Course #650: ECE Principles of Biology I

UConn Course: BIOL 1107

Didactic Syllabus

UConn Credits: 4
Format: On-campus, 70-minute periods as part of the Holy Cross High School block schedule
Prerequisites: Biology Honors, Chemistry Honors; minimum of 92% average in Neuroscience Honors and the recommendation of that teacher; and consent of the current ECE Biology instructor and Science Department Chairperson
Co-requisite: Anatomy & Physiology Honors
HCHS LMS: https://holycross.instructure.com/

Professor: Chris Ciarleglio, Ph.D.
Email: cciarleglio@holycrosshs-ct.com
Phone: (203) 757-9248 x342
Office Hours: Community Period TBD

Course Description

Biology is the critical study of living things. It is the foundation for all of the disciplines that study life in more detail, including medicine, physiology, anatomy, biomechanics, bioengineering, neuroscience, *etc*. An understanding of the basic principles of biology is an invaluable part of any student's repertoire. This course is an undergraduate introduction to biology, allowing students the opportunity to earn 4 credits from the University of Connecticut. The course of study begins with a basic, working definition of life and moves through the study of molecules, cells, and genetics. Many of the classes offer an inquiry-based approach where students are challenged to think critically about why a problem exists and how to solve it. Throughout the course, students write. And they write. Completion of this course will provide students with a comprehensive and solid foundation for further study in biology which they can use to pursue more advanced subspecialties. Perhaps, through this study of other forms of life, students will gain a greater understanding of their own. This course aligns with the ***Portrait of the Crusader*** in that students employ biological research methods, including ethical considerations, as they use the scientific method, evaluate claims and evidence, and effectively communicate ideas.

Course Essential Questions

- How are form and function related in biological systems?
- How does the process of evolution drive the unity and diversity of life?
- How do biological systems utilize energy and molecular building blocks to grow, reproduce, and maintain homeostasis?

- How do living systems store, retrieve, transmit, and respond to information essential to life processes?
- How do biological systems interact? What complex properties do systems and their interactions have?

Curriculum Framework

Unit 0: Introduction to Science and Communication (3 weeks)

Focus Questions:

- How do scientists communicate?
- What are primary, secondary, tertiary, and quaternary literature?
- What are the parts of a scientific manuscript?
- How do you efficiently read scientific papers?
- What is the process of science?
- How are data analyzed using statistical methods?

Concepts/Skills:

- Distinguish between scientific papers, posters, oral presentations, and grants.
- Read scientific papers quickly and efficiently based on specific strategies.
- Correctly graph data using the appropriate presentation type.
- Understand and present error in the proper context.
- Select the appropriate statistical test for the data being analyzed.
- Use PSPP (or other statistical software like SPSS, STATA, R) to analyze data.
- Author a real-world manuscript using data collected in the lab.

Laboratory:

- Introduction to lab science and safety
- Diffusion & Osmosis lab

Assessments:

- Team presentation results from select papers

Unit 1: Introduction to Biology (1 week)

Urry *et al.* (2020). *Campbell Biology in Focus: AP 3rd Edition*. Chapter 1.

Focus Questions:

- What is Life?
- What prefixes and suffixes are used across biological concepts?
- What are the levels of organization in our reality?
- What is a systems approach to understanding the world?
- What is energy, and how does it flow through systems?

Concepts/Skills:

- Recognize common prefixes and suffixes and use to help determine word meaning.
- Explain the concept of systems approach.
- Define energy and analyze how energy flows through specific systems.
- Identify a question about reality and how to properly structure an investigational question.

Laboratory:

- Discussion on Biology in Pop Culture

Summative Assessments:

- Summative quizzes
- Unit 1 Test (in-class on Canvas) w/ FRQ

Unit 2: The Chemistry of Life (4 weeks)

Urry *et al.* (2020). *Campbell Biology in Focus: AP 3rd Edition*. Chapters 2-3.

Focus Questions:

- How is water used for biological systems?
- How does polarity affect how water is used for living organisms?
- What are the four types of macromolecules?
- What are the monomers that make up the four types of macromolecules?
- What polymers make up the four types of macromolecules?
- How does the structure of the macromolecule affect its function for the organism?

Concepts/Skills:

- Determine how the properties of water resulting from polarity and hydrogen bonding affect its biological function.
- Describe the composition of macromolecules required by living organisms.
- Describe the properties of the monomers and the type of bonds that connect the monomers in biological macromolecules.
- Analyze how a change in the subunits of a polymer may lead to changes in the structure or function of the macromolecule.
- Distinguish how proteins function at four levels of organization/structure.
- Analyze the functional similarities and differences between DNA and RNA.

Laboratory:

- Data & Analyses (D&O)
- The Cracker Torture Test

Assessments:

- Summative quizzes
- Unit 2 Test (in-class on Canvas) w/ FRQ

Unit 3: Cell Structure and Function (3 weeks)

Urry *et al.* (2020). *Campbell Biology in Focus: AP 3rd Edition*. Chapters 4-5.

Focus Questions:

- How is a eukaryotic cell different from a prokaryotic cell?
- What organelles are found in eukaryotic cells? Prokaryotic cells?
- How do plasma membranes transport substances into and out of the cell?
- How does the concentration of water affect the size of the cell?
- What is the difference between positive and negative feedback?
- How do cells communicate with each other?
- What are the different parts of a signal transduction pathway?

Concepts/Skills:

- Describe the structure and function of subcellular components and organelles.
- Describe/model the structural features of a cell that allow organisms to capture, store, and use energy.
- Determine the effect of surface area-to-volume ratios on the exchange of material between cells or organisms and the environment.
- Explain how specialized structures are used for the efficient exchange of molecules to the environment.
- Define the role of each component of the cell membrane in maintaining the cell's internal environment.
- Describe the Fluid Mosaic Model of cell membranes.
- Explain how the structure of biological membranes influences selective permeability.
- Describe the role of the cell wall in maintaining structure and function.
- Describe the mechanisms that organisms use to maintain solute and water balance and transport large molecules across the plasma membrane.
- Explain how the structure of a molecule affects its ability to pass through the plasma membrane.
- Explain how concentration gradients affect the movement of molecules across membranes.
- Explain how osmoregulatory mechanisms contribute to the health and survival of organisms.
- Describe the processes that allow ions and other molecules to move across membranes.
- Describe the membrane-bound structures of the eukaryotic cell.
- Explain how internal membranes and membrane-bound organelles contribute to the compartmentalization of eukaryotic cell functions.
- Describe the similarities/differences in compartmentalization between prokaryotic and eukaryotic cells.
- Describe the relationship between the functions of endosymbiotic organelles and their free-living ancestral counterparts.
- Explain the ways that cells can communicate with one another, including over short and long distances.
- Describe the components of a signal transduction pathway and the role of components of a signal transduction pathway in producing a cellular response.
- Describe the role of the environment in eliciting a cellular response.
- Describe the different types of cellular responses elicited by a signal transduction pathway.
- Explain how change in the structure of a signaling molecule affects the activity of the signaling pathway.
- Describe positive and negative feedback mechanisms and how each affects homeostasis.

Laboratory:

- Cell Size Matters Lab
- Elevator Demonstration
- The Pleasant [and unpleasant] Diffusion of Odorants

Assessments:

- Lab Report: Diffusion & Osmosis
- Summative quizzes
- Unit 3 Test (in-class on Canvas) w/ FRQ

Unit 4: Cellular Energetics (3 weeks)

Urry *et al.* (2020). *Campbell Biology in Focus: AP 3rd Edition*. Chapters 6-8.

Focus Questions:

- How do enzymes support cellular activities?
- What are the processes that occur in cellular respiration?
- What are the processes that occur in photosynthesis?
- What role does ATP play in cellular processes?
- How much energy is created in cellular processes?

Concepts/Skills:

- Explain the properties of enzymes and how enzymes affect the rate of biological reactions.
- Analyze how changes to the structure of an enzyme may affect its function.
- Explain how the cellular environment affects enzyme activity.
- Describe the role of energy in living organisms.
- Describe the photosynthetic processes that allow organisms to capture and store energy.
- Determine how cells capture energy from light and transfer it to biological molecules for storage and use.
- Describe the processes that allow organisms to use energy stored in biological macromolecules.
- Explain how cells obtain energy from biological macromolecules to power cellular functions.
- Analyze the connection between variation in the number and types of molecules within cells to the ability of the organism to survive and/or reproduce in different environments.

Laboratory:

- Enzyme Activity Lab
- **Optional** Photosynthesis Lab
- **Optional** Cellular Respiration Lab

Assessments:

- Summative quizzes
- Unit 4 Test (in-class on Canvas) w/ FRQ

Unit 5: Cell Cycle (1 week)

Urry *et al.* (2020). *Campbell Biology in Focus: AP 3rd Edition*. Chapter 9.

Focus Questions:

- What are the different parts of a mitotic cell cycle?
- How do the checkpoints in the cell cycle help regulate it?

Concepts/Skills:

- Describe/model the events that occur in the cell cycle.
- Explain how mitosis results in the transmission of chromosomes from one generation to the next.
- Describe the role of checkpoints in regulating the cell cycle.
- Describe the effects of disruptions to the cell cycle on the cell or organism.

Laboratory:

- Mitosis & Meiosis Lab

Summative Assessments:

- Mitosis Quiz
- Unit 5 Test (in-class on Canvas) w/ FRQ

Unit 6: Genetics (3 weeks)

Urry *et al.* (2020). *Campbell Biology in Focus: AP 3rd Edition*. Chapters 10-13.

Focus Questions:

- How do mitosis and meiosis differ from each other?
- How does meiosis affect genetic diversity?
- How can meiosis malfunction and what are the chromosomal causes and symptoms of the resulting syndromes?
- Why are some diseases and conditions much more common in males than females?
- What are sex-linked genes? How is their pattern of inheritance different from genes on autosomes?

Concepts/Skills:

- Explain how meiosis results in the transmission of chromosomes from one generation to the next.
- Compare/contrast the phases and outcome of mitosis and meiosis.
- Analyze how the process of meiosis generates genetic diversity.
- Examine how shared, conserved, fundamental processes and features support the concept of common ancestry for all organisms.
- Explain the inheritance of genes and traits as described by Mendel's laws.
- Explain deviations from Mendel's model of the inheritance of traits.
- Analyze how the same genotype can result in multiple phenotypes under different environmental conditions.
- Determine how chromosomal inheritance generates genetic variation in sexual reproduction.

Laboratory:

- Pedigree Lab
- Genetic Counseling

Summative Assessments:

- Summative quizzes
- Unit 6 Test (in-class on Canvas) w/ FRQ

Unit 7: Gene Expression and Regulation (5 weeks)

Urry *et al.* (2020). *Campbell Biology in Focus: AP 3rd Edition*. Chapters 14-18 (-17).

Focus Questions:

- Why is DNA so important?
- Why was protein, at one point in the history of science, considered to be a stronger candidate than DNA for being the genetic material?
- What is transformation? How did it contribute to our discovering the significance of DNA?
- What is the one-gene, one-enzyme hypothesis, how was it confirmed, and why is it regarded as a bit of an oversimplification?
- What is the difference between transcription and translation?
- When do mutations cause genetic disease?
- How can two cells with the same DNA express completely different proteins?
- How does the control of gene expression in eukaryotes compare to control of gene expression in prokaryotes?
- How do cells specify and then differentiate in development?
- What is genomics?

Concepts/Skills:

- Define the structures involved in passing hereditary information from one generation to the next.
- Describe the characteristics of DNA that allow it to be used as the hereditary material.
- Describe the mechanisms by which genetic information is copied for transmission between generations and flows from DNA to RNA to protein.
- Explain how the phenotype of an organism is determined by its genotype.
- Analyze the types of interactions that regulate gene expression.
- Determine how the location of regulatory sequences relates to their function.
- Explain how the binding of transcription factors to promoter regions affects gene expression and/or the phenotype of the organism.
- Explain the connection between the regulation of gene expression and phenotypic differences in cells and organisms.
- Distinguish the various types of mutation.
- Explain how changes in genotype may result in changes in phenotype.
- Explain how alterations in DNA sequences contribute to variation subject to natural selection.

- Analyze/evaluate the use of genetic engineering techniques in analyzing or manipulating DNA.

Laboratory:
- Transformation Lab
- Gel Electrophoresis Lab
- Transcription and Translation Lab

Summative Assessments:
- Summative quizzes
- Unit 7 Test (in-class on Canvas) w/ FRQ

Final Exam

Required Materials

- Urry *et al*. (2020). *Campbell Biology in Focus: AP 3rd Edition*. Pearson.
- Ciarleglio, CM (2023). *ECE Principles of Biology: Master Lecture Handout*. SynapticPub, LLC. Waterbury, CT.
- Ciarleglio, CM (Ed.) (2023). *BioPrimer Laboratory Notebook*. SynapticPub, LLC. Waterbury, CT.
- Ashcroft and Pereira (2003). *Practical Statistics for the Biological Sciences*. Palgrave MacMillan, New York, NY. ISBN-10: 0333960440; ISBN-13: 978-0333960448.
- Brown, Dan (2014). *Inferno*. Anchor Publishing. ISBN-10: 1400079152; ISBN-13: 978-1400079155.
- Pechenick (2015). *A Short Guide to Writing about Biology*, 9th Ed. Pearson. ISBN-10: 0321984250; ISBN-13: 978-0321984258.
- Strunk and White (1999). *The Elements of Style*, 4th Edition. Pearson. ISBN-10: 020530902X, ISBN-13: 978-0205309023.
- Taylor (2013). *Study Guide for Campbell Biology in Focus*. Pearson. ISBN-10: 0321864999; ISBN-13: 978-0321864994.

Grading and Late Work

Students must successfully complete (or contribute to, where appropriate) all assignments and exams. Class participation is essential—student participation keeps it interesting. Lab assignments are due by the next lab following the completion of that lab's activities, or the next same-letter day of the following cycle—whichever comes first.

Grading Policy
- Tests: 30%
- Labs: 30%
- HW/Classwork/Effort: 20%
- Final Exam: 20%

Late Policy (Science Department)

For students who are absent, the make-up policy is within 2 days from the return to school; the student must communicate with their science teacher regarding missed work. The student must make up the assigned work ASAP but no later than 2 (14 days) weeks from the date of the communication. On day 15 from that original communication with the teacher, work submitted will be shifted to missed work policy: students who are present for assigned work and for whatever reason choose not to submit, the grading policy is 75% for 1 day late, 50% for days 2-14 late, and zero for anytime thereafter