

Biology 568: Advanced Topics in Molecular Genetics - Epigenetics
Spring, 2017
Karl J. Fryxell

Introduction

“Epigenetics” refers to mechanisms of the inheritance and control of gene expression that do not involve permanent changes in the DNA sequence. Examples include covalent modifications of DNA (methylation) or histones (methylation, acetylation, phosphorylation, etc), and gene regulation by various aspects of chromatin structure, including histone variants, noncoding RNAs, and higher order chromatin structure and remodeling. Epigenetic factors can be quite stable and may be inherited by daughter cells during cell division, or in some cases across generations (from 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 be considered.

Dates & Times

This course meets Tuesdays at 4:30 - 7:10 pm, in Bull Run Hall, room 131.

Contact Information & Office Hours

Office hours (Fairfax campus): Mondays, 1-3 pm, Krasnow room 115.

Prince William campus office: by appointment in Discovery Hall, room 305.

Phone (PW office): 703-993-1069

E-mail: kfryxell@gmu.edu (PLEASE USE “BIOL 568” as the subject line!)

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 is 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 plus 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 study questions.

Lecture 1. Tuesday, January 24 - Introduction to epigenetic marks.

Text chapter 3, pp. 47-71.

Lecture 2. Tuesday, January 31 - Gene regulation at the epigenetic level.

Text chapter 3, pp. 62-86.

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 7 - DNA methylation.

Text chapter 15, pp. 423-443.

Lecture 4. Tuesday, February 14 – Chromosome looping and higher order structures.

Text chapter 2, pp. 21-23.

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.

Tuesday, February 21 - class does not meet (VYTP Conference)

Lecture 5. Tuesday, February 28 - Histone variants and histone chaperones.

Text chapter 22, pp. 580-593.

Text chapter 20, pp. 529-549.

Lecture 6. Tuesday, March 7 - Repression by Polycomb and X chromosome inactivation.

Text chapter 3, pp. 86-88.

Text chapter 17, pp. 463-488

Text chapter 25, pp. 641-665.

Tuesday, March 14 - class does not meet (Spring Break)

Tuesday, March 21 - Midterm Exam (covers lectures 1-6)

Lecture 7. Tuesday, March 28 - Nucleosome remodeling.

Text chapter 21, pp. 555-573.

Lecture 8. Tuesday, April 4 – Transcriptional regulation by Trithorax Group Proteins.

Text chapter 18, pp. 489-506.

Lecture 9. Tuesday, April 11 - Genomic imprinting in mammals.

Text chapter 26, pp. 667-686.

Lecture 10. Tuesday, April 18 - Germ line and pluripotent stem cells.

Text chapter 27, pp. 687-709.

Lecture 11. Tuesday, April 25 - Epigenetic control of immunity.

Text chapter 29, pp. 737-762.

Lecture 12. Tuesday, May 2 Epigenetic control of the nervous system.

Text chapter 32, pp. 807-830.

Numata et al. (2012) DNA methylation signatures in development and aging of the human prefrontal cortex. *Am. J. Hum. Genet.* 90, 260-272.

Tuesday, May 9 – Reading day

Tuesday, May 16 – Final exam (covers lectures 1-12), 4:30 pm – 7:15 pm