Biology 568: Advanced Topics in Molecular Genetics - Epigenetics (Spring, 2019)

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Introduction

"Epigenetics" refers to mechanisms of cellular inheritance and the control of gene expression that do not involve changes in the DNA sequence. Examples include covalent modifications of DNA (methylation), covalent modifications of histones (methylation, acetylation, phosphorylation, etc), and other aspects of chromatin structure, such as histone variants, noncoding RNAs, and higher order chromatin structure and remodeling. These aspects of chromatin structure can be quite stable and may be inherited by daughter cells during cell division, or even inherited from one generation to the next generations (parent to offspring). Epigenetic factors play key roles in virtually all biological processes, including development, stem cell biology, cancer, behavior, drug addiction, learning and memory. In this course, we will focus on epigenetic factors in animals, although a few examples in plants or bacteria may also be considered.

Dates & Times

This course meets Tuesdays at 4:30 - 7:10 pm, in Bull Run Hall, room 258.

Contact Information & Office Hours

Office hours Fridays, 1-3 pm, Discovery Hall room 305.
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Readings

There is one required text for this class: *Epigenetics (2nd edition)* edited by C. D. Allis et al. (2015), Cold Spring Harbor Laboratory Press. One copy will be available at Mercer Library on 2 hour reserve. Most of the reading will be assigned from this text. A few additional readings will be assigned from the primary research literature (listed below). Study questions based on the assigned readings will be posted, along with lecture notes, on Blackboard.

Grading summary: 40% midterm + 50% final exam + 10% participation.

Participation grades are based on a combination of attendance and participation in discussions during class (which is strongly encouraged). Midterm and final examinations will consist of short-answer and short essay questions, modeled on the posted study questions.

Course Schedule

Introductory course meeting. Tuesday, January 22.

Lecture 1. Tuesday, January 29 - A survey of epigenetic marks.

Text chapter 3, pp. 47-76.
Filion, GJ et al. (2010) Systematic protein location mapping reveals five principal chromatin types in *Drosophila* cells. *Cell* 143, 212-224.

Lecture 2. Tuesday, February 5 - Gene regulation at the epigenetic level.

text, pp. 21-23.
Roy, A. L. et al. (2011) Enhancer-promoter communication and transcriptional regulation of Igh. *Trends Immunol*. 32, 532-539.
Ernst, J. et al. (2011) Mapping and analysis of chromatin state dynamics in nine human cell types. *Nature* 473, 43-49.

Lecture 3. Tuesday, February 12 – Chromosome looping and higher order structures.

Text chapter 19, pp. 507-528.

Ong CT and Corces VG (2014) CTCF: an architectural protein bridging genome topology and function. *Nat. Rev. Genet.* 15, 234-246.

Lecture 4. Tuesday, February 19 - DNA methylation.

Text chapter 15, pp. 423-443.

Jones PA (2012) Functions of DNA methylation: islands, start sites, gene bodies and beyond. *Nat. Rev. Genet.* 13, 484-492.

Lecture 5. Tuesday, February 26 - Histone variants and histone chaperones.

Text chapter 20, pp. 529-549.

Text chapter 22, pp. 579-593.

Hammond, CM et al. (2017) Histone chaperone networks shaping chromatin function. *Nat. Rev. Mol. Cell Biol.* 18, 141-158.

Lecture 6. Tuesday, March 5 - Regulation of gene expression by Polycomb and Trithorax.

Text chapter 17, pp. 463-488.

Text chapter 18, pp. 489-506.

Ferrari, KJ et al. (2014) Polycomb-dependent H3K27me1 and H3K27me2 regulate active transcription and enhancer fidelity. *Mol. Cell* 53, 49-62.

Tuesday, March 12 - class does not meet (Spring Break)

Tuesday, March 19 - Midterm Exam (covers lectures 1-6)

Lecture 7. Tuesday, March 26 – Nucleosome remodeling.

Text chapter 21, pp. 555-573.

Petty E, Pillus L (2013) Balancing chromatin remodeling and histone modifications in transcription. *Trends Genet.* 29, 621-629.

Lecture 7. Tuesday, April 2 - X chromosome inactivation

Text chapter 3, pp. 86-88.

Text chapter 25, pp. 641-665.

Jeon Y, Sarma K, Lee JT (2012) New and Xisting regulatory mechanisms of X chromosome inactivation. *Curr. Opin. Genet. Dev.* 22: 62-71.

Lecture 9. Tuesday, April 9 - Genomic imprinting in mammals.

Text chapter 26, pp. 667-686.

Bian C, Yu X (2014) PGC7 suppresses TET3 for protecting DNA methylation. *Nucl. Acids Res.* 42, 2893-2905.

Lecture 10. Tuesday, April 16 - Germ line and pluripotent stem cells.

Text chapter 27, pp. 687-709.

Adam RC and Fuchs E (2016) The Yin and Yang of chromatin dynamics in stem cell fate selection. *Trends Genet.* 32, 89-100.

Lecture 11. Tuesday, April 23 - Epigenetic control of immunity.

Text chapter 29, pp. 737-762.

Guo C et al. (2011) CTCF-binding elements mediate control of V(D)J recombination. Nature 477, 424-430.

Lecture 12. Tuesday, April 30 - Epigenetic control of the nervous system.

Text chapter 32, pp. 807-830.

Tognini P et al. (2015) Dynamic DNA methylation in the brain: a new epigenetic mark for experience-dependent plasticity. *Front. Cell. Neurosci.* 9, 331.

Tuesday, May 7 – Reading day

Tuesday, May 14 – Final exam (covers lectures 1-12), 4:30 pm – 7:10 pm