Course Syllabus: Epigenetics and Chromatin - B 321

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<tr>
<th>Division</th>
<th>Biological and Environmental Sciences &amp; Engineering Division</th>
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<tr>
<td>Course Number</td>
<td>B 321</td>
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<tr>
<td>Course Title</td>
<td>Epigenetics and Chromatin</td>
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<tr>
<td>Academic Semester</td>
<td>Summer</td>
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<td>Academic Year</td>
<td>2018/2019</td>
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<td>Semester Start Date</td>
<td>06/16/2019</td>
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<td>08/08/2019</td>
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<tr>
<td>Class Schedule</td>
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**Instructor(s)**

<table>
<thead>
<tr>
<th>Name</th>
<th>Email</th>
<th>Phone</th>
<th>Office Location</th>
<th>Office Hours</th>
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<tbody>
<tr>
<td>Valerio Orlando</td>
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<td>Thursday, 9-10 am</td>
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<td>Wolfgang Fischle</td>
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<td></td>
<td>Thursday, 9-10 am</td>
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**Teaching Assistant(s)**

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**Course Information**

**Comprehensive Course Description**

This course combines theoretical knowledge with state-of-the-art practical approaches. It was developed on the basis of advanced method courses for students held at the European Molecular Biology Organisation (EMBO) and International Max Planck Research Schools (IMPRS). Profs. Orlando and Fischle (including their laboratories’ staff) will introduce up to date research questions and experimental technologies in current Epigenetics and Chromatin Research. Hands-on experiments with step-by-step instructions will be carried out in the KEEP laboratories involving laboratory staff.

Topics include (not all at the same time):
- Chromatin Architecture: fractionation of cells and nuclei for chromatin preparation, basic analysis of chromatin architecture (nucleosome positioning, and remodeling)
- Histone Code: biochemistry of modifying enzymes, binding proteins and RNAs in chromatin regulation (protein-protein, protein-nucleic acids interactions, complex purification)
- Epigenome Structure I: genome-wide mapping of histone modifications, chromatin factors, ncRNA (ChIP, ChIP-seq, ncRNA mapping, data analysis)
- Cell Memory and Imprinting: DNA methylation and cellular imprinting (analysis of DNA methylation by different methods)
- Epigenome Structure II: nuclear architecture, long-range chromatin interactions, chromosomal domains (chromosome paint, Hi-C)

- The course is open to KAUST M.Sc. and Ph.D. Students (min. 6 and max. 12 participants in total). All students will have to complete reading assignments on basic and advanced topics in Epigenetics and the experimental approaches used in this field (to be provided by instructors ahead of the beginning of the course). Written reports summarizing and discussing the experiments in reflection of this theoretical background are part of the evaluation for all Students.
The major aim of the three-week summer block course is to train participants (min. 6, max. 12) in experimental Cell Biology on the example of Chromatin Biochemistry, Epigenome Structure and Nuclear Organization. To improve students' skills in designing, executing and analyzing experiments, the course combines two principles: theory and practice. Besides covering the fundamental background and theory of Epigenetics and Genome Regulation, participants will learn basic and cutting-edge experimental technologies that are currently used to answer key questions at the frontiers of Epigenetics research. The course is shaped according to international EMBL (European Molecular Biology Laboratories) and MPI (Max Planck Institutes) advanced method courses for M.Sc. and Ph.D. students. Prof.s Orlando and Fischle (including their laboratories staff) will introduce Applied Epigenetics on the basis of dissection of classical and recent experiments. Student participants will carry out several hands-on experiments with step-by-step instructions.

### Goals and Objectives

The course combines two major training objectives:

- To provide the participants with fundamental theoretical understanding of basic and complex Epigenetic Phenomena
- To give the participants hands-on training in the planning, execution and analysis of simple and advanced experiments in Cell Biology in general and with a focus on Epigenome Structure and Function, Chromatin Biology, Nuclear Organization, Noncoding RNA

### Required Knowledge

- Basic experimental skills in Molecular and Cell Biology

M.Sc. Students should have successfully completed the following courses: Molecular and Cellular Biology Lab (B241); Cell Biology I (B241) and II (B223). Successful Applicants will be notified by the Instructors by the end of Spring semester.

### Reference Texts

- Epigenetics, CSHL press, 2nd edition
- Epigenetics Protocols (Methods in Molecular Biology) 2nd edition
- Detailed handouts provided by instructors

### Method of evaluation

- **33.00%** - Attendance and Participation
- **33.00%** - Written report
- **33.00%** - Presentation

### Nature of the assignments

- Students will need to prepare the theoretical background of different scientific topics on the basis of individual and group reading assignments (primary and secondary literature)
- Under supervision students will execute different experiments individually and in groups
- On the basis of detailed assignments students will prepare and present seminars in front of the class to provide the background and scope of different experimental methods and in context of different scientific questions
- Participants are required to prepare a scientific report covering the experiments executed in the form of a manuscript (introduction, rationale, results, discussion, literature)

### Course Policies

Attendance of both theoretical and practical classes is mandatory.

### Additional Information

Daily schedule: each day of the course is divided in theoretical and practical parts

**Theory:**
9 – 10:00 lecture/seminar on the specified topics of Chromatin Biology and Epigenetics (classroom: lecturers, Ph.D. students)

**Practice:**
10:00 – 11:00 theoretical introduction to specified experiment(s) of the day (classroom: instructors)
11:00 – 16:30 execution of specified experiments in small groups under supervision (KEEP laboratories: instructors); variable lunch break (1 hr)
16:30 – 17:30 discussion of results (classroom: instructors)
## Tentative Course Schedule

(Time, topic/emphasis & resources)

<table>
<thead>
<tr>
<th>Week</th>
<th>Lectures</th>
<th>Topic</th>
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| 1    | Sun 06/16/2019  
Mon 06/17/2019  
Tue 06/18/2019  
Wed 06/19/2019  
Thu 06/20/2019 | Day 1 Theory: Epigenome Structure and function  
Chromatin Immunoprecipitation (ChIP) and (RNA Chromatin associated RNA assays (ChIRP)  
Practice: ChIP and ChIRP assays  
Day 2 Theory: Epigenome Structure and function  
Practice: ChIP and ChIRP assays  
Day 3 Theory: Epigenome and Epigenetics  
Practice: ChIP and ChIRP assays  
Day 4 Theory: IncRNA and Epigenome  
Practice: analysis of ChIP and ChiRP  
Day 5 Theory: Epigenome and Environment  
Practice: analysis of ChIP and ChiRP |
| 2    | Sun 06/23/2019  
Mon 06/24/2019  
Tue 06/25/2019  
Wed 06/26/2019  
Thu 06/27/2019 | Day 1 Theory: Nuclear Architecture  
Introduction to Fluorescence In Situ Hybridization (FISH) and Immuno-FISH  
Practice: RNA FISH and i-FISH  
Day 2 Theory: Chromatin by High Resolution Microscopy  
Practice: RNA FISH and i-FISH  
Day 3 Theory: Chromatin architecture by Chromosome Conformation Capture  
Practice: RNA FISH and i-FISH I  
Day 4 Theory: Image analysis  
Practice: RNA FISH and i-FISH I Image analysis  
Day 5 Practice: Student Seminars/Discussion groups |
| 3    | Sun 06/30/2019  
Mon 07/01/2019  
Tue 07/02/2019  
Wed 07/03/2019  
Thu 07/04/2019 | Day 1 Theory: Bioinformatics  
practice: ChIP/ChIRP Seq Analysis  
Day 2 Theory: Bioinformatic  
Practice: HiC analysis  
Day 3 Theory: Bioinformatic  
Practice: Data Integration/Discussion groups  
Day 5 WRAP UP |

**Note**
The instructor reserves the right to make changes to this syllabus as necessary.