



**TOPICS BIOLOGY – BSC 5935**  
**TOPICS STRUCTURE & DEVELOPMENT – BSC 4133**



**CHROMATIN & EPIGENETICS**  
**Spring 2017**

**ACI-226A (BBC Campus)**  
**PG5-155 (MMC Campus)**  
**Fridays, 12:00 pm – 2.30 pm**

**Professor: Dr. Jose M. Eirin-Lopez**  
chromevol.com

### **OVERVIEW**

The organization of our DNA is modified by reversible signals responsive to environmental factors. Those signals constitute epigenetic information (inheritable changes not involving modifications in the DNA sequence) and are responsible, for example, for the phenotypic differences between one of your neurons and one of your skin cells (even though they are genetic clones), for the differences between two monozygotic twins or even the differences between babies born in a post-war period (usually less weight and height) and those born at peace time. The present course wants to introduce you to the fundamentals of Epigenetics and its relevance for virtually all biological processes. The course is intended for Graduate Students and Senior Undergraduates interested in an updated view of this exciting and still young discipline.

The course is divided into two major parts:

- **Part I** will introduce students to the structural organization of DNA in the chromatin fiber and the chromosomal proteins regulating DNA metabolism.
- **Part II** will explore the interaction between chromatin structural components, RNA and DNA in determining epigenetically inheritable traits.

### **LEARNING OBJECTIVES**

Upon successful completion of this course, you will be able to:

- Explain what is Epigenetics and apply this concept to the study of inheritance in natural populations.
- Describe different epigenetic mechanisms and identify how do they interact with genetic mechanisms affecting phenotypes.
- Distinguish the epigenetic information in DNA methylation from the genetic information in the DNA.
- Understand how DNA is dynamically organized into nucleosomes constituting the chromatin fiber.
- Identify the different types of histones and their chemical modifications.
- Understand how modifications in histone structure change the chromatin and modify the expression of the information on the DNA.
- Identify the differences between somatic chromatin and germinal chromatin.
- Integrate different evolutionary mechanisms leading to the differentiation of the chromatin structure in eukaryotes.
- Understand the epigenetic role of RNA modulating the expression of the information on the DNA.

- Identify how different epigenetic mechanisms participate in dosage compensation in mammals.
- Define imprinting and give an example of it.
- Understand the role of epigenetic mechanisms during development.
- Describe how epigenetic mechanisms can lead to disease.
- Explain the epigenetic links between sources of environmental stress and acclimatization responses.

### **HOW THIS COURSE WILL HELP YOU SUCCEED**

The study and understanding of epigenetics is fundamental to take your life sciences education to the next level. Think about it, you know pretty much everything about how the nucleic acids carry the genetic information, the parts of a cell, the different tissues, biodiversity, evolution... however, by studying epigenetics you will be able to understand the actual mechanisms making all that possible, in other words, how the expression of the genetic information is regulated in different environmental, developmental and temporal scenarios. In addition, this course will help you acquire a conceptual and practical framework that you can apply to solve complex problems in in your future research, professional practice, or clinical practice.

Beyond its formal learning objectives, I hope that this course will inspire you to:

- Realize your potential to learn and master complex concepts
- Be open minded about science and epigenetics
- Appreciate the role of epigenetics shaping life on earth
- Care about nature and the environment and their benefits for society
- Be understanding about others' interests, limitations and background
- Become curious and creative in using evolutionary thinking to solve biological, medical and legal problems

### **IMPORTANT INFORMATION**

#### **Policies**

Please review the [FIU's Policies](#) webpage. The policies webpage contains essential information regarding guidelines relevant to all courses at FIU, as well as additional information about acceptable netiquette for online/hybrid courses.

#### **Professional and Academic Integrity**

Florida International University is a community dedicated to generating and imparting knowledge through excellent teaching and research, the rigorous and respectful exchange of ideas, and community service. All students should respect the right of others to have an equitable opportunity to learn and to honestly demonstrate the quality of their learning. Therefore, all students are expected to adhere to a standard of academic conduct, which demonstrates respect for themselves, their fellow students, and the educational mission of the University. All students are deemed by the University to understand that if they are found responsible for academic misconduct, they will be subject to the [Academic Misconduct procedures and sanctions](#).

Academic Misconduct policies and procedures will be strictly enforced regarding cheating. Anyone caught cheating will be asked to leave the class, will be given an “F” for the whole course and a petition will be sent to Academic Affairs. **NO EXCEPTIONS.**

### **Incomplete Grades**

An incomplete grade will be delivered under very exceptional documented circumstances such as major sudden and unexpected serious health problem of the student or his/her family. Other excuses will not be accepted to provide an incomplete grade.

### **Letters of Recommendation**

Letters of recommendation will only be written for the **top 3 students in the class** based on the final numeric grade.

### **Accessibility And Accommodation**

The Disability Resource Center collaborates with students, faculty, staff, and community members to create diverse learning environments that are usable, equitable, inclusive and sustainable. The DRC provides FIU students with disabilities the necessary support to successfully complete their education and participate in activities available to all students. If you have a diagnosed disability and plan to utilize academic accommodations, please contact the Center at 305-348-3532 or visit them at the Graham Center GC 190.

Please visit our [ADA Compliance](#) webpage for information about accessibility involving the tools used in this course.

Please visit [Blackboard's Commitment Accessibility](#) webpage for more information.

For additional assistance please contact FIU's [Disability Resource Center](#).

### **Expectations of this Course**

As a student in this course, you are expected to:

- **Review the Syllabus**
- Review and follow the course **calendar**
- Submit assignments by their respective **due dates**
- Log in to the course **blackboard at least 2 times per week**
- Respond to emails within 2 days

I, the professor, will:

- Log in to the course at least 2 times per week
- Respond to emails within 2 days
- Respond to General Discussion posts within 2 days (see Course Communication section)
- Provide feedback on assignments within 7 days of submission

### **Reference Textbooks**

- 1) *Epigenetics*. Allis, Caparros, Jenuwein, and Reinberg (Eds.). Cold Spring Harbor Press, 2015.
- 2) *The Epigenetics Revolution: How Modern Biology Is Rewriting Our Understanding of Genetics, Disease, and Inheritance*. Nessa Carey. Columbia University Press, 2011.

## **COURSE DETAIL**

### **Course Format**

This course is a combination of 5000 and 4000 courses mixing undergraduate and graduate students. It will be **taught every FRIDAY of the semester, 12 pm – 1:30 pm, simultaneously at BBC (ACI-226A) and MMC (PG5-155) through polycom**. I will teach in person one week at each campus (with polycom to the other). The course will combine **lectures, presentations of**

**current scientific literature and in-class discussions**, focusing on the current questions in Chromatin and Epigenetics and how they are being addressed experimentally.

### **Course Communication**

Outside of our in-person meetings, we'll stay in touch through **Blackboard**.

**Email.** Use email for personal, or time-sensitive questions. The Email feature is an external communication tool that allows users to send emails to users enrolled within the course (including the professor). The Email tool is located on the Course Menu, on the left side of the course.

**General Discussion Forum.** Post your question or comment here if it is related to class material and your classmates could also benefit from my response. Keep in mind that your discussion forum postings will likely be seen by other members of the course. Please review our [netiquette policies](#).

**Office Hours.** Anytime by appointment, email me (jeirinlo@fiu.edu) to set one up.

### **ASSESSMENTS**

Since the present course mixes graduate and undergraduate students, each group will be evaluated based on specific assessments as indicated below:

#### **1. GRADUATE STUDENTS (BSC5935)**

**a. Research Paper Presentation (40% final grade):** Each graduate student will **present 2 research papers in class** (see calendar). The publications are based on content discussed in the lecture from the week prior to the presentations and are **already available in Blackboard**. Presentations should be approx. 15-20 minutes long, supported by slides, and include background information as well as future directions. Following each presentation there will be time for questions and discussion with the rest of the students.

**b. Class Quizzes (20% final grade):** Each graduate student will elaborate 2 lists of 10 multiple-choice questions, each referred a specific session as indicated in the calendar. These questions (with the corresponding solutions) will be **emailed to me on MONDAY after the corresponding class** and will be used as quizzes to evaluate undergraduate students. [Example: Histones are ... a) enzymes, b) genes, c) acidic proteins, d) basic proteins]. Out of the 10 questions, 8 will be referred to the lecture portion of the class and 2 to the research paper presented by the graduate student.

**c. Research Proposal (40% final grade):** Every graduate student will write a NSF/NIH-format proposal linking epigenetics with his/her own research project. There are **two important deadlines** for this: **March 3<sup>rd</sup>, submission of a Letter of Intent (LOI, 1 page)** describing the proposal (Overview, Goals, Relevance...). **April 24<sup>th</sup>, submission of Full Proposal (3-5 pages)** incorporating sections including (but not limited to): Specific Aims, Rationale and Significance, Hypotheses, Research Approach, Timeline. Upon submission, each written proposal will be sent for evaluation to **TWO anonymous graduate students from the course** who will send their reports back to me **by April 28<sup>th</sup>**.

#### **2. UNDERGRADUATE STUDENTS (BSC4133)**

**a. Syllabus quiz (7% final grade):** A quiz consisting of 10 multiple choice questions will be already **available at Blackboard until Jan 20<sup>th</sup>, 11:59 pm**. Once started, the **quiz must be completed in 10 minutes** (if internet connection breaks down in the middle of the quiz it will be possible to log in again and finish, however, remember that the clock will keep running. **MAKE SURE YOU STUDIED the contents and MAKE SURE YOU HAVE A GOOD INTERNET**

**CONNECTION before taking the quiz).** Students are responsible for completing the quiz on time, if they do not, it will be graded as 0 points without option to make up. Correct answers will be released after the quiz's due date.

**b. Weekly quizzes (12 in total, 48% final grade):** A quiz consisting of 10 multiple choice questions will be available each week (except the first week of class) at Blackboard, from Monday afternoon until Sunday 11:59 pm. These quizzes will consist of questions referred to the class from the previous week. Once started, the **quiz will must be completed in 15 minutes** (if internet connection breaks down in the middle of the quiz it will be possible to log in again and finish, however, remember that the clock will keep running. **MAKE SURE YOU STUDIED the contents and MAKE SURE YOU HAVE A GOOD INTERNET CONNECTION before taking the quizzes**). Students are responsible for completing the quizzes on time, if they do not, it will be graded as 0 points without option to make up. Correct answers will be released after each quiz's due date.

**c. Midterm and Final Exam (45% final grade, 22.5% each):** Each exam will consist of 60 multiple choice questions covering the lectures 2-7 (midterm exam) and lectures 8-13. Exams will be done ONLINE and will be available from 9 am until 8 pm the days indicated in the calendar below. Once started, the **exams will must be completed in 60 minutes** (AGAIN, if internet connection breaks down in the middle of the exam it will be possible to log in again and finish, however, remember that the clock will keep running. **MAKE SURE YOU STUDIED the contents and MAKE SURE YOU HAVE A GOOD INTERNET CONNECTION before taking the exams**). Correct answers will be released after each exam due date. MAKE UP EXAMS WILL NOT BE AVAILABLE IN THIS COURSE.

**d. Extra Credit:** There is the possibility of getting extra credit by doing a **Research Paper Presentation**, the same as graduate students will do (see instructions above). This opportunity is limited to undergraduate students ONLY, and ONLY 1 presentation per student. The EC for this presentation will add **5% to your final grade**. If you are interested in doing this presentation you have to proceed as follows: i) identify a paper you would like to present, ii) confirm with me that the paper is suitable for discussion in class, iii) request a date for the presentation in class.

### **How to Succeed in this Course**

**Utilize Your Resources.** Make sure that you come to class and that you follow my class lectures, which are the guiding thread of the present course. In addition, I will provide you with online materials and other resources so you can work on your own. All these materials will be available for you in **blackboard**.

**Participate.** This course will not be any good to you or your future if you don't take an active part on it. First, I want you to be excited and happy about the course, so you can loosen up and start participating. I know sometimes is tough to speak up in front of everybody but guess what, everybody is as frighten as you are, so relax. They key for that is to know what you're talking about, so prepare the class in advance of the in person session.

**Communicate.** We will see each other in person quite often, so we will have the chance of discussing and clarifying all your questions. Don't let that opportunity go to

waste, come to me and ask all questions you have. You should let me know what ideas and tools are challenging to you and how you are doing in the class. If you start this habit early in the semester, then I will be able to better tailor our activities to help you learn.

Have Fun. I don't want to get external distractions, prejudices or invisible barriers in our way to knowledge, so we'll get rid of those right away from the very beginning. In my experience, being relaxed, friendly, funny and close to each other is a great way to do so. I guarantee you that if you do that, you will be having tons of fun and you will be making the most of this learning process. Follow this Buddhist proverb: happy face, happy life.

### GRADING

Grade	% total
A	90 – 100 %
B+	86 – 89 %
B	80 – 85 %
C+	76 – 79 %
C	70 – 75 %
D	60 – 69 %
F	< 60 %

### COURSE CALENDAR

Date	Me	Topic	Presentation (presenter)	Quiz author
01/13	MMC	01. Overview		
01/20	BBC	02. DNA Methylation	Paper 01 (A. SMITH)	A. BEAL
01/27	MMC	03. Chromatin Structure	Paper 02 (C. BURNS)	J. CASTILLO
02/03	BBC	04. Histone Variants	Paper 03 (A. BEAL)	C. VARELA
02/10	MMC	05. Histone Modifications	Paper 04 (J. CASTILLO)	E. BARREDO
02/17	BBC	06. Germ Chromatin	Paper 05 (C. VARELA)	A. SMITH
02/24	MMC	07. Chromatin Evolution	Paper 06 (E. BARREDO)	C. BURNS
<b>03/03</b>	<b>online</b>	<b>Submission LOI (Grad. Students) / Exam 1 (Undergrad. Students)</b>		
03/10	BBC	08. RNAi Heterochromatin	Paper 07 (A. SMITH)	A. BEAL
<b>03/17</b>	<b>NO CLASS (SPRING BREAK)</b>			
03/24	MMC	09. Dosage Compensation	Paper 08 (C. BURNS)	J. CASTILLO
03/31	BBC	10. Genomic Imprinting	Paper 09 (A. BEAL)	C. VARELA
04/07	MMC	11. Stem Cells	Paper 10 (J. CASTILLO)	E. BARREDO
04/14	BBC	12. Epigenetics and Disease	Paper 11 (C. VARELA)	A. SMITH
04/21	MMC	13. Environment Epigenetics	Paper 12 (E. BARREDO)	C. BURNS
<b>04/24</b>	<b>online</b>	<b>Submission Proposal (Grad. Students)</b>		
<b>04/28</b>	<b>online</b>	<b>Exam 2 (Undergrad. Students)</b>		

## **Papers (available in Blackboard)**

### **Paper 01. Overview**

Feil, R., and M. F. Fraga. 2012. Epigenetics and the environment: emerging patterns and implications. *Nature Reviews in Genetics* **13**:97-109.

### **Paper 02. DNA Methylation**

Jenkins, T. G., K. I. Aston, C. Pflueger, B. R. Cairns, and D. T. Carrell. 2014. Age-associated sperm DNA methylation alterations: possible implications in offspring disease susceptibility. *PLoS Genetics* **10**:e1004458.

### **Paper 03. Chromatin Structure**

Probst, A.V., and Mittelstend Scheid, O. 2015. Stress-induced structural changes in plant chromatin. *Current Opinion in Plant Biology* **27**:8-16.

### **Paper 04. Histone Variants**

Turinetto, V., and C. Giachino. 2015. Multiple facets of histone variant H2AX: a DNA double-strand-break marker with several biological functions. *Nucleic Acids Research* **43**:2489-2498.

### **Paper 05. Histone Modifications**

Brunner, A. M., P. Nanni, and I. M. Mansuy. 2014. Epigenetic marking of sperm by post-translational modification of histones and protamines. *Epigenetics & Chromatin* **7**:2.

### **Paper 06. Germ Chromatin**

Tang, W. W. C., T. Kobayashi, N. Irie, S. Dietmann, and M. A. Surani. 2016. Specification and epigenetic programming of the human germ line. *Nature Reviews in Genetics* **17**:585-600.

### **Paper 07. Chromatin Evolution**

Zhou, X., C. E. Cain, M. Myrthil, N. Lewellen, K. Michelini, E. R. Davenport, M. Stephens, J. K. Pritchard, and Y. Gilad. 2015. Epigenetic modifications are associated with inter-species gene expression variation in primates. *Genome Biology* **15**:547.

### **Paper 08. RNAi and Heterochromatin formation**

Chen, Q., and E. Duan. 2016. Epigenetics inheritance of acquired traits through sperm RNAs and sperm RNA modifications. *Nature Reviews in Genetics* **17**:733-743.

### **Paper 09. Dosage Compensation**

Jiang, J., Y. Jing, G. J. Cost, J. C. Chiang, H. J. Kolpa, A. M. Cotton, D. M. Carone, B. R. Carone, D. A. Shivak, D. Y. Guschin, J. R. Pearl, E. J. Rebar, M. Byron, P. D. Gregory, C. J. Brown, F. D. Urnov, L. L. Hall, and J. B. Lawrence. 2013. Translating dosage compensation to trisomy 21. *Nature* **500**:296-300.

### **Paper 10. Genomic Imprinting**

Susiarjo, M., I. Sasson, C. Mesaros, and M. S. Bartolomei. 2013. Bisphenol a exposure disrupts genomic imprinting in the mouse. *PLoS Genetics* **9**:e1003401.

### **Paper 11. Germ Cells and Pluripotent Stem Cells**

Harikumar, A., and E. Meshorer. 2015. Chromatin remodeling and bivalent histone modifications in embryonic stem cells. *EMBO Reports* **16**:1609-1619.

### **Paper 12. Epigenetics and Disease**

Nestler, E. J., C. J. Peña, M. Kundakovic, A. Mitchell, and S. Akbarian. 2016. Epigenetic basis of mental illness. *The Neuroscientist* **22**:447-463.