BIO365 (Molecular Genetics) - Spring 2014

Here are some interesting tidbits of genetics news for your intellectual delectation:

Dogs can do it, and so can bees. Now fruit flies have been shown to be able to discriminate between cancerous and non-cancerous tissue.

Recent advances in sequencing ancient DNA have given us the best picture yet of the genome of Neandertals, and from that, insights into the (surprisingly few) differences in proteins encoded in their DNA compared with our own.

Oetzi the Iceman's genome has been sequenced, revealing that (among other things) he was lactose intolerant and suffered from Lyme disease.

The DNA Learning Center at Cold Spring Harbor Laboratory has a number of good animations of molecular genetic techniques, including ones for gel electrophoresis, PCR, and cycle DNA sequencing.

Animations describing DNA microarrays can also be found at the DNALC as well as at the website for GCAT, the Genome Consortium for Active Teaching.

There are also some good animations at the website of Molecular Medicine in Action; for one on PCR, click on *Other* in the tiny menu on the left side of the page.

Some genetic diseases are so uncommon in humans that it's effectively impossible to determine the genetic flaw responsible using affected individuals. Researchers have now succeeded in identifying a gene which leads to icthyosis when mutated by using highly inbred model organisms, in this case dogs (more specifically, golden retrievers).

Canadian researchers have identified the genes for two non-heme dioxygenases in *Papaver somniferum*. Why is this news? *Papaver somniferum* is the opium poppy, and the products of those two genes are the enzymes which are responsible for the manufacture of codeine and morphine in the plant. Needless to say, this has far-reaching implications for the manufacture of pain relievers.

Plant breeding is a pain. (So is animal breeding, but that's not what I'm on about here.) Once you identify a plant with some characteristic you want, it takes several generations of crosses to get cultivars which breed true. Researchers at UC Davis have found a very fast, simple way to make haploid plants, which contain only one parent's chromosomes, significantly reducing the time it takes to create such true-breeding plants. What I particularly like about this story is that "The discovery came out of a chance observation in the lab that could easily have been written off as an error." — pay attention and think about what you're doing, that's one thing I keep telling you.…

How long before genetic testing forces a confrontation between inborn genetic advantage and competitive fairness? A recent report in *PLoS ONE* describes a the association between two variants of the myostatin gene in thoroughbred horses and their racing abilities: horses homozygous for the C version of the gene were much better sprinters, and those homozygous for the T version excelled in longer races, where stamina is more important. While this is in horses, not humans, we have the same gene: London 2014, anyone? Maybe Rio 2016? It's coming, that's for sure….

In a striking example of convergent evolution, geneticists have discovered that one of the proteins critical for echolocation has changed over time in almost identical ways in echolocating bats and dolphins.

Here's a link to the story about that fascinating animal-plant hybrid, *Elysia chlorotica*.

C l a s s e s

Classes will be held in Room 338 of PPHAC
Mondays, Wednesdays, and Fridays from 11:45 am to 12:35 pm

L a b s

Labs will be held in Room 301, Collier Hall of Science
Tuesdays from 12:45 pm to 3:45 pm

T e x t

The text for this course is *Advanced Genetic Analysis: Genes, Genomes, and Networks in Eukaryotes* by Philip Meneely, published by Oxford University Press.

Other readings were provided throughout the semester.

L i n k s

Our textbook has an associated website.

BIO365 (Molecular Genetics) - Course Objectives

Course Objectives

My goal for Bio365 is to make you comfortable with the terms, concepts, and practices of modern molecular genetics. As this field is built on classical genetics, we'll be spending a little time reviewing the latter (and perhaps using some of its techniques in lab) as well.

In addition to the text, we'll be using articles from the primary literature to hone your skills in analyzing the work of other researchers as well as to see how what we're learning in the classroom relates to what's going on in genetics labs today.

In the laboratory, our primary project will be to precisely engineer particular mutations into the genome of *Drosophila melanogaster*. We'll be doing this from square one, as the CRISPR technology we'll be using was only described in flies a few months ago, so there are no well-established guideposts. In addition, we'll be carrying out other experiments as time allows, including identifying the location of a transposable element in *Drosophila* and designing and carrying out an experiment using DNA microarrays. These experiments will not only give you hands-on experience with the techniques, but also the experimental strategies of molecular genetics.

By the end of the semester, you should:

- understand the terms and concepts of molecular and classical genetics
- be able to explain those terms and concepts clearly to others
- be able to solve molecular genetics problems
- be able to carry out many common molecular genetic laboratory procedures
- understand ***why*** you're carrying them out!
- be able to read a research article *in any area you're at least somewhat familiar with* and be able to confidently analyze its conclusions, strengths, and weaknesses
- be able to devise experimental strategies to answer research questions in molecular genetics

In short, by May I hope that you will feel (and be!) fairly self-sufficient in navigating the ins and outs of a significant part of that area of modern biology called "molecular genetics." More importantly, you'll feel confident in being able to learn what you need on your own — no one course, or even 4 years of them, can prepare you with everything you're going to need to know.

BIO365 (Molecular Genetics) - Course Components

Course Components

A note on grading: I do not grade on a curve, so I hope that each of you will do your best to help your fellow students: if they benefit, it does you no harm. In fact, one of the best ways to learn something is to explain it to someone else, so talk to your classmates (see Studying Molecular Genetics in the "Policies" section).

Here are the basic (by which I mean "important" (by which I mean "they affect your grade" (of course))) components of this course — in alphabetical order.

- Exams
- Lab Reports
- Lab Technique
- Paper
- Participation
- Presentations
- Problem Sets
- Discretionary Points

Attendance

It's important that you be in class. As you will discover, there will be no lecture notes for me to give you should you miss a meeting, no little PowerPoint handouts. Classes will be devoted to reviewing the topic for the day, informed by your preparatory reading. Needless to say, that reading is critical to your ability to participate in class, clarify any difficulties you're having, and succeed in learning as much as you can about molecular genetics. All that said, I assume that you want to be here and want to engage in the class, so I do not award points for attendance in this (or almost any) upper-level elective course.

Exams

There will be two exams, not including the final. Each will focus primarily on the material covered since the previous exam, but anything covered during the semester up to that point is fair game. The final will be cumulative. Barring extenuating circumstances (and it is entirely up to me to decide what is an acceptable circumstance), no make-up exams will be given. The hour exams will each contribute up to 150 points toward your final grade, and the final exam will contribute up to 200 points (but see my policy on extra credit).

There will be no make-up exams except in cases where I had advanced warning of your missing the exam, or you were unable to notify me due to circumstances beyond your control. Note that in **any** case, I may decide not to allow a make-up exam regardless of circumstance.

Lab Reports

I will be asking for formal lab reports for our lab experiments; I anticipate that we will tackle 3 or 4 projects this semester:

- using the recently-described CRISPR system to create one or more precise mutations in the *Drosophila* genome

- identifying a P-element insertion site using standard molecular genetic techniques
- establishing experimental parameters to analyze human ABO blood types
- annotating a portion of genomic DNA from a *Drosophila* species

There will be one report for each of these projects, worth a total of 400 points. I will present the format to be used for each as the semester progresses.

Lab Technique

Those of you who have had me in previous classes know that "getting the right answer" in lab isn't something that I put a lot of emphasis on. Real science isn't so neat and tidy that coming up with the correct answer (even if you or I know what that is, which often won't be the case in this course) is a reliable measure of how good you are.

That said, being right is hella better than being wrong. And having good lab technique is invaluable for getting the right answer. Consequently I will be evaluating your skills in lab. Being prepared (by doing any necessary background reading), following instructions, paying attention, and being careful with your manipulations are all important parts of this. As you'll learn, some of the reagents we'll be using are expensive and/or irreplaceable, and I abhor waste, so just being awake and aware of what's going on will serve you in very good stead. (Actually, being awake and aware is excellent advice in life in general, not just this lab.) I will give you up to 100 points for technique.

Paper

You will have a paper due at the end of the semester which reviews some aspect of molecular genetics and incorporates findings from at least 3 articles from the primary research literature. It must be a minimum of 1000 words long and and should show evidence not only of simply understanding the material you present, but also something deeper: how these results fit into the larger picture, how they might be most profitably extended, or ways in which they are flawed, for example. It should be written in the style of a Perspectives article from *Science*; more on this later. This assignment will be worth up to 100 points toward your final grade.

Presentations

On each day of class beginning April 9th, two of you will give brief presentation on a journal article of your choice which involves some aspect of molecular genetics; plan for 20 minutes with a few minutes for questions; 25 minutes total at most. It will be evaluated by your classmates and myself based on criteria which we will mutually establish. The presentation may be on the same topic as your paper (and may focus on one of the three primary literature articles you'll use for your paper) and will be worth up to 100 points toward your final grade.

Problem Sets

Homework problem sets will be assigned. I will be selecting them throughout the semester, based on our pace and what I feel will be most helpful to you. I will assign points to these based on how difficult I feel they are. As I don't have them all mapped out, I can't know how much they will contribute to your final grade, but I estimate 500 points or so.

(I may, at my discretion, drop the lowest grade from the homework assignments. Do not count on this. If you find yourself thinking that you're sunk if I don't drop those scores, you'd better come talk to me. *Immediately.*)

Discretionary Points

We all have strengths and weaknesses. Some of us are better talking in front of a group of interested fellow scientists, others feel more comfortable presenting a carefully-honed analysis on paper. I'm allowing you 200 points to allot wherever you want: to the problem sets, exams, paper, or presentation. Please let me know how you would like to distribute yours before the midterm (February 28th).

BIO365 (Molecular Genetics) - Course Policies

Course Policies

Below you will find various course policies, including:

- Attendance
- Reading
- Late Assignments
- Extra Credit
- Cell Phones
- Lab Conduct
- Studying Molecular Genetics
- Academic Honesty

Grading

I'm going to be using the point system for this course, so you don't have to worry about calculating percentages for individual components. I'll try to keep an up-to-date total here on the website, so you can always determine your grade so far by comparing what you've earned with the max possible. Given my grading scale, you can therefore calculate your own grade in the course at any time.

I've laid out the course components and their point values separately, but to summarize:

Hour Exams	(2 @ 150 points =) 300 points total
Problem Sets	ca. 500 points
Paper	100 points
Presentation	100 points
Final Exam	200 points
Laboratory Technique	100 points
Laboratory Reports	500 points
Anticipated Total	**2000 points**

(I reserve the right to tweak these distributions as I see fit: if for example no one appears to be doing the reading, I may institute short, sporadic quizzes. These will in all likelihood be given in the first few minutes of class, and no make-ups will be given. In order for them to be taken seriously, I will have to shoehorn them into the grading scheme outlined above.)

Those of you paying attention may have noticed that the individual assignments above only add up to 1800 points. You may assign the remaining 200 points to exams, the presentation, the paper, and/or the lab reports, depending on your own strengths. Within one week after I've returned your first exams, you should email me with instructions on how you'd like those points distributed.

Here is the grading scale I use in all my classes:

numeric grade	letter grade
93.3 - 100	A

90.0 - 93.2	A-
86.7 - 89.9	B+
83.3 - 86.6	B
80.0 - 83.2	B-
76.7 - 79.9	C+
73.3 - 76.6	C
70.0 - 73.2	C-
66.7 - 69.9	D+
63.3 - 66.6	D
60.0 - 63.2	D-

Just to review, this is what the Student Handbook has to say about grades:

A and A-
These grades are given for achievement of the highest caliber. They reflect independent work, original thinking, and the ability to acquire and effectively use knowledge.

B+, B, and B-
These grades are given for higher than average achievement. Evidence of independent work and original thinking is expected.

C+, C, and C-
These grades are given when the student has devoted a reasonable amount of time, effort, and attention to the work of the course and has satisfied the following criteria: familiarity with the content of the course, familiarity with the methods of study of the course, and active participation in the work of the class.

D+, D, and D-
These grades are given for unsatisfactory work, below the standard expected by the College. They indicate work which in one or more important aspects falls below the average expected of students for graduation. The work is, however, sufficient to be credited for graduation, if balanced by superior work in other courses.

Attendance

If you are going to be absent from class or (Heavens forbid!) lab, please do me the courtesy of letting me know in advance if at all possible. Don't forget that it is *your* responsibility to notify me if you will be away for a field trip, sporting event, or other school-related function. It is not my responsibility to keep up with all the myriad activities which you might be involved in, according to the student handbook (and common courtesy as well).

Reading

In this course, the reading is critically important. Classtime will be spent discussing the reading for that day; I will not be lecturing. If you don't keep up with the reading — and by that I mean **active** reading, not just using a highlighter — you won't be able to keep up in class, you won't fully understand what's being taught, the class will rapidly become a waste of time for you.

Late Assignments

Assignments turned in late will not be accepted. Period.

Extra Credit

On a 150-point hour exam, I will give you 165 points-worth of questions. Thus, you can miss (nearly) 10% of the questions on any hour exam and still get the full 100 points. With the exception of these additional points on exams, there will be no opportunity for extra credit in this course.

Cell Phones

Cell phones are tools of Satan. They are without significant positive value in my world and while I don't expect you to share my view of them, I expect you to spare me from being rudely reminded of their existence. If you are expecting an ***urgent*** phone call while in class or lab, alert me to that fact ahead of time. Otherwise, if your cell phone goes off in class or lab, you might as well pack up your things and

go home, because I won't give you any credit for being there. Some day this will be looked on as one of my loveable eccentricities, but until then you'll just have to put up with my sociopathy.

Lab Conduct

There is to be ***NO*** food or drink in the lab at ***ANY*** time. Rules have gotten stricter, fines have gotten much higher, and the government is coming after undergraduate institutions like never before. If I see any comestibles or potables in lab you will be docked points in accordance with my mood; if I see you put anything into your mouth, I may well dock you several hundred (yes, *hundred*) points. This is a serious infraction of laboratory protocols.

The only thing worse is endangering other students or their data, whether through carelessness or malice. If I find anyone doing something which might result in harm to another student or compromise their experimental results, I will fail the perpetrator for the entire course. I am by and large a fairly easy-going guy, but there are some things which are simply beyond the pale; this is one of them.

Studying Molecular Genetics

Science is a collaborative venture. I urge you to get together with your fellow students as much as possible to study the material for this course in groups. Discussing problems, studying for exams with other students, and asking each other questions on the reading assignments are all examples of activities which will benefit you and which I encourage. Obviously you cannot consult with others during exams, but the homework may be something of a grey area foryou. For my courses, you must prepare your own answers to assigned problems, but I feel that getting together with other students in the course to discuss and think through problems together is not only perfectly acceptable, it is a very good idea. If you have arrived at what you believe to be the correct answer, put it aside for fifteen minutes before writing it down; this way you can be more confident that you really know what it is you're saying, and your answers won't be identical to your partners'.

Note that the idea of collaborative learning in this way does not mean that you should ask for answers from others who have already taken this or a similar course, nor should you necessarily just accept an answer from a classmate whom you think is likely to be right. Everybody is mistaken sometimes, and if you don't understand **why** his or her answer is the right one, well, then you don't understand it. And that is not where you want to be. Conversely, if you're sure you've got the right answer, don't just tell your study group and be done with it. Try to help them arrive at the same conclusion you did step by step; someone else may come up with a very different view of the problem which forces you to rethink your approach. And rethinking your approach, even if it doesn't turn out to change your mind about your answer, is critical to your success as a scientist.

My concern is not that you "learn" molecular genetics, seeing it as a (very large) pile of facts, but that you **understand** it. Your fellow students and I are resources to help you; it's up to you to do the work necessary to gain that understanding.

You should expect to spend ***at least*** 2 hours studying on your own for every hour in the classroom. At a ***minimum***. That's true for every class, not just mine. If you're content to just slouch through, willing to trade a better grade in the course for whatever you think is more important than your studies, you're welcome to do so. But if you want to excel, not only for the sake of a higher mark on your transcript, but also for the sake of your education, you owe it to yourself to put in enough effort that you can honestly say to yourself at the end of the semester, "I did my best, and I learned as much as I could in that course." If you do, I'll do everything I can to make this a worthwhile experience for you.

Academic Honesty

I adhere to the Academic Honesty policy of the College. There is nothing more important to me than personal integrity - not molecular genetics, not happiness, not power, nothing - and I conduct myself and all of my classes in that spirit. If you're not familiar with College policy, you should be.

Accommodations

Per Moravian College policy: "Students who wish to request accommodations in this class for a disability should contact Elaine Mara, Assistant Director of Learning Services for Disability Support, 1307 Main Street (extension 1510). Accommodations cannot be provided until authorization is received from the office of Learning Services."

BIO365 (Molecular Genetics) - Course Syllabus

Course Syllabus

Meeting number	Date	In-Class	Background Reading
1	Mon., Jan. 13	organizational meeting	
2	Wed., Jan. 15	review	text chapter 1
3	Fri., Jan. 17	review	text chapter 1
	Mon., Jan. 20	No Class (MLK day)	
4	Wed., Jan. 22	Model organisms	text chapter 2
5	Fri., Jan. 24	Finding mutants	text chapter 3
6	Mon., Jan. 27	Classifying mutants	text chapter 4
7	Wed., Jan. 29	Classifying mutants	text chapter 4
8	Fri., Jan. 31	Cloning genes	text chapter 5
9	Mon., Feb. 3	Cloning genes	text chapter 5
10	Wed., Feb. 5	Paper	Polley & Fay, "A Network of Genes Antagonistic t LIN-35 Retinoblastoma Protein of *Caenorhabditis el* **Genetics 191**: 1367–1380 (2012)
11	Fri., Feb. 7	Paper	Polley & Fay, "A Network of Genes Antagonistic t LIN-35 Retinoblastoma Protein of *Caenorhabditis el* **Genetics 191**: 1367–1380 (2012)
12	Mon., Feb. 10	Reverse genetics	text chapter 6
13	Wed., Feb. 12	Mutant screens	text chapter 7
14	Fri., Feb. 14	exam	
15	Mon., Feb. 17	Paper TBA	
16	Wed., Feb. 19	Paper TBA	
11	Fri., Feb. 21	Analyzing gene expression	text chapter 8
18	Mon., Feb. 24	Analyzing gene expression	text chapter 8
19	Wed., Feb. 26	Gene expression via mutant analysis	text chapter 9
20	Fri., Feb. 28	Gene expression via mutant analysis	text chapter 9
	Mon., Mar. 3	No Class (Spring Break)	
	Wed., Mar. 5	No Class (Spring Break)	
	Fri., Mar. 7	No Class (Spring Break)	
21	Mon., Mar. 10	Paper TBA	
22	Wed., Mar. 12	Paper TBA	
23	Fri., Mar. 14	Finding interacting genes	text chapter 10
24	Mon., Mar. 17	Finding interacting genes	text chapter 10
25	Wed., Mar. 19	Paper TBA	
26	Fri., Mar. 21	Paper TBA	
27	Mon., Mar. 24	Genetic pathways	text chapter 11
28	Wed., Mar. 26	exam	
	Fri., Mar. 28	No Class (Fly Meeting)	
29	Mon., Mar. 31	Pathways, networks & Systems	text chapter 12
30	Wed., Apr. 2	Pathways, networks & Systems	text chapter 12
31	Fri., Apr. 4	Paper TBA	
32	Mon., Apr. 7	Paper TBA	

33	Wed., Apr. 9	student presentations
34	Fri., Apr. 11	student presentations
35	Mon., Apr. 14	student presentations
36	Wed., Apr. 16	student presentations
	Fri., Apr. 18	No Class (Easter Break)
	Mon., Apr. 21	No Class (Easter Break)
37	Wed., Apr. 23	student presentations
38	Fri., Apr. 25	review
	Tues. Apr. 29 1:30 pm	**FINAL EXAM**

Life is fluid, so this syllabus is subject to change. I will do my best to adhere to it, but helping you learn as much as you can about molecular genetics trumps any satisfaction I might glean by marching us in lockstep through the semester.

BIO365 (Molecular Genetics) - Labs

Labs

Meeting number	Date	Lab	Background Rea
1	Tues. Jan. 14	planning our experimental goal Note that we meet in **PPHAC 301**, today only!	
2	Tues. Jan. 21	discuss Gratz *et al.* paper and select mutational goal	
3	Tues. Jan. 28	Drosophilagenomic DNA prep	
4	Tues. Feb. 4	DNA restriction digestion	
5	Tues. Feb. 11	DNA ligation	
6	Tues. Feb. 18	inverse PCR	
7	Tues. Feb. 25	review progress on CRISPR project	
	Tues. Mar. 4	No Lab (Spring Break)	
8	Tues. Mar. 11	P element insert flanking DNA sequence analysis	
9	Tues. Mar. 18	genomic DNA annotation?	
10	Tues. Mar. 25	discuss human ABO genotyping project	
11	Tues. Apr. 1	design ABO primers prep human genomic DNA (cheek cells)	
12	Tues. Apr. 8	test ABO genotyping PCR parameters	
13	Tues. Apr. 15	analyze ABO sequence data	
14	Tues. Apr. 22	final lab	

BIO365 (Molecular Genetics) - Prof. Jones

Prof. Jones

If you ever have questions that you can't answer yourself, realize that there are a lot of resources available to you: if your classmates can't help you, feel free to ask me. This is part of my job, and one which I don't shirk. Depending on what the problem is, the most reliable method is probably email (I sometimes don't realize I have voicemail for a day or two). My email address is cjones [at] moravian [dot] edu and my office (and lab) phone number is 610-861-1614.

If you need to speak with me sometime when I'm not on campus (a rare event!), call me at home any time between 9 am and 9 pm. Students often tell me they don't feel comfortable calling me at home because they think I mind. Consider the logic here: there's nothing that says I have to give you my home phone number, yet I have done so in class. So ***why*** would I give you that number if I didn't want you to use it? Note that "use" is not the same thing as "abuse": don't call me at 3 am the day before an assignment is due and expect much sympathy (or pleasant conversation)!

Here's a copy of my current class schedule. My official office hours are from noon to 1 pm on Mondays. That said, official hours are all but irrelevant to me. If I'm not in my office (Room 310, Collier Hall of Science), try my lab (Room 233, Collier Hall of Science — between the elevator and the loading dock on the main floor). Feel free to get hold of me any time; if I can't spare the time to talk then, I'll tell you so, and we can set up an appointment at our mutual convenience.