Genetics and Molecular Biology for Teachers (SMFT 639)
Course Syllabus

This course will be a fascinating journey delving into the sub-cellular world and its connections to the evolution of interconnected life forms on biosphere Earth. We will explore human evolution at the genetic and molecular as we learn about the molecular biology of sickle cell anemia and how this genetic condition influenced the rise of slavery in the south. We'll discover how genetically modified organisms are impacting our food, our health and the health of our biosphere. We'll make bacteria glow like a jellyfish, peer into the eyes of fruit flies, learn about potential cures for life-threatening genetic conditions, explore what genetics has to tell us about human evolution, and solve a mystery using modern DNA technologies. And, most importantly, we will explore a variety of methods for teaching the abstract foundations of genetics and molecular biology in ways that will engage your students, help them to make connections between other science disciplines and math, and help them to understand the implications of modern molecular biology to their personal, civic and future professional lives.

Course Description

The course will introduce teachers to content and methodology necessary to effectively teach genetics and molecular biology at the middle & high school level. Topics addressed in the course will include Mendelian and chromosomal genetics, evolutionary genetics, molecular biology (the path from gene to protein), biotechnology and the ethical implications of this new technology. In this course, important human, societal or environmental issues related to genetics and molecular biology will be used to engage students and provide a context for the exploration and application of general biological principles. The course will model innovative teaching strategies (problem & case studies-based learning, inquiry-based labs, small-group collaborative learning and technology-supported lectures which encourage student participation. For SMFT degree-seeking students this course satisfies category B2: Integrated Science.

Learning Goals & Objectives

Although this is a course focusing at the genetic, molecular and cellular levels of biology, we will explore concepts and processes at these levels across all levels of biology, from molecules to ecosystems within our biosphere. These broadly include:

- **Evolution**: The diversity of life evolved over time by processes of mutation, selection, and genetic change. The theory of evolution by natural selection allows scientists to understand patterns, processes, and relationships that characterize the diversity of life.
- **Structure and Function**: Basic units of structure define the function of all living things. Structural complexity, together with the information it provides, is built upon combinations of subunits that drive increasingly diverse and dynamic physiological responses in living organisms. Fundamental structural units and molecular and cellular processes are conserved through evolution and yield the extraordinary diversity of biological systems seen today.
- **Information Flow, Exchange & Storage**: The growth and behavior of organisms are activated through the expression of genetic information at different levels of biological organization and depend on specific interactions and information transfer.
- **Pathways and Transformations of Energy & Matter**: Biological systems grow and change by processes based upon chemical transformation pathways and are governed by the laws of thermodynamic and will be explored to understand how living systems operate, how they maintain orderly structure and function, and how physical and

chemical processes underlie processes at the cellular level (i.e. metabolic pathways, membrane dynamics), organismal level (i.e. homeostasis) and ecosystem level (i.e. nutrient cycling).

- **Systems**: Living systems are interconnected and interacting and biological phenomena are the result of emergent properties at all levels of organization, from molecules to ecosystems to social systems. The course will explore the dynamic interactions of components at one level of biological organization to the functional properties that emerge at higher organizational levels.

By the end of this course students will:

- Develop a deeper understanding of Mendelian and modern molecular and evolutionary genetics concepts and tools used to explore genetic and molecular biology-related questions.
- Learn how to employ a variety of active-hands-on & inquiry-based teaching methods to teach genetics and molecular biology at the pre-college level.
- Gain experience with using model genetic organisms in the classroom.
- Develop cost-effective methods of incorporating biotechnology into the middle/high school classroom.
- Develop a deep understanding of and appreciation for the societal impacts and ethical implications of new discoveries and technologies in genetics and molecular biology.
- Gain experience utilizing inquiry and case-based labs, activities, demonstrations and student projects that promote curiosity, and scientific inquiry in the realms of genetics, molecular biology and evolution.
- Develop a rich appreciation of the history of genetics and molecular biology discoveries since Gregor Mendel, and how historical science can be used to engage students, challenge common misconceptions and develop an appreciation for our ever-evolving understanding sub-cellular processes.
- Communicate genetic and molecular biology concepts to diverse audiances.

Problems & Case Studies: In this course we will work both individually and collaboratively to solve (or better understand) real-world biological questions/problems/issues. This will be done to develop a better understanding of essential connections between different areas of biology; how to apply and synthesize biological concepts and principles; find and evaluate biological information; and communicate ideas and information about biology to a variety of audiences. Moreover, we will explore connections between genetics and personal health decisions, between social values and the biotechnological revolution, between food, politics and genetic engineering and a host of other connections. In short, we will be immersed in biology in the context of critically important questions and issues that face us as scientists, teachers, & citizens of this planet. This kind of learning is intended to help you foster important intellectual abilities in your students such as finding and evaluating sources of biological information, using this knowledge to inform a deeper understanding of biological concepts, and to effectively support and communicate ideas. My role as your instructor is as a facilitator guiding your efforts to learn biology, think critically, and modeling effective pedagogies. We will be working on several problems or case studies during the course. At the end of each you will be expected to present your solutions or recommendations for the problem in written or oral format. The format for problem presentations will be assigned with each problem. More information about the Problem/Case-Based Learning approach used in this class can be found in the course information section of the class OAKS page.

Course Requirements

Readiness Assurance Tests (RATs) - *I fully expect that as professional teachers you are already intrinsically motivated to learn, and that you have the skills to work together collaboratively with one another. However, it is likely that your own students will not yet be quite so motivated to learn, and may not have yet developed essential teamwork skills. So in this course I will model strategies that you can use in your own courses to motivate students, check students' understanding, and facilitate effective collaborative learning. So….*

Your preparation for class, by doing the assigned readings and reviewing the previous week's material will be assessed at the beginning of each class through what I call **Readiness Assurance Tests (RATs)**. RATs are short (10 minute) quizzes, or other class activities. The purpose of RATs is to 1) check your knowledge of biological concepts from the reading assigned for that day's class; 2) give both you and I feedback on your learning throughout the course; 3) engender discussion on biological concepts and applications to real-world biological issues; 4) help me determine what concepts from the reading you need help with in the class. Some RAT's will first be taken individually, and then in your teams. Therefore you will receive both and individual grade and a team grade on each RAT. Some RATs will only be taken as a team, and you will receive a team grade on these.

Progress Reports - I want to be clear about the purpose of "exams" in this course! They are not for simply assigning grades, or as an incentive to "force" you to learn. Instead, it is my hope that the relevant and engaging issues that we explore in the course will foster intrinsic learning motivation. The purpose of the exams is to let you know the extent to which you understand the underlying biological concepts that emerge through problem discussions, class activities and lectures, and your ability to apply those concepts to biology-related issues or questions. In short, they are meant to inform you of your learning progress in this course! Since this is their purpose, I refer to these periodic assessments as *Progress Reports*.

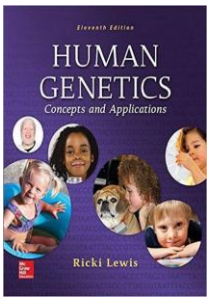
There will be 3 progress reports during the course. Since the class is small, the final progress report will be tailored to each individual student and will mainly focus on those concepts which prior progress reports suggest you do not fully comprehend.

End-of-Problem/Case Studies Assignments - Each case study or problem we work on will have an associated project in which students will present their problem solutions or recommendations. The specific nature of the project will be presented at the start of each unit but can be a policy statement, stake-holder letter, class debate, professional poster presentation, written or oral proposal, newspaper editorial or a magazine article.

Expectations for each problem assignment:

1. All assignments should be completed by the due date (on the class schedule)
    - Assignments must be turned in to me **according to the instructions posted on the assignment** (most assignments will be submitted electronically to an OAKS Dropbox. **Please submit all work as a PDF file.**
    - Late papers will be reduced one grade for each day received past the due date. However, remember that your team may be relying on you to complete your work, so late work could also have an influence on your peer evaluations (see below), and on my assessment of your participation in class.
2. In general, I will ask you to work on assignments in ways that are similar to most professional working environments. This means that you will be allowed to work together with your teammates on problem assignments. In this sense, working together means you can share ideas & research resources, teach each essential concepts, evaluate and edit each other's work, challenge each other's ideas and to dig (think) deeper. However, unless otherwise stated by me, the final draft of each assignment should be a construction of these ideas written in your own words. In fact, I hope you come to realize that the act of expressing your ideas IS LEARNING!

Required Textbook



Human Genetics: Concepts and Applications, 11th Edition
by Ricki Lewis

Grade Determination

Individual vs. Team Work - The majority of your grade will be determined by work that you do individually (~90%); however, we will be working in teams extensively during class, so about ~10% of your grade will be determined by work that you collaborate on with your teammates.

Assessment	% of grade
2 Progress Reports (aka exams)	30%
Final Progress Report (cumulative final exam)	10%
Case Study/Problem Assignments	25%
Lab & Class Discussion Activities	15%
Homework	10%
***Participation & Effort**	10%

**How you can earn the full 10% of the participation & effort grade:*

1. *Always come prepared to class, having completed the readings/homework to the best of your ability.*
2. *Participate in small group and class discussions by asking, trying to answer questions and constructively/thoughtfully/respectfully challenging ideas presented in class…even those of your instructor!*
3. *Try to use/apply knowledge from homework to complete RATs and other in class activities. Improvement over the course of the semester matters here!*
4. *Work effectively with your team.*
5. *Read and follow assignment guidelines carefully.*
6. *Incorporate feedback from me on your work into future work.*
7. *Come and get help early and often if you find you are struggling!*

Grade Cutoffs

To earn a(n)	you need…
A	90%
B+	86%
B	80%
C+	76%
C	70%
F	<70%

Honor Code and Academic Integrity

Again, I fully expect that as professional teachers you are already fully aware of the nature of academic integrity and what constitutes plagiarism. However, given the collaborative nature of this class, I wanted to provide you with an example of the information I provide to my students regarding these issues. These policies will of course apply to this

course, and they are intended to give you an idea of how to structure effective collaboration in classes, and to make explicit what are forms of academic dishonesty. Plus I am required to do this by the college!

The structure of this class is probably going to be different from that of other science classes you have taken. In this class we will, to a large extent, be working in small teams, much like professionals do when they collaborate on projects. The collaborative work we do in this class is meant to encourage you to work together with your teammates to help each other learn. This will require that you share, justify and evaluate the ideas expressed among your teammates. So in short, you are allowed to work together on problem project assignments in this class. Working together means identifying knowledge your team needs to proceed, sharing research knowledge and resources, evaluating each other's ideas/solutions/recommendations & providing constructive feedback to your teammates. However, each of you must individually write the final problem project assignment. When you write, the ideas you express will of course be a collection of those constructed by your team and supported by background research, but what you write should ultimately be written individually by you and in your own words. Any information, concepts, ideas that you acquire from outside research sources must be summarized/explained in your own words, and appropriately cited (both in a work cited section and parenthetically in the body of the paper). In short, this class will be structured to allow you to work together to form your ideas, but you must ultimately express these ideas in your own words! In fact, I hope you come to realize that the act of expressing and justifying your ideas is learning!

For more information about writing in this class, consult the "Guidelines for Writing in this Class" in the Writing Resources section of the class OAKS page.

I am also required to remind you that…

Lying, cheating, attempted cheating, and plagiarism are violations of our Honor Code that, when identified, are investigated. Each incident will be examined to determine the degree of deception involved.

Incidents where the instructor determines the student's actions are clearly related more to a misunderstanding will handled by the instructor. A written intervention designed to help prevent the student from repeating the error will be given to the student. The intervention, submitted by form and signed by both the instructor and the student will be forwarded to the Dean of Students and placed in the student's file.

Cases of suspected academic dishonesty will be reported directly by the instructor and/or others having knowledge of the incident to the Dean of Students. A student found responsible by the Honor Board for academic dishonesty will receive a XF in the course, indicating failure of the course due to academic dishonesty. This grade will appear on the student's transcript for two years after which the student may petition for the X to be expunged. The student may also be placed on disciplinary probation, suspended (temporary removal) or expelled (permanent removal) from the College by the Honor Board.

Students should be aware that unauthorized collaboration--working together without permission-- is a form of cheating. Unless the instructor specifies that students can work together on an assignment and/or test, no collaboration is permitted. Other forms of cheating include possessing or using an unauthorized study aid (such as a PDA), copying from others' exams, fabricating data, and giving unauthorized assistance.

Students can find the complete Honor Code and all related processes in the *Student Handbook* at http://studentaffairs.cofc.edu/honor-system/studenthandbook/index.php