



## **Course Syllabus**

General Biology | Summer 2021

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**Objective:** To gain an understanding of biological concepts and their theoretical and practical applications, and to learn relevant laboratory techniques with biological specimens, equipment, and reagents.

**Prerequisites:** No prior knowledge of chemistry, biology, or physics is expected in this course.

### **Instructor Contact Information:**

Peter Le

[peter.le@fremontstem.com](mailto:peter.le@fremontstem.com)

### **Website:**

All course materials (waiver, syllabi, etc.) will be posted on the course website under "General Biology." Links for Dropbox (files) will also be accessible through the website. The website will be accessible throughout the school year for summer students.

### **Class Times:**

Lecture: Tuesday/Thursday 6:30 PM - 8:00 PM

Lab: Wednesday 6:30 PM - 8:00 PM

### **Required Materials:**

- Computer with Google Meet capability
- Notebook for taking notes
- Pencils, erasers, etc.
- Closed-toed shoes (for labs)
- Hair ties (for long hair on lab days)

### **Program Cost:** \$475 total

Note: the full program cost is due on the first day of lecture, either in person (cash/check) or via Paypal online. If the student for some reason must miss the first day, the fees must be paid by the first attended lecture. The program fee is non-refundable unless unexpected and severe circumstances arise.

**Books and Course Material:** All required materials for the course not listed above will be provided to the student on the first day of class. These include:

- A course reader that will serve as the textbook for the course. Purchase of the textbooks listed below is NOT necessary for successful participation in the summer STEM class. (~100 pgs)



It is the student's responsibility to come to class prepared. Students should bring all booklets to class every day because material covered in lecture is inextricably tied to the week's laboratory experiments and vice versa.

**Homework:** Homework that is assigned is entirely **optional**. Answer keys will be available online the day the homework assignment is due. For help on practice problems, feel free to email me.

**Quizzes:** In order to keep everyone up to speed on the material being covered, online quizzes will be assigned after each lesson. These are short (15 minutes) quizzes and will cover the most recent lecture's material. Please feel free to use any course materials, including the reader, lecture notes, or lab manual, to complete the quiz. Quizzes are accessible on the course website.

Lab quizzes must be completed BEFORE participation in the laboratory session. These are short, 5-question quizzes scored for points that seek to make sure the student is aware of the day's lab experiment as well as the associated procedure and any safety precautions. Students who fail to complete the pre-lab quiz will be asked to take the quiz before beginning the day's experiment. This is to make sure everyone is on the same page with regard to lab safety.

#### **Textbooks:**

Note: Purchase of a textbook is NOT required for participation in the course. All necessary materials will be provided in the coursework folders handed out on the first day of class.

##### *Primary text:*

Njoo, E. *Molecules to Ecosystems: CP Biology Reader*. Edumax, Inc., 2016.

Reece, Jane B. and Ury, Lisa A. *Campbell Biology*, 9<sup>th</sup> edition. Pearson Higher Education Publishing, 2010.

##### *Supplementary text:*

Raven, Peter; Johnson, George; Mason, Kenneth A; Losos, Jonathan; and Singer, Susan. *Biology*, 10<sup>th</sup> edition. McGraw Hill Education, 2013.

**Lab safety:** Safety is of first priority. All students and parents are expected to have read and understand the Lab Safety and Liability waiver. This form is sent out in the registration email and must be turned in before the first day of lab. Inappropriate lab behavior that puts the student or other students in potentially dangerous situations may result in the instructor asking the student to sit out during lab and the student forfeiting participation in that day's experiment.

**Notes:** Please bring a notebook and pencil to take notes. This is not graded or collected, but it is a good habit to always take notes in any class for future reference, studying, or staying awake during lecture.

**Midterm and Final Exam:** All students are encouraged to take the final exam, which will be assigned on the second to last day of class to be taken in a 90 minute timeframe. No cheating or extra time is permitted, on the honor system. The corrected tests with feedback will be returned



during the following lecture, where we will discuss any questions as a class. The purpose of the final exam is to make sure the information taught is being retained and to quantitatively assess the students' progress in their understanding of biology-related concepts. A midterm will also be administered halfway through the course to gauge students' progress and to maintain accountability for learning the material well.

**Grading:** The purpose of assigning numerical grades for assignments and quizzes is not to create additional academic pressure, but for motivation and accountability, and to keep everyone on track in terms of ensuring that the learning outcomes are being met. Grades will be made available by email, intermittently and upon request by student and parents. Since the course covers a year's worth of material over several weeks over the summer, everything will be graded on a curve.

**Tentative Nature of the Syllabus:** The contents of this syllabus and attached schedule are tentative in nature and may be subject to change or revision. The instructor holds the right to make changes to the schedule and/or organization of the class as necessary. Students and parents will be identified of any changes via email.

**Special Accommodations:** If your student requires special accommodations, please notify the instructor as soon as possible.

**Tentative Schedule** *Assignments are noted in italics.*

Date	Lesson	Topic
Week 1	Lab 1	Virtual Microscopy Demonstration & Introduction to Bio Lab
Week 1	Lecture 1	Introduction to Biology; Cell Structure and Function <i>Quiz #1, Worksheet A</i>
Week 1	Lecture 2	Biological Macromolecules <i>Quiz #2, Worksheet A</i>
Week 2	Lecture 3	Metabolism and Cellular Respiration <i>Quiz #3, Worksheet B</i>
Week 2	Lab 2	<i>Gel Electrophoresis Virtual Lab</i>
Week 2	Lecture 4	Photosynthesis <i>Quiz #4, Worksheet B</i>
Week 3	Lab 3	<i>Transgenic Fly Virtual Lab</i>
Week 3	Lecture 5	Mitosis, DNA Replication, and the Cell Cycle <i>Quiz #5, Worksheet C</i>
Week 3	Lecture 6	The Central Dogma: Transcription, Translation, Gene Expression <i>Quiz #6, Worksheet C</i>
Week 4	Lab 4	<i>Extraction of DNA/DNA Extraction Virtual Lab</i>
Week 4	Lecture 7	Mendelian Genetics and Meiosis <i>Review Midterm, Quiz #7, Worksheet D</i>
Week 4	Lecture 8	Evolution and Taxonomy <i>Quiz #8, Worksheet D, <b>Scientific Writing Assignment</b></i>
Week 5	Lab 5	Milk Protein Purification/ <i>Lizard Evolution Virtual Lab</i>
Week 5	Lecture 9	Ecology <i>Quiz #9, Worksheet E</i>
Week 5	Lecture 10	Plant Physiology Biology <i>Quiz #10, Worksheet E</i>
Week 6	Lab 6	<i>Microbiology &amp; Bacterial Culture Gram Staining/Bacterial Identification Virtual Lab</i>
Week 6	Lecture 11	Gram Staining Bacteria Cultures
Week 6	Lecture 12	Final Exam

*\*Note: Lecture and lab days are subject to change if unexpected circumstances arise.*

*\*In-person labs will be subject to virtual labs, pending health official policy regarding the shelter in place.*

## Learning Outcomes:

- Students will classify biologically relevant macromolecules and understand fundamental differences between lipid, carbohydrate, polypeptide, and nucleic acid molecules, as well as their properties, functions, and general reactivity.
- Students will understand basic organic chemistry nomenclature and the way that organic chemistry informs understanding of biochemistry.
- Students will appreciate the importance of chirality in biological molecules and will be able to identify stereocenters of carbon in the three-dimensional structure of biomolecules.
- Students will understand the basic principles of microscopy and how various types of microscopy including light microscopy, scanning electron microscopy, transmission electron microscopy, and atomic force microscopy can have practical applications in visualizing biological material.
- Students will gain an appreciation for the diversity of biomolecules and how they are manifested in various examples.
- Students will gain hands-on experience with modern applications of centrifugation and how it can be applied in fractionation of bio-solutions and of cells.
- Students will gain hands-on experience on various stains available for cell staining including malachite green, gram's iodine, crystal violet, safranin, and methylene blue.
- Students will understand the differences between eukaryotic and prokaryotic cells and will be able to describe their anatomical and physiological components.
- Students will understand mechanisms of cell signaling and communication including G-protein coupled receptors (GPCRs), receptor tyrosine kinases (RTK), toll-like receptors (TLR), voltage-gated ion channels, etc.
- Students will understand the importance of secondary messengers including NO, cAMP, and calcium in activating cellular signal transduction pathways.
- Students will be able to calculate differences in osmolarity and its importance in osmosis in cells and diffusion.
- Students will understand the general mechanisms of metabolic pathways involved in cellular respiration in both oxidative and anaerobic pathways, including glycolysis, the Krebs cycle, electron transport chain, lactic acid fermentation and alcohol fermentation.
- Students will understand the general mechanisms of metabolic pathways involved in photosynthesis, including the light-dependent reactions, the Calvin cycle, and gluconeogenesis.
- Students will gain an understanding of the importance and centrality of the Fundamental Dogma of Molecular Biology (DNA → mRNA → protein) and how transcription and translation are carried out in eukaryotic cells.
- Students will understand the importance of post-transcriptional mRNA modification and post-translational protein modification as important centers of genetic control in eukaryotic cells.
- Students will gain a detailed view of the *Lac* and *Trp* operons and how these are model systems for prokaryotic gene expression.
- Students will appreciate modern applications of biotechnology including PCR (polymerase chain reaction), gel electrophoresis, ELISA, etc.
- Students will gain understanding of how to use the Hardy-Weinberg Theorem and related equations to calculate population microevolution genetic shifts over time.
- Students will be familiarized with modern taxonomy, creation of cladograms, and determination of evolutionary relationships between organisms based on biochemistry, genetics, and traits.
- Students will understand Darwin's theory of evolution by natural selection and descent with modification, and its supporting evidences as well as its weaknesses in light of modern biochemistry and ecological biology.
- Students will gain a deeper knowledge of principles of classical (Mendelian) and modern molecular genetics and be able to apply these to solve genetic problems.
- Students will study the process of cell division at the cellular and molecular level, including the various events of the stages of mitosis and of meiosis.
- Students will be able to demonstrate the events that occur along various stages of the Cell Cycle.

- Students will understand the process of bacterial transformation, including modern techniques including selectable markers, electroporation, bacteriophage vectors, etc.
- Students will understand principles of competition and ecological carrying capacity, symbiosis, and bioenergetics as it relates to the interrelationships between various trophic levels in food webs and food chains.
- Students will gain a basic introduction to microbiology, virology, and bacteriology, and will have the opportunity to perform a Gram stain analysis.
- Students will understand the differences between R- and k-strategists, type I, type II, and type III survivorship curves.
- Students will gain a basic understanding of plant anatomy and physiology, taxonomy of major classifications of plants, and major functions of plant hormones.
- Students will understand the biochemistry of nerve cells, including electrochemical potential gradients, action potentials, neuromuscular junctions, system processing, and neurotransmitters.
- Students will understand cell signaling as it relates to the function of the immune system at both innate and adaptive levels. Students will understand the importance of cytokines and interleukins in the inflammatory response and in the immune system's humoral and cell-mediated specific responses to infection.
- Students will gain appreciation for the interrelationships between various organ systems of the human body and how structure and function are intricately related at the molecular to the organismal level.