New Course Proposal: Epigenetics and Epigenomics

Credit: 3 (only lecture); Elective, Autumn semester

Objective of the course

Epigenetics is a very active and comparatively new field of Biology. The objective of this course is to introduce students to this field of classical Epigenetics, modern Chromatin Biology as well as the most recent and upcoming field of Epigenomics. The course covers three fundamental aspects: Firstly, it will be discussed how epigenetic or chromatin modification has emerged as a key player in regulating genomic structure and function and how that determines cellular functions. Second, the fundamentals of Epigenome structure and function and cutting-edge techniques will be discussed. Finally, the link between epigenetic modulatorsand origin of disease as well as the concept of utilizing chromatin modulators as therapeutic purposes.

In sum, this comprehensive course is directed at introducing the very fundamental topic of Epigenetics in Biology: covering the basic principles, state-of-the-art technological advances in Epigenomics as well as its therapeutic implications in human diseases.

Course Content

1. Genetics vs Epigenetics (1 hour)

2. Basic overview of Epigenetics (3 hours)
    - Position effect variegation
    - Epigenetics research using Model Systems

3. DNA compaction and chromatin (2 hour)
    - From Nucleosome to mitotic Chromosome
    - Heterochromatin and Euchromatin

4. Mechanisms of chromatin modification (5 hours)
    - DNA methylation
    - Histone tail-modifications
    - Histone Variants
    - Chromatin remodelling complexes
    - non-coding RNAs (micro-RNA, pi-RNA, lnc-RNA etc)

5. How chromatin modification affects transcription (2 hour)
    - Histone codes

6. Regulation of transcription by Epigenetic mechanisms (3 hours)
    - Transcriptional regulation by chromatin modificaitons
    - Transcriptional silencing by Polycomb Group proteins

- Transcriptional role of Heterochromatinization
- Transcriptional regulation by Trithorax group proteins

7. Developmental Epigenetics (5 hours)
   - Nuclear transplantation and genomic reprogramming
   - Germ-line and Pluripotent Stem Cells
   - Mechanism of X-chromosome inactivation
   - Dosage compensation in *Drosophila* and Mammals
   - Genomic Imprinting in mammals

8. Neuro-epigenetics (2 hours)

9. Heritability of Epigenetic marks (2 hour)
   - Transmission of chromatin modification marks during cell division
   - Transgenerational inheritance of epigenetic marks

10. Human disorders with Epigenetic link (1 hours)

11. Brief overview of Genomics (2 hour)

12. Genomic Techniques- Principles and overview (2 hours)
   - Next Generation Sequencing techniques

13. Epigenomic techniques (6 hours)
   - RNA-Seq, Bisulfite-seq, CHIP-Seq, MNase-seq, FAIRE-seq, ATAC-seq, DAM-ID,
   - Analysis of epigenomic data

14. Chromosomal conformation (3 hours)
   - HiC, 4C
   - Methods and data analysis

Text Books:

1. Armstrong, L. (2014). *Epigenetics*. New York: Garland Science.

2. Russell, P. (2014). *iGenetics: A Molecular Approach*. 3rd ed. Harlow, Essex: Pearson.

3. Lesk, A. M. (2017). *Introduction to Genomics*. 3rd ed. Oxford: Oxford University Press.

Reference books:

1. Allis, C. D., Caparros, M. L., Jenuwein, T., & Reinberg, D. (Eds.). (2015). *Epigenetics*. 2nd ed. New York: CSHL Press.

2. Ferguson-Smith, A. C., Greally, J. M., & Martienssen, R. A. (Eds.). (2009). *Epigenomics*. Dordrecht: Springer Netherlands.

3. Kwon, Y. M, Ricke, S. C., (Eds.). (2011). *High-Throughput Next Generation Sequencing, Methods and Applications*. Totowa, NJ: Humana Press.