

# Life Sciences Engineering: Genome To Function

## Welcome!



# Today's menu

## Introduction to course:

- Overview of **goals and contents** of the course
- Some **practical aspects**

## Lecture 1:

- Decoding and Understanding Genomes

# Overall goals

- Taking you on a journey from **genome to function**
- **Understand** how the genome can be engineered, interrogated and its output analyzed to uncover biological function
- **Transversal themes** in the life sciences engineering: widely applicable concepts and analytical tools (e.g. for cell cycle and proliferation control)

# Contents (in brief)

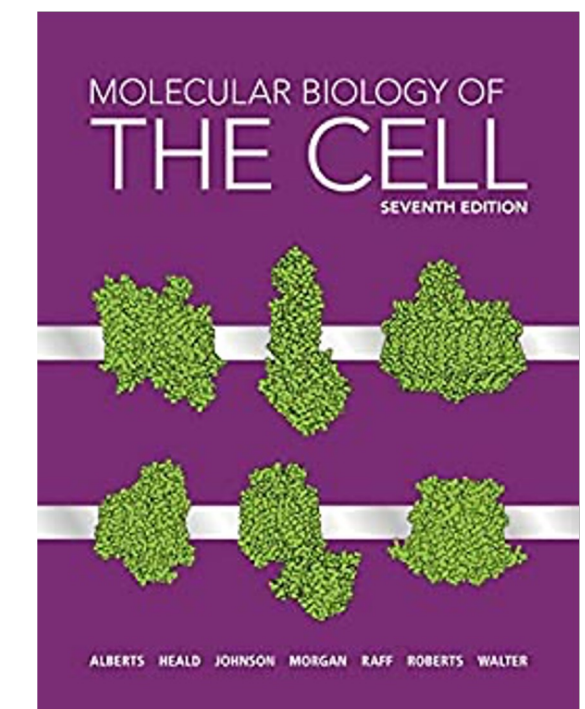
- Module 1: Understand how **genomes can be engineered**  
Brian McCabe
- Module 2: Understand how **genome function can be deciphered**  
Pierre Gönczy
- Module 3: Understand and model **gene expression dynamics**  
Félix Naef

# Cautionary notes

- Part of what will be covered –in particular in module 1- **may be known to many of you**
- Note, however, that **not everyone has the same background**, and we want to bring everyone up to speed
- **Supplementary material** is available on Moodle
- **In addition**, TAs will be available during the exercise sessions to help fill potential knowledge gaps
- Regardless of your background, the contents will rapidly become **more complex**

# Typical weekly cycle

- **Thursday, 1:15pm – 3pm, CM1 1:** lecture (with three exceptions)
- **Monday, 4:15pm - 6pm, SG 0211:** exercises (with three exceptions)
- **TAs: Petra Balbi, Florian Curvaia, Angelika Gebhart, Amin Khan**
- Lecture available on **Moodle** typically the Tuesday before (augmented version after lecture)
- Additional information if needed:  
**Molecular biology of the cell** (copies at the library)
- **Further references** in weekly lectures



# Topics (week indicates that of lecture)

- **Week 1:** Decoding & Understanding Genomes (BM)
- (Lecture: Monday Sep. 8<sup>th</sup>, CO2; exercises Thursday Sep. 11<sup>th</sup>, CM 1)
- **Week 2:** Manipulating Nucleotides 1 (BM)
- (Lecture: Monday Sep. 15<sup>th</sup>, CO2 (*tbc*); exercises Thursday Sep. 18<sup>th</sup>, CM 1)
- **Week 3:** Manipulating Nucleotides 2 (BM)
- **Week 4:** Manipulating Proteins (BM)
- (Lecture: Monday Sep. 29<sup>th</sup>, CO2 (*tbc*); exercises Thursday Oct. 2<sup>nd</sup>, CM 1)
- **Week 5:** Forward genetic screens (PG)
- **Week 6:** Functional genomic screens (PG)
- **Week 7:** Synthetic lethal screens + chemical genomics (PG)

# Topics (continued)

- **Week 8:** Interfering with proteins + analyzing non-model organisms (PG)
- **Week 9:** Gene expression dynamics: Deterministic models (FN)
- **Week 10:** Gene expression dynamics: Stochasticity (FN)
- **Week 11:** Periodic gene expression dynamics: cell-cycle (FN)
- **Week 12:** Periodic gene expression: 24h rhythms (FN)
- **Week 13:** Mock exam questions + Q&A
- **Week 14:** Continuous control (70% of final grade)

# Exercise sessions

- Exercises are related to topic of previous week, and will put your **problem-solving skills** into practice
- Exercises: **integral part of the course**
- **Weeks 1 and 4** of each module: reading scientific paper, questions stemming from lecture, solving problems, computational exercises, ...
- **Weeks 2 and 3** of each module: randomly formed groups of 4 students work together on written graded assignments; corrections in week 4 of each module
- **Assignment due dates:** October 5<sup>th</sup> (Module 1), November 9<sup>th</sup> (Module 2), December 7<sup>th</sup> (Module 3)

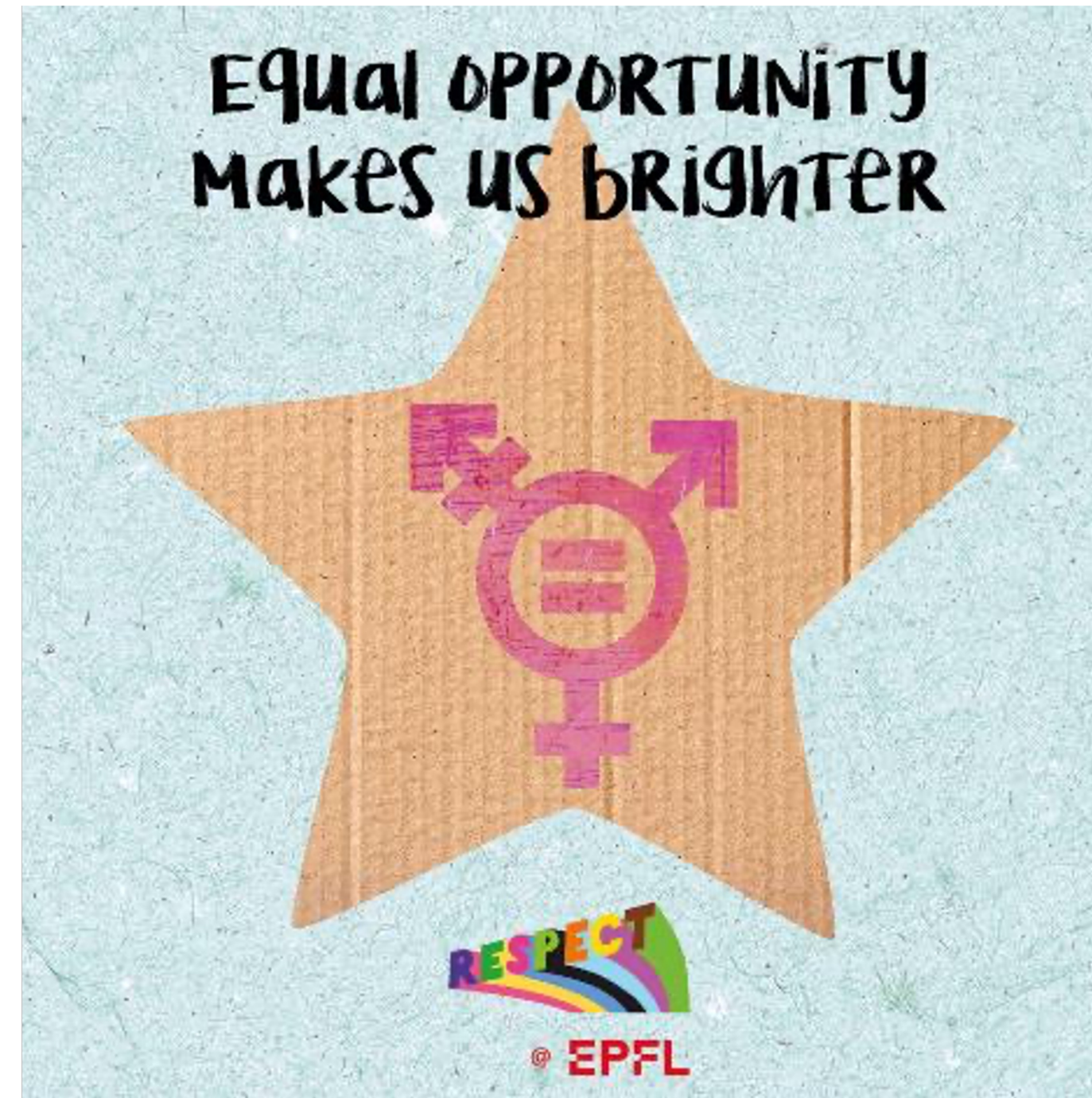
# Course evaluation

- In weeks 2 and 3 of each module: group **written assignment**, each 10% of the final grade (i.e. 30% in total); **everyone must contribute!**
- **Continuous control** in week 14 (Monday December 15<sup>th</sup>), 2 hours, mix of multiple choice and open questions, 5 pages (double-sided) of notes allowed; 70% of the grade.
- Note that that the continuous control will cover material seen and discussed during **both lectures and exercises**
- **Examen blanc** on the open questions part (multiple choice practiced throughout lectures) + Q&A -December 11<sup>th</sup>

# Generative AI in projects?

- Possible, but **remember** that leaving the task to generative AI in the projects will not prepare you to solve analogous problems during the continuous control
- It is good practice to **disclose** the use of generative AI
- Ultimately, you are **the one responsible** for what is written

# Obvious reminder: core values





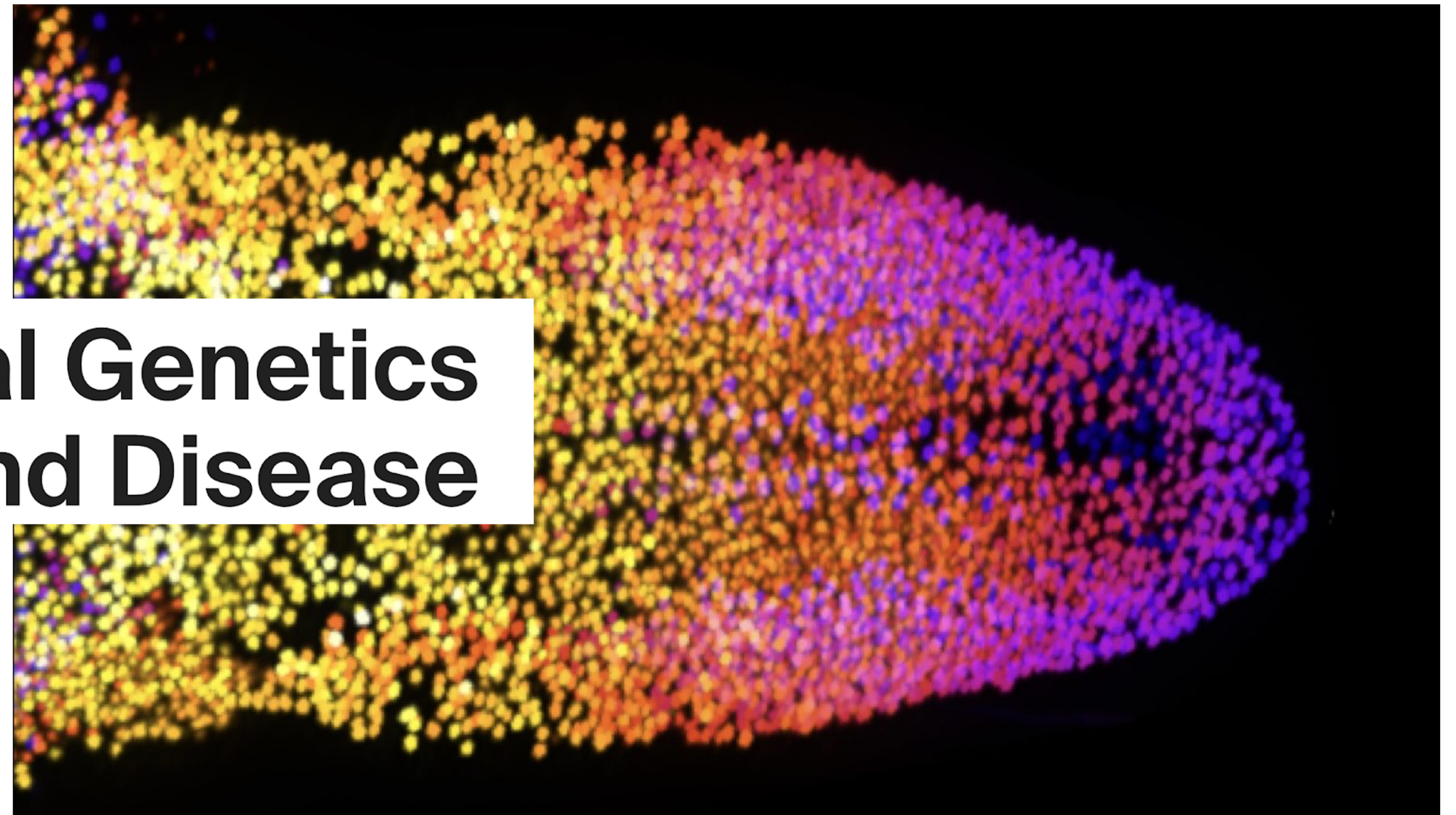
**Who are we?**

# Who are we?

**Brian McCabe**

Dublin > Cambridge > Berkeley > New York City > Lausanne

**Laboratory of Neural Genetics  
and Disease**



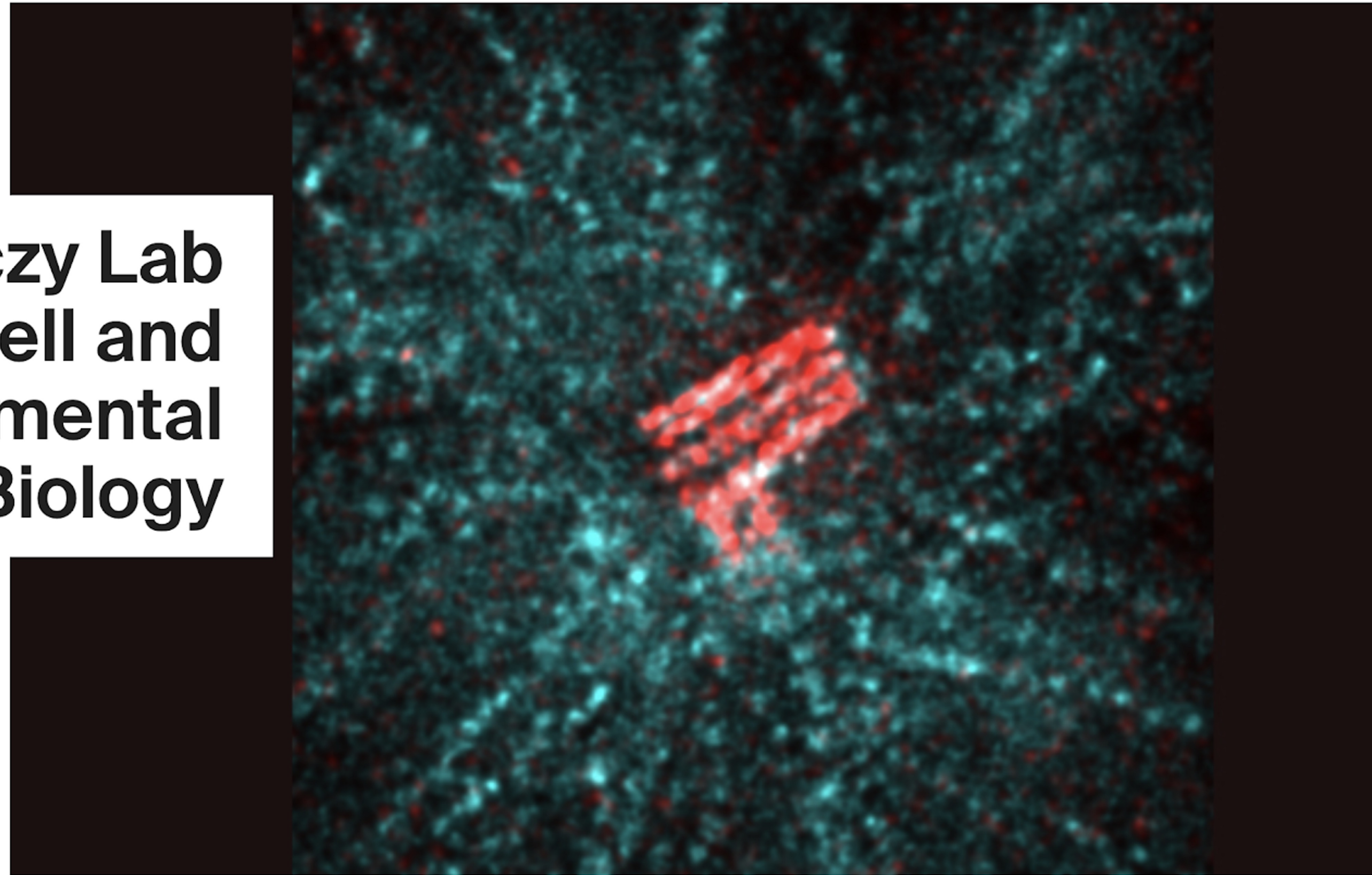
<https://mccabelab.org>

# Who are we?

**Pierre Gönczy**

Geneva > New York City > Heidelberg > Lausanne

**Gönczy Lab  
Cell and  
Developmental  
Biology**



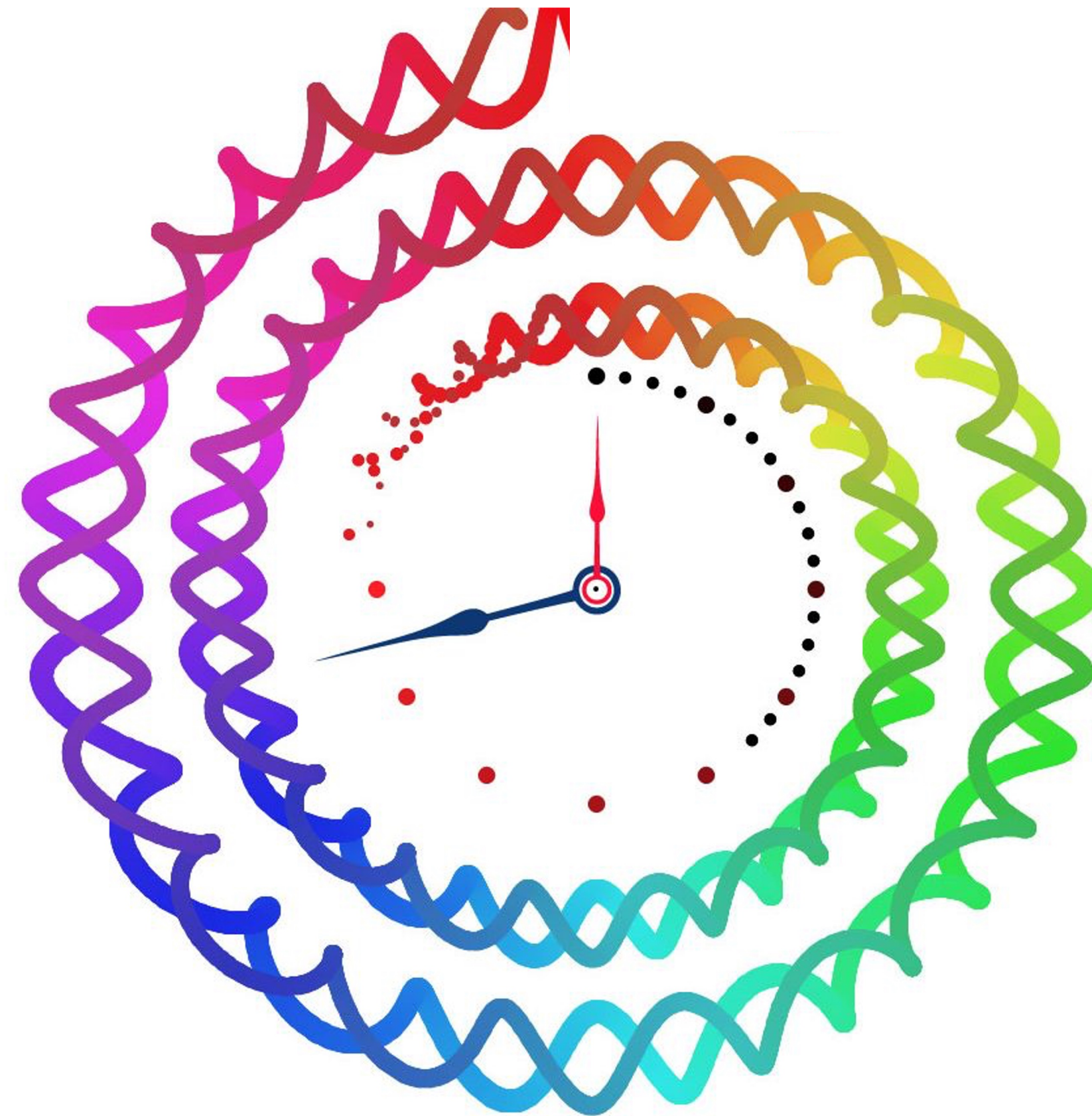
<https://www.epfl.ch/labs/gonczy-lab/>

# Who are we?

**Felix Naef**

Zürich > Lausanne > New York City > Lausanne

**Naef lab – UPNAE Laboratory of  
Computational and Systems  
Biology**



<https://www.epfl.ch/labs/naef-lab/>

# Recurrent special feature: clickers



- **At the onset of each lecture** (starting next week): quiz about previous week's material
- **During the lectures:** other questions

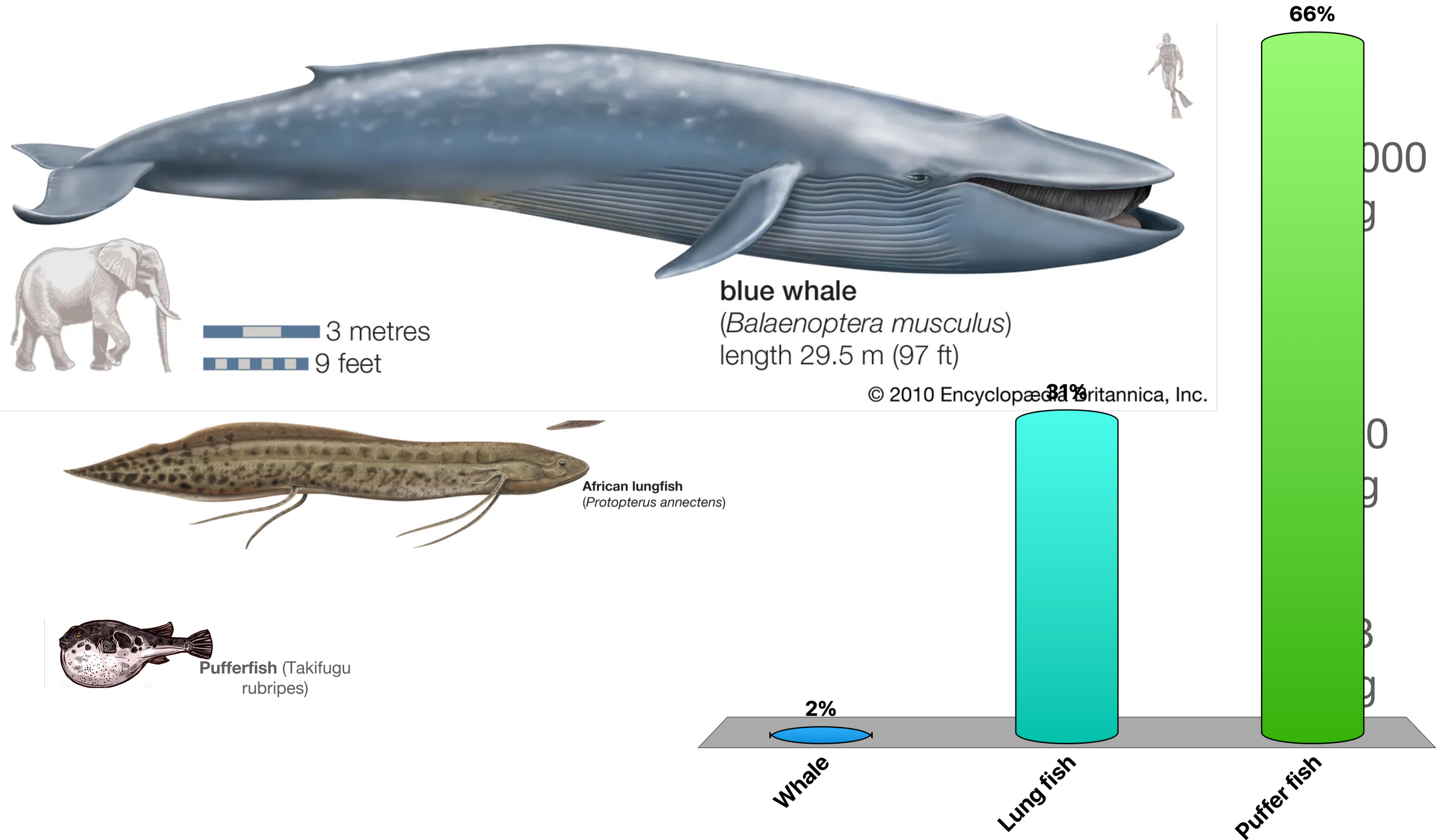
<https://participant.turningtechnologies.eu/en/join>  
<https://go.epfl.ch/TurningPointPoll>

Session ID: bio411



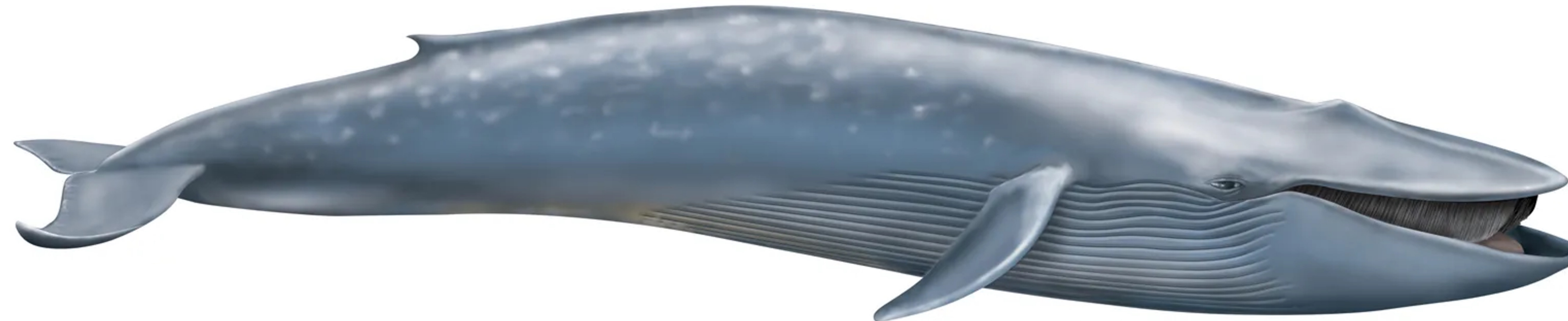
# Teaser 1: which has the bigger genome?

- A. Whale
- B. Lung fish
- C. Puffer fish



# B. Lungfish!

A.



3.09 GBP

blue whale  
(*Balaenoptera musculus*)

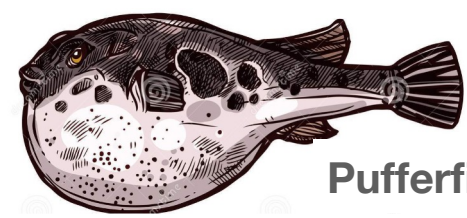
B.



130 GBP

African lungfish  
(*Protopterus annectens*)

C.



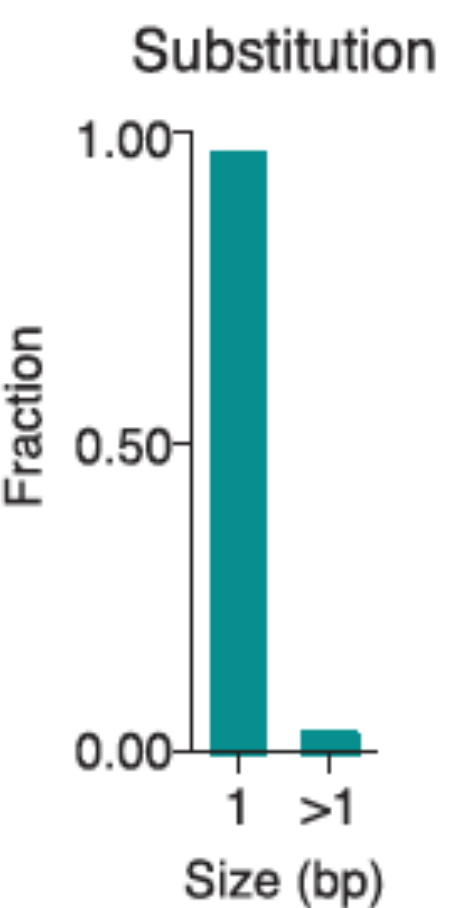
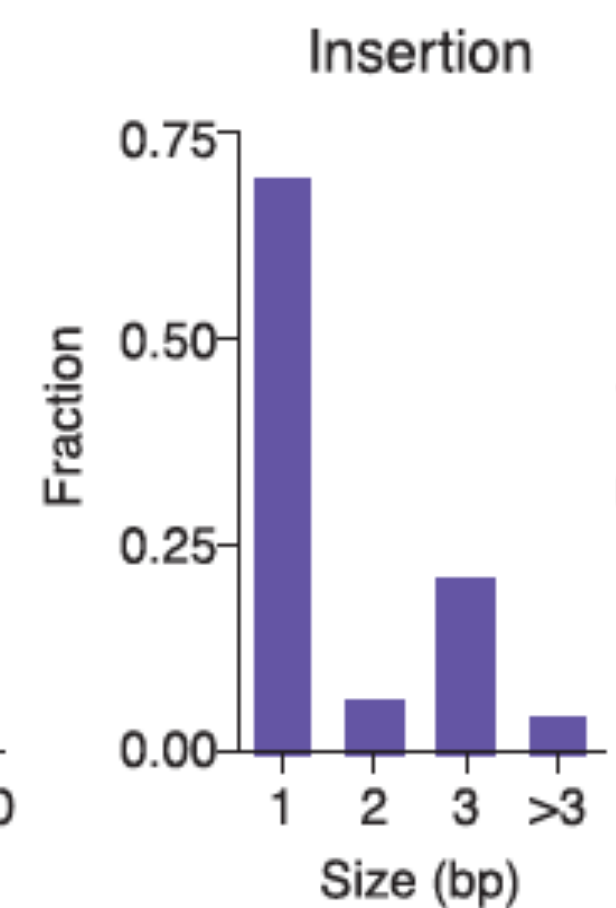
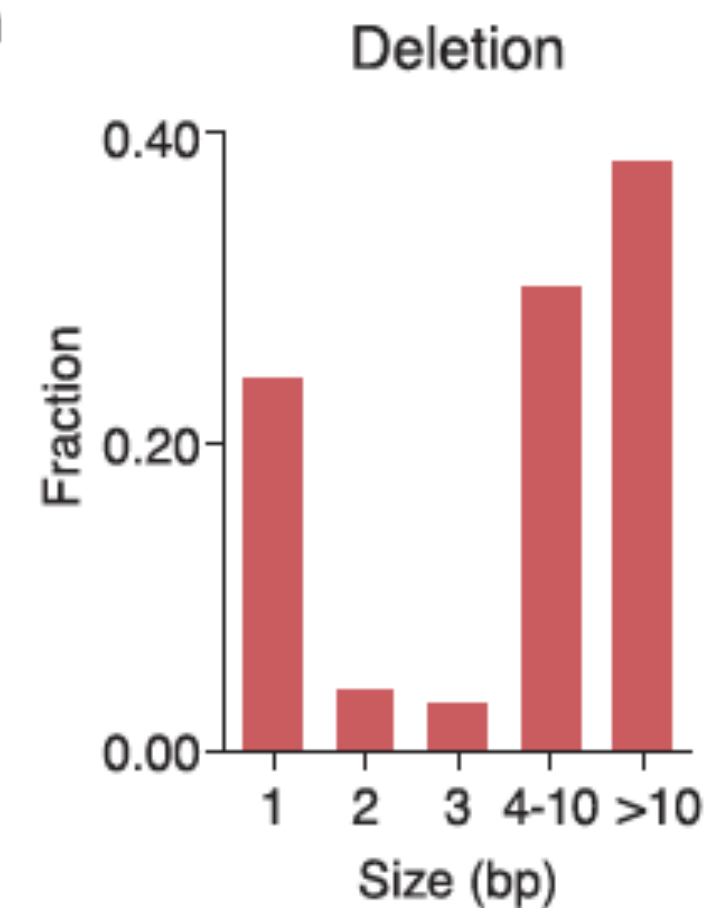
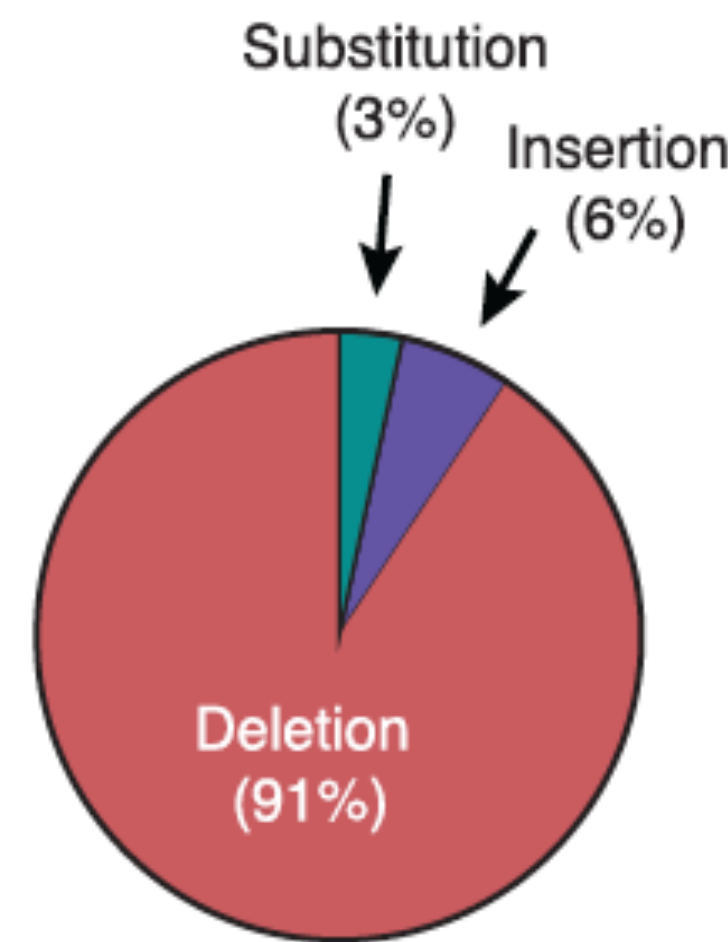
Pufferfish (*Takifugu rubripes*)

0.4 GBP

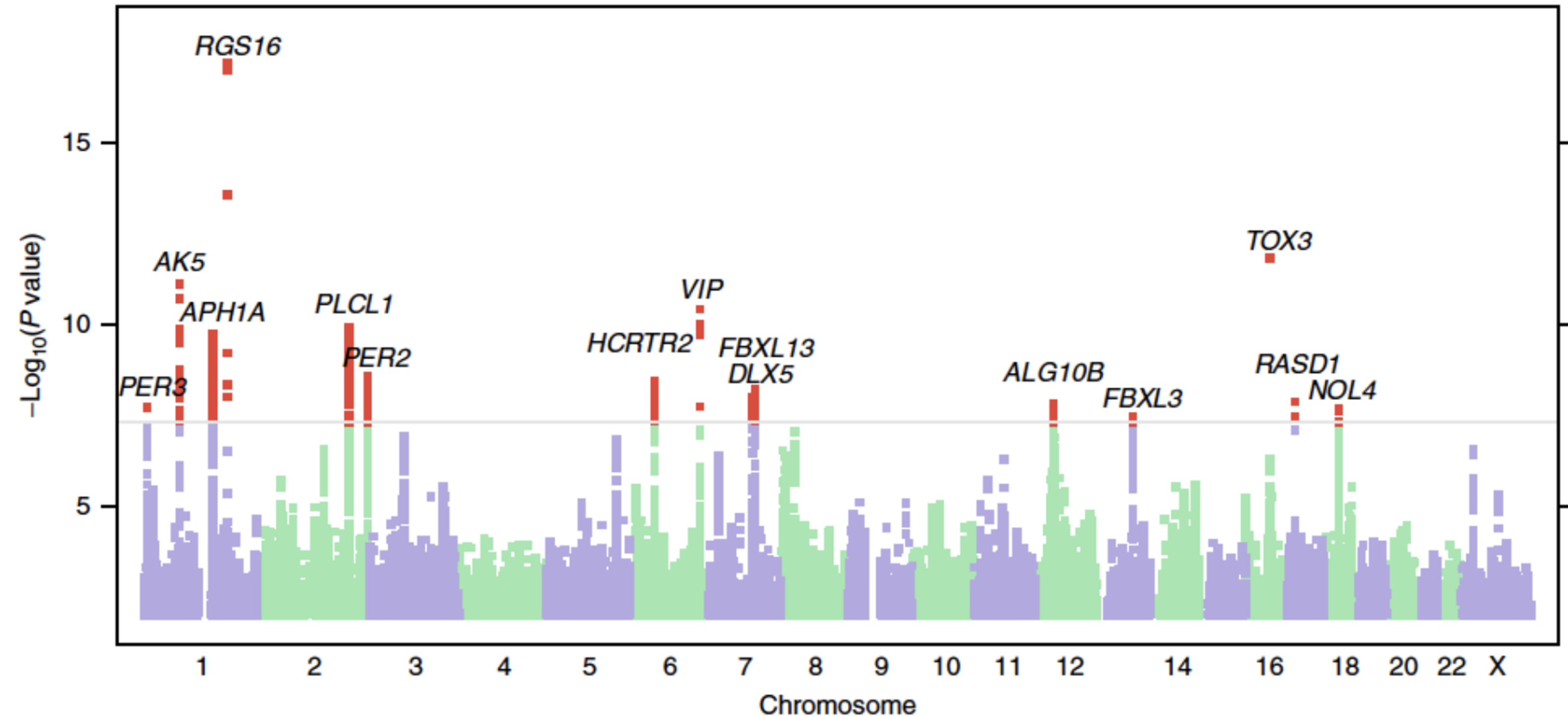
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# Teaser 2: which type of experiment most likely led to these results?

- A. EMS-based forward genetic screen
- B. CRISPR-Cas9-based functional genomic screen
- C. Synthetic lethal screen in yeast
- D. Comparison of *Drosophila* and Tardigrades
- E. Sequencing of Brian's genome



# Teaser 3: what is represented here?



- A. The Manhattan skyline
- B. Genes involved in flowering time in plants
- C. An artistic rendering of the concept of haploinsufficiency
- D. A GWAS study of morning-/evening-ness
- E. SV dean's favorite genes

# Questions?