functional imaging (14-18)
- **F 23 Oct:** Functional imaging + introduction to paper presentation (14-18)
- **W 28 Oct:** Functional imaging (14-18)
- **F 30 Oct:** Introduction to paper presentations (14-18)
- **W 4 Nov:** Modeling + paper assignment (14-16)
- **F 6 Nov:** Molecular tools + optogenetics (14-18)
- **F 13 Nov:** X-genetics + paper discussion (14-18)
- **F 20 Nov:** Laboratory (14-18)
- **F 27 Nov:** Paper presentation (14-18)
- **F 4 Dec:** Paper presentation (14-18)
- **F 11 Dec:** Paper presentation (14-18)
- **Tue 15 Dec:** Test (14-16)
- **Fri 18 Dec:** Seminar Prof. Agenor Limon (University of Texas; 14-18)