Biology 568: Advanced Topics in Molecular Genetics
Spring, 2013 – Epigenetics
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Introduction

"Epigenetics" refers to the mechanisms of 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), gene regulation by chromatin structure and noncoding RNAs, as well as the regulation, replication and remodeling of chromatin structure. Epigenetic factors tend to be quite stable and are inherited by daughter cells during cell division, thus typically play key roles in determining cell type. In some cases, epigenetic factors are inherited 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 emphasize epigenetic factors in animals and microbes, although a few examples from plants will also be considered.

Dates, Times, and Contact Information

This course meets Tuesdays at 4:30 - 7:10 pm, in Bull Run Hall, room 246. My office hours this semester will be Fridays, from 3-4 pm in Discovery Hall, room 305. Phone: 703-993-1069 E-mail: kfryxell@gmu.edu Web site: http://mason.gmu.edu/~kfryxell

Readings

There is one required text for this class: *Epigenetics in Health and Disease* by I. Kovalchuk and O. Kovalchuk (2012). This text contains discussion topics at the end of each chapter, which will be the focus of midterm and final examinations. Additional readings will be assigned each week (listed below), and discussion topics from the outside readings will be posted, along with lecture notes, on the course web site (see above).

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

Participation grades are based on attendance and regular participation in class discussions (i.e., relevant questions or comments during class). Midterm and final examinations will be a mix of short-answer (one or two sentences) to short essay (one half to one page) questions, based on the assigned readings and discussion topics.

Tuesday, January 22. Introduction.

Text, chapter 1.

Fire et al. (1998) Potent and specific genetic interference by double-stranded RNA in Caenorhabditis elegans. *Nature* 391: 806-811.

Tuesday, January 29. Chromatin remodeling.

Text, chapter 2.

Van Bortle K, Corces, VG (2012) Nuclear organization and genome function. *Annu. Rev. Cell Dev. Biol.* 28: 163-187.

Tuesday, February 5. DNA methylation.

Text, chapter 4.

Law JA, Jacobsen SE (2010) Establishing, maintaining, and modifying DNA methylation patterns in plants and animals. *Nat. Rev. Genet.* 11: 204-220.

Tuesday, February 12 Histone modifications.

Text, chapter 5.

Greer EL, Shi Y (2012) Histone methylation: a dynamic mark in health, disease, and inheritance. *Nat. Rev. Genet.* 13: 343-357.

Tuesday, February 19 Non-coding RNAs in epigenetic processes.
Text, chapters 7.
Jeon Y, Sarma K, Lee JT (2012) New and Xisting regulatory mechanisms of X chromosome inactivation. *Curr. Opin. Genet. Dev.* 22: 62-71.

Tuesday, February 26 Non-coding RNAs in bacteria and archaea.
Text, chapter 8.
Walters LS, Storz G (2009) Regulatory RNAs in bacteria. *Cell* 136: 615-628.

Tuesday, March 5 (Midterm Exam)

Tuesday, March 12 (Spring Break)

Tuesday, March 19 Non-coding RNAs in animals.
Text, chapter 10.
Carthew RW, Sontheimer EJ (2009) Origin and mechanisms of miRNAs and siRNAs. *Cell* 136: 642-655.

Tuesday, March 26 Bacterial adaptive immunity.
Text, chapter 14.
Marraffini LA, Sontheimer EJ (2010) CRISPR interference: RNA-directed adaptive immunity in bacteria and archaea. *Nat. Rev. Genet.* 11: 181-190.

Tuesday, April 2 Virus-induced gene silencing, regulation of transposons and genome stability.
Text, chapter 15.
Castel SE, Martienssen RA (2013) RNA interference in the nucleus: roles for small RNAs in transcription, epigenetics and beyond. *Nat. Rev. Genet.* 14: 100-112.

Tuesday, April 9 The germ line and epigenetic memory.
Text, chapter 16.
Hemberger et al. (2009) Epigenetic dynamics of stem cells and cell lineage commitment: digging Waddington's canal. *Nat. Rev. Mol. Cell Biol.* 10: 526-537.

Tuesday, April 16 Epigenetics of cancer.
Text, chapter 17.
Davalos V, et al. (2012) Dynamic epigenetic regulation of the microRNA-200 family mediates epithelial and mesenchymal transitions in human tumorigenesis. *Oncogene* 31: 2062-2074.

Tuesday, April 23 Epigenetics in the nervous system.
Text, chapter 18.
Schaefer A, et al. (2010) Argonaute-2 in dopamine 2 receptor-expressing neurons regulates cocaine addiction. *J. Exp. Med.* 207: 1843-1851.

Tuesday, April 30 Environmental effects on epigenomics, imprinting, and disease susceptibility.
Text, chapter 19.
Jirtle RL, Skinner MK (2007) Environmental epigenomics and disease susceptibility. *Nat. Rev. Genet.* 8: 253-262.

Tuesday, May 7 (Reading day)

Tuesday, May 14 – Final exam (cumulative), 4:30 pm – 7:15 pm in BRH 246.