Course Syllabus

GCB/CAMB/IGG 577 -- Spring 2020

Advanced Epigenetics Technologies

Fridays (10:30-12pm) Stellar Chance 0701

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Propelled by rapid technological advances, the field of epigenomics is enjoying unprecedented growth with no sign of deceleration. An expanding cadre of researchers are working to explore exciting frontiers in epigenomics. Consequently, the number of epigenomics assays increasing the resolution and lowering the throughput has grown exponentially in recent years. This course intends to cover the latest advances in genome-wide epigenetic assays (e.g. single-cell epigenomics) from both experimental and computational perspectives.

Format: This course has three components (lectures, paper presentations, a final project).

(1) Lectures provide a detailed overview of cutting-edge epigenetics technologies emphasizing on both experimental and computational aspects of each assay. Three major topics are covered in this course in depth from both wet and dry perspectives by the course directors: 1D chromatin, 3D chromatin, and single-cell genomics. Two guest lectures will cover topics of DNA methylation and proteomics.

(2) Lectures of a topic are followed by paper presentations by students. The objective of paper presentations is to demonstrate the utilization of discussed techniques in diverse topics.

(3) The final project titled "**A thesis project for a future PhD student**" will be carried out by each student. The major objective is to inspire students to propose a PhD-thesis level project that will address a major gap in our knowledge and can benefit from the techniques discussed in lectures and paper presentations.

Structure of paper presentation: Individual presentations should be organized as seminars, and include an introduction. After the introduction, the presentation will be devoted to a critical evaluation of the paper and how the paper benefited from latest epigenetics techniques. In particular, the presentation should include 1) significance of the study (discuss major hypothesis being tested); 2) experimental design and methods (which assays they used and how that is related class's discussions and lectures); 3) results (discuss their validity, reliability, replicability); 4) conclusions drawn from the study (not just the authors' but yours as well). Students should **not** simply give a blow-by-blow account of each experiment and the authors' conclusions.

Preparation: It is optional for the students to discuss their assigned papers with the course's directors.

Structure of the final project: The project should be summarized in 1 page following the NIH Specific Aims page format. Each student will prepare a 30-min presentation describing the key gap in our knowledge and how epigenetics technologies can fill this gap.

Class participation: Each class member will critically evaluate the papers. Lively discussion and criticism involving all members of the class is expected. A high level of discussion will not occur unless each participant thoroughly reads the papers and formulates questions. Accordingly, each student will be required to prepare at least one question from each of the assigned papers prior to class.

Grading scheme: Grades for the course will be based on their paper presentation (30%), final project (40%), and class participation (30%).

January 17

Organizational meeting

January 24

Topic: 1D chromatin (ChIP-seq/CUT&RUN/ATAC-seq) (wet and dry)

Lecture: Golnaz Vahedi

January 31

Topic: 1D chromatin (ChIP-seq/CUT&RUN/ATAC-seq)

Paper Presentation #1:

Pioneer Factor-Nucleosome Binding Events during Differentiation Are Motif Encoded

https://www.ncbi.nlm.nih.gov/pubmed/31253573 (Links to an external site.)

February 7

Topic: 3D chromatin (HiC/HiChIP/4C/FISH) (wet/dry)

Lecture: R. Babak Faryabi

February 14

Topic: 3D chromatin (HiC/HiChIP/4C/FISH)

Paper Presentation #2:

The Energetics and Physiological Impact of Cohesin Extrusion. *Cell*.
http://doi.org/10.1016/j.cell.2018.03.072 (Links to an external site.)

February 21

Topic: 3D chromatin (HiC/HiChIP/4C/FISH)

Paper Presentation #3:

Circular ecDNA promotes accessible chromatin and high oncogene expression

https://www.ncbi.nlm.nih.gov/pubmed/31748743 (Links to an external site.)

February 28

Topic: single-cell RNA-seq (wet/dry)

Lecture: Golnaz Vahedi

March 6

Topic: single-cell RNA

Paper Presentation #4:

The bone marrow microenvironment at single-cell resolution

https://www.ncbi.nlm.nih.gov/pubmed/30971824 (Links to an external site.)

March 9-13 Spring Break

March 20

Topic: single-cell ATAC-seq-multimodal (wet/dry)

Lecture: R. Babak Faryabi

March 27

Topic: single-cell ATAC-seq-multimodal

Paper Presentation #5:

Massively parallel single-cell chromatin landscapes of human immune cell development and intratumoral T cell exhaustion

https://www.ncbi.nlm.nih.gov/pubmed/31375813 (Links to an external site.)

April 3

Topic: single-cell ATAC-seq-multimodal

Paper Presentation #6:

Joint profiling of chromatin accessibility and gene expression in thousands of single cells

https://www.ncbi.nlm.nih.gov/pubmed/30166440 (Links to an external site.) (Links to an external site.)

(Links to an external site.)An ultra high-throughput method for single-cell joint analysis of open chromatin and transcriptome https://www.nature.com/articles/s41594-019-0323-x (Links to an external site.)

April 10th

Topic: Guest lecture

Lecture: Hao Wu/Rahul Kohli

April 17

Project presentation #1

April 24

Project presentation #2