Biological Chemistry 395: Chemistry & Biology of Nucleic Acids

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Contact policy: I generally check my e-mail between 8 AM and 6 PM on weekdays and once or twice a day on weekends, and will get back to you within 24 hours. Please feel free to stop by my office. If my door is open, I will make time to talk if I am able. If my door is closed, it means I'm in the middle of something and would appreciate not being interrupted.

Course Description:

This course provides a background to nucleic acid structure and function from both a chemical and biological perspective, including synthesis, characterization and applications. The laboratory will consist of an introduction to techniques in nucleic acid chemistry in both chemical and biological contexts.

Office Hours:

Tuesday/Thursday: 9:30-11:00 AM
Monday/Wednesday/Friday: 4-5 PM

I will be in my office and available to meet with individuals or groups during these scheduled office hours for questions or discussion about either the lecture or the lab. If you cannot make these times, feel free to call or e-mail me to schedule another time that works better for you. With less than 24 hours of notice, I may not be able to accommodate you but I will try to work something out.

Class Schedule:

Lecture: 8:00-9:20 AM Tuesday/Thursday, Noyce 1612
Lab: 1:00-3:50 PM Friday, Noyce 1004

Texts:

The main text for the course will be **Nucleic Acids in Chemistry and Biology (3rd Ed.)**, Michael Blackburn (Editor) from RSC Publishing.

Additional readings will be taken from the following texts, as well as from the primary literature:

- Fundamentals of Biochemistry: Life at the Molecular Level (4th or 5th Ed.) by Voet, Voet & Pratt.
- Spectrophotometry & Spectrofluorimetry, Michael C. Gore (Editor)

Additional reading materials from the above sources will be made available in class or through Pioneer Web.

Required Materials:

- Lab Safety Goggles
- Electronic Lab Notebook via LabArchives
- Calculator

Pre-requisites:

A solid background in organic chemistry (CHM 221 & 222) as well as biology (BIO 150, 251) and biochemistry (BCM 262) is required for this course.

Special Needs:

The success of every student in this class is important to me, and I assume that all of us come from different backgrounds and have different needs and learning styles. I am always open to suggestions of how you feel I can make the class more accessible to you, and am happy to work with you to develop strategies that will help you succeed in this course.

I encourage you to visit the Coordinator for Disability Resources, Autumn Wilke, located on the 3rd floor of the Rosenfield center (x3702) to help you find out how your learning could be improved. If you need official accommodations, you have a right to have them met, and the Coordinator for Disability Resources can provide you with documentation that will help me determine how to best provide them for you.

Academic Honesty:

Unless specifically stated in an assignment, all work turned in for credit must be done individually. All work turned in must be your own, and all citations and attributions of ideas and wording must be clear and correct. If you are unsure at any time, please see me. An excellent guide to avoiding accidental plagiarism can be found through Harvard's Writing School: http://usingsources.fas.harvard.edu/icb/icb.do?keyword=k70847&pageid=icb.page342054

Absence and Makeup Policy:

If you know of any days you will be unable to attend class, I encourage you to let me know as soon as possible so we can come to a mutual understanding of how best to allow you to meet the requirements of the course while attending to other important issues in your life. If an emergency situation prevents you from making a class session, or causes you to miss an exam/assignment without prior notice, makeup work can be arranged on an individual basis depending on the assignment.

Course Outline & Goals:

This course will provide an introduction to the study of nucleic acids. Emphasis will be placed on helping you gaining a thorough understanding of their structure and functions from a chemical perspective (synthesis, analysis, modification and applications) and a biological perspective (biosynthesis, metabolism, major biological roles and utility as targets for therapeutics), as well as teaching you to applying that understanding to modern uses of nucleic acids in biotechnology and medicinal chemistry. Accordingly, the course will be divided into three primary portions: Structure, Synthesis & Analysis, Biological Roles, and Applications. Increasing emphasis will be placed on readings and discussions of the primary literature as the course progresses, culminating in a final paper and presentation.

The first part of the course (Structure, Synthesis & Analysis) will focus on the chemistry of nucleic acids, examining them as complex organic molecules. Emphasis will be placed on you developing an understanding of the fundamental chemical principles that drive the interactions. Both chemical synthesis and biosynthesis of nucleotides and oligonucleotides will be discussed, as well as the study (analysis) of nucleotides and oligonucleotides with physical techniques (spectroscopy, spectrometry & NMR). You will be expected to demonstrate an understanding of the structure of oligonucleotides, and how the structure affects assembly and physical properties.

The second part of the course will focus on the biological roles of nucleic acids. This will include the study of higher order biological structures, transcription and translation, and DNA damage and repair mechanisms. An emphasis will be placed on you developing an understanding of the roles nucleic acids play as both information storage (genes and genomes) and as messengers (mRNA, miRNA, lncRNA), as well as how they interact with other biomolecules. You will be expected to develop an understanding of the biosynthesis and degradation of oligonucleotides, as well as how they interact with other biological processes.

The final part of the course will focus on applications of oligonucleotides in biotechnology and medicinal chemistry. This will include the use of synthetic oligonucleotide constructs as therapeutics, as well as developing systems to target biologically relevant oligonucleotides. An emphasis will be placed on exposing you to current advances in the primary literature, as well as examining how basic principles learned in the first two parts can be applied to solve new problems.

Course Expectations & Grading:

I expect that proper preparation and studying for this course will take you about 2 hours out of class for every hour of credit. While recall of information is important, learning how to critically interact with the field and interpret new

literature based on an understanding of the underlying principles is the driving motivation for this class. Accordingly, there will be two midterm exams, with the rest of the class focusing on discussion, short critical analysis papers, and a final paper and presentation. Each of these parts is explained in more detail below.

One of the goals of this course is to introduce you to the literature in the field. Accordingly, 1-3 articles per week will be assigned for reading, and we will discuss these articles in class. It is important that you read the articles before class so you can be ready to discuss them.

In Class Discussion & Participation (10%):

While I will not be directly grading on attendance, good outcomes in the course are largely dependent on you being in class to discuss the material. I expect you to attend all classes that you are able to, and your prepared and active participation will be counted.

Short Papers (5, 20% Total):

As part of the focus on the primary literature, five short (1-2 page) papers critically examining articles we have discussed in class will be assigned regularly throughout the semester (every 2-3 weeks). Each short paper will be worth 4% of your final grade. If you have a paper you would like to write on that is topically relevant to the class, please come talk to me and I will consider letting you write on it instead.

Exams (2, 20% total):

There will be two midterm exams for this course, one following each of the first two portions of material. Each will be worth 10% of the final grade. These exams will have a short portion for which no outside sources can be used, and a longer portion for which any outside sources can be used, and will be given as a take-home exam.

Final Paper & Presentation:

As we progress through the final part of the course, students will (with my approval) select an area within biotechnology that interests them for a final paper. This final paper will incorporate an overview of research in that area (a short literature review) as well as a proposal for a research topic based on that literature. A summary of both the current literature and research proposal will be given in class at the end of the semester. The paper will be worth 15% of your final grade, and the in-class presentation will be worth 10%.

Laboratory (25%):

While an introduction to the principles driving oligonucleotide structure and function is important, it is equally important to learn practical techniques for manipulating them in a laboratory setting. The laboratory will be project based, exploring both the introduction of synthetic oligonucleotides into biological systems and the extraction and analysis of DNA and RNA from biological systems.

Course Grade:

Grades in the course will be assessed according to the following point scheme:

Attendance and Discussion	10 %
Short Papers (4% each)	20 %
Exam 1	10 %
Exam 2	10 %
Final Paper	15 %
Final Presentation	10 %
Lab	25 %
Total	100 %

Final grades in the course will be assigned based on percent completion, as follows:

A/A-: 90-100% B+/B/B-: 78-89% C+/C: 68-78% D: 55-67%

However, both a passing grade (55%+) must be obtained in both the lecture and lab portions of the class to receive a passing grade for the course.

I do not adjust grades to a particular distribution (i.e., a curve), but I may, at my discretion, adjust the grading ranges to better fit individual performance in the course. If at any point in the semester you are concerned about your grade or have any questions, please come see me as soon as possible.

Tentative Fall 2016 Schedule

Week	Lecture Dates	Lecture Topics	Assignments
1	25-Aug	Course Overview, History of Nucleic Acids	
2	30-Aug	Nucleotides, Nucleosides & Properties	
	1-Sep	DNA & RNA Helices	Paper 1 Due
3	6-Sep	Dynamics of Helices	
	8-Sep	Higher Order Structures	
4	13-Sep	Chemical Synthesis of Nucleotides	
	15-Sep	Chemical Synthesis of Oligonucleotides	Paper 2 Due
5	20-Sep	Physical and Structural Techniques for Analysis	
	22-Sep	Exam 1 / Data Analysis Discussion (Lab)	Exam 1 (Take Home)
6	27-Sep	Biosynthesis of Nucleotides	
	29-Sep	Biosynthesis Oligonucleotides	Paper 3 Due
7	4-Oct	Genes & Chromosomes	
	6-Oct	Bioinformatics	
8	11-Oct	Mutations & Repair	
	13-Oct	Biology of RNA	Paper 4 Due
9	18-Oct	Fall Break	Fall Break
	20-Oct		
10	25-Oct	Protein-Nucleic Acid Interactions	
	27-Oct	Biological Techniques for Analysis	Final Paper Topics Due
11	1-Nov	Exam 2 / Discussion of Lab Projects	
	3-Nov	DNA & RNA Aptamers	Exam 2 (Take home)
12	8-Nov	Oligonucleotides as Therapeutics	Paper 5 Due
	10-Nov	Oligonucleotides as Therapeutics	
13	15-Nov	Oligonucleotides as Targets	Bibliography Draft Due
	17-Nov	Oligonucleotides as Targets	
14	22-Nov	Oligonucleotides as Targets	Outline Due (Before Break)
	24-Nov	Thanksgiving Break	Thanksgiving Break
15	29-Nov	Special Topics	Optional Paper Draft
	1-Dec	Special Topics	Optional Paper Draft
16	6-Dec	Final Presentations	
	8-Dec	Final Presentations	