Course Title:	Content Area:	Grade Level:	Credit (if applicable)
ECE Biology - UConn 1107	Biology	11-12	4

Course Description:

UCONN Biology is designed to provide a foundation for more advanced courses in Biology and related sciences. This course will acquaint students with scientific thought, observation, experimentation, and formal hypothesis testing, and enable students to consider the impact that developments in science and technology have on the nature and quality of life. Topics covered include molecular and cell biology, animal anatomy and physiology. Lab exercises include dissection of preserved animals.

Upon completion of this course, the student should be able to:

1. Examine the underlying principle that structure leads to function in living systems and how our understanding of this physiology can enable human beings to more efficiently address modern societal issues.
2. Describe current methods used in biotechnology, such as Gel Electrophoresis, and how it would be used to gain scientific or technical knowledge.
3. Explain the conceptual basis of the Scientific Method, including its definition, motivation, steps of application, hypothesis testing, and misapplications.
4. Analyze published articles from scientific journals to discern integrity of scientific claims

UConn Early College Experience (UConn ECE) provides students with the opportunity to take university courses while in high school. These challenging courses allow students to preview college work, build confidence in their readiness for college, and earn college credits that provide both an academic and a financial head start on a college degree and other post-secondary opportunities. UConn ECE Instructors are high school teachers certified by the University and affiliated with their corresponding academic department. UConn ECE Instructors foster independent learning, creativity, and critical thinking - all important for success in college and careers. Bristol Public Schools offers UConn courses in many disciplines. To support rigorous learning, University of Connecticut academic resources, including library and online classroom access, are available to all UConn ECE Students.

Adapted from: https://biosci.clas.uconn.edu/courses/course/BIOL/1107/ and https://ece.media.uconn.edu/wp-content/uploads/sites/2571/2020/02/BIOL-Spring-2019-Syllabus-1107_Final.pdf

Aligned Core Resources:	Connection to the ***BPS Vision of the Graduate***
• Campbell Biology in Focus (Urry, Cain, et al) (Pearson 2025) • UConn, Storrs publishes its own laboratory manuals for Biology 1107	The ECE program will provide students with a pathway to meet the Bristol Public School's vision of the graduate through advanced learning opportunities such as: • Problem solving • Critical thinking • Effective Communication The Science Practice Standards support the VOG Skills: • Science Practice 1: Effective Communication • Science Practice 2: Critical Thinking • Science Practice 3: Problem Solving • Science Practice 4: Effective Communication • Science Practice 5: Critical Thinking • Science Practice 6: Effective Communication

Additional Course Information: Knowledge/Skill Dependent courses/prerequisites	Link to ***Completed Equity Audit***
PREREQUISITES • Precalculus ACC taken concurrently or permission of instructor • Biology ACC - Minimum final grade of 83 or Biology ACA - Minimum final grade of 93 • Biology ACC may be taken concurrently for grade 10 students with instructor permission if a final average of 83 was earned in Physical Science ACC.	Equity Curriculum Review Audit - ECE/AP Bio (2025)

Standard Matrix				
Standard	Unit 1	Unit 2	Unit 3	Unit 4
Science Practice 1: Explain biological concepts, processes, and models presented in written format.	✓	✓	✓	✓
Science Practice 2: Analyze visual representations of biological concepts and processes.		✓	✓	✓
Science Practice 3: Determine scientific questions and methods.	✓			
Science Practice 4: Represent and describe data	✓	✓	✓	✓
Science Practice 5: Perform statistical tests and mathematical calculations to analyze and interpret data.	✓		✓	
Science Practice 6: Develop and justify scientific arguments using evidence.		✓	✓	✓
Big Idea 1: Evolution (EVO) The process of evolution drives the diversity and unity of life.				✓
Big Idea 2: Energetics (ENE) Biological systems use energy and molecular building blocks to grow, reproduce, and maintain dynamic homeostasis		✓		
Big Idea 3: Information Storage and Transmission (IST) Living systems store, retrieve, transmit, and respond to information essential to life processes.		✓	✓	
Big Idea 4: Systems Interactions (SYI) Biological systems interact, and these systems and their interactions exhibit complex properties	✓	✓	✓	✓

Unit Links

Unit 1: Cell Biology and Biochemistry
Unit 2: Genetics and Molecular Biology
Unit 3: Animal Physiology and Homeostasis
Unit 4: Evolution

<table>
<tr><th colspan="2">Unit Title:</th></tr>
<tr><td colspan="2">Unit 1: Cell Biology and Biochemistry</td></tr>
<tr><th colspan="2">Relevant Standards:</th></tr>
<tr><td colspan="2">Big Idea 1: Evolution (EVO)
The process of evolution drives the diversity and unity of life.
Science Practice 1:
Explain biological concepts, processes, and models presented in written format.
Science Practice 3:
Determine scientific questions and methods.
Science Practice 4:
Represent and describe data
Science Practice 5:
Perform statistical tests and mathematical calculations to analyze and interpret data.</td></tr>
<tr><th>Essential Question(s):</th><th>Enduring Understanding(s):</th></tr>
<tr><td>• How is function tied to form at the cellular and molecular levels?
• What fundamental chemical rules govern all life processes?
• How do cells coordinate their complex activities in a multicellular organism?
• If a single component in a signaling pathway is altered, how does this ripple effect impact the ultimate cellular response?</td><td>• Biological systems are built on a hierarchical structure where structure dictates function.
• Life processes fundamentally obey the laws of chemistry and physics.
• Communication is essential for the survival and coordination of both single cells and multicellular organisms.
• Changes in molecular structure, no matter how small, can drastically alter the outcome of a biological process.</td></tr>
<tr><th>Demonstration of Learning:</th><th>Pacing for Unit</th></tr>
<tr><td>• Laboratory investigations, experiments, and reports
• Written & oral explanations in collaborative settings
• Unit Quizzes and Tests</td><td>Approximately 15 Class Periods
and 2 Lab Days</td></tr>
<tr><th>Family Overview</th><th>Integration of Technology:</th></tr>
<tr><td>• Family Overview: UConn ECE Biology (English
• Family Overview: UConn ECE Biology (Spanish))</td><td>• Virtual Labs & 3D Modeling: Simulate complex cellular processes (e.g., photosynthesis, diffusion) using platforms (PhET, Labster, Gizmos). Explore structures in detail with 3D models (Visible Body, Merge EDU) and molecular modeling software.
• Data Processing: Record, analyze, and visualize experimental data using software like Google Sheets, Excel, or specialized graphing programs.
• Digital Observation & Sharing: Capture real-time observations with digital microscopes or smartphone adapters. Facilitate sharing of reports, maps, and projects using collaboration platforms (Google Classroom, Padlet).</td></tr>
<tr><th>Unit-specific Vocabulary:</th><th>Aligned Unit Materials, Resources, and Technology (beyond core resources):</th></tr>
<tr><td>Element
Compound
Atom
Proton
Neutron
Electron
Atomic number
Mass number
Isotope
Valence shell
Carbonyl group
Carboxyl group
Amino group
Sulfhydryl group
Phosphate group
Methyl group
ATP (adenosine triphosphate)
Macromolecule
Monomer</td><td>None</td></tr>
</table>

Valence electrons
Covalent bond
Ionic bond
Electronegativity
Hydrogen bond
Van der Waals interactions
Polar molecule
Cohesion
Adhesion
Surface tension
Specific heat
Evaporative cooling
Hydrophilic
Hydrophobic
Solution
Solvent
Solute
pH scale
Acid
Base
Buffer
Organic chemistry
Hydrocarbon
Isomer
Structural isomer
Cis-trans isomer
Enantiomer
Functional group
Hydroxyl group

Polymer
Dehydration reaction
Hydrolysis
Carbohydrate
Monosaccharide
Disaccharide
Polysaccharide
Lipid
Fat
Phospholipid
Steroid
Saturated fat
Unsaturated fat
Protein
Amino acid
Peptide bond
Polypeptide
Primary structure
Secondary structure
Tertiary structure
Quaternary structure
Denaturation
Nucleic acid
DNA
RNucleotide
Sugar-phosphate
backbone
Nitrogenous base

Opportunities for Interdisciplinary Connections:

Chemistry
Underpins molecular structures, bonding, reactions, and macromolecule formation.
Physics
Explains energy transfer, thermodynamics, and molecular motion.
Mathematics
Supports quantitative analysis, data interpretation, and experimental design.
Computer science/technology
Enables modeling, bioinformatics, and visualization of molecules, DNA sequences, and cellular processes.
Earth and environmental sciences
Connect biological systems to climate, biogeochemical cycles, water distribution, and carbon cycling, demonstrating how life interacts with global systems.

Anticipated misconceptions:

- Atoms in a compound retain their individual properties (they do not).
- Electrons orbit the nucleus in fixed circular paths like planets (modern models use probability clouds).
- Covalent bonds are always stronger than ionic bonds (depending on the environment, ionic bonds weaken in water).
- All atoms of an element are identical (isotopes exist).
- Hydrogen bonds occur only in water (they can form in many biological molecules).
- Hydrogen bonds are the same as covalent bonds (they are much weaker and form between molecules).
- Water is always neutral and cannot vary in pH (it can self-ionize slightly).
- Ice is denser than liquid water (it's actually less dense, which allows ice to float).
- Cohesion and adhesion are the same process.
- Hydrophobic substances "repel" water with force (they simply do not form hydrogen bonds with it).
- All molecules containing carbon are organic (CO_2 and carbonates are exceptions).
- Carbon can only form single bonds (it can form single, double, or triple bonds).
- Functional groups don't affect molecular behavior (they determine chemical properties).
- Isomers have the same properties since they have the same formula (structure determines function).
- ATP "stores energy in its bonds" like a battery (energy

	is released when bonds are rearranged, not simply broken). • All macromolecules are polymers (lipids are not true polymers). • Dehydration and hydrolysis are the same process (they are opposites). • Proteins are functional immediately after being synthesized (they must fold properly first). • Denaturation breaks peptide bonds (it disrupts shape, not the covalent backbone). • DNA and RNA have the same function (DNA stores genetic information; RNA carries it and plays multiple roles). • Carbohydrates are only for energy (they also serve structural and signaling functions).
Connections to Prior Units:	**Connections to Future Units:**
This unit builds upon the subject matter covered in accelerated biology **Introduction to Biology / Scientific Practices** Unit 1 builds on foundational skills in scientific inquiry, data collection, and lab techniques introduced in the introductory unit. Students apply observation, measurement, graphing, and experimental design skills to investigate cells and molecular processes. **Chemistry Foundations** Concepts from students' previous chemistry course (atomic structure, bonding, hydrogen bonding, and chemical reactions) underpin understanding of biomolecules and cellular chemistry. Knowledge of acids, bases, pH, and solution chemistry helps students understand enzyme activity, protein structure, and cellular processes. **Energy and Matter in Biological Systems** Students use prior understanding of energy and matter to explore how cells capture, store, and transform energy in biochemical reactions. Conservation of matter and energy principles support analysis of molecular interactions, enzyme activity, and metabolic pathways. **Foundational Biology Vocabulary** Key terms such as molecule, atom, energy, and reaction are reinforced and expanded to include macromolecules, organelles, and cellular processes.	Unit 1 provides the foundational knowledge necessary for understanding later units in the course. Concepts such as biomolecules, molecular interactions, and enzyme function prepare students to explore energy transformations in Unit 3 (Cellular Energetics), including photosynthesis and cellular respiration. Similarly, DNA, RNA, and protein structure and function introduced in Unit 1 are essential for studying gene expression, transcription, translation, and inheritance in Unit 4 (Genetics and Molecular Biology). Knowledge of membrane structure and molecular interactions also sets the stage for future exploration of cell signaling, homeostasis, and feedback mechanisms. Additionally, the laboratory and research skills developed in Unit 1 are applied across future units, including investigations in metabolism, genetics, and biotechnology. Biochemical foundations such as energy flow and molecular interactions also connect to ecological and evolutionary concepts, helping students understand how cellular processes influence populations, ecosystems, and adaptations.

Differentiation through *Universal Design for Learning*
Learning Targets and Teacher Actions

	Engagement	Representation	Action & Expression
LT 1	Challenge students to research a disease or condition linked to a malfunctioning organelle to establish relevance. Offer choice in exploration: a virtual lab, a reading, or a video documentary. Facilitate small group "Organelle Expert" sessions where groups teach one organelle to the class.	Offer diagrams, 3D models, and animations to demonstrate structure and function. Use metaphors and analogies (e.g., the cell as a factory or city) to connect functions to familiar concepts. Provide text descriptions in varied formats (digital, printed, audio-recorded).	Allow students to demonstrate knowledge by: drawing/labeling, building a 3D model, creating a presentation, or writing a detailed explanatory paragraph. Provide a variety of scaffolding/supports (checklists, graphic organizers, sentence starters) for describing function.

LT 2	Start with a brief, intriguing story or video about a rapid body response (like "fight or flight") to pique interest. Use a sorting or matching game where students match the communication type to its description and example.	Use labeled diagrams and flowcharts to illustrate the different types of cell signaling (paracrine, endocrine, autocrine, direct contact). Provide real-world examples for each type (e.g., synaptic signaling, hormones in the bloodstream).	Have students create a storyboard or a short skit demonstrating the process of each communication type. Offer a template for a comparison chart to describe the four main ways cells communicate.
LT 3	Use a "Cell Mail Carrier" simulation/activity where students act as signaling molecules, demonstrating short (local) vs. long (systemic) delivery. Encourage peer discussion on which method is faster/slower and why (promoting self-regulation).	Use a visual continuum or scale to represent distance (from direct contact to long-distance endocrine signaling). Explicitly use consistent vocabulary and provide a glossary of terms related to distance and signaling mechanisms.	Ask students to write an analogy or metaphor explaining the difference between short- and long-distance signaling (e.g., a text message vs. a package). Require students to draw a concept map linking the different mechanisms based on distance and speed.
LT 4	Have students build a physical model of the pathway components using everyday objects (e.g., a tennis ball for a ligand, a bucket for a receptor). Use "jigsaw" activities where groups specialize in one component and teach it to others.	Break the pathway down into the three distinct stages: Reception, Transduction, and Response. Provide a simple, clear graphic organizer or labeled diagram of a generic pathway, clearly naming the ligand, receptor, relay molecules, and effector protein	Students can create a "How-To" guide for the pathway, outlining each component's role. Offer multiple-choice or drag-and-drop activities to assess component identification.
LT 5	Use a case study (e.g., epinephrine/adrenaline signaling) to show how the pathway components actually work together in a real-world scenario. Implement an interactive quiz/poll where students predict the outcome if one component is missing or mutated.	Use an animation that highlights what changes in each component (e.g., the receptor changing shape, relay molecules being activated/phosphorylated). Provide a key/legend that shows the function of common components (e.g., kinases, second messengers).	Students annotate a diagram of a pathway, focusing on describing the action (verb) of each component. Use a verbal explanation or a short video recording to describe the sequence of events.

Supporting Multilingual/English Learners (*CELP standards*)
Differentiated Learning Targets

	Emerging	Expanding	Bridging
LT1	I can describe one or two key features of a few common subcellular components using simple sentences and basic science vocabulary, with prompting and support.	I can describe the structure and function of multiple subcellular components and organelles using facts and relevant details, employing general academic and content-specific vocabulary.	I can coherently describe the structure and function of organelles, comparing or analyzing their interdependent roles using a wide variety of complex, precise vocabulary.
LT2	I can state a limited relationship between a basic chemistry concept and a simple life process using simple sentences and basic science vocabulary, with prompting and support.	I can relate multiple basic chemistry and biochemistry concepts to life processes by providing a reasoned explanation supported by specific details and content-specific vocabulary.	I can explain and evaluate how changes in chemistry/biochemistry affect life processes, presenting a coherent analysis using a wide variety of complex, precise vocabulary.
LT3	I can identify one or two key terms related to cell communication (e.g., ligand, receptor) and use simple sentences to provide a very limited explanation, with prompting and support.	I can explain the mechanism of cell communication over both short and long distances, using a structured response and providing specific details and content-specific vocabulary.	I can provide a coherent, detailed analysis that explains and compares different cell communication mechanisms, utilizing a wide variety of complex, precise vocabulary.

LT4	I can list a few major components of a pathway using simple sentences and basic science vocabulary, with prompting and support.	I can describe all key components of a signal transduction pathway, using specific facts and relevant details and employing general academic and content-specific vocabulary.	I can provide a detailed description of the components, including a precise analysis of their structural relationships, utilizing a wide variety of complex, precise vocabulary.
LT5	I can state the basic action of one or two pathway components using simple sentences and basic science vocabulary, with prompting and support.	I can describe the roles of multiple components of the pathway and how they lead to the cellular response, providing specific details and employing general academic and content-specific vocabulary.	I can provide a coherent, detailed analysis of the entire pathway, describing the precise role of each component and evaluating their sequential actions, utilizing a wide variety of complex, precise vocabulary.

Lesson Sequence	Learning Target	Success Criteria	Assessment
1-3	**Learning Target 1** I can describe the structure and/or function of subcellular components and organelles.	I can... • Describe how ribosomes comprise ribosomal RNA (rRNA) and protein. Ribosomes synthesize protein according to mRNA sequence. • Explain how ribosomes are found in all forms of life, reflecting the common ancestry of all known life. • Explain how endoplasmic reticulum (ER) occurs in two forms—smooth and rough. Rough ER is associated with membrane-bound ribosomes— a. Rough ER compartmentalizes the cell. b. Smooth ER functions include detoxification and lipid synthesis. • Explain how golgi complex is a membrane-bound structure that consists of a series of flattened membrane sacs— a. Functions of the Golgi include the correct folding and chemical modification of newly synthesized proteins and packaging for protein trafficking. b. Mitochondria have a double membrane. The outer membrane is smooth, but the inner membrane is highly convoluted, forming folds. c. Lysosomes are membrane-enclosed sacs that contain hydrolytic enzymes. d. A vacuole is a membrane-bound sac that plays many and differing roles. In plants, a specialized large vacuole serves multiple functions. e. Chloroplasts are specialized organelles that are found in photosynthetic algae and plants. Chloroplasts have a double outer membrane.	Model project- trace the path of a protein being synthesized.
4-6	**Learning Target 2** I can relate basic chemistry and biochemistry to life processes.	I can... • Identify the four major classes of biomolecules based on their chemical structures or descriptions. • Explain how monomers are assembled into polymers (and vice versa) through	Calorimetry lab

		dehydration synthesis and hydrolysis reactions. ● Relate the structure of a given biomolecule (e.g., enzyme, cell membrane component) to its specific function in the cell. ● Explain the basic principles of energy flow (e.g., laws of thermodynamics) as they relate to cellular chemical reactions. ● Distinguish between catabolic and anabolic pathways in terms of energy requirements and outcomes.	
7-9	**Learning Target 3** I can explain how cells communicate with one another over short and long distances.	I can… ● List the ways in which cells communicate: a. cell-to-cell contact, b. local regulators, c. or by long distances. d. Signal transduction may result in changes in gene expression and cell function, which may alter phenotype or result in programmed cell death (apoptosis).	1. Written analogy or metaphor explaining the difference between short- and long-distance signaling, focusing on changes to structure and function of the molecules. 2. Create a cause-and-effect chain.
10-12	**Learning Target 4** I can describe the components of a signal transduction pathway.	I can… ● Explain how signal transduction pathways include protein modification and phosphorylation cascades. ● Describe how signaling begins with the recognition of a chemical messenger—a ligand—by a receptor protein in a target cell— a. The ligand-binding domain of a receptor recognizes a specific chemical messenger, which can be a peptide, a small chemical, or protein, in a specific one-to-one relationship. b. G protein-coupled receptors are an example of a receptor protein in eukaryotes.	
13-15	**Learning Target 5** I can describe the role of components of a signal transduction pathway in producing a cellular response and how a change in the structure of any signaling molecule affects the activity of the signaling pathway	I can… ● List how signaling cascades relay signals from receptors to cell targets. a. After the ligand binds, the intracellular domain of a receptor protein changes shape, initiating transduction of the signal. b. Second messengers (such as cyclic AMP) are molecules that relay and amplify the intracellular signal. c. Binding of ligand-to-ligand-gated channels can cause the channel to open or close.	

<table>
<tr><th colspan="2">Unit Title: Bio Energetics</th></tr>
<tr><td colspan="2">Unit 2: Genetics and Molecular Biology</td></tr>
<tr><th colspan="2">Relevant Standards:</th></tr>
<tr><td colspan="2">Big Idea 2: Energetics (ENE)
Biological systems use energy and molecular building blocks to grow, reproduce, and maintain dynamic homeostasis
Big Idea 3: Information Storage and Transmission (IST)
Living systems store, retrieve, transmit, and respond to information essential to life processes.
Big Idea 4: Systems Interactions (SYI)
Biological systems interact, and these systems and their interactions exhibit complex properties
Science Practice 1:
Explain biological concepts, processes, and models presented in written format.
Science Practice 2:
Analyze visual representations of biological concepts and processes.
Science Practice 4:
Represent and describe data
Science Practice 6:
Develop and justify scientific arguments using evidence.</td></tr>
<tr><th>Essential Question(s):</th><th>Enduring Understanding(s):</th></tr>
<tr><td>● How is the organization and compartmentalization of a cell essential for life?
● How does the specific arrangement of atoms determine the function of the molecules of life?
● How do cells and organisms maintain the necessary dynamic balance for survival?
● How do scientists use quantitative evidence to understand and model the invisible, dynamic processes within a cell?</td><td>● Cellular function depends on the precise location and interaction of specialized, membrane-bound components.
● The specific structure of macromolecules, determined by their subunits and chemical bonds, dictates their unique functional roles in all biological systems.
● Life requires the continuous, selective movement of materials across membranes, and the concentration gradients that drive this movement are crucial for energy and signaling.
● All living systems utilize feedback mechanisms at the molecular, cellular, and organismal levels to maintain the dynamic steady state (homeostasis) essential for life.</td></tr>
<tr><th>Demonstration of Learning:</th><th>Pacing for Unit</th></tr>
<tr><td>● Laboratory investigations, experiments, and reports
● Written & oral explanations in collaborative settings
● Unit Quizzes and Tests</td><td>Approximately 24 Class Periods
and 2 Lab Days</td></tr>
<tr><th>Family Overview</th><th>Integration of Technology:</th></tr>
<tr><td>● Family Overview: UConn ECE Biology (English
● Family Overview: UConn ECE Biology (Spanish))</td><td>● Use PhET, HHMI BioInteractive, or Learn Genetics simulations to demonstrate DNA replication, transcription, translation, and Punnett squares. PhET simulations on osmosis/diffusion, enzyme activity; Labster virtual labs on cell biology and molecular interactions.
● HHMI Biointeractive videos on cell structure, organelles, and biomolecular functions.
● 3D cell and organelle models (Merge EDU, Visible Body) to visualize structures and processes.
● Google Sheets or Excel for lab results, graphs, and quantitative analysis of enzyme kinetics or diffusion rates.
● Google Classroom and Docs for shared lab notebooks, discussion boards, and group projects.</td></tr>
<tr><th>Unit-specific Vocabulary:</th><th>Aligned Unit Materials, Resources, and Technology (beyond core resources):</th></tr>
</table>

Gene Trait Heredity Genetics Allele Dominant Recessive Genotype Phenotype Homozygous Heterozygous Purebred Hybrid Punnett square Probability Monohybrid cross Dihybrid cross Law of Segregation Law of Independent Assortment Test cross Chromosome Chromatin Homologous chromosomes Sister chromatids Diploid (2n) Haploid (n) Gamete Somatic cell Meiosis Crossing over Independent assortment Nondisjunction Karyotype Sex chromosomes Autosomes DNA (deoxyribonucleic acid) RNA (ribonucleic acid) Nucleotide Nitrogenous base Adenine Thymine Cytosine Guanine Uracil Double helix Complementary base pairing Replication DNA polymerase Helicase Ligase Leading strand Lagging strand Okazaki fragments Template strand Transcription Translation mRNA (messenger RNA) tRNA (transfer RNA) rRNA (ribosomal RNA) Codon Anticodon Ribosome Start codon Stop codon RNA polymerase Promoter Terminator Introns Exons Splicing Mutation Point mutation Frameshift mutation Gene regulation Operon (e.g., lac operon) Genetic engineering Recombinant DNA Restriction enzyme Gel electrophoresis DNA fingerprinting Polymerase Chain Reaction (PCR) Cloning Plasmid Vector Transformation Genome Gene therapy CRISPR-Cas9 Bioinformatics Human Genome Project	None
Opportunities for Interdisciplinary Connections:	**Anticipated misconceptions:**
Chemistry DNA and RNA structure involves covalent and hydrogen bonding; enzymes catalyze reactions in replication and transcription. **Mathematics** Probability and statistics apply to inheritance patterns and genotype ratios. Use Punnett squares and chi-square analysis to test Mendelian ratios in simulated crosses.	• Each trait is controlled by a single gene. • Genes and chromosomes are the same thing. • DNA strands are made of amino acids. • DNA replication happens only once in a lifetime. • Base-pairing rules are A–G and C–T. • Transcription and translation are the same process. • tRNA carries amino acids to DNA instead of the ribosome.

Environmental Science Genetic diversity supports ecosystem stability and adaptation. **Language Arts / Humanities** Genetics raises social, ethical, and historical questions; historical contributions of Mendel and Franklin. **Health & Medical Science** Genetic knowledge is applied in medicine for diagnosis and treatment.	• Every DNA mutation changes a protein. • Dominant traits are always more common or stronger. • Heterozygotes express both traits equally. • All offspring show only parental traits. • Meiosis and mitosis are the same process. • Gametes have the same number of chromosomes as body cells. • Crossing over always produces identical gametes. • Genetic modification always involves adding foreign DNA.
Connections to Prior Units:	**Connections to Future Units:**
Unit 1: Cell Biology and Biochemistry Builds on understanding of basic cell structure, organelles, and biomolecules. Uses foundational knowledge of macromolecules, molecular interactions, and chemical principles to explore more complex cellular processes, such as transport mechanisms, energy transfer, and enzyme activity. **Introduction to Biology / Scientific Practices** Reinforces skills in observation, measurement, experimental design, and data analysis from Unit Students apply prior lab techniques to investigate diffusion, osmosis, enzyme kinetics, and membrane function. **Chemistry Foundations** Prior knowledge of atomic structure, chemical bonding, polarity, and solution chemistry underpins understanding of biomolecular structure and function. Concepts such as hydrogen bonding and pH are essential for exploring protein folding, enzyme activity, and cellular homeostasis. **Mathematics and Data Analysis** Builds on graphing, quantitative reasoning, and statistical skills from earlier units to analyze lab data and model cellular processes.	Unit 2 helps to bridge over to genetics in Unit 3

Differentiation through *Universal Design for Learning*
Learning Targets and Teacher Actions

	Engagement	Representation	Action & Expression
LT 1	Recruit Interest: Students choose 3-4 organelles to "pitch" to a committee, arguing why their chosen organelles are the most essential for cell survival.	Vary Presentation: Present organelles using physical 3D models and high-resolution, color-coded diagrams to highlight structural differences.	Compose & Construct: Students can demonstrate understanding by building a model (digital or physical) of a eukaryotic cell and labeling the function of the organelles, or by writing a comparative essay.
LT 2	Optimize Challenge: Introduce a "Molecular Mystery" where students are given a cell's symptoms (e.g., loss of energy storage) and must diagnose which biomolecule is malfunctioning.	Highlight Relationships: Use concept maps and simplified chemical structures to show the structure-function link (e.g., the folded shape of a protein dictates its function).	Use Manipulatives: Provide molecular model kits or digital modeling software for students to physically or virtually build the monomers of two different biomolecules (e.g., amino acid and glucose).
LT 3	Sustain Effort: Allow students to choose the medium for their practice problems: either traditional written calculations of water potential (Ψ) or an interactive, digital	Vary Presentation: Present the Fluid Mosaic Model using both static diagrams and a dynamic animation showing protein movement, diffusion, and active transport.	Support Planning: Provide a decision tree or flowchart guiding students to predict the direction of water movement based on given external and internal

	simulation where they control concentration gradients.		concentrations, and justify the mechanism (passive vs. active).
LT 4	Recruit Interest: Use the analogy of a "Cellular Factory" or an assembly line and assign students roles that correspond to the function of the ribosome, ER, and Golgi.	Highlight Patterns: Provide a clear flowchart or diagram that shows the sequential movement of a protein from the mRNA's creation to its final destination (export or membrane insertion).	Compose & Construct: Students can demonstrate understanding by drawing and annotating the entire pathway, or by writing a "travel journal" from the perspective of an exported protein detailing its processing at each organelle.
LT 5	Optimize Challenge: Students participate in a virtual enzyme kinetics lab where they can digitally manipulate temperature and pH and observe the effects on reaction rate and enzyme shape.	Non-Linguistic Illustrations: Use animated visuals (digital or video) to show the conformational change of the active site upon substrate binding (induced fit).	Use Manipulatives: Students use physical objects (like LEGOs) to model the binding of a substrate and the mechanism of a competitive inhibitor blocking the active site.
LT 6	Sustain Effort: Provide scaffolding choices for analysis: students can choose between a simpler data set requiring only graphical interpretation or a more complex one requiring Q10 calculation.	Highlight Patterns: Provide annotated example graphs of enzyme activity showing how to find the optimal pH or temperature and clearly identifying the regions of denaturation.	Support Planning & Strategy: Give students a Claim-Evidence-Reasoning (CER) template for writing conclusions, emphasizing the need to cite specific numbers from the provided tables/graphs as evidence.
LT 7	Recruit Interest: Begin with a scenario of cellular stress (e.g., a rapid increase in waste products) and ask students to brainstorm solutions to bring the cell "back to normal."	Non-Linguistic Illustrations: Use a clear, simple diagram of a feedback loop with visual icons for the stimulus, sensor, and response, focusing on the correcting action.	Compose & Construct: Students can demonstrate understanding by creating a labeled diagram/model of a negative feedback mechanism (e.g., pH regulation) or by writing a sequenced explanation of the process.
LT 8	Foster Collaboration: Assign groups to investigate one specific homeostasis system (e.g., glucose, temperature, water balance) and trace its regulation from the organismal level down to the cellular mechanism.	Highlight Relationships: Use a multi-level diagram that explicitly connects the organ system (e.g., pancreas/liver) down to the cellular level (e.g., insulin binding to a cell receptor).	Support Expression: Students write a short explanation connecting the need for ATP (from cellular respiration) to the sustained function of an entire organismal system (e.g., the sodium-potassium pump in the nervous system).

Supporting Multilingual/English Learners (*CELP standards*)
Differentiated Learning Targets

	Emerging	Expanding	Bridging
LT1	Use large, labeled diagrams and sentence frames to state one function for each of two organelles. Product: Match the organelle name to its primary function and general location.	Write simple comparative sentences (e.g., "Prokaryotes do not have a nucleus, but eukaryotes do"). Product: Fill in a structured T-Chart comparing 3-4 organelles between prokaryotic and eukaryotic cells, using descriptive adjectives.	Justify the structural differences between organelles (e.g., why mitochondria have a folded inner membrane). Product: Write a compare/contrast paragraph analyzing the structural adaptations of three organelles (e.g., mitochondria, chloroplast, nucleus) that support their function.
LT2	Match a simplified chemical model (e.g., chain of hexagons) to the correct biomolecule name. Product: Label the monomer (single unit) of two biomolecules using one-word labels.	Use sequence words and simple causal language (e.g., "because of") to describe the function of one biomolecule. Product: Write short descriptive sentences detailing the	Analyze the impact of a structural change on function (e.g., saturated vs. unsaturated fat). Product: Model and explain how the primary structure of a protein determines

		primary function of each of the four biomolecules.	its 3D folding and specific catalytic function.
LT3	Label a diagram of the cell membrane using visual cues. Product: Identify the direction of water movement (in, out, or none) in a simple hypertonic or hypotonic scenario using a labeled arrow.	Use comparative language (e.g., "unlike, both") to distinguish between simple diffusion and active transport. Product: Write a descriptive paragraph explaining the difference between passive and active transport, including the need for ATP.	Apply water potential (Ψ) concepts to predict outcomes and justify the prediction. Product: Justify a prediction of cell volume change in a specific molar concentration using precise terms like water potential, osmosis, and hypotonic.
LT4	Use labeled sequence cards to order the path of an exported protein (Ribosome →ER→Golgi). Product: Use a simple sentence to state the function of the ER and the Golgi in protein processing.	Use sequencing language (e.g., "first, next, finally") to describe the steps of protein modification and transport. Product: Write a short, descriptive sequence of how a hormone (an exported protein) is processed and released from the cell.	Evaluate the interconnectedness of organelles to explain a system. Product: Illustrate and explain the collaborative roles of the nucleus, ribosomes, RER, and Golgi in synthesizing, modifying, and exporting a specific protein.
LT 5	Label a diagram with the key terms: enzyme, substrate, active site. Product: Match the environmental factor (pH or temperature) to its potential effect (denaturation or optimal function).	Use causal language ("causes, results in") to explain why high temperature causes denaturation. Product: Write simple explanatory sentences describing how enzymes speed up a reaction and how pH affects their activity.	Explain the kinetic effects of inhibitors and environmental changes. Product: Write an argumentative summary explaining the relationship between an enzyme's shape, its optimal environmental conditions, and the concept of induced fit.
LT 6	Identify the highest data point on a graph of enzyme activity vs. pH to find the optimum. Product: Identify the independent and dependent variables in a simple data table.	Use sentence frames to describe a trend shown on a graph (e.g., "As the temperature increases, the enzyme rate..."). Product: Plot provided data points onto a pre-labeled graph and correctly identify the optimum condition.	Synthesize data and quantitative concepts (Q10) to draw a formal conclusion. Product: Write a claim-evidence-reasoning (CER) paragraph analyzing an experimental data table and justifying a conclusion about enzyme function.
LT 7	Match the component of a feedback loop (stimulus, sensor, response) to its definition. Product: Label the components of a simple negative feedback loop (e.g., maintaining pH) on a provided diagram.	Write simple, sequenced sentences (e.g., "The sensor detects the change, then the response corrects it"). Product: Describe the function of buffers and how they help the cell maintain its internal pH stability.	Differentiate the functional impact of positive vs. negative feedback loops. Product: Model and explain a specific cellular-level negative feedback mechanism, using precise vocabulary like dynamic homeostasis and set point.
LT 8	Match a cellular process (e.g., cellular respiration) to its organismal result (e.g., heat production). Product: Identify the two main hormones (insulin, glucagon) involved in blood glucose regulation.	Write sentences to describe the role of ATP (from cellular respiration) in maintaining a body function (e.g., nerve signaling). Product: Write a descriptive paragraph explaining how the body regulates blood glucose levels using both the pancreas and the liver.	Trace the entire regulatory pathway across multiple levels of organization. Product: Write a well-structured explanation connecting the cellular function of insulin receptors to the overall organismal goal of maintaining blood glucose levels.

Lesson Sequence	Learning Target	Success Criteria	Assessment
1-3	**Learning Target 1** I can compare and contrast the structure and function of major	I can... • Accurately label and describe the unique	*To be formalized during Implementation Year Update: [ECE Biology]()*

	organelles in prokaryotic and eukaryotic cells, including the nucleus, mitochondria, chloroplasts, and ribosomes.	function of at least five major organelles on a diagram of a eukaryotic cell . • Explain the endosymbiotic theory by comparing and contrasting the structure of mitochondria and chloroplasts with that of prokaryotic cells. • Create a Venn diagram that correctly identifies structures shared by all cell types (prokaryotic and eukaryotic) and those unique to each.	*Implementation Guide (2021)*
4-6	**Learning Target 2** I can model and explain the relationship between the structure of the four major biomolecules (carbohydrates, lipids, proteins, nucleic acids) and their specific functional roles in the cell (e.g., energy storage, information transfer, or catalysis)	I can... • Identify the monomer and polymer forms (e.g., amino acid → polypeptide) for all four major biomolecules. • Describe the structural differences between saturated and unsaturated fats and explain how this difference impacts membrane fluidity. • Describe the four levels of protein structure (primary, secondary, tertiary, and quaternary) and explain how changes in primary structure can lead to loss of function (e.g., sickle cell anemia).	
7-9	**Learning Target 3** I can predict the direction and rate of material movement across a cell membrane (e.g., water, ions, macromolecules) given specific concentrations, and distinguish between passive and active transport mechanisms	I can... • Create a model of the cell membrane (Fluid Mosaic Model) to identify the roles of phospholipids, cholesterol, and various membrane proteins • Calculate and use water potential to accurately predict the direction of water movement (osmosis) across a semi-permeable membrane in hypertonic, hypotonic, and isotonic solutions. • Distinguish between and provide examples of simple diffusion, facilitated diffusion, and	

		active transport (including the use of ATP).	
10-12	**Learning Target 4** I can illustrate and explain how multiple cell components (e.g., ribosomes, ER, Golgi) work collaboratively to synthesize, modify, and transport a protein required for an essential life process.	I can... • Trace the path of a protein intended for export, beginning with transcription in the nucleus and ending with exocytosis . • Identify the specific roles of the rough endoplasmic reticulum (RER) and the Golgi apparatus in the modification, sorting, and packaging of proteins. • Explain the potential consequences for a cell if the function of the ribosome, RER, or Golgi apparatus is compromised.	
13-15	**Learning Target 5** I can explain the catalytic action of enzymes and demonstrate how changes in environmental factors (e.g., temperature, pH), substrate concentration) will affect the enzyme's reaction rate	I can... • Label the active site, substrate, and enzyme-substrate complex on a diagram and explain the concept of induced fit. • Predict the effect of denaturing an enzyme and identify factors (e.g., extreme heat or pH) that cause irreversible denaturation. • Differentiate between competitive and non-competitive enzyme inhibitors and explain the impact of each on the enzyme's maximum reaction rate.	
16-18	**Learning Target 6** I can analyze and interpret quantitative experimental data (e.g., graphs, tables, Q10 calculations) to draw conclusions about the effects of variables on enzyme activity or molecular interactions.	I can... • Plot, label, and interpret a standard enzyme kinetics curve, identifying Vmax and Michaelis constant. • Calculate the Q10 value from provided temperature and reaction rate data and explain the biological meaning of the result. • Analyze a data table or graph from a molecular interaction experiment and use the evidence to state and justify a	

		conclusion.	
19-21	**Learning Target 7** I can describe and model how cellular-level feedback mechanisms (e.g., changes in pH) or enzyme regulation) maintain dynamic homeostasis within the cell	I can… ● Define dynamic homeostasis and explain why it is essential for cell survival. ● Differentiate between positive and negative feedback loops and provide a specific, accurate example of each at the cellular or molecular level. ● Diagram a negative feedback mechanism, labeling the stimulus, receptor, control center, and effector, using a cellular example.	
21-24	**Learning Target 8** I can connect a specific cellular process (e.g., cellular respiration, gene regulation) to the overall regulation of internal conditions (e.g., body temperature, blood glucose levels) in a complex organism.	I can… ● Explain how the process of cellular respiration contributes to organismal homeostasis for active transport and muscle contraction). ● Describe the roles of specific hormones and their target cells in maintaining blood glucose homeostasis. ● Trace the regulatory pathway, from stimulus to response, that an organism uses to maintain body temperature (thermoregulation) .	

Unit Title:	
Unit 3: Animal Physiology and Homeostasis	
Relevant Standards: Bold indicates priority	
Big Idea 3: Information Storage and Transmission (IST) Living systems store, retrieve, transmit, and respond to information essential to life processes. **Big Idea 4: Systems Interactions (SYI)** Biological systems interact, and these systems and their interactions exhibit complex properties **Science Practice 1:** Explain biological concepts, processes, and models presented in written format. **Science Practice 2:** Analyze visual representations of biological concepts and processes. **Science Practice 4:** Represent and describe data **Science Practice 5:** Perform statistical tests and mathematical calculations to analyze and interpret data. **Science Practice 6**: Develop and justify scientific arguments using evidence.	
Essential Question(s):	**Enduring Understanding(s):**
• What fundamental trade-offs exist between acquiring energy and using energy for survival and reproduction? • How do the behavioral choices of individual organisms scale up to affect the structure and success of an entire ecosystem? • To what extent is all ecological stability fundamentally dependent on the capture of solar energy? • How does the availability of energy act as the ultimate constraint on life at all biological levels?	• Organisms employ diverse, evolved strategies to acquire, transform, and utilize energy, which directly influences their overall fitness. • Energy flows through an ecosystem, beginning with the autotrophs, and is subject to the laws of thermodynamics, which fundamentally limits the structure of food webs. • The behavioral responses of organisms are adaptations that enhance fitness and serve as a key mechanism for energy acquisition and defense within a population. • The dynamics and stability of populations and entire ecosystems are critically dependent upon the availability and distribution of energy resources.
Demonstration of Learning:	**Pacing for Unit**
• Laboratory investigations, experiments, and reports • Written & oral explanations in collaborative settings • Unit Quizzes and Tests	Approximately 12 Class Periods and 2 Lab Days
Family Overview	**Integration of Technology:**
• Family Overview: UConn ECE Biology (English • Family Overview: UConn ECE Biology (Spanish))	• PhET "Cellular Respiration" and "Photosynthesis" simulations; Labster virtual labs. • 3D models and animations of chloroplasts, mitochondria, and the electron transport chain help students visualize complex cellular processes. • HHMI Biointeractive videos on mitochondria, chloroplasts, and energy flow. • Molecular modeling software can illustrate ATP synthesis, electron flow, and chemical reactions in metabolism. • Use Google Sheets, Excel, or graphing software to record experimental data from virtual or classroom labs. Students can analyze trends, calculate rates of photosynthesis or respiration, and create graphs or charts.
Unit-specific Vocabulary:	**Aligned Unit Materials, Resources, and Technology (beyond core resources):**

Homeostasis Negative feedback Positive feedback Set point Stimulus Sensor / Receptor Effector Control center Thermoregulation Osmoregulation Endotherm Ectotherm Poikilotherm Homeotherm Ion Channel Membrane potential Resting potential Action potential Depolarization Repolarization Hyperpolarization Neurotransmitter Synapse Hormone Receptor Second messenger Signal transduction Atrium / Ventricle Artery / Vein / Capillary Blood Red blood cell / White blood cell Platelet Plasma Hemoglobin Oxygen transport Carbon dioxide transport Pulmonary circuit / Systemic circuit Respiration Ventilation Gas exchange Nephron Glomerulus Bowman's capsule Proximal tubule Loop of Henle Distal tubule Collecting duct Filtration Reabsorption Secretion Excretion Urea / Ammonia / Uric acid Osmotic gradient Antidiuretic hormone (ADH) Enzyme Substrate Absorption Peristalsis Small intestine / Large intestine Liver / Pancreas / Gallbladder Metabolism Anabolism / Catabolism ATP / Energy balance Central nervous system (CNS) Peripheral nervous system (PNS) Brain / Spinal cord Neuron Dendrite / Axon / Synaptic terminal Myelin sheath Reflex arc Sensory neuron / Motor neuron / Interneuron Endocrine gland Exocrine gland Pituitary / Thyroid / Adrenal / Pancreas Feedback regulation	None
Opportunities for Interdisciplinary Connections:	**Anticipated misconceptions:**
Chemistry Chemical basis of physiological processes: ion gradients, neurotransmitters, enzyme activity, ATP, pH, and buffer systems. **Mathematics** Analyze physiological data; graph homeostatic set points; model diffusion rates and enzyme kinetics. **Physics** Fluid dynamics in circulation, diffusion, gas exchange, thermodynamics in heat regulation, electrophysiology. **Environmental Science** Effects of temperature, salinity, and water availability on homeostasis; adaptations to extreme environments; survival strategies.	• Homeostasis means the body keeps everything constant (students may think all internal conditions stay the same, rather than within set ranges). • Positive feedback always "corrects" changes (students may confuse it with negative feedback; it actually amplifies changes). • Endotherms do not rely on the environment for temperature regulation (students may overlook behavioral or physiological thermoregulation). • Ectotherms are "cold-blooded" in the sense that their body is always cold (students may not realize they can regulate temperature behaviorally). • Action potentials are caused by "flowing electricity" rather than ion movement across membranes. • All neurons have the same resting potential or

	respond the same way (students may neglect variation in neuron type or threshold). • Enzymes and hormones are interchangeable (students may confuse biochemical signals with catalysts). • Blood always carries oxygen the same way in all animals (students may ignore hemoglobin differences or dissolved oxygen). • Kidneys "store" urine rather than filtering and concentrating it continuously. • Osmoregulation only occurs in aquatic environments (students may not consider terrestrial animals or humans). • Gas exchange occurs in all animals the same way (students may overgeneralize lungs, gills, or diffusion across skin). • Reflexes involve conscious thought (students may not understand that many reflex arcs bypass the brain). • Heat loss and heat gain are always passive processes (students may not account for active physiological mechanisms like shivering or sweating). • Hormone levels act instantly and always have uniform effects (students may not understand timing, receptor sensitivity, or feedback control). • Digestive enzymes can digest any food without specificity (students may not understand enzyme-substrate specificity).
Connections to Prior Units:	**Connections to Future Units:**
Macromolecules in Unit 1 ties genetics and cell communication together.	Cell communication helps students understand the undertones of evolution and evolutionary progression.

Differentiation through *Universal Design for Learning*
Learning Targets and Teacher Actions

	Engagement	Representation	Action & Expression
LT 1	Recruit Interest: Present a "Behavioral Choice" scenario (e.g., risk of foraging vs. safety of hiding) and allow students to collaboratively debate and predict the optimal strategy for maximum fitness.	Vary Presentation: Present behavior examples through both video clips (e.g., animal communication, foraging) and written case studies focused on specific behavioral patterns.	Support Planning & Strategy: Offer a structured template for analyzing behavior that includes prompts for identifying the cost, benefit, and impact on fitness. Allow students to present findings via oral report or infographic.
LT 2	Sustain Effort: Give students a choice of species (e.g., predator, grazer, filter feeder, parasite) to investigate in depth. Students research the specific structural adaptations used for their chosen species' energy acquisition.	Clarify Vocabulary: Use graphic organizers that visually categorize organisms by their energy source (e.g., Autotroph → Photoautotroph → Chemolithoautotroph), defining the terms with simple visuals.	Use Multi-Media: Students demonstrate understanding by either drawing/labeling an organism and its feeding structure or by writing a comparison summary of two different energy strategies (e.g., bulk feeding vs. fluid feeding).
LT 3	Optimize Challenge: Introduce a simulation or game (digital or physical) where students manage a model ecosystem and must make decisions based on changing energy resources (e.g., drought)	Highlight Patterns: Use the 10% rule to model energy flow. Display the pattern using both a numerical data table and a logarithmic-scale energy pyramid diagram.	Compose and Construct: Students analyze a data set showing population changes following an environmental shift. They must then write a predictive explanation using causal language (e.g., "The decrease

	and observe the population consequences.		in X caused a decrease in Y...") about the ecosystem change.
LT 4	Foster Collaboration: Conduct a "Molecule Exchange" activity where one half of the class represents autotrophs and the other half represents heterotrophs, and they must physically exchange tokens representing CO2, O2, and glucose.	Highlight Relationships: Use a circular diagram or cyclical flowchart that clearly illustrates how the products of photosynthesis are the reactants for cellular respiration, and vice-versa, demonstrating the continuous energy cycle.	Support Executive Function: Provide a step-by-step checklist for the final product. Students must illustrate the processes. Allow students to present the content via annotated poster or a simple, labeled digital animation.

Supporting Multilingual/English Learners (*CELP standards*)
Differentiated Learning Targets

	Emerging	Expanding	Bridging
LT1	Match a simple behavior (e.g., migration, hiding) to its survival benefit. Product: Use a simple sentence to state how one behavior helps an animal survive (e.g., Migration helps the birds find food).	Write simple cause-and-effect sentences linking a behavior to reproduction and survival. Product: Write a descriptive paragraph explaining how a specific behavioral response (e.g., a mating ritual) contributes to an individual's fitness.	Analyze a case study of a behavioral trade-off (e.g., predator avoidance vs. foraging). Product: Explain and justify how the cost and benefit of a complex behavior (e.g., territoriality) impacts the overall success of a population.
LT2	Match images of different feeding strategies (e.g., grazing, filtering, predation) to their names. Product: Identify the primary source of energy (e.g., sun, plants, other animals) for two types of organisms.	Use descriptive verbs to explain how two different organisms (e.g., a plant and a cow) acquire energy. Product: Write a comparison paragraph detailing the different structures and methods organisms use to gather energy (e.g., roots vs. mouth).	Analyze the efficiency and trade-offs of different energy acquisition strategies. Product: Explain and justify why a specific strategy (e.g., being an endotherm vs. ectotherm) is advantageous for an organism in a particular environment.
LT3	Label a simple food chain and identify the producer and primary consumer. Product: Complete sentence frames to show a simple cause-and-effect relationship (e.g., Less sun means less food for the...).	Use sequential language (e.g., "if... then... therefore") to describe the impact of a change at one trophic level. Product: Write a short descriptive passage explaining how a decrease in the number of producers would affect the primary consumer population.	Analyze the efficiency of energy transfer (\text{10%} rule) and predict long-term changes. Product: Write a predictive explanation detailing how a \text{10%} decrease in available energy at the producer level affects the carrying capacity of the tertiary consumer population.
LT4	Define autotroph and heterotroph using simple synonyms (e.g., Autotroph: makes own food). Product: Identify the two main processes (photosynthesis and cellular respiration) used by autotrophs and heterotrophs.	Write simple explanatory sentences detailing the specific roles of autotrophs and heterotrophs in the ecosystem. Product: Create a simple diagram or flowchart showing the sequential flow of energy from the sun through the producer to the consumer.	Explain the biochemical processes that drive energy flow. Product: Write an analytical summary explaining how the outputs of photosynthesis (glucose and oxygen) are the essential inputs for cellular respiration, demonstrating the continuous cycle of energy flow.

Lesson Sequence	Learning Target	Success Criteria	Assessment
1-3	**Learning Target 1** I can explain how the behavioral responses of organisms affect their	I can... • Describe how responses to information and communication of information are vital to natural selection	*To be formalized during Implementation Year Update: ECE Biology Implementation Guide*

	overall fitness and may contribute to the success of the population.	and evolution such as: • a. Natural selection favors innate and learned behaviors that increase survival and reproductive fitness. • b. Cooperative behavior tends to increase the fitness of the individual and the survival of the population.	*(2021)*
4-6	**Learning Target 2** I can describe the strategies organisms use to acquire and use energy.	I can… • Describe how organisms use energy to maintain organization, grow, and reproduce. • Explain ethology behavior proximate cause innate behaviors, learned behaviors and ultimately cause fixed action patterns. • Describe how pheromones sign stimulus migration. • Define: Kinesis, taxis, phototaxis, chemotaxis and Geotaxis. • Compare and contrast primary producer, heterotrophs, primary consumer, secondary consumer, tertiary consumer and decomposers.	
7-9	**Learning Target 3** I can explain how changes in energy availability affect populations and ecosystems.	I can… • Describe the difference between a food chain and a food web. • Describe how organisms use different strategies to regulate body temperature and metabolism: a. Endotherms use thermal energy generated by metabolism to maintain homeostatic body temperatures. b. Ectotherms lack efficient internal mechanisms for maintaining body temperature, though they may regulate their temperature behaviorally by moving into the sun or shade or by aggregating with other individuals. • Describe how different organisms use various reproductive strategies in response to energy availability. • Explain how a net gain in energy results in energy storage or the growth of an organism and how a net loss of energy results in loss of mass and, ultimately, the death of an organism. • Explain how changes in energy availability can result in changes in population size. • List how changes in energy availability can result in disruptions to an ecosystem in the following ways: a. A change in energy resources such as sunlight can affect the number and size of the trophic levels. b. A change in the producer level can affect the number and size of other trophic levels.	
10-12	**Learning Target 4** I can explain how the	I can… • Describe how autotrophs capture energy	

	activities of autotrophs and heterotrophs enable the flow of energy within an ecosystem	from physical or chemical sources in the environment such as: a. Photosynthetic organisms capture energy present in sunlight. b. Chemosynthetic organisms capture energy from small inorganic molecules present in their environment, and this process can occur in the absence of oxygen. • Describe how heterotrophs capture energy present in carbon compounds produced by other organisms.	

Unit Title:

Unit 4: Evolution

Relevant Standards: Bold indicates priority

Big Idea 1: Evolution (EVO)
The process of evolution drives the diversity and unity of life.
Big Idea 4: Systems Interactions (SYI)
Biological systems interact, and these systems and their interactions exhibit complex properties
Science Practice 1:
Explain biological concepts, processes, and models presented in written format.
Science Practice 2:
Analyze visual representations of biological concepts and processes.
Science Practice 4:
Represent and describe data
Science Practice 6:
Develop and justify scientific arguments using evidence.

Essential Question(s):

- How does natural selection drive evolution and what factors influence this process?
- What evidence supports the theory of evolution and how scientists interpret this evidence?
- How do genetic mutations and environmental factors contribute to variation within a population?
- How does the process of speciation occur and what role does it play in the diversity of life?
- In what ways can human activity influence evolutionary processes?

Enduring Understanding(s):

- Natural selection is the primary, non-random process where environmental pressures act upon heritable variation, leading to the differential survival and reproduction of individuals and the gradual adaptation of populations.
- The theory of descent with modification from a common ancestor is supported by independent and converging lines of evidence from multiple scientific disciplines, including the fossil record, comparative anatomy, and molecular biology.
- Evolutionary change is fundamentally dependent on genetic variation, which originates from mutation and meiosis, and is shaped by both selective forces and random events like genetic drift.
- Speciation results from the establishment of reproductive isolation, and human activities are now powerful selective pressures that influence the rate, direction, and magnitude of evolutionary change.

Demonstration of Learning:

- Laboratory investigations, experiments, and reports
- Written & oral explanations in collaborative settings
- Unit Quizzes and Tests

Pacing for Unit

Approximately 24 Class Periods
and 2 Lab Days

Family Overview

- Family Overview: UConn ECE Biology (English
- Family Overview: UConn ECE Biology (Spanish))

Integration of Technology:

- PhET Simulations to experiment with concepts like enzyme activity, diffusion, or genetic crosses without needing lab materials.
- Gizmos virtual labs for more complex experiments (e.g., DNA extraction, photosynthesis measurements).
- Google Sheets/Excel to plot population growth, enzyme activity, or experimental results.
- Students can use tools like NCBI BLAST or DNA sequence simulators.
- 3D models: Programs like Visible Body or Tinkercad for molecular and cellular structures.
- Augmented reality apps like Merge EDU can bring structures like DNA or the heart to life in 3D.

Unit-specific Vocabulary:

Aligned Unit Materials, Resources, and Technology (beyond

	core resources):
Biogeography Evolution Descent with modification Natural selection Fitness Competition Biotic factors Abiotic factors Selective pressures Adaptations Phenotype Genotype Mutation Population Gene pool Fixed Genetic drift Bottleneck effect Founder effect Gene flow Directional selection Stabilizing selection Disruptive selection Sexual selection Hardy Weinberg equilibrium Comparative morphology Analogous structures Embryonic homology Vestigial structure Molecular homology Homologous structures Common ancestor Convergent evolution Homology Fossil Node Cladogram Phylogenetic tree Systemics Basal taxon Sister taxa Monophyletic group Derived characteristic Ancestral characteristic Synapomorphy Paraphyletic group Polyphyletic group Taxonomy Phylogenetics Root Outgroup Parsimony Species Speciation Geography Temporal isolation Prezygotic barrier Postzygotic barrier Sympatric speciation Behavioral isolation Mechanical isolation Reduced hybrid viability Reduced hybrid fertility Punctuated equilibrium Macroevolution Hybrid breakdown Gradualism Divergent evolution Convergent evolution Allopatric speciation Gametic isolation Microevolution Adaptive radiation Habitat isolation	None
Opportunities for Interdisciplinary Connections:	**Anticipated misconceptions:**
Chemistry Reactions like ATP hydrolysis, enzyme activity, and macromolecule structure **Physics** Energy transformations, diffusion, fluid dynamics, and optic **Mathematics** Statistical analysis, probability in genetics, and modeling population growth. **Social Studies** Discussions of human impacts on ecosystems, conservation, and genetic engineering.	• Belief that individual organisms evolve, rather than populations over generations. • Misunderstanding adaptation: thinking traits appear “because organisms need them” rather than via variation and selection. • Confusing fitness with strength or speed rather than reproductive success.
Connections to Prior Units:	**Connections to Future Units:**
Builds on knowledge of DNA, RNA, proteins, and enzyme activity introduced in Unit 1. Understanding of biomolecules and molecular	None

interactions supports the study of transcription, translation, and replication. Reinforces concepts of organelle function, particularly the nucleus, ribosomes, and endoplasmic reticulum, in gene expression and protein synthesis from Unit 2.	

Differentiation through *Universal Design for Learning*
Learning Targets and Teacher Actions

	Engagement	Representation	Action & Expression
LT 1	Optimize Challenge: Provide a choice between two real-world case studies (e.g., antibiotic resistance or fish evolution due to fishing) for analysis, allowing students to select the topic most intriguing to them.	Clarify Vocabulary: Use a structured glossary tool that provides definitions, visual diagrams, and non-linguistic examples for core terms like heritability, fitness, and adaptation.	Use Multi-Media: Allow students to demonstrate their understanding of the four steps of natural selection by either writing a detailed narrative or creating a short narrated video explaining the process.
LT 2	Recruit Interest: Present a "Mystery Population" scenario where different groups are given data showing the effects of either genetic drift (bottleneck), gene flow, or non-random mating, requiring them to first identify the mechanism at play.	Highlight Patterns: Provide a color-coded graphic organizer that visually compares and contrasts the source, magnitude of effect, and randomness of the five evolutionary forces.	Support Planning: Give students a step-by-step checklist for using the Hardy-Weinberg equation, including reminders on when to use allele vs. genotype frequencies for calculations.
LT 3	Sustain Effort: Allow students to choose their evidence focus (e.g., a student interested in vertebrates chooses homologous anatomy; a student interested in ancient life chooses the fossil record).	Vary Presentation: Present the evidence through both physical models (3D printed homologies) and virtual exploration (online interactive fossil databases or 3D digital fossil reconstructions).	Compose and Construct: Students can demonstrate understanding by either drawing/labeling homologous structures or by writing a comparative essay justifying why specific structures prove common ancestry.
LT 4	Foster Community: Assign pairs to collaboratively build a phylogenetic tree using provided sequence data, requiring each partner to take responsibility for different parts of the analysis (e.g., one analyzes molecular data, the other constructs the tree).	Use Scaffolded Visualization: Provide a template for a phylogenetic tree and an interactive, digital tool where students can plug in molecular distance data to visualize the branching patterns immediately.	Monitor Progress: Provide a digital self-assessment quiz that focuses only on phylogenetic tree interpretation (e.g., identifying sister taxa and common ancestors) to allow students to check their comprehension before a final exam.
LT 5	Individual Choice: Allow students to choose the specific type of mutation or meiotic event they want to study in depth (e.g., point mutation vs. aneuploidy) for a mini-presentation or modeling activity.	Non-Linguistic Illustrations: Use animated GIFs or short video clips to clearly illustrate the dynamic processes of crossing over and independent assortment during meiosis, alongside static diagrams.	Use Manipulatives: Provide pipe cleaner or paper chromosome models to allow students to physically model the impact of a non-disjunction or a successful crossing-over event, explaining the resulting genetic variation.
LT 6	Recruit Interest: Begin the lesson with an engaging "What If?" scenario (e.g., What if a sudden canyon formed through a deer habitat?) to immediately relate speciation to a real-world, high-stakes event.	Clarify Syntax and Symbols: Use concept maps or flowcharts that visually organize the cause-and-effect relationship between geographic isolation, reproductive isolation, and the formation of a new species.	Use Scaffolds for Synthesis: Provide a Speciation Event Template that prompts students to identify the environment, the specific pre- or postzygotic barrier, and the type of speciation (allopatric or sympatric) for three distinct case studies.

LT 7	Optimize Challenge: Introduce opposing scientific quotes regarding the validity of gradualism vs. punctuated equilibrium, requiring students to take a side and defend it using provided fossil data examples.	Multiple Analogies: Explain the two models using a range of analogies (e.g., comparing a smoothly rising ramp vs. a flight of stairs) and ask students to choose the analogy that best helps them conceptualize the difference.	Differentiate Expression: Allow students to either sketch and annotate the two models of evolutionary tempo on a graph or write a journal entry from the perspective of a paleontologist arguing for one model based on their fossil finds.
LT 8	Promote Self-Reflection: Conclude the unit by having students participate in a structured debate or Socratic Seminar on the ethical and evolutionary consequences of human actions (e.g., genetic engineering vs. conservation efforts).	Highlight Critical Features: Use annotated graphs and data tables from current scientific journals (e.g., data on fish size over time due to human harvesting) to clearly highlight the cause-and-effect patterns of human selective pressure.	Provide Sentence Starters/Tools: For the analytical essay or debate preparation, provide argumentation sentence starters ("This evidence shows directional selection because...", "A counter-argument to this is...") to help students formulate clear, evidence-based claims.

Supporting Multilingual/English Learners (CELP standards)
Differentiated Learning Targets

	Emerging	**Expanding**	**Bridging**
LT 1	Use sentence frames and visual aids (diagrams with arrows) to label the four components of Natural Selection. Product: Define the terms using one-word labels or short, familiar phrases.	Use simple, compound sentences to describe the relationship between the four components. Product: Write a short paragraph or create a labeled flowchart explaining the process of natural selection in a case study.	Use complex sentences and domain-specific vocabulary (e.g., differential survival). Product: Write a two-paragraph analytical response explaining how a change in environment drives a specific mode of selection.
LT 2	Match images or definitions of Bottleneck, Founder Effect, and Gene Flow to the correct term. Product: Create a T-Chart listing key differences using nouns and simple verbs (e.g., Drift: small population, random).	Write comparative sentences using signal words (e.g., while, similarly) to distinguish between two forces. Product: Write a short comparison/contrast detailing the impact of gene flow vs. genetic drift on allele frequency.	Synthesize information to evaluate the relative importance of each force in a given scenario. Product: Write a justified conclusion about which force is most likely acting on a population, supported by evidence from a provided data set.
LT 3	Label diagrams of homologous and analogous structures. Product: Use a short sentence/caption to identify whether a structure is evidence of shared ancestry or convergent evolution.	Use descriptive language to explain the relationship between a structure (e.g., bone arrangement in a whale fin) and a common ancestor. Product: Complete a fill-in-the-blank paragraph explaining how the fossil record shows transitional forms.	Analyze images of different anatomical structures and justify their classification. Product: Write an evidence-based paragraph using precise vocabulary to argue how vestigial structures support the theory of descent with modification.
LT 4	Correctly identify the common ancestor and sister taxa on a simplified phylogenetic tree. Product: Answer single-word or short-phrase questions about relationships on the tree.	Write sentences to describe relationships (e.g., "Species A is more closely related to B than C"). Product: Construct a basic phylogenetic tree from highly simplified molecular distance data.	Analyze quantitative data (e.g., sequence comparison percentages) to build a tree and draw conclusions. Product: Justify the placement of a novel organism on a phylogenetic tree using molecular clock data and advanced reasoning.
LT 5	Label a diagram of crossing over and a diagram of a point mutation. Product: Define mutation and meiosis using a simple dictionary definition or image.	Describe, using sequencing language (e.g., first, then, resulting in), how crossing over increases genetic variation. Product: Write a descriptive paragraph explaining why sexual reproduction creates more variation than asexual reproduction.	Synthesize the concepts of gene flow, mutation, and meiosis to assess their combined role. Product: Write a coherent argument explaining why variation is the prerequisite for evolution and why new mutations are essential.

LT 6	Match visual examples (e.g., different mating dances) to the correct prezygotic barrier name. Product: Create a simple two-column chart listing prezygotic barriers and postzygotic barriers using short phrases.	Use comparison language to explain the difference between a prezygotic barrier (no fertilization) and a postzygotic barrier (inviable/sterile offspring). Product: Write descriptive sentences for 3-4 different reproductive isolation mechanisms.	Analyze a case study of two populations and determine the type of speciation and the barrier responsible. Product: Write an explanatory text outlining the sequence of events that led to either allopatric or sympatric speciation, using precise domain vocabulary.
LT 7	Match a graph of gradualism to its definition, and a graph of punctuated equilibrium to its definition. Product: Use simple, comparative sentences (e.g., Gradualism is slow. Punctuated is fast).	Use transition words (e.g., in contrast, however) to explain the main difference between the two models. Product: Write a comparison paragraph detailing why the fossil record often appears to support punctuated equilibrium.	Analyze a provided fossil data set and interpret the rate of change. Product: Write an argumentative summary justifying which model (gradualism or punctuated equilibrium) best fits the provided evidence.
LT 8	Match images of human activities (e.g., pollution, farming) to the evolutionary effect (e.g., resistance, small size). Product: Answer "yes/no" or true/false questions about whether a human action acts as a selective pressure.	Write sentences describing how a specific human activity acts as a directional selective pressure. Product: Write a short explanation detailing how the use of pesticides has caused the evolution of resistance in insect populations.	Evaluate the long-term impact of human actions on genetic diversity and extinction rates. Product: Write a well-developed persuasive paragraph discussing the ethical and biological consequences of human-induced rapid evolutionary change.

Lesson Sequence	Learning Target	Success Criteria	Assessment
1-3	**Learning Target 1** I can explain the process of natural selection as the primary mechanism driving evolution and identify the four key components necessary for it to occur.	I can... • Define and provide examples for the four components of natural selection: variation, inheritance, selection (differential survival/reproduction), and time. • Differentiate between the three modes of natural selection (directional, stabilizing, and disruptive) and sketch a graph illustrating the change in phenotype distribution for each. • Apply the principles of natural selection to explain the rapid evolution of antibiotic resistance in bacteria.	*To be formalized during Implementation Year Update: ECE Biology Implementation Guide (2021)*
4-6	**Learning Target 2** I can compare and contrast the roles of genetic drift, gene flow, mutation, and non-random mating in altering allele and genotype frequencies within a population.	I can... • Distinguish between the bottleneck effect and the founder effect as mechanisms of genetic drift, and explain their impact on genetic diversity, particularly in small populations. • Explain how gene flow (migration) and mutation introduce or create new genetic variation in a population, while non-random mating only rearranges existing alleles. • Calculate the impact of an evolutionary force on allele	

		frequencies using the Hardy-Weinberg equation.	
7-9	**Learning Target 3** I can evaluate evidence from the fossil record and comparative anatomy to support the theory of descent with modification from a common ancestor.	I can… ● Interpret a series of fossil strata to infer evolutionary changes in morphology and identify transitional fossils that link major taxonomic groups. ● Define and provide examples of homologous structures (e.g., vertebrate forelimbs), vestigial structures, and explain how they provide evidence for shared ancestry. ● Differentiate between homologous structures and analogous structures (convergent evolution) and explain how each supports the theory of evolution.	
10-12	**Learning Target 4** I can interpret molecular evidence, such as DNA sequences and protein comparisons, to establish evolutionary relationships and construct phylogenetic trees.	I can… ● Explain the concept of a molecular clock and use differences in DNA or amino acid sequences between species to infer time since divergence. ● Interpret a phylogenetic tree or cladogram by identifying the most recent common ancestor, sister taxa, and outgroups . ● Analyze data on gene or protein similarity across multiple species (e.g., comparing cytochrome c or hemoglobin) and use that data to correctly construct a basic phylogenetic tree.	
13-15	**Learning Target 5** I can explain how genetic mutations and meiotic processes create the heritable variation upon which selection acts.	I can… ● Define mutation and explain how point mutations and chromosome mutations introduce new alleles into a population's gene pool. ● Explain the three meiotic processes (crossing over, independent assortment, and random fertilization) that lead to recombination and genetic variation in offspring. ● Explain why only mutations in gametes (sex cells), and not somatic (body) cells, are heritable and relevant to the long-term evolutionary change of a species.	
16-18	**Learning Target 6** I can describe the process of speciation and differentiate between the various forms of prezygotic and	I can… ● Define speciation and distinguish between allopatric speciation (geographic isolation) and sympatric speciation (no geographic isolation).	

	postzygotic reproductive isolation.	• Provide specific examples and mechanisms for at least three types of prezygotic barriers (e.g., habitat, temporal, behavioral, mechanical). • Explain the difference between reduced hybrid viability and reduced hybrid fertility (postzygotic barriers) and how both prevent gene flow between incipient species.	
19-21	**Learning Target 7** I can compare and contrast the models of gradualism and punctuated equilibrium to describe the varying tempo of evolutionary change.	I can… • Describe the theory of gradualism and identify fossil evidence that would be interpreted to support this model of slow, steady change. • Describe the theory of punctuated equilibrium and explain why the fossil record often shows long periods of stasis followed by rapid morphological change. • Explain how environmental changes (e.g., mass extinction events) can influence the rate and scale of speciation and extinction events.	
22-24	**Learning Target 8** I can evaluate the ways in which human activities act as selective pressures and influence the direction and rate of evolutionary change.	I can… • Explain how practices like intensive pesticide use or industrial fishing can lead to rapid, unintended directional selection in target populations. • Analyze a case study (e.g., changes in flowering time due to climate change, or the evolution of drug-resistant pathogens) and identify the specific human-induced selective pressure. • Discuss the ethical and biological implications of human activities that reduce genetic diversity (e.g., habitat fragmentation, artificial selection) on the long-term adaptability of populations	