

# KEYSTONE SYMPOSIA

on Molecular and Cellular Biology

## Chromatin Architecture and Chromosome Organization (X5)

Scientific Organizers: Edith Heard and Peter Fraser

Supported by Directors' Fund

## Gene Control in Development and Disease (X6)

Scientific Organizers: Richard A. Young, Joanna Wysocka and Phillip A. Sharp

March 23-27, 2018 • Whistler Conference Centre • Whistler, British Columbia, Canada

Sponsored by Novartis Institutes for BioMedical Research

Abstract & Scholarship Deadline: November 28, 2017 / Abstract Deadline: December 20, 2017 / Discounted Registration Deadline: January 17, 2018

### FRIDAY, MARCH 23

#### Arrival and Registration

### SATURDAY, MARCH 24

#### Welcome and Keynote Address (X5)

\***Edith Heard**, Institut Curie, France

\***Peter Fraser**, Florida State University, USA

**Job Dekker**, University of Massachusetts Medical School, USA  
*Folding, Unfolding and Refolding of Genomes*

#### Welcome and Keynote Address (X6)

\***Richard A. Young**, Whitehead Institute for Biomedical Research, USA

\***Joanna Wysocka**, Stanford University School of Medicine, USA

\***Phillip A. Sharp**, Massachusetts Institute of Technology, USA

**Jennifer A. Doudna**, HHMI/University of California, Berkeley, USA  
*Unexpected Activities of RNA-Guided CRISPR Enzymes*

#### Chromosome Architecture (X5)

\***Wendy A. Bickmore**, University of Edinburgh, UK

\***William Stafford Noble**, University of Washington, USA

**Carlo Vermeulen**, Hubrecht Institute, Netherlands  
*Locus-Specific Enhancer Hubs and Architectural Loop Collisions Uncovered from Single Allele DNA Topologies*

**Peter Fraser**, Florida State University, USA  
*Chromosome Architecture Dynamics Using Single Cell HiC*

**Suzana Hadjur**, University College London, UK  
*Role of Cohesin Complex Diversity in Genome Organization and Cell Fate Determination*

**Maciej Piotr Zaczek**, Institute of Molecular Pathology, Austria  
*Short Talk: CTCF Constrains Cohesin Translocation along DNA*

**Elphège P. Nora**, Gladstone Institute, USA  
*Short Talk: Dissecting the Molecular Connection between CTCF and Cohesin*

#### Basics (X6)

\***Jennifer A. Doudna**, HHMI/University of California, Berkeley, USA

**Patrick Cramer**, Max Planck Institute for Biophysical Chemistry, Germany  
*Integrated Structural Biology of Gene Transcription*

**Karen Adelman**, Harvard Medical School, USA  
*Pause Control in Development and Disease*

**Ronald M. Evans**, HHMI/The Salk Institute, USA  
*Vitamin D and Dysregulated Transcription*

**Xiong Ji**, Peking University, China  
*Short Talk: RNAPII Elimination Reveals Transcriptional-Dependent Three-Dimensional Chromatin Landscape*

**Diego Villar Lozano**, University of Cambridge, UK

*Short Talk: The Gene Expression Consequences of Mammalian Regulatory Evolution*

#### Workshop 1: 4DN (X5)

\***Job Dekker**, University of Massachusetts Medical School, USA

\***Thoru Pederson**, University of Massachusetts Medical School, USA  
*CRISPR Barcoding Reveals Changes in Interphase Chromosome Conformation and Dynamics in Human Cells*

**Josef Redolfi**, Friedrich Miescher Institute for Biomedical Research, Switzerland  
*Crosslinking- and Ligation-Free Detection of Chromosomal Interactions using DamID and Physical Modeling*

**Kerstin Bystricky**, University of Toulouse, France  
*Chromatin Dynamics in Real Time and at Nanoscale Resolution Reveal Transcription-Dependent Long-Range Correlation*

**Saumya Agrawal**, RIKEN, Yokohama Campus, Japan  
*Association between Three-Dimensional Localization and Function of Long Noncoding RNAs*

**Sofia Quinodoz**, California Institute of Technology, USA  
*Higher-Order Inter-Chromosomal Hubs Shape 3-Dimensional Genome Organization in the Nucleus*

**Valerio Orlando**, King Abdullah University of Science and Technology, Saudi Arabia  
*Ago1 in Association with NEAT1 lncRNA Contributes to Nuclear and 3D Chromatin Architecture in Human Cells*

**Alice Sherrard**, University of Bristol, UK  
*Imaging Chromatin Dynamics Reveals a Novel Mechanism for Nuclear Organization after Cell Division*

**Marlies E. Oomen**, University of Massachusetts Medical School, USA  
*Cell Cycle Dynamics of CTCF Binding and its Relation to Chromosome Organization*

#### Workshop 1: Transcription and Development (X6)

\***Karen Adelman**, Harvard Medical School, USA

\***Patrick Cramer**, Max Planck Institute for Biophysical Chemistry, Germany

**Richard G. Jenner**, University College London, UK  
*RNA Antagonizes the Interaction of PRC2 and Other Epigenetic Modifiers with Chromatin*

**Natalia B. Ivanova**, Yale University School of Medicine, USA  
*Chromatin-Associated Factors Dppa2 and Dppa4 Guide Epigenetic Remodeling during Cellular Reprogramming*

**Ido Sagi**, Hebrew University of Jerusalem, Israel  
*Studying Haploidy and Parental Imprinting in Human Pluripotent Stem Cells*

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**Aydan Bulut-Karslioglu**, University of California, San Francisco, USA  
*Chd1-Mediated Repair of Physiological DNA Breaks Sustains Hypertranscription and Proliferation of ES Cells*

**Ruben Esse**, Boston University, USA  
*DOT1L in Enhancer Regulation*

**Sudhir Thakurela**, Harvard University, USA  
*Genetic Determinants and Epigenetic Effects of Pioneer Factor Occupancy during Development*

**Elodie Emilie Thierion**, University of Cambridge, UK  
*Gene Regulation Dynamics and Evolution in Somites*

### Control Elements (Joint)

\***Bing Ren**, Ludwig Institute for Cancer Research, USA

\***Mikhail Spivakov**, Babraham Institute, UK

**Eileen E.M. Furlong**, European Molecular Biology Laboratory, Germany  
*Functional Insights into Genome Topology and Enhancer Function during Embryonic Development*

**Joanna Wysocka**, Stanford University School of Medicine, USA  
*Enhancers in Development*

**Rajat Gupta**, Massachusetts General Hospital, USA  
*Short Talk: A Genetic Variant Associated with Five Vascular Diseases Distally Regulates Gene Expression via Long-Range Enhancer Interactions*

**Jeff Alexander**, University of California, San Francisco, USA  
*Short Talk: Live-Cell Imaging Reveals Enhancer-Dependent Sox2 Transcription Is Not Associated with Enhancer Proximity*

### Poster Session 1

#### SUNDAY, MARCH 25

##### Genome Structure (Joint)

\***Suzana Hadjur**, University College London, UK

\***Stavros Lomvardas**, Columbia University, USA

**Juanma Vaquerizas**, Max Planck Institute for Molecular Biomedicine, Germany  
*Chromatin Architecture during Early Development*

**Bing Ren**, Ludwig Institute for Cancer Research, USA  
*Regulation of Lineage-Specific Chromatin Organization at Enhancers*

**Wendy A. Bickmore**, University of Edinburgh, UK  
*The Remote Control of Gene Expression*

**Edda G. Schulz**, Max Planck Institute for Molecular Genetics, Germany  
*Two Coupled Feedback Loops Explain Random Mono-Allelic Xist Upregulation at the Onset of X-Chromosome Inactivation*

**Julie Ahringer**, University of Cambridge, UK  
*Short Talk: ARC-C for Genome-Wide Analysis of Regulatory Element Interactions at High Resolution*

##### Meet the Editors Panel (Joint)

\***Edith Heard**, Institut Curie, France

\***Richard A. Young**, Whitehead Institute for Biomedical Research, USA

**Sharon Ahmad**, Journal of Cell Science, UK

**Marie Bao**, Cell Press, USA

**Katherine Brown**, Company of Biologists, UK

**Melina Casadio**, Rockefeller University Press, USA

**Alex Eccleston**, Nature, UK, UK

**Markus Elsner**, Nature Biotechnology, Germany

**Tiago Faial**, Nature Genetics, USA

**Sarah Geisler**, Cell, USA

**Di Jiang**, PLOS Biology, USA

**Steve Mao**, Science, AAAS, USA

**Carolina Perdigoto**, Nature Communications, UK

**Nicole Rusk**, Nature Methods, USA

**Rupa Sarkar**, Nature Protocols, UK

**Esther Schnapp**, EMBO, Germany

**Julie Sollier**, Cell Press, USA

**Anke Sparmann**, Nature Structural and Molecular Biology, UK

**Ruth Zearfoss**, Cell Press, USA

**Eytan Zlotorynski**, Springer Nature, UK

##### Spatio-Temporal Dynamics of Chromatin (X5)

\***Eileen E.M. Furlong**, European Molecular Biology Laboratory, Germany

\***Juanma Vaquerizas**, Max Planck Institute for Molecular Biomedicine, Germany

**Stavros Lomvardas**, Columbia University, USA  
*Interchromosomal Interactions Regulate Singular Olfactory Receptor Choice*

**Victor G. Corces**, Emory University, USA  
*Mechanisms of Transgenerational Inheritance*

**Amos Tanay**, Weizmann Institute, Israel  
*Single Cell Approaches in Epigenomics and 3D Chromosome Organization*

**Yong Hoon Kim**, University of Pennsylvania School of Medicine, USA  
*Short Talk: Rev-erb alpha Dynamically Modulates Chromatin Looping to Control Circadian Gene Transcription*

##### Epigenetics (X6)

\***Geeta J. Narlikar**, University of California, San Francisco, USA

\***Joseph R. Ecker**, The Salk Institute for Biological Studies, USA

**Leonard I. Zon**, HHMI/Boston Children's Hospital, USA  
*Epigenetic Pathways Regulating Cell Fate*

**Oliver J. Rando**, University of Massachusetts Medical School, USA  
*Small RNA Trafficking during Sperm Epididymal Maturation Is Essential for Early Development in Mammals*

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**Edith Heard**, Institut Curie, France

*Developmental Dynamics of X-Chromosome Structure*

**Zachary Hugh Harvey**, Stanford University, USA

*Short Talk: A Prion That Mediates Meiotic Inheritances of Activated Chromatin States*

### Poster Session 2

#### MONDAY, MARCH 26

##### Chromatin Architecture, Development and Disease (X5)

\***Karen L. Reddy**, Johns Hopkins University, USA

\***Leonid Mirny**, Massachusetts Institute of Technology, USA

**Jane A. Skok**, New York University School of Medicine, USA

*The Mechanisms Underlying the Impact of MMSET Overexpression on Gene Regulation in Multiple Myeloma*

**Ana Pombo**, Max-Delbrück-Centrum für Molekulare Medizin, Germany

*Genome Architecture Mapping: Exploring Mechanisms of 3D Chromatin Folding in Rare Cell Types*

**Mikhail Spivakov**, Babraham Institute, UK

*Mapping Genomic Regulatory Architecture and Interpreting Non-coding Variation with Promoter Capture Hi-C*

**Kevin G. Monahan**, Columbia University, USA

*Short Talk: Ldb1 Is Required for the Formation of a Multi-Chromosomal Enhancer Hub that Governs Singular Olfactory Receptor Transcription*

**Alistair Boettiger**, Stanford University, USA

*Short Talk: Nanoscale Visualization of cis-Regulation in Development using ORCA*

**Jean J. Gautier**, Columbia University, College of Physicians and Surgeons, USA

*Short Talk: Nuclear Actin Polymerization Drives DNA Double-Strand Break Mobility and Clustering for Homology-Directed Repair*

**Rani E. George**, Dana-Farber Cancer Institute, USA

*Short Talk: The CTCF Paralog BORIS Promotes Novel Chromatin Regulatory Interactions in Cancer Cells*

##### New Models (X6)

\***Magdalena D. Zernicka-Goetz**, University of Cambridge, UK

\***Yonatan Stelzer**, Weizmann Institute of Science, Israel

**Phillip A. Sharp**, Massachusetts Institute of Technology, USA

*Phase Separation in Transcription Control*

**Ibrahim Cissé**, Massachusetts Institute of Technology, USA

*Super-Resolution Imaging of Transcription in Live Mammalian Cells*

**Geeta J. Narlikar**, University of California, San Francisco, USA

*Phase-Separation in Heterochromatin Formation*

**Ankur Jain**, University of California, San Francisco, USA

*RNA Phase Separation and Neurodegenerative Disease*

**Sheila Teves**, University of California, Berkeley, USA

*Short Talk: A Stable Mode of Bookmarking by TBP Recruits RNA Polymerase II to Mitotic Chromosomes*

**Mounia Lagha**, Centre National de la Recherche Scientifique, France

*Short Talk: Zelda and Transcriptional Memory in Drosophila Embryos*

**Yuelin Song**, Massachusetts Institute of Technology, USA

*Short Talk: Dynamic DNA Methylation Heterogeneity at Super-Enhancers in Single-Cells*

##### Integrating Chromatin States and Genome Architecture to Understand Genome Function (X5)

\***Susan M. Gasser**, Friedrich Miescher Institute for Biomedical Research, Switzerland

\***Giacomo Cavalli**, Institute of Human Genetics, France

**John A. Stamatoyannopoulos**, Altius Institute for Biomedical Sciences, USA

*Transcriptional Circuitry and Regulatory Landscapes*

**Richard A. Young**, Whitehead Institute for Biomedical Research, USA

*Phase Separation and Genome Architecture*

**William J. Greenleaf**, Stanford University, USA

*Understanding the Physical Genome*

**Jiao Sima**, Florida State University, USA

*Short Talk: CRISPR Dissection of a Replication Domain Reveals Discrete Internal cis Elements Regulating Replication Timing and Chromatin Compartment*

##### Development (X6)

\***Natalia B. Ivanova**, Yale University School of Medicine, USA

\***Peter C. Scacheri**, Case Western Reserve University, USA

**Eliezer Calo**, Massachusetts Institute of Technology, USA

*Tissue-Selective Effects of Nucleolar Stress and rDNA Damage in Developmental Disorders*

**Magdalena D. Zernicka-Goetz**, University of Cambridge, UK

*Building the Mammalian Embryo in vivo and in vitro*

**Joseph R. Ecker**, The Salk Institute for Biological Studies, USA

*Single Cell Methylomes Reveal Neuronal Populations and Regulatory Elements in the Mammalian Brain*

**Yonatan Stelzer**, Weizmann Institute of Science, Israel

*Short Talk: Parent- and Sex-Specific DNA Methylation Dynamics during Mouse Development*

### Poster Session 3

#### TUESDAY, MARCH 27

##### Chromatin Architecture and the Nuclear Positioning (X5)

\***Ana Pombo**, Max-Delbrück-Centrum für Molekulare Medizin, Germany

\***Jane A. Skok**, New York University School of Medicine, USA



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**Karen L. Reddy**, Johns Hopkins University, USA

*The Nuclear Lamina and the Shifting Shape of Epigenomes*

**Bas van Steensel**, Netherlands Cancer Institute, Netherlands  
*Mechanisms of Gene Regulation in Lamina-Associated Domains.*

**Susan M. Gasser**, Friedrich Miescher Institute for Biomedical Research, Switzerland  
*Histone H3K9me Mediates Heterochromatin Sequestration and Stabilizes Repeat Elements with BRCA1*

**Giacomo Cavalli**, Institute of Human Genetics, France  
*Polycomb Proteins and 3D Genome Folding in the Epigenetic Regulation of Development*

**Robert Johnston**, Johns Hopkins University, USA  
*Short Talk: Pairing TADs (PairiTs) Drive Homologous Chromosomes Together to Promote Interchromosomal Gene Regulation*

**Wei Xie**, Tsinghua University, China  
*Short Talk: Conservation and Divergence of Chromatin Reprogramming in Early Mammalian Development*

### Disease (X6)

\***Richard A. Young**, Whitehead Institute for Biomedical Research, USA

\***Cheryl Arrowsmith**, University of Toronto, Canada

**Peter C. Scacheri**, Case Western Reserve University, USA  
*Mechanisms of Aberrant Enhancer Activation in Cancer*

**Manolis Kellis**, Massachusetts Institute of Technology, Broad Institute, USA

*Functional Dissection of Disease-Associated Variation*

**Matthias Merckenschlager**, Imperial College London, UK  
*Cohesin Links Inflammation and Cancer*

**Chao Lu**, Columbia University, USA  
*Short Talk: Reprogramming of Chromatin Organization by Cancer-Associated Histone H3 Mutations*

**Michele Gabriele**, University of Milan, European Institute of Oncology, Italy

*Short Talk: YY1 Haploinsufficiency Disrupts Histone Acetylation in Gabriele-De Vries Neurodevelopmental Syndrome*

**Jesse M. Engreitz**, Broad Institute of Harvard and MIT, USA  
*Short Talk: Principles of Enhancer Function from Thousands of CRISPR Perturbations*

### Poster Session 4

#### Workshop 2: Disease Connections (X6)

\***Ross L. Levine**, Memorial Sloan Kettering Cancer Center, USA

\***Manolis Kellis**, Massachusetts Institute of Technology, Broad Institute, USA

**Zuzana Tothova**, Dana-Farber Cancer Institute, USA  
*STAG2 Mutations Alter Cohesin Ring Structure and Function and Provide Therapeutic Vulnerabilities in Acute Myeloid Leukemia*

**Damien Downes**, University of Oxford, UK  
*Systematic Dissection of GWAS loci using Chromatin Conformation and NG Sequencing Approaches*

**Elliott C. Ferris**, University of Utah, USA  
*Convergent Patterns of Accelerated Evolution in Hibernating Mammals May Elucidate New Regulatory Mechanisms Shaping Human Metabolic Disease*

**Nicholas C. Gomez**, Rockefeller University, USA  
*Stem Cell Reprogramming during Oncogenesis and Development*

**Kai Ge**, NIDDK, National Institutes of Health, USA  
*Enhancer Epigenomic Regulation in Differentiation, Development and Cancer*

**Debora R. Sobreira**, University of Chicago, USA  
*Obesity-Associated Variants within FTO Are Functionally Connected to the Coordinated Expression of IRX3 and IRX5 in Brain and Adipose Tissue*

**Rajesh C. Rao**, University of Michigan, USA  
*Wdr5 Acts as a Temporal Rheostat to Control Retinal Neuroectoderm Versus Mesoderm Fate Choice*

#### Workshop 2: Modeling and Simulations (X5)

\***Geoffrey Fudenberg**, University of California, San Francisco, USA

\***Marc A. Marti-Renom**, CNAG-CRG, Spain  
**Kristin Abramo**, University of Massachusetts Medical School, USA  
*Building an Interphase Nucleus*

**Annaelle Brunet**, University of Oslo, Norway  
*Lamina-Associated Domains as Tuning Actors Configuring the Mechanical Constraints of the Chromatin Domain at Nuclear Periphery*

**Nick Gilbert**, University of Edinburgh, UK  
*Chromatin-Associated RNA Recycling by XRN2 Regulates Transcription and Chromosome Structure*

**Kohta Ikegami**, University of Chicago, USA  
*Phospho-Lamin A Binding at Enhancers Coordinates Nuclear Envelope Breakdown with Mitotic Transcriptional Quiescence*

**Michele Di Pierro**, Rice University, USA  
*De Novo Prediction of Human Chromosome Structures: Epigenetic Marking Patterns Encode Genome Architecture*

**Jie Liang**, University of Illinois at Chicago, USA  
*Deep Sampling to Reconstruct Large 3D Ensembles of Chromatin Chains from 2D Heatmaps of Captured Conformations*

**Marc A. Marti-Renom**, CNAG-CRG, Spain  
*Structure Determination of Genomes and Genomic Domains by Satisfaction of Spatial Restraints*

#### Therapeutics (X6)

\***Leonard I. Zon**, HHMI/Boston Children's Hospital, USA

\***Zuzana Tothova**, Dana-Farber Cancer Institute, USA

**James E. Bradner**, Novartis Institutes for BioMedical Research, USA  
*Transcription and Drug Discovery*

**Cheryl Arrowsmith**, University of Toronto, Canada  
*Probing the Epigenome using Chemical Biology*

**Ross L. Levine**, Memorial Sloan Kettering Cancer Center, USA  
*Mutations in*

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### Physical Modeling of Chromatin and Chromosomes (X5)

\***William J. Greenleaf**, Stanford University, USA

**William Stafford Noble**, University of Washington, USA

*Modeling the 3D Architecture of the Genome*

**Leonid Mirny**, Massachusetts Institute of Technology, USA

*Biophysical Models of Chromatin (re)Organization*

*Epigenetic Regulators in the Biology and Therapy of Myeloid Malignancies*

**Meeting Wrap-Up: Outcomes and Future Directions (Organizers) (X5)**

**Meeting Wrap-Up: Outcomes and Future Directions (Organizers) (X6)**

**WEDNESDAY, MARCH 28**

**Departure**