Special Topics: RNA Biology and Biotechnology (3 credit hours)
(BIOL 4803-B/8803-B) Spring, 2016

Instructor: **Francesca Storici**, Associate Professor School of Biology (storici@gatech.edu); office hours Tuesday 11AM- 12PM, EBB room 5017. Prior appointment by E-mail is strongly recommended for a meeting during office hours and required for any meeting outside of the office hours.

Time and location: Tuesday and Thursday, 9:35AM – 10:55AM, Building: Cherry Emerson, Room: 204.

Course description: The purpose of this course is to introduce students (graduate and upper level undergraduate) to the fundamental concepts of RNA biology and to state-of-the-art biotechnologies that use RNA for medical and industrial applications. It is now clear that most of genomic DNA is transcribed into RNA and only about 2% of genomic DNA is coding, while all the rest is transcribed into non-coding RNA. RNA has an ample spectrum of functions and many of its functions are yet to be discovered. RNA impacts almost every aspect of gene expression and regulation and its malfunction is associated with many types of human diseases. RNA is also a catalyst, a scaffold and a guide for sequence-specific recognition and processing of other RNA and protein molecules. Moreover, progress in our understanding of RNA biology has made it possible to identify RNA molecules as targets of therapeutic intervention and to use RNA as a tool for functional studies, to treat human disease and for industrial applications. Understanding the biology of RNA is an essential investigation for basic, medical, pharmaceutical, agricultural and environmental research. RNA-based techniques (RNA interference, antisense RNA, CRISPR system, RNA nanotechnology etc.) are becoming more and more useful in gene therapy and applied research. These topics will be covered in depth with lectures, workshops, seminars and debates, with the goal to attract students from a multidisciplinary audience between the colleges of science and engineering.

Optional textbook: No textbook covers all the information in this course; however, some parts of the topics of the class are covered in 'Molecular Biology: Genes to Proteins, 4th edition' by Burton Tropp, 2012; ISBN: 978-1-4496-0091-4., in 'The Molecules of life – Physical and Chemical Principles' by John Kuriyan, Boyana Konforti and David Wemmer, Garland Science, Taylor and Francis Group, LLC, New York, 2013; ISBN: 978-0-8153-4188-8, and in the 'Molecular Biology of RNA' 1st Edition by David Elliott and Michael Ladomery, 2011 Oxford University Press, ISBN: 978-0-19-928837-3. These books are on reserve in the library.

All of the information that you will be required to know will be presented in class or assigned as research papers.

Notes: 1) Students who have previously taken BIOL 4668 (Euk. Mol. Genetics – undergraduate) or BIOL 7668 (Euk. Mol. Genetics - graduate) cannot get additional credit for BIOL 4803-B/8803-B.

2**)** Exam will be given only during class hours on the dates specified in the syllabus.
3) There will be no early finals.

Grading: For registered attendees, the grade will be based on exams on the material of the lectures and presentations, presentations at in-class seminars, workshops and/or debates, and homework (homework only for BIOL 8803) on material of seminars/workshops/debates according to this proportion:

BIOL 4803-B:
Exams - 60%:
Exam I – 30%
Final Examination – 30%

At least two presentations at seminars, workshops or debates - 40%
(Oral presentation - 20%; Slide preparation - 20%; students will be graded individually)

Quiz I and Quiz II - are counted as bonus points (up to 5 points) for Exam I and the Final Exam, respectively.

Attendance before each exam is counted as bonus points for the exam (week 1 does not count): no absence = 4 points, 1 absence = 3 points).

BIOL 8803-B:
Exams – 40%:
Exam I – 20%
Final Examination – 20%

At least three presentations at seminars, workshops or debates - 40%
(Oral presentation - 20%; Slide preparation - 20%; students will be graded individually)

Homework - 20%
Homework is in the form of report/questions based on materials covered in seminars/workshops/debates.

Quiz I and Quiz II - are counted as bonus points (up to 5 points) for Exam I and the Final Exam, respectively.

Attendance before each exam is counted as bonus points for the exam (week 1 does not count): no absence = 4 points, 1 absence = 3 points).

Final grades will be assigned using the following scale:

90% and greater	A
80-89%	B
70-79%	C
60-69%	D
Less than 60%	F

Prerequisites: BIOL 1510/BIOL 1511, Minimum Grade of D.

Learning Objectives: Upon completion of this course, students will be able to:

1. Describe the processes involved in RNA metabolism, processing and function, and the basic concepts of major RNA technologies.
2. Become familiar with theoretical foundations of the major technical approaches involved in RNA detection and quantification.
3. Understand molecular and cellular foundations of RNA biology and major approaches utilized in RNA biotechnology.
4. Get exposure to the integrative interdisciplinary approaches to major biological problems.
5. Read, interpret, explain and discuss primary literature that concerns RNA biology and biotechnology.
6. Develop skills that are necessary for scientific discussion and for the analysis of current scientific literature.

Learning Accommodations: If needed, we will make classroom accommodations for students with documented disabilities. These accommodations must be arranged in advance and in accordance with the Office of Disability Services (http://disabilityservices.gatech.edu/).

Course format: Classes will be comprised of introductory lectures, assigned research papers for seminars, recent papers for workshops chosen by students with help of instructor on assigned topics, and debates on assigned topics. This course places also a strong emphasis on developing the student's ability to understand and critically evaluate scientific literature and discuss about recent exciting findings and challenging problems in RNA biology and biotechnology. The lecture part of the course is intercalated with three seminars, where students (2-3) will make a presentation on the assigned topic on assigned research paper(s) or on material chosen by the students, three workshops, where (~5) students will make short presentations on the assigned topic on research papers (published in the last year) chosen by the students, and two debates, where (~6) students will make

short presentations (~3 pro and ~3 contra) on the assigned topic for debate using material chosen by the students.

TENTATIVE COURSE SCHEDULE

Week 1:	01/12, 14	Overview of program and RNA structure and properties	*A-Ch.4.9,10, B-Ch.2, C-Ch.1,2
Week 2:	01/19, 21	Techniques in RNA biology and biotechnology	A-Ch.5.1,4,6,7, C-Ch.2
Week 3:	01/26, 28	Synthesis of ribonucleotides, transcription, RNA processing I; **Quiz I**	A-Ch.17, 19, C-Ch.5-9
Week 4:	02/02	RNA processing II and export	A-Ch.19, C-Ch.10, 11
	02/04	**Seminar I** on extracellular RNA biology	
Week 5:	02/09, 11	Protein synthesis, Regul. of gene expr. and Antisense technology	A-Ch.18, 20, 22, 23 C-Ch.13, 16, 17
Week 6:	02/16	**Workshop I** on transcription processing	
	02/18	RNAi	A-Ch. 21, C-Ch.18
Week 7:	02/23	**Seminar II** on discovery of RNAi	
	02/25	RNAi in medical and industrial applications	C-Ch.18
Week 8:	03/01	**Debate I** on use of RNAi spray in agriculture	
	03/03	Preparation for EXAM I	
Week 9:	03/08	**EXAM I**	
	03/10	Biology of the CRISPR/Cas9 system	
Week 10:	03/15	Applications of the CRISPR/Cas9 system (Chance Meers)	
	03/16	**Withdrawal Deadline**	
	03/17	**Debate II** on use of the CRISPR/Cas9 system in gene therapy (Chance Meers)	
Week 11:	03/22, 24	**SPRING BREAK**	
Week 12:	03/29	lncRNA and circRNA as biomarkers of human disease and druggable targets	C-Ch.17
Week 12:	03/31	RNA editing and modification	C-Ch.15
Week 13:	04/05	**Workshop II** on RNA editing and modification	
Week 14:	04/07	Role of RNA in DNA repair and modification (TC-NER, DSB repair, RER)	A-Ch.12.3
	04/12	**Seminar III** on RNA in DNA repair and modification	
Week 15:	04/14	Retrotransposons, retroviruses and RNA viruses; **Quiz II**	A-Ch. 8.6, 14.3
	04/19	RNA nanotechnology	
Week 16:	04/21	**Workshop III** on RNA nanotechnology applications	
	04/26	Course wrap-up	

Finals week: 05/05 (8:00am - 10:50am) **FINAL EXAM**

*All lectures will have Francesca Storici as Instructor, unless otherwise indicated. All lectures are based mostly on outside sources, which will be provided to the students. Some of the topics covered can also be seen in suggested book chapters. The specific books and book chapters are indicated.
A = 'Molecular Biology: Genes to Proteins, 4th edition' by Burton Tropp, 2012; ISBN: 978-1-4496-0091-4.
B = 'The Molecules of life – Physical and Chemical Principles' by John Kuriyan, Boyana Konforti and David Wemmer, Garland Science, Taylor and Francis Group, LLC, New York, 2013; ISBN: 978-0-8153-4188-8.
C = 'Molecular Biology of RNA' 1st Edition by David Elliott and Michael Ladomery, 2011 Oxford University Press, ISBN: 978-0-19-928837-3.
Ch. = Chapter.

Additional information (required by Georgia Tech):

All students are required to adhere to the Georgia Tech Academic Honor Code (www.honor.gatech.edu). This includes, but is not limited to, the following issues that pertain to the exams, oral and slide presentations, and homework for this class:

1. Plagiarism is not allowed. Plagiarizing is defined by Webster's as "to steal and pass off (the ideas or words of another) as one's own; use (another's production) without crediting the source."

In simpler terms: When you use any phrases, sentences, etc. verbatim from another source, they must be identified by quotation marks and citation of the source. In scientific writing, it is generally preferable to rephrase information from other sources and cite the source rather than use the same text, even when you offset the text with quotation marks. When you show diagrams, models and other materials that are not your own, the sources must also be identified.

These rules apply both to published information and information that you might receive from another student, website, previous class report, etc.

Plagiarizing will be dealt with according to the GT Academic Honor Code.

2. Unless specifically identified as group work; exam tests, slide preparation and homework, etc. are to be completed alone.

3. For exams: Cheating off of another person's test or is unethical and unacceptable. Cheating off of anyone else's work is a direct violation of the GT Academic Honor Code, and will be dealt with accordingly.

4. At exams, students are allowed to use notes in the form of 1 paper page per person, could be double-sided, handwritten or printed (you can use only your own notes and cannot ask another person for his/her notes).

For any questions involving these or any other Academic Honor Code issues, please consult the professors, or www.honor.gatech.edu.