Syllabus – Fall 2021

BIOLOGY 111 LC 26: Introduction To Cell and Molecular Biology
(CRN 14716.202310)
MWF 10:00pm – 10:50 RITA 154

Required: FYE Synthesis Seminar - Tuesday 3:05-3:55 BellSouth Building 408

INSTRUCTOR:
Mrs. Emily Giarrocco, M.S.
giarroccoea@cofc.edu

Note: Please make sure to use your CofC email only when emailing me; I do my best to reply the same day if the email is received before 5 p.m., but I do not check my emails after 5 p.m. or over the weekend. Also, please include your course number and section number.

OFFICE LOCATION: 65 Coming St., Rm. 214  (across Coming St. from the loading dock area of RITA)
OFFICE HOURS: Mondays at 12pm and Tuesdays at 11am (via zoom). These are optional. Feel free to “drop by” at any time during the hour. You are also welcome to email me to schedule an appointment.

Course Description
Introduction to Cell and Molecular Biology is a foundation course for those intending to major in science, and therefore emphasizes critical thinking skills while delving into the basic concepts of biology including structure and function at molecular and cellular levels. This course is part of a learning community with precalculus (MATH 111), which will allow us to explore the intricate and functional connections between biology and mathematics. Topics covered include the scientific process, biochemistry, molecular biology, cell structure and function, respiration, photosynthesis and genetics. There are no prerequisites, but Biology 111 Laboratory (BIOL111L) is a corequisite along with the Synthesis Seminar (see FYE information).

First Year Experience Synthesis Seminar (FYSS 101)
This Learning Community is part of the First Year Experience (FYE) Program, and participation in the Synthesis Seminar is mandatory. Your participation in the seminar will count toward your grade (10%) in this course and the coinciding Math 111 course. This means that if you choose to neglect this portion of the course, your grade will suffer twice and you may have to take another FYE course in the future. Your Peer Facilitator for the Seminar is Khalea Richards (richardkd@g.cofc.edu). She is an excellent resource for general college-related questions & resources.

FYE Learning Objectives
By the completion of the First Year Experience, a student will be able to identify and use the appropriate academic resources and student support services at College of Charleston. These include the Addleston library, information technology, the Center for Student Learning, the Career Center, and other appropriate academic resources, student support services, and cultural resources.
By the completion of the First Year Experience, a student will be able to:
- use appropriate tools and search strategies for identifying particular types of information specific to the discipline.
- evaluate the relevance, quality and appropriateness of different sources of information.
- recognize and classify the information contained within a bibliographic citation.
- access and use information ethically and legally.

Faculty will use writing, speech or media in innovative ways to achieve integrative learning by students. By the completion on the first year, a student will be able to:
- use appropriate critical thinking skills and problem-solving techniques in appropriate disciplinary contexts.
- make connections across disciplines and/or relevant experiences.

**Supplemental Instruction (SI)**
Supplemental Instruction, or SI, is a collaborative, peer-assisted group study session. It is for everyone and is not remedial. **Attendance is strongly encouraged.** Your SI leader for this course is Cecelia Spain (spaincn@g.cofc.edu).

[https://csl.cofc.edu/supplemental-instruction/](https://csl.cofc.edu/supplemental-instruction/)

**Required Course Materials**

1. **Textbook:** Free online open access text *Open Stax Biology 2e*  
   [https://openstax.org/details/books/biology-2e](https://openstax.org/details/books/biology-2e) (please set up a student account)

2. **Computer and online access:** All students must have access to a computer equipped with a web camera, microphone, and Internet access. **You will be required to download, install and use Respondus Lockdown Browser and Monitor for certain quizzes and possibly exams.** Further instructions will be provided about this. Resources are available to provide students with these essential tools if they need assistance - please let me know if you need help accessing those resources. If you need a reminder of laptop requirements, please visit: [https://it.cofc.edu/laptops/](https://it.cofc.edu/laptops/)

Class materials require online access through MyCharleston to both OAKS and Voice Thread; make sure you’re familiar with both. If you’re new to OAKS, start here: [http://blogs.cofc.edu/oaks/students/getting-started/](http://blogs.cofc.edu/oaks/students/getting-started/). Another good resource for technology questions or help is: [http://blogs.cofc.edu/sits/](http://blogs.cofc.edu/sits/).

**Suggested Course Material**
A physical notebook with paper and a writing utensil is **strongly** encouraged. If you need convincing: [https://www.scientificamerican.com/article/a-learning-secret-don-t-take-notes-with-a-laptop/](https://www.scientificamerican.com/article/a-learning-secret-don-t-take-notes-with-a-laptop/).

The **Center for Student Learning** (CSL) has resources to facilitate peer education through tutoring, supplemental education and development of skills that contribute to academic success. It’s also free to you! For more information, please visit the CSL website at [http://csl.cofc.edu](http://csl.cofc.edu) or drop by their location (first floor of the Addlestone Library).

**COVID-19 Protocols for the 2022-23 Academic Year**
The College of Charleston is committed to promoting the health and safety of our campus community. To that end, all faculty and students must abide by current COVID-19 protocols.

**VACCINATIONS**
Every student, including returning students, should complete the College of Charleston COVID-19 Vaccination Documentation Form by visiting go.cofc.edu/vax-upload by 5 p.m., Tuesday, Aug. 30, 2022. This information is critical to decision-making for College operations.

- Information provided in the COVID-19 Documentation Form is kept strictly confidential and will only be used by the COVID-19 team for operational decisions. Neither parents nor students will receive an email after submitting this form that indicates a student’s vaccination status – whether vaccinated or unvaccinated.

- In accordance with guidelines from the Centers for Disease Control and Prevention (CDC) and the South Carolina Department of Health and Environmental Control (DHEC), the College strongly recommends that its students, faculty and staff receive the COVID-19 vaccine.

- CDC recommends COVID-19 primary series vaccines for everyone ages 6 months and older and COVID-19 boosters for everyone ages 5 years and older, if eligible.
  - Visit the CDC website to check whether you are current with your COVID vaccine.

- COVID-19 vaccination is not required for any student to enroll or any employee to work at the College of Charleston.

FACE-COVERINGS/MASKS

- Masks are not currently required on campus unless one of the following applies:
  - You are on days 1-5 of isolation or required quarantine and have not yet left campus.
  - You are on days 6-10 of your isolation and have returned to campus.
  - You are unvaccinated or not current on your COVID-19 vaccines and are returning to campus on days 6-10 of your quarantine due to a close contact with a positive COVID-19 case.

- Those who are not vaccinated and/or those who wish to continue to wear high-quality, well-fitted masks such as a KN95 are encouraged to do so, especially in large indoor gatherings.

- The College will make KN95 masks available to students, faculty and staff. Information about pick-up locations for masks will be announced prior to the start of classes.

Regardless of how this policy might change over the course of the semester, I may request you wear a mask if we have an outbreak in this class in an attempt to limit my family’s exposure. If you should become ill, supporting your needs through absence or quarantine related to sickness is not an issue, but you must communicate your needs. This also applies if you think you may be sick or have had a close contact. If you do have symptoms or were a close contact, PLEASE GET TESTED. It’s free. It’s quick. Students should be aware that extended absences for any reason cannot be accommodated in every course. Missed assignments and assessments may result in poor or failing grades. If a student is absent from class for an extended period, a withdrawal (W) before the deadline should be strongly considered. In all cases, assigning course grades is the responsibility of the instructor consistent with the grading policy published on the syllabus.

In regards to your actual in-person classes, classrooms and course sections will be filled to the fire-code capacity of the room. Within each classroom, 3 feet of social distancing should be maintained.

**Inclement Weather, College Closure, and the Class Schedule**

If the College of Charleston closes and members of the community are evacuated due to inclement weather or for any other reason, students are responsible for taking course materials with them in order to continue with course assignments consistent with instructions provided by faculty. In cases of extended periods of institution-wide closure where students have relocated, instructors may articulate a plan that allows for supplemental academic engagement despite these circumstances.
**Teaching Philosophy**

Student engagement and effective communication of both students and instructor are essential to a successful learning experience. In college, your responsibility toward your classes can be fueled by a variety of motivators, from enjoyment of the material, desire to succeed, or even simply worldview expansion. Whatever your motivator, it is your responsibility to learn the material, ask questions and explore available resources. As an instructor, I am here as a resource and guide.

**Course Policies and Requirements**

**Accommodations**

Any student in this class who has a documented disability should speak to me as soon as possible, as well as contact the Center for Disability Services (CDS/SNAP program), located on the first floor of the Lightsey Center, Suite 104, (843) 953-1431, SNAP@cofc.edu

The College of Charleston community is enriched by students of many faiths that have various religious observances, practices, and beliefs. We value student rights and freedoms, including the right of each student to adhere to individual systems of religion. The College prohibits discrimination against any student because of such student’s religious belief or any absence that results from held beliefs. Please contact me if this course’s schedule directly conflicts with one of your observances. Please see: https://academicaffairs.cofc.edu/documents/procedures-and-practices/statement-of-accommodation.pdf

**Class Delivery Format**

COVID-19 pandemic permitting, we will be having our lecture portion of class in person in RITA Room 154 unless notified otherwise.

This class will be administered through OAKS, the College of Charleston’s learning management system. To access OAKS go to http://my.cofc.edu and login to My Charleston. The OAKS icon is the acorn located in the upper righthand corner of the screen.

I expect you to regularly login to OAKS to check for course updates, complete quizzes, etc. Please also check your email regularly as I may send e-mail updates to the class through OAKS to update you on class events and assignments.

**Class Attendance**

Attendance of all scheduled meeting times for class is expected. If you miss a class, it is your responsibility to review materials from that day. I am also teaching this class asynchronously (online) and so will have VoiceThread lectures for you to review. Exams will be based primarily on lectures, but the textbook is an invaluable resource, so it is important to keep up with your readings which will be explicitly outlined on OAKS. As mentioned above, should a student in our class test positive for COVID-19, the entire course will be moved online for the duration of the quarantine & attendance will be measured by completion of the materials.

**Honor Code**

Students are required to adhere to the guidelines outlined by the Honor Board in the Student Handbook (please see http://deanofstudents.cofc.edu/policies-and-procedures/honor-code-and-code-of-conduct.php)
includes lying, which will not be tolerated in this course. All work that you turn in for this course (whether for assignments, quizzes, or exams) must be your own independent scholarship. Students should be aware that unauthorized collaboration—working together without permission—is a form of cheating; this includes collaborating with classmates or other individuals on online quizzes or exams. Other forms of cheating include possessing or using an unauthorized study aid (which could include accessing information via a cell phone or computer), copying from others’ exams, fabricating data, and giving unauthorized assistance. Any form of plagiarism (intentional and unintentional), cheating, or presenting someone else’s work as one’s own will be treated as a serious academic transgression and will be communicated accordingly by the instructor as an honor code violation to Student Affairs. Be especially cautious of plagiarism when using Internet sources. Cheating, attempted cheating, or plagiarism will result in a grade of zero on that assignment, quiz or exam and may result in a final overall grade of F or XXF (failure due to academic dishonesty) for the course.

Quizzes & Assignments
Multiple choice quizzes will be given weekly and conducted through OAKS. They are intended to help students in keeping up with the large amount of information in this course by encouraging them to prepare and study/read/revieW EVERY day. It is your responsibility to keep up with due dates and times! A missed quiz will result in a 0 for that quiz, unless you talk to me to explain the situation (serious illness, including but not limited to COVID-19, family responsibilities, other extreme circumstances). It is imperative that you communicate with me and tell me the truth, so that I can work with you. Your lowest 3 quiz scores will be dropped in the final grade calculation. All cell phones, Apple watches, pagers, iPods, iPads, tablets, laptops, etc. are to be turned off and put away during each quiz, and you are expected to take them by yourself without other people, notes, books or websites. The use of any wireless communication device during a quiz, test, or final exam is a violation of the Honor Code. Since the lowest 3 quiz/assignment grades will be dropped, there will be no make-up quizzes or homework assignments. Regular quizzes open Thursday morning each week and close Friday with a few exceptions due to testing days.

Throughout the semester, you will have assignments that you will have to complete after class. I do usually give in class time to work on them, so please use your time wisely. In addition, toward the end of the semester, you will have a final project to do for this class that explores a topic in which mathematics and biology intersect, which you will learn more about later in the semester.

Exams
In this course, there are 3 regular exams scheduled during the semester (see calendar below for dates) and 1 cumulative final exam scheduled during the final examination period. Anyone who misses an exam will receive a 0, unless you talk to me to explain the situation (serious illness, including but not limited to COVID-19, family responsibilities, other extreme circumstances). If you have any conflicts with the scheduled exams, you must see me ahead of time, well before the exam date. All cell phones, Apple watches, pagers, iPods, iPads, tablets, laptops, etc. are to be turned off and put away completely during each exam. The use of any wireless communication device during a quiz, test or final exam is a violation of the Honor Code. The final exam will be comprehensive (and will be given during finals week) but will emphasize topics covered after Exam III. Exams will be mostly in multiple choice format but may also include some short answer/discussion questions. Much of the exams will be in SCANTRON format

Grading
You may check the Gradebook on OAKS throughout the semester. If you see a discrepancy or error in your grades, please contact me as early as possible. The sooner you bring it to my attention, the easier it is to fix.

<table>
<thead>
<tr>
<th>Assessment</th>
<th>Weight (% of total grade)</th>
</tr>
</thead>
<tbody>
<tr>
<td>FYSS 101</td>
<td>10</td>
</tr>
<tr>
<td>Quizzes/Homework (lowest 3 scores dropped)</td>
<td>20</td>
</tr>
<tr>
<td>Exams (3) + final project</td>
<td>50</td>
</tr>
<tr>
<td>Cumulative Final</td>
<td>20</td>
</tr>
</tbody>
</table>

Letter grades are determined as follows:

\[
\begin{align*}
\geq 93\% & = A \\
90-92 & = A- \\
87-89 & = B+ \\
83-86 & = B \\
80-82 & = B- \\
77-79 & = C+ \\
73-76 & = C \\
70-72 & = C- \\
67-69 & = D+ \\
63-66 & = D \\
60-62 & = D- \\
\leq 59 & = F \\
0 & = XXF \\
\end{align*}
\]

**Expectations**

1. Please **NO FOOD and NO DRINK in the classroom** with the exception of water.

2. Students are expected to be respectful of your teacher and other students. Talking, texting and computer uses other than note-taking are prohibited. Research has shown that learning is negatively affected when students and those around them use phones/electronic devices during class. **Everyone deserves a learning-focused environment!**

3. **Electronic device policy:** We will be using PollEverywhere from time to time during lecture, but for the rest of the time I expect your phone to be on silent. If you forget to do so you **RISK BEING PERSONALLY REMINDED DURING CLASS** and you may be asked to leave and not to return that class period. During class, please do not record the lectures.

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**COURSE CALENDAR***
<table>
<thead>
<tr>
<th>Day/Date</th>
<th>Topic</th>
<th>Chapter (Readings)</th>
</tr>
</thead>
<tbody>
<tr>
<td>W 24-Aug</td>
<td>Welcome, Overview of Syllabus, Exploring Life</td>
<td>Chapter 1</td>
</tr>
<tr>
<td>F 26-Aug</td>
<td>Biology and the Chemical Context of Life</td>
<td>Chapter 2</td>
</tr>
<tr>
<td>M 29-Aug</td>
<td>Chemical Context of Life (Water, Carbon)</td>
<td>Chapter 2</td>
</tr>
<tr>
<td>M 29-Aug</td>
<td><em>Syllabus Quiz Due</em></td>
<td></td>
</tr>
<tr>
<td>W 31-Aug</td>
<td>Biological Macromolecules</td>
<td>Chapter 3 (3.1, 3.2)</td>
</tr>
<tr>
<td>F 2-Sep</td>
<td>Biological Macromolecules Quiz 1 Due</td>
<td>Chapter 3 (3.3)</td>
</tr>
<tr>
<td>M 5-Sep</td>
<td>Biological Macromolecules</td>
<td>Chapter 3 (3.4)</td>
</tr>
<tr>
<td>W 7-Sep</td>
<td>Biological Macromolecules</td>
<td>Chapter 3 (3.5)</td>
</tr>
<tr>
<td>F 9-Sep</td>
<td>Biomolecules Quiz 2 Due</td>
<td>Chapter 4 (4.3, 4.4)</td>
</tr>
<tr>
<td>M 12-Sep</td>
<td>Finish Biomolecules</td>
<td></td>
</tr>
<tr>
<td>W 14-Sep</td>
<td>Basics of Cells: Case Study</td>
<td>Chapter 4 (4.2, 4.5)</td>
</tr>
<tr>
<td>F 16-Sep</td>
<td>Cells Quiz 3 Due</td>
<td>Chapter 4</td>
</tr>
<tr>
<td>M 19-Sep</td>
<td>Cell Structure &amp; Cell-Cell Interactions</td>
<td>Chapter 4 (4.6)</td>
</tr>
<tr>
<td>W 21-Sep</td>
<td><strong>EXAM 1</strong></td>
<td>Chapters 1-4</td>
</tr>
<tr>
<td>F 23-Sep</td>
<td>Cell Membranes</td>
<td>Chapter 5 (5.1-5.2)</td>
</tr>
<tr>
<td>M 26-Sep</td>
<td>Cell Membranes</td>
<td>Chapter 5 (5.3-5.4)</td>
</tr>
<tr>
<td>W 28-Sep</td>
<td>Energy &amp; Metabolism</td>
<td>Chapter 6 (6.1 - 6.4)</td>
</tr>
<tr>
<td>F 30-Sep</td>
<td>Enzymes Quiz 4 Due</td>
<td>Chapter 7 (7.1-7.5)</td>
</tr>
<tr>
<td>M 3-Oct</td>
<td>Cellular Respiration</td>
<td>Chapter 7 (7.1-7.5)</td>
</tr>
<tr>
<td>W 5-Oct</td>
<td>Cellular Respiration</td>
<td>Chapter 6 (6.5)</td>
</tr>
<tr>
<td>F 7-Oct</td>
<td>Cellular Respiration Quiz 5 Due</td>
<td>Chapter 7</td>
</tr>
<tr>
<td>M 10-Oct</td>
<td>Photosynthesis</td>
<td>Chapter 8 (8.1-8.2)</td>
</tr>
<tr>
<td>Date</td>
<td>Day</td>
<td>Activity</td>
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<tr>
<td>12-Oct</td>
<td>W</td>
<td>Photosynthesis</td>
</tr>
<tr>
<td>14-Oct</td>
<td>F</td>
<td>Photosynthesis</td>
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<tr>
<td></td>
<td></td>
<td><strong>Quiz 6 Due</strong></td>
</tr>
<tr>
<td>17-Oct</td>
<td>M</td>
<td>Photosynthesis</td>
</tr>
<tr>
<td>19-Oct</td>
<td>W</td>
<td>Wrap up Cell Resp. &amp; Photosynthesis</td>
</tr>
<tr>
<td>21-Oct</td>
<td>F</td>
<td><strong>EXAM 2</strong></td>
</tr>
<tr>
<td>24-Oct</td>
<td>M</td>
<td>Cell Cycle</td>
</tr>
<tr>
<td>26-Oct</td>
<td>W</td>
<td>Cell Cycle &amp; Mitosis</td>
</tr>
<tr>
<td>28-Oct</td>
<td>F</td>
<td>Cancer &amp; Mitosis</td>
</tr>
<tr>
<td>31-Oct</td>
<td>M</td>
<td>Meiosis</td>
</tr>
<tr>
<td>2-Nov</td>
<td>W</td>
<td>Mendelian Genetics</td>
</tr>
<tr>
<td>4-Nov</td>
<td>F</td>
<td>Inheritance</td>
</tr>
<tr>
<td></td>
<td></td>
<td><strong>Quiz 8 Due</strong></td>
</tr>
<tr>
<td>7-Nov</td>
<td>M-T</td>
<td>FALL BREAK</td>
</tr>
<tr>
<td>9-Nov</td>
<td>W</td>
<td>Modern Inheritance</td>
</tr>
<tr>
<td>11-Nov</td>
<td>F</td>
<td>Chromosomes &amp; Inheritance</td>
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<tr>
<td></td>
<td></td>
<td><strong>Quiz 9 Due</strong></td>
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<tr>
<td>14-Nov</td>
<td>M</td>
<td>Inheritance Activity</td>
</tr>
<tr>
<td>16-Nov</td>
<td>W</td>
<td><strong>EXAM 3</strong></td>
</tr>
<tr>
<td>18-Nov</td>
<td>F</td>
<td>DNA Structure &amp; Function</td>
</tr>
<tr>
<td>21-Nov</td>
<td>M</td>
<td>Case Study - DNA &amp; Heredity</td>
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<tr>
<td>23-Nov</td>
<td>W-Sun</td>
<td>THANKSGIVING BREAK</td>
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<tr>
<td>Date</td>
<td>Day</td>
<td>Event</td>
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<tr>
<td>28-NoV</td>
<td>M</td>
<td>Genes &amp; Proteins - Quiz 10 Due</td>
</tr>
<tr>
<td>30-NoV</td>
<td>W</td>
<td>Translation</td>
</tr>
<tr>
<td>2-Dec</td>
<td>F</td>
<td>Translation &amp; Processing</td>
</tr>
<tr>
<td>5-Dec</td>
<td>M</td>
<td>Viruses (last day of class)</td>
</tr>
<tr>
<td>7-Dec</td>
<td>W</td>
<td>FINAL CUMULATIVE EXAM** (See assigned time on final exam schedule)</td>
</tr>
</tbody>
</table>

*Exam dates are firm. However, topics covered on certain days are subject to change.

** Please note: as stated in the Undergraduate Catalog:
http://catalog.cofc.edu/content.php?catoid=14&navoid=671#final-examinations

“Examinations must be taken at the time scheduled (https://registrar.cofc.edu/pdf/exam-schedule-fall2020.pdf), except when:
1. Two or more exams are scheduled simultaneously.
2. Legitimate AND documentable extenuating circumstances prevent the student from completing the examination at the scheduled time (e.g., burial services for an immediate family member).”

**Learning Goals and Objectives**

Learning Goals & Objectives for Biology 111 and 111L Introduction to Cell and Molecular Biology/ BIOL 112 & 112L Evolution, Form, and Function of Organisms

Department: Biology

This general education science sequence provides a background for understanding and evaluating contemporary topics in biology. Students develop a foundational understanding of core concepts to use and on which to expand in upper level courses. They also develop the critical competencies that form the bases for the practice of science and use of scientific knowledge.

**Core Concepts**

This 2-semester course sequence in general biology addresses fundamental principles in biology to prepare students for sophomore and upper level courses in biology:

- **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, AND 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 AND 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.

The specific topics covered in each course include:

Biology 111 & Biology 111L
- Chemical and physical properties of life
- Cell form & function
- Energetics, metabolism, and photosynthesis
- The cell cycle
  - Mitosis and cell reproduction
  - Meiosis and sexual reproduction
- Mendelian genetics / Patterns of inheritance
- Human Inheritance
- The molecular basis of inheritance
- DNA and protein production
- Regulation of gene expression
- Some aspects of biotechnology

Biology 112 & Biol 112 L
- The development of evolutionary thinking
- Basic evolutionary processes
- Comparative plant form & function
- Comparative animal form & function

Core Competencies

- Nature of Scientific Knowledge
  - Understand the intellectual standards used by scientists to establish the validity of knowledge, evidence, and decisions about hypothesis & theory acceptance. These standards include: 1) science relies on external and naturalistic observations, and not internal convictions; 2) scientific knowledge is based on the testing of hypotheses and theories, which are under constant scrutiny and subject to revision based on new observations; 3) the validity of scientifically generated knowledge is established by the community of scientists through peer review and open publication of work.
o Understand that new ideas in science are limited by the context in which they are conceived; are often rejected by the scientific establishment; sometimes spring from unexpected findings; and usually grow slowly, through contributions from many investigators.
o Understand that science operates in a world defined by the laws of chemistry and physics.
o Understand the differences and relationships among scientific theories, hypotheses, facts, laws, & opinions.
o Understand the differences between science and technology, but also their interrelations.
o Understand the dynamic (tentative) nature of science.

- **Scientific Methods of Discovery**
  o [1] Understand the methods scientists use to learn about the natural world (observing; questioning; formulating testable deductive hypotheses; controlled experimentation when possible; observing a wide range of natural occurrences and discerning (inducing) patterns).
o Apply physical/natural principles to analyze and solve problems.

- **Develop a Scientific Attitude**
o Develop habits of mind that foster interdisciplinary and integrative thinking (within biology; between biology and other sciences; between science and other disciplines).
o Develop an appreciation for the scientific attitude - a basic curiosity about nature and how it works.

- **Develop scientific analysis and communication skills**
o Develop quantitative reasoning skills (quantitatively expressing the results of scientific investigations, or patterns in nature and using knowledge of biological concepts to explain quantitatively-expressed data or patterns).
o Understand the probabilistic nature of science and the use/application of inferential statistics to test hypotheses.
o Develop scientific information literacy (library, internet, databases etc…); find and evaluate the validity of science-related information.
o Communicate scientific knowledge, arguments, and ideas in a variety of different contexts (scientific, social, cultural), utilizing a variety of different media (scientific articles, policy statements, editorials, oral presentations etc.).
o Develop cooperative problem-solving skills (working effectively in teams), but also habits of mind and skills that foster autonomous learning.

- **Develop an appreciation for the impact of science on society.**
o Develop an appreciation of humans as a part of the biosphere and the impact of biological science on contemporary societal/environmental concerns.
o Knowledge of the history of the biological sciences and the influences of politics, culture, religion, race, and gender on the scientific endeavor.

**Signature assignments for measuring learning outcomes**

**Learning Outcome 1: Students apply physical/natural principles to analyze and solve problems.**

This learning outcome is assessed using the poster (or scientific article) generated in Biology 112 lab as part of the multi-week student-directed independent research project. In this project students use data they collect (or has been collected in actual research investigations) to test an hypothesis of their choosing. These projects may be themed, with all student groups addressing different aspects of a larger question, emphasizing the interdependence of various research groups needed to address complicated problems. This multi-week project begins the class identifying what questions need to be addresses in the larger problem. Individual student groups then become experts in these areas
of the larger problem. The smaller research teams develop a hypothesis, and write a research proposal to test their hypothesis. Students collect (or use already collected data), summarize and statistically analyze the data, and draw conclusions.

**Learning Outcome #2** - Students demonstrate an understanding of the impact that science has on society.

**Biology 112 lab** Students produce a written document based on one of the case-based labs (examples - policy statement, article, stake-holder professional letter or poster) that requires them to research and apply biological knowledge or evidence to defend or critique a proposed solution to a biology-related societal issue. Although the choice of the specific issue or proposed solution is course-section specific, some examples of potential issues include

- exploring environmental/health impacts of genetically modified organisms
- the use of performance enhancing drugs in sports
- the development of antibiotic resistance in disease organisms

[1] This learning goal will be measured as part of the general education assessment. The specific learning outcome to be measured is: *Students can apply physical/natural principles to analyze and solve problems.*

[2] This learning goal will be measured as part of the general education assessment. The specific learning outcome to be measured is: *Students can demonstrate an understanding of the impact that science has on society.*