Lecture

Principles of Epigenetics WS2023/2024

The lecture series comprises 9 lectures introducing into basic mechanisms of epigenetics and epigenetics in human diseases. We also provide a short introduction into state of the art epigenomic methods used in biomedical research. All lectures (except lecture 1) will be held live and streamed via MS Teams (Code: e7o1ma4). The slides can be downloaded (password protected) from our homepage.

The lectures will held in the context of the ADVI course for the Biology Master students is open for Students of Biotechnology, Biophysics and Bioinformatics. For the later credit points for the participation will be given after passing successfully with the final exam on 24th of January 2023, 8:30 - 10:00 am, buildg. A4.3, seminar and microscopy room.

A successful passing of this examen is obligatory to get a preference to participate in the second lecture series and course in SS 2024 "Analysis of functional genomics data"*.*

Lecturers: Julia Schulze-Hentrich (JSH), Jörn Walter (JW), Konstantin Lepikhov (KL) Gilles Gasparoni (GG), Kathrin Kattler (KK)

Venue: Building A4.3, seminar room, ground floor (except for the first introductory lecture which will be only online). Lecture will be recorded and live streamed via MS Teams.

Schedule

Lecture 1:   *10.11. 2023 8:30 – 10:00*
   Introduction (JW)
- Definition of Epigenetics,
- General impact for developmental biology, cell biology, genetics.
- Principles of chromatin organisation: Nucleosomes, histones and histone variants.
- Introduction into the core types of epigenetic modifications and their interrelation.
- Concept of epigenetic reversibility and molecular function: introduction into writers (establishing enzymes), readers (binders) and erasers (demodifying enzymes).
- Chromatin and chromosomes, chromatin dynamics during cell replication & cell division.
- Chromosome folding and looping. Approaches to analyse chromatin structures and states „*in vivo*".

Lecture 2:   *13.11.2023 8:30-10:00*
   Chromatin based epigenetic control (JSH)
- Introduction into major classes of chromatin modifications and their nomenclature.
- Basic reactions of chromatin modifying enzymes
- Role and function of key histone modifications
- Methods to analyse histone modifications in chromatin (ChIP, IF, MassSpec),
- Histone modifications and gene regulation: classification of regulatory regions
- Interplay with RNAi and DNA-methylation,

Lecture 3:   *14.11.2023 8:30–10:00*
   DNA-methylation and epigenetic control (KK)
- Evolution of DNA-methylation: from viral defense to gene regulation
- Introduction into DNA-methylation reactions: the general principles and diversities of DNA-base modifications
- Basic methods to measure DNA-methylation in DNA
- DNA-methylation in mammals: Concept of establishment, maintenance (inheritance) and erasure of DNA-methylation.
- Function of DNA-methylation in mammals: genome wide distribution, changes during development and disease impact on gene regulation and on the transcriptional control of transposable elements.
- in development and disease.

Lecture 4:   *15.11.2023 8:30 – 10:00*
   Non-coding long and small RNAs in epigenetic control (JSH)
- Basic mechanisms of RNA-interference: enzymes and reactions.
- Concept of transcriptional and posttranscriptional control.
- Definition of small RNA classes and their function.
- RNAi mediated control of chromatin/DNA- modifications
- The role of small RNAs in development and disease.

- Classes and functions of lncRNAs for epigenetic control in mammals.

Lecture 5:   *16.11.2023 8:30 – 10:00*
  Epigenetics and development (KL)
  - Mammalian development and epigenetic control.
  - Mechanisms of reprogramming in stem cells
  - Molecular control of X-chromosome inactivation.
  - Genomic imprinting.
  - Epigenetic programs of cell identity.

Lecture 6:   *20.11.2023 08:30-10:00*
  Epigenetics and human diseases I (JSH)
  Neurodegenerative Diseases
  - Epigenetics of Parkinsons Disease
  - Epigenetics of Alzheimers Disease
  - Epigenetics and aging.

Lecture 7:   *21.11.2023 08:30-10:00*
  Epigenetics and human diseases II (JW)
  Cancer, Imprinting and Immune Diseases
  - Genetic and epigenetic signatures in human cancer.
  - DNA-methylation and cancer diagnosis
  - Imprinting disorders.
  - Epigenetic control of the immune cell system.

Lecture 8:   *22.11.2023 8:30 – 10:00*
  Epigenomics I (GG)
  Introduction into epigenome experiments
  - Definition of epigenomes
  - DNA-methylome analysis
  o Chemical and enzymatic conversion reactions,
  o Array applications
  - RNA-Seq
  - ChIP-Seq
  - Library preparation and NGS sequencing

Lecture 9:   *23.11.2023 8:30 – 10:00*
  Epigenomics II (KK)
  Data analysis, integration and interpretation (KK)
  - Examples and use of data interpretation tools/software packages.
      - DNA-methylation data (RNBeads),
      - ChIP-seq and ATAC-seq data (ChromHMM, DeepTools),
      - RNA-Seq data (EdgeR, GO/Pathway analysis),
      - Integration of multiple epigenomic datatypes

Test/Examen for Bioinformaticians/Biotechnologist:
January 24th, seminar and microscopy room, building A 4.3, 8.30 to 10.00.