Bi282H Genetics and Molecular Biology

In this course we will examine the genetic and molecular mechanisms responsible for the inheritance of physical characteristics. We will begin with the key role of DNA as the hereditary material in cells. We will then learn how DNA directs the synthesis of proteins, including how that synthesis is regulated. Finally, we will explore the ways in which DNA is inherited and thereby passes molecular information to subsequent generations.

Learning outcomes

By the end of this course, you will be able to demonstrate an understanding of:
1. how DNA directs the synthesis of proteins, including how protein synthesis is regulated
2. how variations in DNA sequence affect proteins and thereby phenotype
3. how DNA is inherited and thereby specifies the phenotypes of subsequent generations
4. how to design and interpret experiments that test #1-3.

Instructors

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Course organization

Lecture: To achieve fluency in a subject, you need both practice and feedback on how you are doing. We will therefore spend much of our in-class "lecture" time on solving problems related to the course material. These problems will cement your understanding of the material and will train you in the approaches and kinds of critical thinking that are used in the biological sciences. To get the most out of these problems, you must PREPARE BEFORE CLASS (starting with lecture 2) by reading the material and completing the pre-class quiz on Canvas.

Lab: The intent of the weekly labs are to reinforce and elaborate upon the material you will be learning in lecture. Much of the work that has led to an understanding of the molecular mechanisms of growth and inheritance has been performed with a few key organisms. We believe that by performing exercises with these organisms, you will be better able to appreciate some of the basic biological phenomena that we deal with in the course, and how our present understanding of these phenomena was achieved.

Your lab/tutorial section will meet for one three hour period each week of the term **beginning week one**. Some of the sessions are "wet" labs that involve the manipulation of real biological materials. The remaining sessions are "dry" labs that involve exercises with models, computer simulations, and hypothetical data. Labs will be posted to canvas each week. **We expect that you will have read, completed the pre-lab (except week 1) and tried to understand the relevant material for the lab when you arrive at your section each week.**

Lab exercises will be done in small groups. Answer the written questions as you work through each exercise. Our goal is that you think actively while you work and that you understand what you are doing and why you are doing it. If you do not understand something, take advantage of the resources available to you: your instructors and peers. If you take full advantage of the lab period you will often find that your lab report will be nearly complete at the end of the session. The lab sections will also provide you with an opportunity to work through and discuss problems related to the lecture material. Instructors will be available for the last hour or so of most sessions to answer questions regarding the lecture material and problems.

Pre-lecture readings

Before each lecture (starting with lecture 2), read through the corresponding "pre-class annotated slides" (pdfs posted on Canvas). Each of these pdfs contains my explanation of the topics for that day. For a more detailed account of this material or for clarification, refer to the assigned reading(s) (see below). Many readings come from the course textbook, *Molecular Biology of the Gene* (either the *6th or 7th edition* is fine) by Watson et al. (Pearson). This textbook was selected, in part, because it is also used in Bi320 Molecular Genetics, which many of you will take in the future and is on reserve at the Science Library. For several topics, readings from other sources (indicated by asterisks in the table below) will be posted on Canvas.

Pre-class quizzes (available on Canvas, due <u>before</u> each lecture)

Before each lecture (starting with lecture 2), complete the pre-class quiz, which will be automatically graded within Canvas. Each quiz will consist of 3-4 questions.

Practice problems

Three sets of problems and answers (corresponding to the three exams), as well as sample exams, will be available on Canvas but will NOT be graded. Our time in class is limited. These problems will allow you to continue to practice on your own. They will train you in how to think critically and will help you understand the biological mechanisms that underlie heredity. **The midterm and final exams will consist of problems such as these**. Try to WORK THROUGH THE PRACTICE PROBLEMS <u>without</u> looking at the answers first.

Exams

There will be two one-hour midterm exams plus a comprehensive two-hour final exam. The midterm exams will take place **from 7-9pm in Willamette 100** (i.e. NOT our regular lecture room or time!). They will be written as one-hour exams, but you will have two hours in which to complete the exams. Students are expected to make arrangements in their class and work schedules so that conflicts will not arise. The exams are not open book - you are allowed only writing implements (no calculators or other devices).

Lab work

There are 10 labs, which include a pre-lab assignment (except week 1), a lab report, and a quiz.

The total points earned in the lab will account for **~35%** of your overall Bi 282H grade. Quizzes are worth 16 points each and are based upon the previous week's exercises and concepts. They are closed book, and are **administered at the beginning of the lab session**. There will be no opportunities to make up missed quizzes, so don't come to lab late! However, your lowest quiz score will be dropped when final points are totaled. Lab reports are due at the beginning of your next lab session. Most lab reports are worth 17 points. Labs 4 and 10 will be worth 23 points. Even though lab reports are graded and submitted individually, we expect and encourage you to cooperate with your partner and colleagues in preparing your reports. In addition, you should consult with your instructors during the lab session and at office hours if you have questions. However, **reports must be written in your own words**. Duplicated lab reports are unacceptable, and the students involved will receive no credit. **10% will be deducted each day a lab report is late and will not be accepted more than one week late.**

Academic honesty

Academic dishonesty includes various forms of cheating (e.g. copying another person's answers to exam questions, altering your exam for a regrade, etc.) and will not be tolerated. For the definition of cheating and its penalties, consult the University of Oregon Student Conduct Code. All work submitted in this course must be your own. Instances of suspected cheating or plagiarism on exams, quizzes, and reports will be referred to the Office of Student Conduct and Community Standards for consideration of sanction.

Your final grade

Your grade for the course will be based upon the combination of your performance on the exams and your work in the labs. Scores will be determined in two ways for each student:

Exam points

Method 1	Midterm #1	150
	Midterm #2	150
	Final exam	300
	Total	600
Method 2	Better midterm x 1.33	200
	Final exam x 1.33	400
	Total	600

Non-exam points

Component	**Number**	**Points each**	**Total points**
Pre-lecture quizzes	27	2	54
Pre-labs	9	4	36
Lab reports	10	17-23	182
Lab quizzes	8	16	128
Total			400

Letter grades will be assigned based on the higher of the two scores (calculated by method 1 or method 2) for each student. Letter grades are determined only after the total course points have been calculated, not for individual hour exams. Since grades are not assigned strictly on the basis of statistical distribution about a numerical mean, the opportunities to earn good grades in this course are not limited, and students are not in competition with each other for those grades.

P/N option: A grade of "P" is given when the calculated grade is "C-" or better; a grade of "N" is given when the calculated grade is "D+" or lower.

Exam re-grades: If you feel that a mistake has been made in the grading of your exam, you must write a logical explanation for why your answer merits a higher score, attach it to the exam, and submit both the explanation and the exam to your lab instructor. Well-thought-out arguments will be considered, but other questions on the exam may be re-graded as well, and requests that we simply "look again" at an answer will not be honored. Please do not abuse this system. The deadline for submission of exams for re-grading is one week following receipt of the graded exam.

Early and make-up exams will not be administered. Please do not ask for exceptions. If you miss an exam for a valid reason (medical or family emergency), you must provide written documentation of the reason to avoid a score of 0. Your grade will then be based on the exams you have taken. A second missed exam will not be excused. Note that Club Sports events do not qualify as excusable absences.

Lecture, Lab, and Exam schedule BI282H Winter 2017.

	Lectures	Concepts include:	Readings to supplement the "pre-class annotated slides"	Labs
	DNA is the genetic material			
M 1/9	1. Course overview; DNA is the genetic material?	necessary vs sufficient, fractionation, differential labeling		**Chemical Nature of Genetic Material** No pre-lab this week
W 1/11	2. What is the structure of DNA?	base complementarity, antiparallel 5'-3' strands, Meselson-Stahl	Watson 6th ed. 19-28 **or** Watson 7th ed. 21-30	
F 1/13	3. How is DNA replicated?	DNA polymerase, leading & lagging strands, telomeres	Watson 6th 195-9, 207-11, 218, 230, 246-51 **or** Watson 7th 257-62, 265-72, 277, 288, 302-6	
	DNA contains separate units of function = genes			
M 1/16	**Martin Luther King Jr holiday**	**NO CLASS**		**Luria-Delbruck: Poisson Distribution and Mutation Rate** Pre-lab 2 due Report 1 due Quiz covering lab 1
W 1/18	4.DNA sequences can change: mutation	causes of mutations, mutation rates, replica plating, Luria-Delbruck	Griffiths 461-3* Watson 6th 257-60, 265-6 **or** Watson 7th 313-5, 320	
F 1/20	5. DNA has separable units of function = genes	auxotroph, genetic screen, complementation test, biosynthetic pathway	Griffiths 187-90*	
M 1/23	6. Each gene encodes an amino acid sequence	potential genetic codes, frameshift, suppressor	Griffiths 277-82* Crick et al.*	**DNA Structure** Pre-lab 3 due Report 2 due Quiz covering lab 2
	How does DNA sequence affect phenotype?			
W 1/25	7. How does DNA sequence encode amino acid sequence?	actual genetic code, mRNA, dominant vs recessive, loss- vs gain-of-function mutations	Watson 6th 28-37 **or** Watson 7th 30-8	
F 1/27	8. How do mutations affect protein function and phenotype?	null, hypomorph, hypermorph, antimorph (dominant negative), neomorph	Hartwell et al.*	

M 1/30	9. Mutations, protein function, and phenotype (cont'd)	importance to understanding human traits		**Part A. Genetic Complementation in Yeast** **Part B. Metabolic Pathways: eye pigment biosynthesis in *Drosophila*** Pre-lab 4 due Report 3 due Quiz covering lab 3
	How do cells use the DNA code to synthesize proteins?			
W 2/1	10. Step 1: transcription (in prokaryotes)	pulse-chase, transcription, RNA polymerase, consensus, promoter.	Watson 6th 136-9, 377-86, 388 **or** Watson 7th 200-3, 429-38, 440	
W 2/1	**MIDTERM EXAM 1**	**lectures 1-9**	**7-9PM in WILLAMETTE 100**	
F 2/3	11. Step 1 (cont'd) & Step 2: translation (in prokaryotes)	TX termination, dyad symmetry, stem-loop, translation, operon, ribosome	Watson 6th 394-6, 457-76 **or** Watson 7th 445-7, 509-26	
M 2/6	12. Step 2 translation (cont'd)	RBS, charged tRNAs, translation cycle	Watson 6th 479-81, 487-8, 492-6 **or** Watson 7th 528-30, 535-7, 541-4	**Transcription and Translation** Pre-lab 5 due Report 4 due Quiz covering lab 4
	Cells can turn the expression of some genes on and off			
W 2/8	13. How is gene expression regulated (in prokaryotes)? ex: *lac* operon in *E. coli*	constitutive vs inducible, activator, repressor, allostery	Watson 6th 547-50, 553-60 **or** Watson 7th 615-8, 620-7	
F 2/10	14. Why is the *lac* operon only TX'd in the presence of lactose?	cis vs trans	Griffiths 305-315* (has ERROR)	
M 2/13	15. Why is the *lac* operon only TX'd in the absence of glucose?	signal integration, "AND" gate	Watson 6th 716-7 **or** Watson 7th 776	**Gene Regulation: Lac Operon** Pre-lab 6 due Report 5 due Quiz covering lab 5
	Gene expression in eukaryotes			
W 2/15	16. How are genes TX'd and TL'd in eukaryotes (like us)?	chromatin, chromatin regulators, 5' cap, splicing, polyA signal, translation	Watson 6th Figs 7.17, 7.32, 12.15, 402-3, 408-10, 415-7, 482-7 **or** Watson 7th Figs 8-17, 8-32, 13-16, 453-4, 457-60, 467-8, 530-5	
F 2/17	17. How is gene expression regulated in eukaryotes? ex: Gal genes in yeast	regulatory pathway diagrams, signal transduction	Cox 743-6* (has ERROR)	

	How is gene expression regulated in multicellular animals?			
M 2/20	18. Part 1: transcriptional networks. ex: early *Drosophila* (fruitfly) development	asymmetric localization of mRNA or protein, gradient, syncytium	Cox 749-50*, Nusslein-Volhard* Watson 6th 676-8, 682-93 **or** Watson 7th 746, 748-9, 751-762	**Early *Drosophila* Development**
W 2/22	19. Part 2: cell-cell signaling	regulatory network, cell-cell signaling, asymmetric cell division	Watson 6th 661-6 **or** Watson 7th 733-8	Pre-lab 7 due Report 6 due **Report 7 due** Quiz covering lab 6
W 2/22	**MIDTERM EXAM 2**	**lectures 1-17**	**7-9PM in WILLAMETTE 100**	
F 2/24	20. example: early *C. elegans* (worm) development	isolating individual cells from embryo to test for signaling	Gilbert 251-7*	
	How are DNA sequences transmitted to progeny (in eukaryotes)?			
M 2/27	21. Asexual reproduction: mitosis	cohesin, centromere, MTOC, spindle. sister chromatid, genetic variation	Watson 6th 144-54 **or** Watson 7th 208-17	**Mitosis and Meiosis** Pre-lab 8 due Quiz covering lab 7
W 3/1	22. Sexual reproduction: meiosis	homologous chromosomes, crossovers, segregation	Watson 6th 154-6, 303-5 **or** Watson 7th 217-9, 362-3	
F 3/3	23. Single Mendelian traits	chromosome theory of inheritance, sex linkage, non-disjunction	Griffiths 28-35, 75-80*	
M 3/6	24. Multiple Mendelian traits	independent assortment, linkage	Griffiths 36-40*	**Linkage Analysis and Recombination**
W 3/8	25. Linkage	recombination, chi-square test, p value	Griffiths 40-2, 116-124*	
F 3/10	26. Special cases of inheritance: maternal, epigenetic, & organelle	maternal vs zygotic effect, genomic imprinting, mitochondria & chloroplasts	Non-Mendelian inheritance 103-6, 109-11, 113-6*	Pre-lab 9 due Report 8 due Quiz covering lab 8

	Analyzing the inheritance of human traits			
M 3/13	27. Pedigree analysis	is a trait genetic or environmental?	Griffiths 42-8, 52-6*	**Part A: *Drosphila Life Cycle and Genetics*** **Part B. *Mendelian Genetics*** Pre-lab 10 due Report 9 due Quiz covering lab 9
W 3/15	28. Genome sequencing	genome sequencing, DNA polymorphisms, causation	NYTimes*	
F 3/17	29. Complications: gene interactions	incomplete penetrance, polygenic inheritance	Lander 2037-9*	
T 3/21				**Report 10 due Tuesday March 21st by 5 pm**
F 3/24	**FINAL EXAM**	**10:15AM-12:15PM**	**LOCATION to be announced**	

***reading posted on Canvas (i.e. not from Watson et al. textbook)**