BIOL 220H – Molecular Genetics

Spring 2023
Tuesday Thursday 9:30-10:45

Instructor: Dr. Kerry Bloom
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623 Fordham Hall

Office Hours: Tuesday 3-4:00 pm
Thursday 3-4:00 pm

I use Sign-up on Sakai to schedule office hours. 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 and we will find a suitable time to meet.

Prerequisites:
BIOL 101 – Principles of Biology
BIOL 103 - Fundamentals in Genetics, Molecular, and Cellular Biology

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 occasional announcements on this site. Please make every effort to check the site regularly.

Main Goals of the course

1. To provide you with the core principles of genetics and molecular biology
2. To gain higher level thinking skills
3. To excite you about basic science and its applications

Course Learning Outcomes

Upon completion of Biology 220H, a student should be able to:

Skills –

- Build hypotheses to answer a specific scientific question, design an experiment using an appropriate technique/assay to answer the question, predict and analyze the results of the experiment

- Give examples of how advances in genetics and molecular biology, from the discovery of DNA's structure to the sequencing of individual genomes, have changed the world (e.g. recombinant insulin, personalized medicine, transgenic crops)
- Prepare and deliver a short presentation based on reading and research

Concepts –

- Explain the term "allele" for a single gene at a population, organismal, cellular and molecular level; explain how dominance and recessiveness are expressed at these levels
- Explain where genetic variation comes from in a population (e.g. meiosis, mutation and epigenetic changes)
- Predict genotypic and phenotypic ratios of offspring in defined genetic crosses and work these problems in reverse (i.e. when given data about offspring determine the genotypes and phenotypes of parents)
- Deduce modes of inheritance (e.g. autosomal dominance, X-linked recessive) from genetic pedigrees and explain how incomplete penetrance and variable expressivity complicate these analyses
- Distinguish single gene traits from polygenic traits and the influence of environment on traits
- Explain how DNA is replicated normally and abnormally, and how these concepts are utilized in polymerase chain reaction (PCR)
- Understand the mechanism of recombination and its impact on genetic variability
- Compare and contrast the consequences of germline errors during meiosis (such as non-disjunction and translocations) and somatic errors during abnormal mitosis (such as non-disjunction and cancer)
- Explain the flow of genetic information based on the central dogma from DNA to proteins and how mutations are carried through this flow of information
- Describe the nature of the genetic code
- Describe the general organization of prokaryotic and eukaryotic genomes, including the identification and significance of the different parts of a gene (i.e. regulatory/nonregulatory, exons/introns, transcription start site, translation start site, UTRs)
- Explain how a gene can be regulated transcriptionally and post-transcriptionally and how this leads to limited expression under different conditions (e.g. different environments, during the course of development or under disease conditions)
- Predict the outcome of experimental manipulations in genes
- Describe the basic steps in gene cloning
- Design a transgenic animal/bacteria where a protein of interest is specifically produced
- Explain the significance of research in genetic model organisms to understand fundamental biological phenomena

Course goals

1. To provide you with the core principles of genetics and molecular biology.

The lecture/discussion sessions and the book will provide the basic content. We will take an historical approach at times to discuss seminal experiments and how they were done. We will examine the basic "rules" of genetics and molecular biology. After this class you will be prepared to do research in a lab on campus and to build upon this content with upper-level genetics courses and/or molecular biology courses.

2. 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. By the way – UNC medical school thinks this course is an excellent pre-requisite for medical school because it teaches students to *think*.

3. This course should excite you about basic science and its application.

A foundation in genetic crosses with model organisms (basic science tool) allows you to understand human genetic diseases. A foundation in making recombinant DNA constructs (basic science tool) allows you to understand how plants are modified to be herbicide resistant or how recombinant proteins are turned into medicines. Genetics and molecular biology provide the tools that other disciplines use in biological research.

Expectations

The course will have two class meetings each week. You are expected to attend as many class sessions as possible.

Please note this is not a passive class – participation is key to developing an advanced understanding of genetics and molecular biology. You are expected to be actively engaged in this course through class activities and pre- as well as post-class assignments and readings. It is expected that you will spend several hours reading and working problems associated with each class period. If you stay on top of your reading and homework there will be no need to "cram" for an exam. You will be ready. Practice, practice, practice.

Textbook

Essentials of Genetics/Klug, 10th ed. The textbook comes with a web-based software package called Mastering-Genetics, Feel free to choose an ebook or a physical book

Required: **Access to Mastering Genetics** 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 Genetics access card at the bookstore. However, the cost of the used textbook 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 the Guided Reading Questions (GRQs) and/or quiz assignment and be able to participate fully in the class discussion.

Class Attendance

Students are expected to attend and participate in class meetings. While the course follows the textbook, some of the material discussed in class may not be found in the text. You are responsible for all material and announcements made in class. You will not be 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 will involve answering a set of Guided Reading Questions (available on Sakai). These are for your edification and will not be graded.
- In-class assignments may include Poll Everywhere (see below) and other activities.
- Post-class assignments will be Mastering Genetics homework assignments that will be graded.

Due dates for homework assignments will be 6 pm on Saturday. Any changes will be announced on Sakai. You are responsible for submitting the assignments on time. If you cannot submit your homework assignment on time please contact me as soon as possible.

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

There will be one homework assignment each week covering the material that was covered in class. 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 Genetics.

Homework assignments will be due on Saturday of the week they are assigned at 6 pm. Some Mastering Genetics homework assignments may take as little as 30 minutes while

others will take 2 hours with animations and short tutorials interspersed in the homework. Do not count on the Mastering Genetics program to provide an accurate account of how long the assignment will take. These estimates are just that – estimates. Please make every effort to complete the homework before the deadline. You will not have access to the assignment once the deadline has passed.

Please sign up and complete all assignments for the class.

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 please go to https://poll.unc.edu/. As an incentive to engage during class, 5% of your grade will come from Poll Everywhere participation. Answering the question correctly is *not* what counts here – participation counts. In addition, some of the questions posed in class will reflect questions used previously on exams and therefore are good examples of what will be expected of you on exams.

Writing Assignment

There will be one major writing/media assignment in this class. This will be a creative writing/media assignment to be discussed in more detail during the first two weeks of class. You must complete and submit this assignment no later than 5 PM on May 5.

This cannot be a research paper. Any student submitting a research paper will be asked to redo the assignment. Failure to complete this assignment will result in a grade of Incomplete for the course.

This assignment will be graded H (honors), P (pass) or F (fail). Students receiving an F will be allowed to re-write their paper to receive a passing grade. A grade of H on the writing assignment will raise your letter grade, as determined by test scores, your group presentation, class participation and homework, by one-half grade (i.e. C to C+ or B+ to A-, etc.). A grade of P on the assignment will have no impact on your earned letter grade. Any student receiving a grade of F who fails to make up the assignment will receive an F for the course. Papers turned in late can receive a grade no higher than P (this includes re-writes of F papers).

Group Presentation (10% of your final grade)

The class will be divided into groups of approximately 4 students and each group will be responsible for preparing and making a 10-minute media (e.g. PowerPoint, video, etc.) presentation to the class. Each group will be assigned a fully sequenced genome and will be responsible for discussing the sequencing, annotation and unique characteristics of that genome. There will be a 5 minute question period following each presentation during

which the group will be responsible for answering questions asked by other members of the class. The finished presentations will be placed on the class Sakai site as a reference for other members of the class. In-class presentations will begin on March 31.

The presentations will be graded as follows: accuracy of information (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.

Dynamic Study Modules (Optional with extra credit)

Dynamic Study Modules are provided to help you check and improve your knowledge of material. Each module contains 15-20 unique questions and, depending on how well you know the material, should take less than 20 min. to complete. While these modules are in the assignment list on Mastering Genetics, they have no due date. They are not required but recommended and will carry extra credit (1 pt per module) for those students choosing to complete the module. One idea is to complete these modules as you prepare for an exam to test your knowledge in a specific area.

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)

Grading

Your grade for this course will be determined as follows:

2 midterm exams (20% each = 40%)
1 cumulative final exam (30%)
MasteringGenetics assignments (15%)
Participation/Poll Everywhere (5%)
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 based on the total number of points for the entire semester: 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 class meetings and assigned readings. Exams 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 reviewed in class.

This is not a weed-out course. I believe all students can succeed in BIOL220H and, in fact, the average grade in this course is in the B/B+ range. Remember, a C is average. If you are wondering if there are a predetermined number of students who will receive an A or a D the answer is NO. It is possible for everyone in the class to receive an A if everyone in the class performs at an A level. You have many opportunities to demonstrate your mastery of the material in this course.

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/.

Recordings

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. 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.

Accessibility Resources and Service (ARS), Counseling and Psychological Services (CAPS), and Title IX Resources

The University of North Carolina at Chapel Hill facilitates the implementation of reasonable accommodations, including resources and services, for students with disabilities, chronic medical conditions, a temporary disability or pregnancy complications resulting in barriers to fully accessing University courses, programs and activities. Accommodations are determined through the Office of Accessibility Resources and Service (ARS) for individuals with documented qualifying disabilities in accordance with applicable state and federal laws. See the ARS Website for contact information: https://ars.unc.edu or email ars@unc.edu.

Counseling and Psychological Services (CAPS) is strongly committed to addressing the mental health needs of a diverse student body through timely access to consultation and connection to clinically appropriate services, whether for short or long-term needs. Go to their website: https://caps.unc.edu/ or visit their facilities on the third floor of the Campus Health Services building for a walk-in evaluation to learn more.

Any student who is impacted by discrimination, harassment, interpersonal (relationship) violence, sexual violence, sexual exploitation, or stalking is encouraged to seek resources on campus or in the community. Please contact the Director of Title IX Compliance (Adrienne Allison – Adrienne.allison@unc.edu), Report and Response Coordinators in the Equal Opportunity and Compliance Office (reportandresponse@unc.edu), Counseling and Psychological Services (confidential), or the Gender Violence Services Coordinators (gvsc@unc.edu; confidential) to discuss your specific needs. Additional resources are available at safe.unc.edu.

Dates, topics and assignments

Date	Topic	Reading	Pre-class assignment (Optional Study Modules)	Homework
Week 1				
1/20	Overview of genetics; process of science	Ch. 1; Reading on Sakai (see week 1)	Introduction to Mastering; GRQ#1	MG1
Week 2				
1/25	Chromosomes, mitosis, meiosis and the cell cycle	Ch. 2; skip 2.5	GRQ#2 (DSM Ch.2)	

1/27	Genetic crosses; Mendel's pea experiments	Ch. 3; pp. 31-42; Reading on Sakai	GRQ#3 (DSM Ch. 3)	MG2
Week 3				
2/1	Pedigrees and probability	Ch. 3; pp. 42-49; Reading on Sakai	GRQ#4	
2/3	Modifying Mendel's ratios	Ch. 4; pp. 53-76	GRQ#5 (DSM Ch. 4)	MG3
Week 4				
2/8	Sex determination & sex chromosomes	Ch. 5; pp. 83-96; Reading on Sakai	GRQ#6 (DSM Ch. 5)	
2/10	Chromosome mutations	Ch. 6; pp. 99-116 Reading on Sakai	GRQ#7 (DSM Ch. 6)	MG4
Week 5				
2/15	No class – wellness day			
2/17	Linkage and mapping	Ch. 7; pp. 121-139	GRQ#8 (DSM Ch. 7)	MG5
Week 6				
2/22	Bacterial genetics	Ch. 8; pp.144-159 Reading on Sakai	GRQ#9 (DSM Ch. 8)	MG6
2/24	**Midterm exam I**	Exam window 3-9 pm		
Week 7				
3/1	DNA/RNA structure	Ch. 9; pp. 161-178 Reading on Sakai	GRQ#10 (DSM Ch. 9)	
3/3	DNA replication	Ch. 10; pp.182-200 Reading on Sakai	GRQ#11 (DSM Ch. 10)	MG7
Week 8				
3/8	Chromosome structure	Ch. 11; pp. 202-216 Reading on Sakai	GRQ#12 (DSM Ch. 11)	
3/10	Genetic code	Ch. 12; pp. 218-228	GRQ#13	MG8
Week 9				
3/15	Transcription and splicing	Ch. 12; pp. 228-238	GRQ#14 (DSM Ch. 12)	
3/17	Translation/protein structure	Ch. 13; pp. 241-258 Reading on Sakai	GRQ#15 (DSM Ch. 13)	MG9
Week 10				
3/22	Recombinant DNA technology	Ch. 17; pp. 323-338, 341-343	GRQ#16	
3/24	Genomics & bioinformatics	Ch. 18; pp. 347-360; 365-366	GRQ#17 (DSM Ch. 18)	MG10
Week 11				
3/29	**Midterm Exam II**	Exam window 3-9 pm		
3/31	GMOs Group presentations (2)	ST6, pp. 500-509 Reading on Sakai	GRQ#18	MG11
Week 12				

4/5	No class—wellness day			
4/7	Group presentations (4-5)	N/A	N/A	N/A
Week 13				
4/12	Regulating gene expression prokaryotes	Ch. 15; pp. 285-297	GRQ#19 (DSM Ch. 15)	
4/14	Regulating gene expression eukaryotes	Ch. 16; pp. 302-319	GRQ#20 (DSM Ch. 16)	MG12
Week 14				
4/19	Gene Mutation	Ch. 14; pp. 261-270 Reading on Sakai	GRQ#21	
4/21	DNA repair and transposons	Ch. 14; pp. 271-281	GRQ#22 (DSM Ch. 14)	MG13
Week 15				
4/26	Cancer Genetics	Ch. 19; pp 376-389	GRQ#23 (DSM Ch. 19)	
4/28	Genetic testing	ST2; pp. 450-461	GRQ#24	MG14
Week 16				
5/3	Epigenetics	ST1, pp. 439-449 Reading on Sakai	GRQ#25	
5/5	Gene therapy Personalized medicine	ST3; pp. 468-480 ST7; pp. 510-520 Reading on Sakai	GRQ#26	MG15
5/14	**Final Exam**	Exam window 4 pm to 10 pm		