BIOL 434 – Molecular Biology: DNA Replication, Repair and Recombination

Fall 2020
M, W, F 12:00 – 12:50
215 Coker Hall

Instructor: Dr. Steve Matson
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502 Fordham Hall
Office Hours: Monday 2-4:00 pm
Wednesday 3-5:00 pm

I use the sign up tool in Sakai to schedule office hours to be held using Zoom. Please go to Sakai and sign up for office hours so that I know you are coming. I am also available by appointment. Please contact me if you cannot see me during the times listed above.

Prerequisites: CHEM261 and BI0L202

This course will explore the biochemistry, genetics and molecular biology of three of the most fundamental of all processes involving DNA – replication, repair and recombination. We will take an historical and experimental perspective to gain insight into each process. Approximately one-third of the semester will be devoted to each topic.

This course is intended to be interactive with significant student participation. Class sessions will entail brief lectures to introduce the topic followed by a class discussion of papers from the primary literature.

Sakai Site

You must have an onyen to log on -- if you do not have an onyen go to (https://improv.itsapps.unc.edu/#UserCreateOnyenPlace:createOnyen). The Sakai site will have the detailed syllabus for the course, postings from lectures such as PowerPoint slides and any supplemental material. I will also post announcements on this site. It is your responsibility to check it regularly. The course Sakai site is BIOL434.002.FA20.

Main Goals of the course

1. To provide you with a deep understanding of DNA metabolism within the cell
2. To provide you with the skills required to read and analyze the primary scientific literature
3. To gain higher level thinking skills
4. To excite you about basic science and its applications

Course goals

1. To provide you with a deep understanding of DNA metabolism within the cell. The lectures, the book, and the research and review papers you read will provide the basic content for the course. We will take an historical approach at times to discuss significant experiments and how they were done. We will examine the basic biochemistry, genetics and molecular biology of DNA replication, DNA repair and recombination. After this class you will be prepared to do research in a lab on campus and to build upon this content with additional upper level biochemistry and/or molecular biology courses.

2. To provide you with the skills required to read and analyze the primary scientific literature. You will be reading research papers and review papers from the primary literature on a regular basis. The content and approaches detailed in these papers will form the basis of class discussion and will serve as an introduction to reading the primary literature in biology, biochemistry and genetics. After this course you will be prepared to read the primary literature and design your own research questions and methods to test your hypotheses.

3. To gain higher level thinking skills.
To the right there is a visual representation of "Revised Bloom's Taxonomy" which was developed as method of classifying educational goals for student performance evaluation. You should be well equipped to remember and understand facts with good study habits. We are looking for you to apply and analyze. How will we achieve this in this class? We will have in-class questions to practice this immediately and you will have homework problems to practice on your own or in groups. We will also explore classic experiments as a way of thinking through the logic of the experiment. What question were they trying to answer? What data was collected and how was it analyzed? This will allow us to see where the foundations of genetics and molecular biology come from. Practice is the most important way to gain these skills. In short – you will learn how to *think*.

4. This course should excite you about basic science and its application. It is my hope this course will excite you about basic science and its application to medicine, public health and biotechnology in the same way I became excited as an undergraduate student.

Expectations

The course will have three class meetings each week. We will be appropriately physically distanced in the classroom and everyone is expected to wear a face covering (mask) at all times.

Please note this is not a passive class – participation is key to developing an advanced understanding of the biochemistry of DNA replication, repair and recombination. You are expected to be actively engaged in this course through discussions, class activities and pre- as well as post-class assignments and readings. It is expected that you will spend several hours reading and doing homework outside of class.

Textbook

Watson, et. al. Molecular Biology of the Gene, 7th Edition

Feel free to choose an ebook or a physical book

Required: **Access to Mastering Biology** an online activity and homework tool (more detail below). This comes included with a new physical textbook or ebook but can be purchased separately if you buy a used textbook. If you have a used textbook you can buy the Mastering Biology access card at the bookstore. However, the cost of the used text book and the access card may be greater than purchasing a new book.

Required Reading

Particular book chapters and supplemental readings are required (see course dates/topics/assignments for details) and you will be expected to read them before class so that you can complete tutorials in Mastering Biology, where they are assigned, and participate fully in the class discussion.

Class Attendance

Students are expected to attend and participate in class meetings. While the course follows the reading, some of the material discussed in class may not be found in the text or the assigned readings. You are responsible for all material and announcements made in class. You are not responsible for material that was not covered in class unless it was specifically assigned.

Assignments

You will have pre-class assignments, in-class assignments and post class assignments.

- The pre-class assignments will be based on assigned readings from the textbook and may involve tutorials in Mastering Biology and/or forums on Sakai.
- In-class assignments may include Poll Everywhere questions (see below) and other activities.
- Post-class assignments will be Mastering Biology homework assignments that will be graded.

Due dates for homework assignments will be 9 am on the following class day. Updates will be announced on Sakai. You are responsible for submitting the assignments on time. There will be no "second chances". The homework is intended to provide the practice required to master the material.

Pre-class assignments via Mastering Biology and/or Sakai (5% of your final grade)

Pre-class assignments, where assigned, are due before you come to class. These will be tutorials and reading questions designed to prepare you to discuss the reading assignment during class. While these assignments will not be graded you are expected to complete them. You will be given credit for completion of the assignment.

Homework via Mastering Biology (10% of your final grade)

Homework will be due at 9 am on the following class day. Some Mastering Biology homework assignments may take as little as 15 minutes while others will take over an hour with animations and short tutorials interspersed in the homework. It is your responsibility to complete the homework before the deadline. To be safe assume your clock is 5 min slower than the time stamp on Mastering Biology. Late homework will receive zero credit. Please do not ask me to make an exception to this rule.

It is your responsibility to finish your homework early so that late night crises do not prevent your finishing on time. Do not count on the Mastering Biology program to provide an accurate account of how long the assignment will take. These estimates are just that – estimates. There will be numerous graded at-home assignments. We are trying to ensure that you succeed by giving you these regular opportunities to assess your understanding of the material. See Sakai (under Resources) for the course code and how to register for Mastering Biology.

Please sign up and complete all assignments for the class matson15925

Poll Everywhere (5% of your final grade)

In this class we will use a polling system to answer questions that are posed during class. You can submit your responses using a laptop or other mobile device with a WiFi connection. For instructions on how to access or register for Poll Everywhere go to poll.unc.edu. As an incentive to engage during class, 5% of your grade will come from Poll Everywhere participation.

Research Paper and Presentation (10% of your final grade)

Each student will complete a short (10-15 page) research paper for this course. You will choose a topic that interests you to complete this assignment. The topic must be approved by the instructor. To ensure ample time to complete this paper, your topic must be

approved no later than August 31. Please contact Dr. Matson via e-mail to have your topic approved. This is your chance to dig deeply into a topic of particular interest to you.
A detailed rubric for the grading of the research paper will be posted on Sakai.

Each student will also make a 5 minute presentation on the topic of their research paper. These presentations will be made to the class during the last week of the semester. The presentation will be no longer than 5 minutes and will use no more than 3 PowerPoint slides. For more detail see the Sakai site.

Group Project (10% of your final grade)

Students will engage in a group project that will enhance your understanding of a particular aspect of the course material, will improve your ability to read and analyze a research paper, will strengthen your presentation skills and will provide an opportunity to collaborate with other students.

Beginning week 5, and then every other week, a group of 4-5 students will be responsible for presenting a specific research paper to the class at our Friday class meeting. Dr. Matson will assign the groups based on an interest survey you will complete. Dr. Matson will also assign the paper to be presented by the group. The group will prepare and present a PowerPoint presentation. After class this presentation will be posted on the Sakai site.

The presentations will be graded as follows: accuracy (25%), clarity in both the oral and media presentation (25%), accuracy in answering questions (25%) and overall quality of the complete presentation (25%). It is possible for different members of the group to receive different scores where there is a clear difference in effort and participation.

Grading

Your grade for this course will be determined as follows:

2 midterm exams (20% each = 40%)
1 final exam (20%)
Mastering Biology assignments (10%)
Pre-class assignments (5%)
Participation/Poll Everywhere (5%)
Research paper and presentation (10%)
Group project (10%)

Grades will not be assigned for individual exams, only points. You will be able to determine how you did from the posted distribution of scores after each test. Final grades will be assigned on the total number of points for the entire summer session: A 93 – 100%;

A- 90-92%; B+ 87-89%; B 83-86%; B- 80-82%; C+77-79%; C 73-76%, C- 70-72%, D+ 66-69%; D 60-65%; F < 60%

Exam questions will be taken from the material we cover in class and assigned readings. The exams will be take-home exams and must be taken on the dates indicated. There will be no make-up exams except in extraordinary circumstances (e.g. medical emergency or family emergency documented in writing). The final exam will be retained by the instructor but will be available for viewing by appointment. Requests for regrades must be submitted in writing within 1 week after the exam is returned in class.

It is possible for everyone in the class to receive an A. You have many opportunities to demonstrate your mastery of the material in this course.

What you should bring to class everyday

1. PowerPoint slide outlines (for taking notes)
2. Extra blank paper for drawings, notes, activities, etc.
3. Poll Everywhere device (laptop, smart phone, tablet)
4. Your mask
5. A strong desire to participate and learn

Diversity and Inclusion

It is my intent that students from all diverse backgrounds and perspectives be well served by this course, that students' learning needs be addressed both in and out of class, and that the diversity that students bring to this class be viewed as a resource, strength and benefit. It is my intent to present materials and activities that are respectful of diversity: gender, sexuality, disability, age, socioeconomic status, ethnicity, race, and culture. Your suggestions are encouraged and appreciated. Please let me know ways to improve the effectiveness of the course for you personally or for other students or student groups. In addition, if any of our class meetings conflict with your religious events, please let me know so that we can make arrangements for you.

The University of North Carolina Office of Diversity and Inclusion provides resources, events and information about current initiatives at UNC to support equality for all members of the Carolina community. I hope that you will communicate with me if you experience anything in this course that does not support an inclusive environment. You can also report any incidents you may witness or experience on campus on in your remote class to the Equal Opportunity and Compliance Office at https://eoc.unc.edu/report-an-incident/ as well as finding information at the Office of Diversity and Inclusion on their website https://diversity.unc.edu/.

Community Standards in Our Course and Mask Use

This fall semester, while we are in the midst of a global pandemic, all enrolled students are required to wear a mask covering your mouth and nose at all times in our classroom. This requirement is to protect our educational community — your classmates and me —

as we learn together. If you choose not to wear a mask, or wear it improperly, I will ask you to leave immediately, and I will submit a report to the Office of Student Conduct. At that point you will be disenrolled from this course for the protection of our educational community. An exemption to the mask wearing community standard will not typically be considered to be a reasonable accommodation. Individuals with a disability or health condition that prevents them from safely wearing a face mask must seek alternative accommodations through the Accessibility Resources and Service. For additional information, see Carolina Together.

Zoom Recording

The University may record meetings of this class for educational purposes. These recordings will be shared only with students enrolled in the course for purposes of academic instruction only. Your instructor will communicate to you how you may access any available recordings.

Unauthorized student recording of classes on personal devices or on any other format is prohibited.

Students requesting the use of assistive technology as an accommodation should contact Accessibility Resources & Service. Other students must obtain express permission from the department to record the class, and the University will only grant such permission in extraordinary circumstances in which the student otherwise lacks access to a recording made by the University or instructor. Students shall not copy, reproduce, or distribute any recordings of their classes, and students shall delete any recordings at the conclusion of the course.

Any violation of these prohibitions or restriction on the making, use, copying, or distribution of recording of classes shall constitute an honor code violation.

Dates, topics and assignments

Date	Topic	Reading	Pre-class assignment	Homework
Week 1				
8/10	Overview of DNA metabolism	Review Sakai site and syllabus; Ferry, G. *Nature* **575**, 35-36 (2019) on Sakai	Intro to Mastering Biology	N/A
8/12	DNA structure	Ch. 4, pp. 77 – 92; Watson and Crick Nature papers on Sakai	DNA structure	N/A
8/14	DNA topology	Ch. 4, pp 91—103; topoisomerase functions paper on Sakai	DNA topology https://www.youtube.com/watch?v=az2c6UbEdug	DNA structure & topology
Week 2				
8/17	Chemistry of DNA synthesis	Ch. 9, pp. 257 – 269; Discovery of DNA polymerase I on Sakai	Chemistry of DNA synthesis	N/A
8/19	DNA polymerases & sliding clamps	Ch. 9, pp. 277 – 283 Multiple DNA polymerases on Sakai	DNA polymerases & sliding clamps	N/A
8/21	No class – COVID cancellation			N/A
Week 3				
8/24	No class –COVID cancellation			
8/26	Replication fork	Ch. 9, pp. 269 – 276; Reading on Sakai	Replication fork https://scienceprimer.com/replication-fork	N/A
8/28	Elongation; prokaryotes	Ch. 9, pp. 283 – 288 Reading on Sakai	N/A	DNA synthesis; complete DNA replication animation
Week 4				
8/31	Initiating DNA replication	Ch. 9, pp. 288 – 296 Reading on Sakai	Initiation of replication	N/A
9/2	Initiation: prokaryotes	Reading on Sakai	Initiation; prokaryotes	N/A
9/4	Replication origins in eukaryotes	Reading on Sakai	Eukaryotic Initiation reading Quiz in Mastering	Initiating replication

Week 5				
9/7	No class – Labor Day			
9/9	Elongation; eukaryotes	Reading on Sakai		
9/11	**Group 1 presentation** Leading & lagging strand synthesis	Reading on Sakai	DNA Replication animation in Study Area	TBD
Week 6				
9/14	Telomere replication	Ch. 9, pp. 303-311 Reading on Sakai		
9/16	Coronavirus replication	Guest lecture Dr. Tim Sheahan	Reading on Sakai	
9/18	**Group 2 presentation** Mammalian telomeres	Reading on Sakai	N/A	Take home exam – due Monday, September 21
Week 7				
9/21	Licensing replication; eukaryotes	Ch. 9, pp. 297 – 302 Reading on Sakai	Licensing replication	N/A
9/23	Termination; prokaryotes	Ch. 9, pp. 302-303 Reading on Sakai		
9/25	DNA damage: proofreading slippage	Ch. 10, pp. 313-315, box 1 on p 316; paper	Video on slippage	TBD
Week 8				
9/28	DNA damage: chemistry	Ch. 10, pp 320 – 324; Ch. 4, pp 80-81;		
9/30	Mismatch repair	Ch. 10; pp 316-320 Reading on Sakai	MutS tutorial	
10/2	**Group 3 presentation** Mismatch correction	Reading on Sakai		TBD
Week 9				
10/5	MMR in eukaryotes	Guest lecture; Dorothy Erie Reading on Sakai	Reading on Sakai	
10/7	Photo-reactivation; base excision repair	Ch. 10, pp. 324 – 328		
10/9	Retrovirus replication	Guest lecture Dr. Ron Swanstrom	Reading on Sakai	TBD
Week 10				
10/12	Nucleotide excision repair	Ch. 10, pp. 328 – 330 Reading on Sakai		
10/14	NER eukaryotes	Reading on Sakai		
10/16	Group 4 presentation			Take home exam – due Monday, October 19
Week 11				
10/19	Translesion DNA repair	Ch. 10; pp. 331-338		

10/21	DNA repair in cancer			N/A
10/23	Homologous recombination	Ch. 11; pp. 341-349	Web animation: Holliday model	TBD
Week 12				
10/26	RecBCD	Ch. 11; pp 349-355 Web tutorial; RecBCD	Web animation: Homologous recombination	N/A
10/28	RecA	Ch. 11; pp 355-362		N/A
10/30	Group 5 presentation			TBD
Week 13				
11/2	Resolving HJs RuvAB	Ch. 11; pp. 359-361 Reading on Sakai	Web tutorial RuvA	
11/4	Eukaryotic recombination	Ch. 11; pp. 362-375		
11/6	Site specific recombination	Ch. 12; pp. 377-393		TBD
Week 14				
11/9	Five minute presentations	N/A		N/A
11/11	Five minute presentations	N/A		N/A
11/13	Five minute presentations	N/A		N/A
Week 15				
11/16	Transposition	Ch. 12; pp. 393-406		TBD
11/21	Final exam (12:00 PM)			