



Springfield Public Schools
Springfield, New Jersey 07081

Biology Honors
Grade 9

Curriculum Guide

2026

This curriculum may be modified through varying materials, techniques, and strategies as per an individual student's IEP.

Springfield Board of Education
Approved July 27, 2026

Springfield Public Schools

Cultivating compassionate and extraordinary learners!

EXTRACT OF THE MINUTES OF A MEETING OF THE BOARD OF EDUCATION OF THE TOWNSHIP OF SPRINGFIELD COUNTY OF UNION, NEW JERSEY AS RECORDED IN THE OFFICIAL MINUTE BOOK

Resolution: 21

Introduced By: Mrs. Gamarekian

Seconded By: Vice President Rinaldi

Adopted: July 27, 2026

Curriculum Adoption

To approve the following new and revised curriculum and courses for the 2026-2027 school year:

1. High School Courses

- a. AP Cybersecurity (new course)
- b. AP Business with Personal Finance (new course)
- c. AP Biology
- d. AP Chemistry
- e. AP Physics 1
- f. PLTW Robotics and Automation
- g. PLTW Introduction to Engineering Design
- h. PLTW Principles of Engineering
- i. Biology
- j. Biology Honors
- k. Chemistry
- l. Chemistry Honors
- m. Conceptual Physics
- n. Physics
- o. Environmental Science
- p. Forensics
- q. Human Anatomy and Physiology
- r. Oceanography
- s. Science 8
- t. Molecular Biology Research Lab (new course)

2. Middle School Courses

- a. Science 6
- b. Science 7

3. Elementary School Courses

- a. Kindergarten Science
- b. Grade 1 Science
- c. Grade 2 Science

Michelle Catas, School Business Administrator/Board Secretary

(continued)

I, Michelle Calas, School Business Administrator/ Board Secretary of the Springfield Board of Education, hereby certify that the extract from the minutes of a meeting of the Board of Education duly called and held on July 27, 2026 has been compared by me with the original minute book of said Board of Education, and is a true, complete and exact copy thereof, as far as the same relates to the subject matter to on said extract.

In WITNESS THEREOF, I have hereunto set my hand and seal of the Springfield Board of Education, this 28th day of July 2026.

SEAL.



Michelle Calas

School Business Administrator/ Board Secretary



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**Springfield Public Schools
Springfield, New Jersey**

**Rachel Goldberg
Superintendent of Schools**

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Curriculum Developed By:

Dr. Norman Francis ~ Principal of Jonathan Dayton High School

Gregory Salmon ~ STEM Supervisor

Nathaniel Lazar ~ Biology Teacher

Carla Kelly ~ Biology Teacher



Unit Overview Template

Content Area: Honors Biology **Grade Level:** 9 **Unit Title:** Structure and Function, Energy, Cell Specialization and Homeostasis

Unit Summary: In this unit of study, students formulate the answer to the question “How do the structures of organisms enable life’s functions?” Students investigate explanations for the structure and functions of cells as the basic unit of life, of hierarchical organization of interacting organ systems, and of the role of specialized cells for maintenance and growth. Students apply mathematical concepts to develop evidence to support explanations of the interactions of photosynthesis and cellular respiration.

Primary Interdisciplinary Connections: Genetics

21st Century Themes ☒ Creativity and Innovation ☒ Critical Thinking and Problem Solving ☐ ICT Literacy
☒ Information Literacy ☐ Life and Career Skills ☒ Communication and Collaboration ☐ Media Literacy

Unit Rationale: Students will analyze and interpret data, use mathematical and computational thinking, and construct explanations as they demonstrate an understanding of the interrelationship between structure and function that leads to homeostasis of cells and organisms.

Career Readiness (Standard 9):

9.2.12.CAP.4: Evaluate different careers and develop various plans.

9.2.12.CAP.5: Assess and modify a personal plan to support current interests and postsecondary plans.

9.2.12.CAP.13: Analyze how the economic, social, and political conditions of a time period can affect the labor market.

9.4.12.CI.1: Demonstrate the ability to reflect, analyze, and use creative skills and ideas.

9.4.12.CI.2: Identify career pathways that highlight personal talents, skills, and abilities.

9.4.12.DC.8: Explain how increased network connectivity and computing capabilities of everyday objects allow for innovative technological approaches to climate protection.

9.4.12.GCA.1: Collaborate with individuals to analyze a variety of potential solutions to climate change effects and determine why some solutions (e.g., political, economic, cultural) may work better than others.

9.4.12.IML.1: Compare search browsers and recognize features that allow for filtering of information.

9.4.12.IML.2: Evaluate digital sources for timeliness, accuracy, perspective, credibility of the source, and relevance of information, in media, data, or other resources.

9.4.12.IML.3: Analyze data using tools and models to make valid and reliable claims, or to determine optimal design solutions.

9.4.12.TL.2: Generate data using formula-based calculations in a spreadsheet and draw conclusions about the data.

9.4.12.TL.4: Collaborate in online learning communities or social networks or virtual worlds to analyze and propose a resolution to a real-world problem.

Learning Targets

Standards: HS-LS1



Content Statements: From Molecules to Organisms: Structures and Processes

CPI#:	Cumulative Progress Indicator (CPI):
HS-LS1-1	Construct an explanation based on evidence for how the structure of DNA determines the structure of proteins which carry out the essential functions of life through systems of specialized cells.
HS-LS1-2	Develop and use a model to illustrate the hierarchical organization of interacting systems that provide specific functions within multicellular organisms.
HS-LS1-3	Plan and conduct an investigation to provide evidence that feedback mechanisms maintain homeostasis.
HS-LS1-4	Use a model to illustrate the role of cellular division (mitosis) and differentiation in producing and maintaining complex organisms.
HS-LS1-5	Use a model to illustrate how photosynthesis transforms light energy into stored chemical energy.
HS-LS1-6	Construct and revise an explanation based on evidence for how carbon, hydrogen, and oxygen from sugar molecules may combine with other elements to form amino acids and/or other large carbon-based molecules.
HS-LS1-7	Use a model to illustrate that cellular respiration is a chemical process whereby the bonds of food molecules and oxygen molecules are broken and the bonds in new compounds are formed resulting in a net transfer of energy.
8.2.12.ED.1	Use research to design and create a product or system that addresses a problem and make modifications based on input from potential consumers.
8.2.12.ED.4	Design a product or system that addresses a global problem and document decisions made based on research, constraints, trade-offs, and aesthetic and ethical considerations and share this information with an appropriate audience.

Science and Engineering Practices:

Developing and Using Models

Modeling in 9–12 builds on K–8 experiences and progresses to using, synthesizing, and developing models to predict and show relationships among variables between systems and their components in the natural and designed worlds.

- Develop and use a model based on evidence to illustrate the relationships between systems or between components of a system. (HS-LS1-2)
- Use a model based on evidence to illustrate the relationships between systems or between components of a system. (HS-LS1-4), (HS-LS1-5), (HS-LS1-7)

Planning and Carrying Out Investigations

Planning and carrying out in 9–12 builds on K–8 experiences and progresses to include investigations that provide evidence for and test conceptual, mathematical, physical, and empirical models.

- Plan and conduct an investigation individually and collaboratively to produce data to serve as the basis for evidence, and in the design: decide on types, how much, and accuracy of data



needed to produce reliable measurements and consider limitations on the precision of the data (e.g., number of trials, cost, risk, time), and refine the design accordingly. (HS-LS1-3)

Constructing Explanations and Designing Solutions

Constructing explanations and designing solutions in 9–12 builds on K–8 experiences and progresses to explanations and designs that are supported by multiple and independent student-generated sources of evidence consistent with scientific ideas, principles, and theories.

- Construct an explanation based on valid and reliable evidence obtained from a variety of sources (including students' own investigations, models, theories, simulations, peer review) and the assumption that theories and laws that describe the natural world operate today as they did in the past and will continue to do so in the future. (HS-LS1-1)
- Construct and revise an explanation based on valid and reliable evidence obtained from a variety of sources (including students' own investigations, models, theories, simulations, peer review) and the assumption that theories and laws that describe the natural world operate today as they did in the past and will continue to do so in the future. (HS-LS1-6)

Disciplinary Core Ideas (DCIs):

LS1.A: Structure and Function

- Systems of specialized cells within organisms help them perform the essential functions of life. (HS-LS1-1)
- All cells contain genetic information in the form of DNA molecules. Genes are regions in the DNA that contain the instructions that code for the formation of proteins, which carry out most of the work of cells. (HS-LS1-1)
- Multicellular organisms have a hierarchical structural organization, in which any one system is made up of numerous parts and is itself a component of the next level. (HS-LS1-2)
- Feedback mechanisms maintain a living system's internal conditions within certain limits and mediate behaviors, allowing it to remain alive and functional even as external conditions change within some range. Feedback mechanisms can encourage (through positive feedback) or discourage (negative feedback) what is going on inside the living system. (HS-LS1-3)

LS1.B: Growth and Development of Organisms

- In multicellular organisms, individual cells grow and then divide via a process called mitosis, thereby allowing the organism to grow. The organism begins as a single cell (fertilized egg) that divides successively to produce many cells, with each parent cell passing identical genetic material (two variants of each chromosome pair) to both daughter cells. Cellular division and differentiation produce and maintain a complex organism, composed of systems of tissues and organs that work together to meet the needs of the whole organism. (HS-LS1-4)

LS1.C: Organization for Matter and Energy Flow in Organisms

- The process of photosynthesis converts light energy to stored chemical energy by converting carbon dioxide plus water into sugars plus released oxygen. (HS-LS1-5)



- The sugar molecules thus formed contain carbon, hydrogen, and oxygen: their hydrocarbon backbones are used to make amino acids and other carbon-based molecules that can be assembled into larger molecules (such as proteins or DNA), used for example to form new cells. (HS-LS1-6)
- As matter and energy flow through different organizational levels of living systems, chemical elements are recombined in different ways to form different products. (HS-LS1-6), (HS-LS1-7)
- As a result of these chemical reactions, energy is transferred from one system of interacting molecules to another. Cellular respiration is a chemical process in which the bonds of food molecules and oxygen molecules are broken and new compounds are formed that can transport energy to muscles. Cellular respiration also releases the energy needed to maintain body temperature despite ongoing energy transfer to the surrounding environment. (HS-LS1-7)

Crosscutting Concepts:

Systems and System Models

- Models (e.g., physical, mathematical, computer models) can be used to simulate systems and interactions—including energy, matter, and information flows—within and between systems at different scales. (HS-LS1-2), (HS-LS1-4)

Energy and Matter

- Changes of energy and matter in a system can be described in terms of energy and matter flows into, out of, and within that system. (HS-LS1-5), (HS-LS1-6)
- Energy cannot be created or destroyed—it only moves between one place and another place, between objects and/or fields, or between systems. (HS-LS1-7)

Structure and Function

- Investigating or designing new systems or structures requires a detailed examination of the properties of different materials, the structures of different components, and connections of components to reveal its function and/or solve a problem. (HS-LS1-1)

Stability and Change

- Feedback (negative or positive) can stabilize or destabilize a system. (HS-LS1-3)

Connections to Nature of Science

Scientific Investigations Use a Variety of Methods

- Scientific inquiry is characterized by a common set of values that include: logical thinking, precision, open-mindedness, objectivity, skepticism, replicability of results, and honest and ethical reporting of findings. (HS-LS1-3)

Unit Essential Questions:



- How do we build and refine models that describe and explain the natural and designed world?
- How is scientific knowledge constructed?
- What is the basic structure of the atom and how is it related to cellular processes?
- How is matter transferred and energy transferred and transformed in living systems?
- How is conservation of matter represented in biochemical processes?
- What is the effect on the rate of reactions when conditions are varied?
- How are food molecules built and broken down by cells?
- How does structure relate to function in living systems from the organism to the cellular level?

Unit Enduring Understandings:

- Cells are the basic unit of life.
- There are levels of organization at the cellular level among prokaryotes and eukaryotes.
- Cells are specialized to carry out different functions.
- Subcellular structures are specialized organelles that carry out different functions to increase efficiency.
- Organisms regulate homeostasis using negative and positive feedback systems.
- Cells and organisms regulate concentration of internal water and solutes.
- DNA codes for the formation of proteins that function in a variety of ways to maintain homeostasis.
- Photosynthesis and cellular respiration (including anaerobic processes) provide most of the energy for life processes.
- Photosynthesis and cellular respiration are important components of the carbon cycle, in which carbon is exchanged among the biosphere, atmosphere, oceans, and geosphere through chemical, physical, geological, and biological processes.
- The main way that solar energy is captured and stored on Earth is through the complex chemical process known as photosynthesis.
- Cells divide through the process of mitosis, resulting in daughter cells that have the same genetic composition as the original cell.

Unit Learning Targets:

Students will....

- Develop a model that will explain how the fundamental life processes of organisms depend on a variety of chemical reactions that occur in specialized areas of the organism's cells.
- Model how cells are enclosed within semipermeable membranes that regulate their interaction with their surroundings, including the transport of materials into and out of the cell.
- Develop a model that will explain how the many cells in an individual can be very different from one another, even though they are all descended from a single cell and thus have essentially identical genetic instructions.
- Trace the general process where the progeny from a single cell form an embryo in which the cells multiply and differentiate to form the many specialized cells, tissues and organs that comprise the final organism.
- Present evidence that supports the concept that complex multicellular organisms are formed as a highly organized arrangement of differentiated cells.



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- Providing examples of how photosynthesis and cellular respiration are related and necessary to maintain homeostasis and provide energy.



Evidence of Learning

Summative Assessment: Unit Assessment and Labs

Equipment Needed: Teacher laptop, lab equipment

Teacher Resources: Textbook, lab activities and supplies

Formative Assessments:

- Quizzes
- Assignments
- Activities
- Labs
- Project



Lesson Plans

Lesson	Time Frame
Lesson 1 Why Aren't all Elephants the Same Size?	3 days
Lesson 2 Membrane Channels	3 day
Lesson 3 How Does Energy Flow?	3 days

Teacher Notes:

Students will work collaboratively to design models.

Curriculum Development Resources/Technology Resources:

Click the links below to access additional resources used to design this unit:

<https://concord.org/stem-resources/leaf-photosynthesis>

<https://phet.colorado.edu/en/simulation/membrane-channels>

<http://www.hhmi.org/biointeractive/biology-cells>

<http://outreach.mcb.harvard.edu/teachers/Summer09/KarynCoulon/TeacherNotes.pdf>



Lesson Plan 1 Template

Content Area: Honors Biology Lesson Title: Why Aren't Elephants the Same Size?
 Time Frame: 3 days

Lesson Components

21st Century Themes

- ☒ Global Awareness ☐ Financial, Economic, Business and Entrepreneurial Literacy
☒ Civic Literacy ☒ Health Literacy

21st Century Skills

- ☒ Creativity and Innovation ☒ Critical Thinking and Problem Solving ☒ Information Literacy
☐ Life and Career Skills ☒ Communication and Collaboration ☒ Media Literacy ☒ ICT Literacy

Interdisciplinary Connections:

Genetics

Integration of Technology:

- iPads for data analysis, modeling, and digital presentation creation
- Vernier Go Direct sensors for optional exploration of scale relationships and measurement accuracy in model testing
- Google Sheets for calculating and graphing surface area to volume relationships
- Digital presentation tools (Google Slides or equivalent) for model construction and explanation

Equipment Needed:

- Rulers
- Calculators
- Paper, tape, and clay for physical cell models
- Grid paper for scaling and visualization
- Optional modeling templates for structured surface area and volume calculations

Goals/Objectives	Learning Activities/ Instructional Strategies	Formative Assessment Tasks
Students will: • Calculate surface area and volume for objects of different sizes • Analyze how changes in size affect surface area to volume ratio • Construct and revise models to explain why cells must remain small or divide • Use evidence to explain how cell division and differentiation support organism growth and homeostasis	Lesson Sequence Anchoring Phenomenon: "Why Aren't All Elephants The Same Size?" 1. Students observe images and data showing: ○ Elephants of different sizes within populations ○ Microscopic comparison of small vs large cells	• Surface area and volume calculations checked during modeling work • Google Sheets graph of surface area to volume ratio • Initial written explanation of size limitation phenomenon • Mid-lesson model checkpoint (must include accurate relationship between size and efficiency)



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| <ul style="list-style-type: none"> • Communicate how structure influences function in biological systems | <ul style="list-style-type: none"> ○ Organisms ranging from single-celled to multicellular <ol style="list-style-type: none"> 2. Students record initial ideas about why size might be biologically constrained 3. Class discussion surfaces questions about limits to growth and structure 4. Students construct physical models of three differently sized cubes representing cells 5. Students calculate surface area and volume for each model 6. Students record data and begin identifying patterns in how ratios change with size 7. Students organize results in a shared Google Sheet 8. Students graph surface area to volume ratios across different sizes 9. Students identify and describe patterns in how efficiency changes with scale 10. Students connect mathematical findings to biological function: <ul style="list-style-type: none"> ○ How surface area relates to nutrient and waste exchange ○ Why larger cells become less efficient at exchange 11. Students refine initial explanations based on quantitative evidence 12. Students build or revise a model explaining why cells divide rather than continuously grow 13. Students incorporate: | <ul style="list-style-type: none"> • Final explanation connecting: <ul style="list-style-type: none"> ○ Cell size ○ Mitosis ○ Differentiation ○ Homeostasis |
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- Mitosis as a mechanism for maintaining efficiency
- Structure-function relationships in cells
- 14. Peer review is used to test clarity and completeness of models
- 15. Students analyze how differentiation allows cells to specialize while maintaining overall organism function
- 16. Students connect cell specialization to system-level organization in multicellular organisms
- 17. Students revise explanations to include both division and differentiation as linked processes
- 18. Students construct a final explanation addressing:
 - Why size is limited in cells
 - How mitosis supports growth and homeostasis
 - How differentiation supports complex organism function
- 19. Students submit a model-based response using evidence from calculations, models, and peer feedback

Differentiation:

- Scaffolded calculation templates for surface area and volume
- Extension tasks using irregular shapes or real cell images for comparison
- Choice of model representation (physical, digital, or hybrid)
- Structured group roles (calculator, model builder, recorder, presenter)
- Sentence frames for explaining cause-and-effect relationships in biology

Resources Provided:

- Model construction materials (paper, tape, clay)
- Surface area and volume calculation guides
- Graphing template in Google Sheets
- Model explanation scaffold



- Exit ticket prompts
- Rubric for structure-function biological modeling



Lesson Plan 2 Template

Content Area: Honors Biology Lesson Title: Membrane Channels Time Frame: 3 days

Lesson Components

21st Century Themes

- ☒ Global Awareness ☒ Financial, Economic, Business and Entrepreneurial Literacy
☒ Civic Literacy ☒ Health Literacy

21st Century Skills

- ☒ Creativity and Innovation ☒ Critical Thinking and Problem Solving ☒ Information Literacy
☐ Life and Career Skills ☒ Communication and Collaboration ☒ Media Literacy ☒ ICT Literacy

Interdisciplinary Connections:

Genetics

Integration of Technology:

- PhET Membrane Channels simulation to model selective permeability and particle movement
- Google Sheets for organizing dialysis tubing data and comparing diffusion rates across conditions
- Digital lab recording tools on iPads for capturing observations, diagrams, and data
- Video clips illustrating real-world applications of membrane transport in medical dialysis and biotechnology
- Optional interactive annotation tools for labeling membrane structures and transport pathways

Equipment Needed:

- Student iPads
- Dialysis tubing
- Beakers
- Corn syrup, glucose solution, starch solution, iodine solution, and water
- String or clips for sealing tubing
- Graduated cylinders for measuring volumes
- Paper, pipe cleaners, beads, and other craft materials for membrane modeling
- Desks or tape to structure human diffusion simulation space

Goals/Objectives	Learning Activities/ Instructional Strategies	Formative Assessment Tasks
Students will: • Investigate diffusion through membrane channels using physical and simulated models • Design and conduct a controlled investigation using dialysis tubing to model selective permeability	Lesson Sequence Anchoring Phenomenon: “How do cells control what enters and leaves them?” 1. Students participate in a human diffusion simulation:	• Observation notes from human diffusion simulation • Dialysis tubing lab data table and analysis • Google Sheets graph or summary of diffusion trends



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| <ul style="list-style-type: none">• Collect, organize, and analyze qualitative and quantitative data on molecular movement• Develop and revise models of membrane structure and function• Construct an evidence-based explanation of how membrane channels support cellular homeostasis• Connect membrane transport processes to real-world biological, medical, and biotechnological systems | <ul style="list-style-type: none">○ Room represents a cell environment with areas of high and low concentration○ Students represent particles moving randomly○ A “membrane barrier” is created using desks with limited taped openings representing channels <ol style="list-style-type: none">2. Students observe and record how movement changes when only certain pathways are available3. Students generate questions about why only some particles can pass and how selectivity might work4. Students design and conduct a dialysis tubing investigation:<ul style="list-style-type: none">○ Tubing filled with different solute solutions placed in beakers○ Students observe diffusion over time and record changes5. Students collect qualitative and quantitative data on movement of substances6. Students record results in iPads and organize data in Google Sheets7. Students analyze diffusion data: | <ul style="list-style-type: none">• PhET simulation response questions (predict, test, revise cycle)• Model checkpoint: accuracy of membrane structure and channel representation• Final CER explanation linking structure, function, and homeostasis |
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- Compare rate and direction of movement across different substances
 - Identify patterns in permeability and molecule size/behavior
- 8. Students connect experimental results back to human diffusion simulation
- 9. Students use PhET membrane channels simulation:
 - Manipulate channel number, concentration gradients, and molecule types
- 10. Students compare simulation outcomes with lab results and refine explanations of diffusion mechanisms
- 11. Students construct and revise physical models of the plasma membrane:
 - Include phospholipid bilayer, channel proteins, and selective pathways
 - Use materials such as beads, pipe cleaners, and paper
- 12. Students revise models based on peer critique and evidence from investigation and simulation
- 13. Students apply their model to explain



- real-world biological and applied contexts:
- How kidney dialysis machines mimic membrane function
 - How drug delivery depends on membrane transport
 - How cells maintain internal stability despite environmental change
14. Students discuss how industries such as healthcare and biotechnology rely on controlling diffusion and transport processes
15. Students develop a final Claim–Evidence–Reasoning explanation:
- Claim: How membrane channels regulate movement
 - Evidence: Dialysis lab, simulation data, and diffusion modeling
 - Reasoning: Connection to concentration gradients and homeostasis
16. Students present and defend their models in small group peer review

Differentiation:

- Structured lab roles (materials manager, data recorder, analyst, presenter)
- Scaffolded CER templates for writing support
- Extension tasks involving disease connections (e.g., cystic fibrosis and ion channels)



- Choice of model format (physical, digital, or hybrid)
- Guided vs open-ended data analysis templates
- Sentence frames for scientific reasoning and comparison

Resources Provided:

- PhET simulation link and guided exploration sheet
- Dialysis lab protocol handout
- Data tables for recording observations
- CER writing scaffold
- Membrane modeling template
- Exit ticket prompts
- Textbook reference for membrane structure and transport



Lesson Plan 3 Template

Content Area: Honors Biology Lesson Title: How does Energy Flow? Time Frame: 3 days

Lesson Components

21st Century Themes

- ☒ Global Awareness ☒ Financial, Economic, Business and Entrepreneurial Literacy
☒ Civic Literacy ☒ Health Literacy

21st Century Skills

- ☒ Creativity and Innovation ☒ Critical Thinking and Problem Solving ☒ Information Literacy
☐ Life and Career Skills ☒ Communication and Collaboration ☒ Media Literacy ☒ ICT Literacy

Interdisciplinary Connections:

Genetics

Integration of Technology:

- iPads for data analysis, modeling, and simulation-based learning
- Vernier Go Direct sensors to measure respiration rates, temperature change, or CO₂ production in lab setups
- PhET simulations for modeling photosynthesis, cellular respiration, and energy transfer processes
- Google Sheets for organizing experimental data and tracing carbon/oxygen movement quantitatively
- Digital modeling tools on iPads for constructing and revising energy flow diagrams

Equipment Needed:

- Student iPads
- Teacher laptop for analysis and modeling
- Vernier Go Direct sensors (CO₂, O₂, or temperature probes if available)
- Respirometers or simple respiration lab materials (beans, yeast, or germinating seeds)
- Beakers, tubing, and basic lab glassware
- Chart paper or modeling templates for energy and matter cycling diagrams
- Colored markers, string, or tokens for kinesthetic carbon/oxygen tracking activity
- Timer or stopwatch

Goals/Objectives	Learning Activities/ Instructional Strategies	Formative Assessment Tasks
Students will: • Analyze the reactants and products of photosynthesis and cellular respiration (aerobic and anaerobic) • Construct explanations of how matter cycles and	Lesson Sequence Anchoring Phenomenon: "Where does the energy in living systems actually go?" 1. Students observe contrasting scenarios:	• Kinesthetic model tracking sheet of carbon and oxygen movement • Lab data from cellular respiration investigation



energy transfers in biological systems - Trace the movement of carbon and oxygen through biological processes using models - Design and build representations of energy flow and matter cycling - Connect cellular processes to homeostasis at both cellular and ecosystem scales - Evaluate how disruptions in energy flow impact biological and environmental systems	- A sprouting seed that grows without external food input - A resting organism that still consumes oxygen - Ecosystems where energy appears to “disappear” over time - Students record initial ideas about where energy comes from and where it goes - Class discussion surfaces confusion between energy flow and matter cycling - Students engage in a kinesthetic carbon and oxygen tracking simulation: - Students represent carbon and oxygen atoms moving through photosynthesis and cellular respiration - Movement pathways include plants, animals, atmosphere, and decomposition routes - Students record pathways and identify recurring cycles - Students analyze chemical equations for photosynthesis and cellular respiration: - Identify reactants and products	- Google Sheets graphs of gas exchange or respiration rates - PhET simulation checkpoints (prediction, testing, revision) - Model checkpoint focusing on accuracy of energy vs matter distinction - Final CER-style explanation linking cellular processes to system-level homeostasis
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- Connect equations to observed movement in kinesthetic model
- 7. Students begin constructing a conceptual explanation of energy transfer vs matter cycling
- 8. Students conduct a lab investigation on cellular respiration:
 - Use germinating seeds, yeast, or plant material
 - Measure CO₂ production or oxygen consumption using Vernier Go Direct sensors
- 9. Students record and graph data in Google Sheets
- 10. Students compare lab results to models and simulations:
 - PhET simulations of photosynthesis and respiration
 - Students adjust models based on differences between predicted and observed results
- 11. Students construct a physical or digital model showing:
 - Photosynthesis
 - Cellular respiration (aerobic and anaerobic)
 - Carbon and oxygen cycling



- Energy flow through systems (not recycled, but transferred)
- 12. Students revise models after peer critique and evidence review
- 13. Students extend models to ecosystem and real-world contexts:
 - How energy flow supports food webs and agriculture systems
 - How disruptions in energy flow impact ecosystems and food supply chains
 - How industries (agriculture, energy production, biotechnology) rely on managing biological energy systems
- 14. Students discuss how biological energy systems influence economic systems such as food production, biofuels, and medical biotechnology
- 15. Students construct a final evidence-based explanation:
 - How photosynthesis and cellular respiration are connected
 - How carbon and oxygen cycle through systems



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- How energy flows through biological systems and is transformed
 - How these processes maintain homeostasis at multiple scales
16. Students present models and participate in structured peer evaluation

Differentiation:

- Choice of model format (physical, digital, kinesthetic, or hybrid)
- Scaffolded data tables and guided graphing templates
- Extension analysis using anaerobic vs aerobic respiration comparison
- Structured roles in lab groups (data collector, sensor manager, model builder, presenter)
- Sentence frames for explaining energy flow vs matter cycling
- Tiered modeling templates for varying complexity

Resources Provided:

- Photosynthesis and respiration equation reference sheet
- Lab protocol for respiration investigation
- Data recording templates
- PhET simulation guide
- Model construction templates
- CER writing scaffold
- Peer evaluation checklist
- Exit ticket prompts



Lesson Reflection

Reflect on the lesson you have developed and rate the degree to which the lesson **Strongly, Moderately** or **Weakly** meets the criteria below.

Lesson Activities	Strongly	Moderately	Weakly
Are challenging and require higher order thinking and problem solving skills	☒	☐	☐
Allow for student choice	☒	☐	☐
Provide scaffolding for acquiring targeted knowledge/skills	☒	☐	☐
Integrate global perspectives	☐	☒	☐
Integrate 21st century skills	☐	☒	☐
Provide opportunities for interdisciplinary connection and transfer of knowledge and skills	☒	☐	☐
Foster student use of technology as a tool to develop critical thinking, creativity and innovation skills	☒	☐	☐
Are varied to address different student learning styles and preferences	☒	☐	☐
Are differentiated based on student needs	☒	☐	☐
Are student-centered with teacher acting as a facilitator and co-learner during the teaching and learning process	☒	☐	☐
Provide means for students to demonstrate knowledge and skills and progress in meeting learning goals and objectives	☒	☐	☐
Provide opportunities for student reflection and self- assessment	☒	☐	☐
Provide data to inform and adjust instruction to better meet the varying needs of learners	☒	☐	☐

Curriculum Design Template

Content Area: Science **Grade Level:** 9 **Unit Title:** Structure and Function, Energy, Cell Specialization and Homeostasis

Created: 2026

Board Approved on:



Unit Overview Template

Content Area: Honors Biology **Grade Level:** 9 **Unit Title:** Ecosystems: Interactions Energy and Dynamics

Unit Summary: In this unit of study, students formulate answers to the question “how and why do organisms interact with each other (biotic factors) and their environment (abiotic factors), and what affects these interactions?” Students construct explanations for the role of energy in the cycling of matter in organisms and ecosystems. They apply mathematical concepts to develop evidence to support explanations of the interactions of photosynthesis and cellular respirations. Students also understand organisms’ interactions with each other and their physical environment and how organisms obtain resources. Secondary ideas include the interdependent relationships in ecosystems; dynamics of ecosystems; and functioning, resilience, and social interactions, including group behavior. Students examine factors that have influenced the distribution and development of human society: these factors include climate, natural resource availability, and natural disasters. Students analyze how earth systems are being modified by human activity. Students use mathematical reasoning and models to make sense of carrying capacity, factors affecting biodiversity and populations, the cycling of matter and flow of energy through systems. Students design, evaluate and refine solutions for reducing the impact of human activities on the environment and maintaining biodiversity. The crosscutting concepts of scale, proportion, and quantity and stability and change are organizing concepts for the disciplinary core ideas.

Primary Interdisciplinary Connections: Environmental Science and Engineering

21st Century Themes ☒ Creativity and Innovation ☒ Critical Thinking and Problem Solving ☐ ICT Literacy
☐ Information Literacy ☐ Life and Career Skills ☒ Communication and Collaboration ☐ Media Literacy

Unit Rationale: Students will analyze and interpret data, use mathematical and computational thinking, and construct explanations as they demonstrate understanding of systems and the effect of human activity on the environment and maintaining biodiversity.

Career Readiness (Standard 9):

9.2.12.CAP.4: Evaluate different careers and develop various plans

9.2.12.CAP.5: Assess and modify a personal plan to support current interests and postsecondary plans.

9.2.12.CAP.13: Analyze how the economic, social, and political conditions of a time period can affect the labor market.

9.4.12.CI.1: Demonstrate the ability to reflect, analyze, and use creative skills and ideas.

9.4.12.CI.2: Identify career pathways that highlight personal talents, skills, and abilities.

9.4.12.DC.8: Explain how increased network connectivity and computing capabilities of everyday objects allow for innovative technological approaches to climate protection.

9.4.12.GCA.1: Collaborate with individuals to analyze a variety of potential solutions to climate change effects and determine why some solutions (e.g., political, economic, cultural) may work better than others.



- 9.4.12.IML.1: Compare search browsers and recognize features that allow for filtering of information.
- 9.4.12.IML.2: Evaluate digital sources for timeliness, accuracy, perspective, credibility of the source, and relevance of information, in media, data, or other resources.
- 9.4.12.IML.3: Analyze data using tools and models to make valid and reliable claims, or to determine optimal design solutions.
- 9.4.12.TL.2: Generate data using formula-based calculations in a spreadsheet and draw conclusions about the data.
- 9.4.12.TL.4: Collaborate in online learning communities or social networks or virtual worlds to analyze and propose a resolution to a real-world problem.

Learning Targets	
Standards: HS-LS2, HS-ETS1, HS-ESS1	
Content Statements: Ecosystems: Interactions, Energy, and Dynamics; Engineering Design; Earth's Place in the Universe	
CPI#:	Cumulative Progress Indicator (CPI):
HS-LS2-1.	Use mathematical and/or computational representations to support explanations of factors that affect carrying capacity of ecosystems at different scales.
HS-LS2-2.	Use mathematical representations to support and revise explanations based on evidence about factors affecting biodiversity and populations in ecosystems of different scales.
HS-LS2-3.	Construct and revise an explanation based on evidence for the cycling of matter and flow of energy in aerobic and anaerobic conditions.
HS-LS2-4.	Use mathematical representations to support claims for the cycling of matter and flow of energy among organisms in an ecosystem.
HS-LS2-5.	Develop a model to illustrate the role of photosynthesis and cellular respiration in the cycling of carbon among the biosphere, atmosphere, hydrosphere, and geosphere.
HS-LS2-6.	Evaluate the claims, evidence, and reasoning that the complex interactions in ecosystems maintain relatively consistent numbers and types of organisms in stable conditions, but changing conditions may result in a new ecosystem.
HS-LS2-7	Design, evaluate, and refine a solution for reducing the impacts of human activities on the environment and biodiversity.
HS-LS2-8	Evaluate the evidence for the role of group behavior on individual and species' chances to survive and reproduce.
HS-ESS1-1	Develop a model based on evidence to illustrate the life span of the sun and the role of nuclear fusion in the sun's core to release energy that eventually reaches Earth in the form of radiation.
HS-ESS1-4	Use mathematical or computational representations to predict the motion of orbiting objects in the solar system.
HS-ESS1-5	Evaluate evidence of the past and current movements of continental and oceanic crust and the theory of plate tectonics to explain the ages of crustal rocks.



HS-ESS1-6	Apply scientific reasoning and evidence from ancient Earth materials, meteorites, and other planetary surfaces to construct an account of Earth's formation and early history.
HS-ETS1-1	Analyze a major global challenge to specify qualitative and quantitative criteria and constraints for solutions that account for societal needs and wants.
HS-ETS1-2	Design a solution to a complex real-world problem by breaking it down into smaller, more manageable problems that can be solved through engineering.
HS-ETS1-3	Evaluate a solution to a complex real-world problem based on prioritized criteria and trade-offs that account for a range of constraints, including costs, safety, reliability, and aesthetics, as well as possible social, cultural, and environmental impacts.
HS-ETS1-4	Use a computer simulation to model the impact of proposed solutions to a complex real-world problem with numerous criteria and constraints on interactions within and between systems relevant to the problem.
Math.F-LE.A	Construct and compare linear and exponential models and solve problems.
8.2.12.ETW.1	Evaluate ethical considerations regarding the sustainability of environmental resources that are used for the design, creation, and maintenance of a chosen product.
8.2.12.ETW.3	Identify a complex, global environmental or climate change issue, develop a systemic plan of investigation, and propose an innovative sustainable solution.

Science and Engineering Practices:

Developing and Using Models

Modeling in 9–12 builds on K–8 experiences and progresses to using, synthesizing, and developing models to predict and show how relationships among variables between systems and their components in the natural and designed worlds.

- Develop a model based on evidence to illustrate the relationships between systems or components of a system. (HS-LS2-5)

Using Mathematics and Computational Thinking

Mathematical and computational thinking in 9–12 builds on K–8 experiences and progresses to using algebraic thinking and analysis, a range of linear and nonlinear functions including trigonometric functions, exponentials and logarithms, and computational tools for statistical analysis to analyze, represent, and model data. Simple computational simulations are created and used based on mathematical models of basic assumptions.

- Use mathematical and/or computational representations of phenomena or design solutions to support explanations. (HS-LS2-1)
- Use mathematical representations of phenomena or design solutions to support and revise explanations. (HS-LS2-2)
- Use mathematical representations of phenomena or design solutions to support claims. (HS-LS2-4)



Asking Questions and Defining Problems

Asking questions and defining problems in 9–12 builds on K–8 experiences and progresses to formulating, refining, and evaluating empirically testable questions and design problems using models and simulations.

- Analyze complex real-world problems by specifying criteria and constraints for successful solutions. (HS-ETS1-1)

Using Mathematics and Computational Thinking

Mathematical and computational thinking in 9–12 builds on K–8 experiences and progresses to using algebraic thinking and analysis, a range of linear and nonlinear functions including trigonometric functions, exponentials and logarithms, and computational tools for statistical analysis to analyze, represent, and model data. Simple computational simulations are created and used based on mathematical models of basic assumptions.

- Use mathematical models and/or computer simulations to predict the effects of a design solution on systems and/or the interactions between systems. (HS-ETS1-4)

Constructing Explanations and Designing Solutions

Constructing explanations and designing solutions 9–12 builds on K – experiences and progresses to explanations and designs that are supported by multiple and independent student-generated sources of evidence consistent with scientific ideas, principles and theories.

- Design a solution to a complex real-world problem, based on scientific knowledge, student generated sources of evidence, prioritized criteria, and tradeoff considerations. (HS-ETS1-2)
- Evaluate a solution to a complex real-world problem, based on scientific knowledge, student generated sources of evidence, prioritized criteria, and tradeoff considerations. (HS-ETS1-3)

Disciplinary Core Ideas (DCIs):

LS2.A: Interdependent Relationships in Ecosystems

- Ecosystems have carrying capacities, which are limits to the numbers of organisms and populations they can support. These limits result from such factors as the availability of living and nonliving resources and from such challenges such as predation, competition, and disease. Organisms would have the capacity to produce populations of great size were it not for the fact that environments and resources are finite. This fundamental tension affects the abundance (number of individuals) of species in any given ecosystem. (HS-LS2-1), (HS-LS2-2)

LS2.B: Cycles of Matter and Energy Transfer in Ecosystems

- Photosynthesis and cellular respiration (including anaerobic processes) provide most of the energy for life processes. (HS-LS2-3)
- Plants or algae form the lowest level of the food web. At each link upward in a food web, only a small fraction of the matter consumed at the lower level is transferred upward, to produce growth and release energy in cellular respiration at the higher level. Given this inefficiency, there are generally fewer organisms at higher levels of a food web. Some matter reacts to



release energy for life functions, some matter is stored in newly made structures, and much is discarded. The chemical elements that make up the molecules of organisms pass through food webs and into and out of the atmosphere and soil, and they are combined and recombined in different ways. At each link in an ecosystem, matter and energy are conserved. (HS-LS2-4)

- Photosynthesis and cellular respiration are important components of the carbon cycle, in which carbon is exchanged among the biosphere, atmosphere, oceans, and geosphere through chemical, physical, geological, and biological processes. (HS-LS2-5)

LS2.C: Ecosystem Dynamics, Functioning, and Resilience

- A complex set of interactions within an ecosystem can keep its numbers and types of organisms relatively constant over long periods of time under stable conditions. If a modest biological or physical disturbance to an ecosystem occurs, it may return to its more or less original status (i.e., the ecosystem is resilient), as opposed to becoming a very different ecosystem. Extreme fluctuations in conditions or the size of any population, however, can challenge the functioning of ecosystems in terms of resources and habitat availability. (HS-LS2-2), (HS-LS2-6)
- Moreover, anthropogenic changes (induced by human activity) in the environment—including habitat destruction, pollution, introduction of invasive species, overexploitation, and climate change—can disrupt an ecosystem and threaten the survival of some species. (HS-LS2-7)

LS4.D: Biodiversity and Humans

- Biodiversity is increased by the formation of new species (speciation) and decreased by the loss of species (extinction). (secondary to HS-LS2-7)
- Humans depend on the living world for the resources and other benefits provided by biodiversity. But human activity is also having adverse impacts on biodiversity through overpopulation, overexploitation, habitat destruction, pollution, introduction of invasive species, and climate change. Thus sustaining biodiversity so that ecosystem functioning and productivity are maintained is essential to supporting and enhancing life on Earth. Sustaining biodiversity also aids humanity by preserving landscapes of recreational or inspirational value. (secondary to HS-LS2-7) (Note: This Disciplinary Core Idea is also addressed by HS-LS4-6.)

PS3.D: Energy in Chemical Processes

- The main way that solar energy is captured and stored on Earth is through the complex chemical process known as photosynthesis. (secondary to HS-LS2-5)

ETS1.B: Developing Possible Solutions

- When evaluating solutions, it is important to take into account a range of constraints including cost, safety, reliability and aesthetics and to consider social, cultural and environmental impacts. (secondary to HS-LS2-7).

Delimiting Engineering Problems



- Criteria and constraints also include satisfying any requirements set by society, such as taking issues of risk mitigation into account, and they should be quantified to the extent possible and stated in such a way that one can tell if a given design meets them. (HS-ETS1-1)
- Humanity faces major global challenges today, such as the need for supplies of clean water and food or for energy sources that minimize pollution, which can be addressed through engineering. These global challenges also may have manifestations in local communities. (HS-ETS1-1)

ETS1.B: Developing Possible Solutions

- When evaluating solutions, it is important to take into account a range of constraints, including cost, safety, reliability, and aesthetics, and to consider social, cultural, and environmental impacts. (HS-ETS1-3)
- Both physical models and computers can be used in various ways to aid in the engineering design process. Computers are useful for a variety of purposes, such as running simulations to test different ways of solving a problem or to see which one is most efficient or economical; and in making a persuasive presentation to a client about how a given design will meet his or her needs. (HS-ETS1-4)

ETS1.C: Optimizing the Design Solution

- Criteria may need to be broken down into simpler ones that can be approached systematically, and decisions about the priority of certain criteria over others (tradeoffs) may be needed. (HS-ETS1-2)

Crosscutting Concepts:

Cause and Effect

- Empirical evidence is required to differentiate between cause and correlation and make claims about specific causes and effects. (HS-LS2-8)

Scale, Proportion, and Quantity

- The significance of a phenomenon is dependent on the scale, proportion, and quantity at which it occurs. (HS-LS2-1)
- Using the concept of orders of magnitude allows one to understand how a model at one scale relates to a model at another scale. (HS-LS2-2)

Systems and System Models

- Models (e.g., physical, mathematical, computer models) can be used to simulate systems and interactions—including energy, matter, and information flows—within and between systems at different scales. (HS-ETS1-4)

Energy and Matter

- Energy cannot be created or destroyed—it only moves between one place and another place, between objects and/or fields, or between systems. (HS-LS2-4)



- Energy drives the cycling of matter within and between systems. (HS-LS2-3)

Stability and Change

- Much of science deals with constructing explanations of how things change and how they remain stable. (HS-LS2-6), (HS-LS2-7)

Connections to Nature of Science

Scientific Knowledge is Open to Revision in Light of New Evidence

- Most scientific knowledge is quite durable, but is, in principle, subject to change based on new evidence and/or reinterpretation of existing evidence. (HS-LS2-2), (HS-LS2-3)
- Scientific argumentation is a mode of logical discourse used to clarify the strength of relationships between ideas and evidence that may result in revision of an explanation. (HS-LS2-6), (HS-LS2-8)

Connections to Engineering, Technology, and Applications of Science

Influence of Science, Engineering, and Technology on Society and the Natural World

- New technologies can have deep impacts on society and the environment, including some that were not anticipated. Analysis of costs and benefits is a critical aspect of decisions about technology. (HS-ETS1-1), (HS-ETS1-3)

Unit Essential Questions:

- How and why do organisms interact with each other (biotic factors) and their environment (abiotic factors) and what affects these interactions?
- How is mathematics used to analyze changes in the ecosystem?
- How does matter cycle through an ecosystem?
- How does energy flow through an ecosystem?
- What are the effects of human activity on the biosphere?

Unit Enduring Understandings:

- Ecosystems have carrying capacities, which are limits to the numbers of organisms and populations they can support. These limits result from such factors as the availability of living and nonliving resources and from such challenges such as predation, competition, and disease. Organisms would have the capacity to produce populations of great size were it not for the fact that environments and resources are finite. This fundamental tension affects the abundance (number of individuals) of species in any given ecosystem.
- Photosynthesis and cellular respiration (including anaerobic processes) provide most of the energy for life processes.
- Plants or algae form the lowest level of the food web. At each link upward in a food web, only a small fraction of the matter consumed at the lower level is transferred upward, to produce growth and release energy in cellular respiration at the higher level. Given this inefficiency,



there are generally fewer organisms at higher levels of a food web. Some matter reacts to release energy for life functions, some matter is stored in newly made structures, and much is discarded. The chemical elements that make up the molecules of organisms pass through food webs and into and out of the atmosphere and soil, and they are combined and recombined in different ways. At each link in an ecosystem, matter and energy are conserved.

- Photosynthesis and cellular respiration are important components of the carbon cycle, in which carbon is exchanged among the biosphere, atmosphere, oceans, and geosphere through chemical, physical, geological, and biological processes.
- A complex set of interactions within an ecosystem can keep its numbers and types of organisms relatively constant over long periods of time under stable conditions. If a modest biological or physical disturbance to an ecosystem occurs, it may return to its more or less original status (i.e., the ecosystem is resilient), as opposed to becoming a very different ecosystem. Extreme fluctuations in conditions or the size of any population, however, can challenge the functioning of ecosystems in terms of resources and habitat availability.
- Anthropogenic changes (induced by human activity) in the environment—including habitat destruction, pollution, introduction of invasive species, overexploitation, and climate change—can disrupt an ecosystem and threaten the survival of some species.
- Group behavior has evolved because membership can increase the chances of survival for individuals and their genetic relatives.
- Biodiversity is increased by the formation of new species (speciation) and decreased by the loss of species (extinction).
- Humans depend on the living world for the resources and other benefits provided by biodiversity. But human activity is also having adverse impacts on biodiversity through overpopulation, overexploitation, habitat destruction, pollution, introduction of invasive species, and climate change.
- Sustaining biodiversity so that ecosystem functioning and productivity are maintained is essential to supporting and enhancing life on Earth. Sustaining biodiversity also aids humanity by preserving landscapes of recreational or inspirational value.
- The main way that solar energy is captured and stored on Earth is through the complex chemical process known as photosynthesis.
- When evaluating solutions it is important to take into account a range of constraints including cost, safety, reliability and aesthetics and to consider social, cultural and environmental impacts.

Unit Learning Targets:

- Students will....
- Use a model to illustrate how photosynthesis transforms light energy into stored chemical energy.
- Use mathematical representations to support claims for the cycling of matter and flow of energy among organisms in an ecosystem.
- Develop a model to illustrate the role of photosynthesis and cellular respiration in the cycling of carbon among the biosphere, atmosphere, hydrosphere, and geosphere.
- Use mathematical and/or computational representations to support explanations of factors that affect carrying capacity of ecosystems at different scales.



- Use mathematical representations to support and revise explanations based on evidence about factors affecting biodiversity and populations in ecosystems of different scales.
- Construct and revise an explanation based on evidence for the cycling of matter and flow of energy in aerobic and anaerobic conditions.
- Evaluate the claims, evidence, and reasoning that the complex interactions in ecosystems maintain relatively consistent numbers and types of organisms in stable conditions, but changing conditions may result in a new ecosystem.
- Design, evaluate, and refine a solution for reducing the impacts of human activities on the environment and biodiversity.
- Evaluate the evidence for the role of group behavior on individual and species' chances to survive and reproduce.
- Construct an explanation based on evidence for how the availability of natural resources, occurrence of natural hazards, and changes in climate have influenced human activity.
- Use a computational representation to illustrate the relationships among Earth systems and how those relationships are being modified due to human activity.
- Analyze geoscience data and the results from global climate models to make an evidence-based forecast of the current rate of global or regional climate change and associated future impacts to Earth systems.
- Evaluate or refine a technological solution that reduces impacts of human activities on natural systems.
- Create a computational simulation to illustrate the relationships among management of natural resources, the sustainability of human populations, and biodiversity.
- Design, evaluate, and refine a solution for reducing the impacts of human activities on the environment and biodiversity.
- Create or revise a simulation to test a solution to mitigate adverse impacts of human activity on biodiversity.
- Analyze a major global challenge to specify qualitative and quantitative criteria and constraints for solutions that account for societal needs and wants.
- Design a solution to a complex real-world problem by breaking it down into smaller, more manageable problems that can be solved through engineering.



Evidence of Learning

Summative Assessment: Unit Assessment and Labs

Equipment Needed: Teacher laptop, lab equipment

Teacher Resources: Textbook, lab activities and supplies

Formative Assessments:

- Quizzes
- Assignments
- Activities
- Labs
- Project



Lesson Plans

Lesson	Time Frame
Lesson 1 Ecosystem Under Investigation – Trophic Cascade	3 days
Lesson 2 The "Eco-Audit" – Habitat Investigative Reports	1 day
Lesson 3 The "Human Surge" – Global Population Investigative Reports	1 day

Teacher Notes: Students may work alone or with up to two students on projects.

Curriculum Development Resources/Technology Resources:

Click the links below to access additional resources used to design this unit:

<http://www.nature.com/scitable>

www.nytimes.org

<https://www3.epa.gov/>

<http://www.conserve-energy-future.com/15-current-environmental-problems.php>

<http://www.nature.org/ourinitiatives/urgentissues/>

<http://datanuggets.org/>

<http://www.hhmi.org/educational-materials>



Lesson Plan 1 Template

Content Area: Honors Biology Lesson Title: Ecosystem Under Investigation – Trophic Cascade

Time Frame: 3 days

Lesson Components

21st Century Themes

- ☒ Global Awareness ☐ Financial, Economic, Business and Entrepreneurial Literacy
☒ Civic Literacy ☐ Health Literacy

21st Century Skills

- ☒ Creativity and Innovation ☒ Critical Thinking and Problem Solving ☐ Information Literacy
☐ Life and Career Skills ☐ Communication and Collaboration ☐ Media Literacy ☐ ICT Literacy

Interdisciplinary Connections:

Engineering

Integration of Technology:

Google Sheets, iPads, Vernier GoDirect

Equipment Needed:

iPads

Goals/Objectives	Learning Activities/ Instructional Strategies	Formative Assessment Tasks
Students will: - Describe the relationships (predation, competition, and energy flow) among organisms within a specific ecosystem. - Analyze the "Top-Down" or "Bottom-Up" effects of losing a specific species. - Create a visual model (Food Web) to support their investigative journalism.	Lesson Sequence Anchoring Phenomenon: After wolves were reintroduced to Yellowstone National Park, populations of elk, beavers, fish, and even the shapes of rivers changed dramatically. How can the presence or absence of a single species trigger changes throughout an entire ecosystem? Individual/Pair Research: Students are assigned a "Missing Species" case file. They use a worksheet to document the species'	- The "Field Notes": Research worksheet documenting the food web links and sources. - The Evidence Board: A visual food web showing the "Missing" species and the resulting population shifts (arrows up/down). - The Final Broadcast: The live or filmed news report.



- Trophic Level, its Prey, its Predators, and its Niche within its specific ecosystem.
3. The "Crime Scene"
Assignments: Divide the class into six "Expert Investigative Teams" focused on famous ecological disruptions:
- The Yellowstone Case: The disappearance (and return) of the Gray Wolf.
 - The Kelp Forest Crisis: The loss of Sea Otters and the rise of "Urchin Barrens."
 - The African Savanna Mystery: The impact of Elephants as ecosystem engineers.
 - The Coral Reef Collapse: The decline of Reef Sharks and the impact on parrotfish.
 - The Mid-Atlantic Mystery: The overfishing of Menhaden and its effect on Ospreys/Striped Bass.
 - The Rainforest Ripple: The loss of Jaguars and the overpopulation of seed-eaters.



4. Expert Groups: Teams compare their individual research. They must "connect the dots" by drawing a Food Web of their ecosystem and identifying where the "break" occurred. They then consolidate this into one TV News Investigative Script.
5. Assistance: Provide "Evidence Photos" (diagrams of energy pyramids or population graphs) to help groups resolve "areas of dissention" regarding which species increased or decreased.
6. The Breaking News Broadcast: Groups present their findings as a "Special Report: Ecosystem in Crisis."
 - o Example: "Live from the Pacific Coast: The Kelp Forests are vanishing! Our lead investigator reveals how the missing Sea Otter has left the Sea Urchins unchecked. Is this the end of the kelp?"
7. Audience Interaction: After each report, the "studio audience" (the class) must ask one question about the Energy Flow (e.g., "If the producer population



	crashes, how does that affect the Tertiary consumers?").	
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Differentiation:

Students may use the modality they are proficient and comfortable with, including PowerPoint, iMovie, 3D model.

Resources Provided:

- Textbook
- Rubric



Lesson Plan 2 Template

Content Area: Honors Biology Lesson Title: The "Eco-Audit" – Habitat Investigative Reports

Time Frame: 1 day

Lesson Components

21st Century Themes

- ☐ Global Awareness ☒ Financial, Economic, Business and Entrepreneurial Literacy
☐ Civic Literacy ☐ Health Literacy

21st Century Skills

- ☐ Creativity and Innovation ☒ Critical Thinking and Problem Solving ☐ Information Literacy
☐ Life and Career Skills ☐ Communication and Collaboration ☐ Media Literacy ☐ ICT Literacy

Interdisciplinary Connections:

Mathematics

Integration of Technology:

Google Sheets, iPads, Vernier GoDirect

Equipment Needed:

Calculator

Goals/Objectives	Learning Activities/ Instructional Strategies	Formative Assessment Tasks
Students will: - Model the relationship among organisms using complex food webs rather than simple chains. - Trace the flow of energy (10% Rule) and the cycling of matter (Carbon/Nitrogen). - Predict the impact of a disturbance (invasive species or pollution) on the ecosystem's stability.	Lesson Sequence - Anchoring Phenomenon: A seemingly healthy ecosystem can suddenly experience population crashes, algal blooms, or invasive species outbreaks after only one small change in resource availability or species composition. Why are ecosystems so interconnected and sometimes surprisingly fragile? - Group students in pairs of 2. Assign each pair a	- The Eco-Map: A photographed or sketched version of their yarn-and-card food web. - The "Audit Report": A script detailing the specific symbiotic relationships (Mutualism, Parasitism) discovered during the audit. - The Impact Prediction: A written "Forecast" on how the ecosystem will look in 10 years if the



	specific "Local Client" (e.g., A local pond, a backyard forest, or a nearby marsh). 3. The Resource Kit: Instead of a worksheet, give students a bag of "Species Cards" (organisms found in that habitat) and "Resource Tokens" (representing Sunlight, Water, and Nutrients). 4. The "Audit" Mapping: ○ Students must physically arrange their cards to create a Food Web. ○ They must use colored yarn to connect them: Red for energy flow (who eats whom) and Blue for nutrient cycling (who dies and decomposes). 5. The "Expert" Investigation: Divide the class into "Expert Bureaus" to deep-dive into the audit: ○ The Productivity Desk: Calculate if there are enough Producers to support the Tertiary	current disturbances continue.
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- consumers (using the 10% rule).
 - The Scavenger Squad: Report on how Decomposers are recycling "Large Carbon-Based Molecules" back into the soil.
 - The Invasive Alert Team: Introduce a "Mystery Card" (an invasive species like a Spotted Lanternfly or Kudzu) and have students predict which native populations will crash.
6. The Breaking News Broadcast: Groups present their "Audit" as a Formal TV News Report.
- Example: "Live from the Oak Forest: We've discovered a major energy leak! With the decline of the fox population, the primary consumers are overgrazing the producers. Is the forest's carrying capacity at risk?"



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| | 7. The "Is over Of" Math Check: Use the percent math we practiced to have the audience calculate: "What is the energy available to the hawk of the original energy from the sun?" | |
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Differentiation:

Students will work in non-homogeneous lab groups and help each other with graphing and math calculations.

Resources Provided:

- Rubric



Lesson Plan 3 Template

Content Area: Honors Biology Lesson Title: The "Human Surge" – Global Population Investigative Reports
 Time Frame: 1 day

Lesson Components

21st Century Themes

- ☒ Global Awareness ☐ Financial, Economic, Business and Entrepreneurial Literacy
☒ Civic Literacy ☐ Health Literacy

21st Century Skills

- ☐ Creativity and Innovation ☒ Critical Thinking and Problem Solving ☐ Information Literacy
☐ Life and Career Skills ☐ Communication and Collaboration ☐ Media Literacy ☐ ICT Literacy

Interdisciplinary Connections:

Chemistry

Integration of Technology:

Google Sheets, iPads, Vernier GoDirect

Equipment Needed:

Water Sampling kit: thermometer, turbidity test decal, reagents for pH, nitrogen, phosphorus, dissolved oxygen

Goals/Objectives	Learning Activities/ Instructional Strategies	Formative Assessment Tasks
Students will: • Create a graph of human population growth (Historical to Present). • Predict future growth based on current trends and demographic transitions. • Identify and report on specific factors (Medical, Agricultural, Industrial) that drive growth and the resulting impact on ecosystems.	Lesson Sequence 1. Anchoring Phenomenon: The human population required approximately 200,000 years to reach one billion people but grew from seven billion to eight billion people in just eleven years. What biological, technological, and environmental factors caused human population growth to accelerate so rapidly, and what consequences might follow? 2. Individual/Pair Research (The Data Dive):	• The "Census Log": The completed graph of human population growth with labeled milestones (Industrial Revolution, etc.). • The "Trend Forecast": A written prediction of where the graph will go in the next 50 years (logistic vs. exponential). • The Final Broadcast: The live or filmed news report.



	Students are given a set of historical population data (from 10,000 BCE to 2026). They must create a line graph of the data. ○ Task: Identify the "J-Curve" (Exponential Growth) and mark the specific year the population hit 1 Billion (1804) versus 8 Billion (2022). 3. The "Regional Bureau" Assignments: Divide the class into six "Expert Investigative Teams," each representing a different region or factor affecting the "Human Surge": ○ The Medical Correspondents: Impact of vaccines, antibiotics, and sanitation on death rates. ○ The Green Revolution Reporters: Impact of industrial agriculture and synthetic fertilizers on carrying capacity. ○ The Urbanization Unit: Analysis of habitat fragmentation and "Heat Islands" as cities expand. ○ The Resource Rangers:	
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SPRINGFIELD PUBLIC SCHOOLS

ENGAGING STUDENTS • FOSTERING ACHIEVEMENT • CULTIVATING 21ST CENTURY GLOBAL SKILLS

- Investigating the "Trash Paradox"—how population growth correlates with plastic pollution and landfill space.
- The Biodiversity Desk: Reporting on the "Sixth Mass Extinction"—how human expansion leads to species loss (HIPPCO).
 - The Future Forecasters: Using current growth rates to predict the population in 2050 and 2100.
4. Expert Groups: Teams compare their graphs and research. They must "connect the dots" between their specific factor and the global J-Curve. They then consolidate this into one TV News Investigative Script.
 5. Assistance: Provide "Population Pyramid" diagrams for different countries (e.g., Nigeria vs. Japan) to help groups understand why some populations are exploding while others are shrinking.
 6. The Breaking News Broadcast: Groups present their findings as a "World Census Special Report."



Differentiation:

Students will work in non-homogeneous lab groups to conduct tests, record results and create reports.

Resources Provided:

- Water testing kit Mott
- Textbook
- Water pollution PowerPoint
- Website resources
- Runoff watershed model



Lesson Reflection

Reflect on the lesson you have developed and rate the degree to which the lesson **Strongly, Moderately or Weakly** meets the criteria below.

Lesson Activities	Strongly	Moderately	Weakly
Are challenging and require higher order thinking and problem solving skills	☒	☐	☐
Allow for student choice	☒	☐	☐
Provide scaffolding for acquiring targeted knowledge/skills	☒	☐	☐
Integrate global perspectives	☒	☐	☐
Integrate 21st century skills	☒	☐	☐
Provide opportunities for interdisciplinary connection and transfer of knowledge and skills	☒	☐	☐
Foster student use of technology as a tool to develop critical thinking, creativity and innovation skills	☒	☐	☐
Are varied to address different student learning styles and preferences	☐	☒	☐
Are differentiated based on student needs	☒	☐	☐
Are student-centered with teacher acting as a facilitator and co-learner during the teaching and learning process	☒	☐	☐
Provide means for students to demonstrate knowledge and skills and progress in meeting learning goals and objectives	☒	☐	☐
Provide opportunities for student reflection and self- assessment	☐	☒	☐
Provide data to inform and adjust instruction to better meet the varying needs of learners	☒	☐	☐

Curriculum Design Template

Content Area: Science
Energy and Dynamics

Grade Level: 9

Unit Title: Ecosystems: Interactions

Created: 2026

Board Approved on:



Unit Overview Template

Content Area: Honors Biology **Grade Level:** 9 **Unit Title:** Heredity: Inheritance and Variation of Traits

Unit Summary: In this unit of study students analyze data and develop models to make sense of the relationship between DNA and chromosomes in the process of cellular division, which passes traits from one generation to the next. Students determine why individuals of the same species vary in how they look, function, and behave. Students develop conceptual models of the role of DNA in the unity of life on Earth and the statistical models to explain the importance of variation within populations for the survival and evolution of species. Ethical issues related to genetic modification of organisms and the nature of science are described. Students explain the mechanisms of genetic inheritance and describe the environmental and genetic causes of gene mutation and the alteration of gene expressions.

Primary Interdisciplinary Connections: Genetics

21st Century Themes ☒ Creativity and Innovation ☒ Critical Thinking and Problem Solving ☐ ICT Literacy
☐ Information Literacy ☐ Life and Career Skills ☒ Communication and Collaboration ☐ Media Literacy

Unit Rationale: Students also use the science and engineering practices to demonstrate understanding of the disciplinary core ideas.

Career Readiness (Standard 9):

- 9.2.12.CAP.4: Evaluate different careers and develop various plans.
- 9.2.12.CAP.5: Assess and modify a personal plan to support current interests and postsecondary plans.
- 9.2.12.CAP.13: Analyze how the economic, social, and political conditions of a time period can affect the labor market.
- 9.4.12.CI.1: Demonstrate the ability to reflect, analyze, and use creative skills and ideas.
- 9.4.12.CI.2: Identify career pathways that highlight personal talents, skills, and abilities.
- 9.4.12.DC.8: Explain how increased network connectivity and computing capabilities of everyday objects allow for innovative technological approaches to climate protection.
- 9.4.12.GCA.1: Collaborate with individuals to analyze a variety of potential solutions to climate change effects and determine why some solutions (e.g., political, economic, cultural) may work better than others
- 9.4.12.IML.1: Compare search browsers and recognize features that allow for filtering of information.
- 9.4.12.IML.2: Evaluate digital sources for timeliness, accuracy, perspective, credibility of the source, and relevance of information, in media, data, or other resources.
- 9.4.12.IML.3: Analyze data using tools and models to make valid and reliable claims, or to determine optimal design solutions.
- 9.4.12.TL.2: Generate data using formula-based calculations in a spreadsheet and draw conclusions about the data.
- 9.4.12.TL.4: Collaborate in online learning communities or social networks or virtual worlds to analyze and propose a resolution to a real-world problem.



Learning Targets

Standards: HS-LS3

Content Statements: Heredity: Inheritance and Variation of Traits

CPI#:	Cumulative Progress Indicator (CPI):
HS-LS3-1.	Ask questions to clarify relationships about the role of DNA and chromosomes in coding the instructions for characteristic traits passed from parents to offspring.
HS-LS3-2.	Make and defend a claim based on evidence that inheritable genetic variations may result from: (1) new genetic combinations through meiosis, (2) viable errors occurring during replication, and/or (3) mutations caused by environmental factors.
HS-LS3-3.	Apply concepts of statistics and probability to explain the variation and distribution of expressed traits in a population.
Math.MP.2	Reason abstractly and quantitatively.

Science and Engineering Practices:

Asking Questions and Defining Problems

Asking questions and defining problems in 9–12 builds on K–8 experiences and progresses to formulating, refining, and evaluating empirically testable questions and design problems using models and simulations.

- Ask questions that arise from examining models or a theory to clarify relationships. (HS-LS3-1)

Analyzing and Interpreting Data

Analyzing data in 9–12 builds on K–8 experiences and progresses to introducing more detailed statistical analysis, the comparison of data sets for consistency, and the use of models to generate and analyze data.

- Apply concepts of statistics and probability (including determining function fits to data, slope, intercept, and correlation coefficient for linear fits) to scientific and engineering questions and problems, using digital tools when feasible. (HS-LS3-3)

Engaging in Argument from Evidence

Engaging in argument from evidence in 9–12 builds on K–8 experiences and progresses to using appropriate and sufficient evidence and scientific reasoning to defend and critique claims and explanations about the natural and designed world(s). Arguments may also come from current scientific or historical episodes in science.

- Make and defend a claim based on evidence about the natural world that reflects scientific knowledge, and student-generated evidence. (HS-LS3-2)

Disciplinary Core Ideas (DCIs):

LS1.A: Structure and Function



- All cells contain genetic information in the form of DNA molecules. Genes are regions in the DNA that contain the instructions that code for the formation of proteins. (secondary to HS-LS3-1) (Note: This Disciplinary Core Idea is also addressed by HS-LS1-1.)

LS3.A: Inheritance of Traits

- Each chromosome consists of a single very long DNA molecule, and each gene on the chromosome is a particular segment of that DNA. The instructions for forming species' characteristics are carried in DNA. All cells in an organism have the same genetic content, but the genes used (expressed) by the cell may be regulated in different ways. Not all DNA codes for a protein; some segments of DNA are involved in regulatory or structural functions, and some have no as-yet known function. (HS-LS3-1)

LS3.B: Variation of Traits

- In sexual reproduction, chromosomes can sometimes swap sections during the process of meiosis (cell division), thereby creating new genetic combinations and thus more genetic variation. Although DNA replication is tightly regulated and remarkably accurate, errors do occur and result in mutations, which are also a source of genetic variation. Environmental factors can also cause mutations in genes, and viable mutations are inherited. (HS-LS3-2)
- Environmental factors also affect expression of traits, and hence affect the probability of occurrences of traits in a population. Thus the variation and distribution of traits observed depends on both genetic and environmental factors. (HS-LS3-2), (HS-LS3-3)

Crosscutting Concepts:

Cause and Effect

- Empirical evidence is required to differentiate between cause and correlation and make claims about specific causes and effects. (HS-LS3-1), (HS-LS3-2)

Scale, Proportion, and Quantity

- Algebraic thinking is used to examine scientific data and predict the effect of a change in one variable on another (e.g., linear growth vs. exponential growth). (HS-LS3-3)

Connections to Nature of Science

Science is a Human Endeavor

- Technological advances have influenced the progress of science and science has influenced advances in technology. (HS-LS3-3)
- Science and engineering are influenced by society and society is influenced by science and engineering. (HS-LS3-3)

Unit Essential Questions:



- What is the role of DNA in determining traits?
- What is the relationship between DNA codes and the production of proteins?
- How do DNA mutations cause harmful and beneficial variations?
- How do errors in replication cause mutations?
- How does meiosis lead to genetic variation and recombination in offspring?
- How is probability used to predict the distribution of expressed traits in generations?
- What role does the environment have in causing genetic mutations?

Unit Enduring Understandings:

- All cells contain genetic information in the form of DNA molecules. Genes are regions in the DNA that contain the instructions that code for the formation of proteins.
- Each chromosome consists of a single very long DNA molecule, and each gene on the chromosome is a particular segment of that DNA. The instructions for forming species' characteristics are carried in DNA. All cells in an organism have the same genetic content, but the genes used (expressed) by the cell may be regulated in different ways. Not all DNA codes for a protein; some segments of DNA are involved in regulatory or structural functions, and some have no as-yet known function.
- In sexual reproduction, chromosomes can sometimes swap sections during the process of meiosis (cell division), thereby creating new genetic combinations and thus more genetic variation. Although DNA replication is tightly regulated and remarkably accurate, errors do occur and result in mutations, which are also a source of genetic variation. Environmental factors can also cause mutations in genes, and viable mutations are inherited.
- Environmental factors also affect expression of traits, and hence affect the probability of occurrences of traits in a population. Thus the variation and distribution of traits observed depends on both genetic and environmental factors.

Unit Learning Targets:

Students will....

- Use a model to illustrate the role of cellular division and differentiation to produce and maintain complex organisms.
- Explain how the process of meiosis results in the passage of traits from parent to offspring, and how that results in increased genetic diversity.
- Ask questions to clarify relationships about the role of DNA and chromosomes in coding the instructions for characteristic traits passed from parents to offspring.
- Create a visual representation to illustrate how changes in a DNA nucleotide sequence can result in a change in the polypeptide produced.
- Make and defend claims based on evidence that inheritable genetic variations may result from 1) new genetic recombination through meiosis, 2) viable errors occurring during replication, and/or 3) mutations caused by environmental factors.



Evidence of Learning

Summative Assessment: Unit Assessment and Labs

Equipment Needed: Teacher laptop, lab equipment

Teacher Resources: Textbook, lab activities and supplies

Formative Assessments:

- Quizzes
- Assignments
- Activities
- Labs
- Project



Lesson Plans

Lesson	Time Frame
Lesson 1 Genetics Crime Scene	3 days
Lesson 2 Growing Stem Cells	3 days
Lesson 3 Genes and You: Weighing Pros and Cons	3 days

Teacher Notes: This unit is designed to move students from classical Mendelian genetics toward real-world human genetics applications, including inheritance patterns, probability reasoning, and ethical decision-making.

Emphasis should be placed on helping students distinguish between biological mechanisms (how inheritance works) and social/ethical implications (how genetic information is used).

Students will often default to “opinion-based” reasoning in Lesson 3; instructors should consistently redirect them back to evidence from inheritance patterns, probability, and case data.

Modeling is central across all lessons: pedigree construction, probability modeling, and genetic screening interpretation should be treated as evidence tools, not just activities.

The unit intentionally integrates discussion of modern biotechnology (genetic testing, stem cell applications, tissue engineering) to connect genetics to real-world economic, medical, and societal systems.

Encourage students to revisit earlier lessons when making arguments (especially inheritance probability from Lesson 1 and disease mechanisms from Lesson 2) to build coherence across the unit.

Assessment should prioritize reasoning quality over correctness of “answers,” especially in ethical and screening debates where multiple defensible positions exist.

Curriculum Development Resources/Technology Resources:

Click the links below to access additional resources used to design this unit

http://www.exploratorium.edu/genepool/ETHEX_info.html

http://www.biology.arizona.edu/human_bio/activities/karyotyping/karyotyping.html

<http://learn.genetics.utah.edu/content/molecules/transcribe/><https://www.dnalc.org/>

<https://ghr.nlm.nih.gov/chromosome>

<https://phet.colorado.edu/en/contributions/view/3829>

<http://www.geneticalliance.org.uk/genesandyouunitsix.htm>

<http://www.biology.arizona.edu/>



Lesson Plan 1 Template

Content Area: Honors Biology Lesson Title: Genetics Crime Scene Time Frame: 3 days

Lesson Components

21st Century Themes

- ☒ Global Awareness ☐ Financial, Economic, Business and Entrepreneurial Literacy
☒ Civic Literacy ☒ Health Literacy

21st Century Skills

- ☒ Creativity and Innovation ☒ Critical Thinking and Problem Solving ☒ Information Literacy
☒ Life and Career Skills ☒ Communication and Collaboration ☒ Media Literacy ☒ ICT Literacy

Interdisciplinary Connections:

Genetics

Integration of Technology:

- iPads for accessing digital case files, genetic databases, and analysis tools
- Online karyotype and pedigree simulation tools for chromosomal and inheritance analysis
- Google Sheets for organizing genotype frequencies, probability calculations, and suspect comparisons
- Digital collaboration tools for group evidence sharing and claim construction

Equipment Needed:

- Printed or digital crime scene evidence packets
- Genotype and phenotype evidence cards for suspects
- Pedigree charts and inheritance maps
- Karyotype analysis sheets or digital karyotype datasets
- Blood type inheritance reference charts
- Colored pencils or markers for modeling genetic relationships
- Evidence tracking sheets or digital lab notebook templates

Goals/Objectives	Learning Activities/ Instructional Strategies	Formative Assessment Tasks
Students will: • Analyze genetic evidence from multiple sources to solve a complex inheritance-based scenario • Construct models of genotype, phenotype, and inheritance patterns across individuals • Apply probability to predict genetic outcomes and evaluate competing hypotheses	Lesson Sequence Anchoring Phenomenon: “Who left the genetic evidence at the crime scene?” 1. Students are introduced to a fictional investigation involving multiple suspects 2. Each suspect has a unique genetic profile including: ○ Blood type ○ Inherited traits	• Initial hypothesis based on crime scene evidence • Completed pedigree and inheritance analysis worksheets • Karyotype interpretation checkpoint • Probability calculations using Punnett squares or equivalent models • Group comparison reflection on reasoning differences



• Interpret karyotypes to identify chromosomal abnormalities linked to evidence • Construct evidence-based explanations using multiple forms of genetic data • Compare and defend scientific claims using reasoning supported by quantitative genetic analysis	◦ Partial pedigree information ◦ Chromosomal/karyotype anomalies 3. Students generate initial hypotheses about which suspect may match the crime scene evidence 4. Students analyze inheritance patterns from evidence sets: ◦ Blood type inheritance rules ◦ Simple Mendelian trait analysis ◦ Expression of dominant and recessive traits 5. Students begin constructing genetic profiles for each suspect 6. Students construct and revise pedigree models: ◦ Map trait inheritance across generations ◦ Identify carriers and expression patterns ◦ Revise initial hypotheses based on inheritance logic 7. Students justify changes in thinking using evidence from pedigree structure 8. Students interpret karyotype data: ◦ Identify chromosomal abnormalities or genetic conditions ◦ Connect abnormalities to	• Final claim supported by multi-source genetic evidence (CER response)
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- possible
phenotypic
outcomes
9. Students refine suspect matching based on chromosomal evidence
 10. Students apply probability reasoning:
 - Use Punnett squares and probability models to test trait likelihood
 - Compare predicted vs observed trait distributions
 11. Students quantify how strongly each suspect matches the evidence
 12. Students collaborate with another group:
 - Compare investigative strategies and conclusions
 - Identify differences in reasoning, assumptions, and interpretation of evidence
 13. Groups revise conclusions based on peer critique and additional reasoning
 14. Students construct a final evidence-based conclusion:
 - Identify the most likely suspect
 - Justify using multiple data types (inheritance, pedigree,



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| | karyotype,
probability)
○ Defend reasoning
in structured
scientific
argument format | |
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Differentiation:

- Scaffolded inheritance charts and guided Punnett square templates
- Extension cases involving incomplete dominance or codominance
- Choice of output format (written report, visual model, or digital presentation)
- Structured group roles (evidence analyst, geneticist, recorder, presenter)
- Sentence frames for constructing scientific reasoning and claims
- Tiered datasets with varying complexity

Resources Provided:

- Crime scene genetics case file packets
- Pedigree and inheritance mapping templates
- Karyotype analysis resources
- Punnett square and probability guides
- CER writing scaffold
- Digital or printed trait databases



Lesson Plan 2 Template

Content Area: Honors Biology Lesson Title: Growing Stem Cells Time Frame: 3 days

Lesson Components

21st Century Themes

- ☒ Global Awareness ☒ Financial, Economic, Business and Entrepreneurial Literacy
☒ Civic Literacy ☒ Health Literacy

21st Century Skills

- ☒ Creativity and Innovation ☒ Critical Thinking and Problem Solving ☒ Information Literacy
☒ Life and Career Skills ☒ Communication and Collaboration ☒ Media Literacy ☒ ICT Literacy

Interdisciplinary Connections:

Genetics

Integration of Technology:

- iPads for accessing case studies, scientific articles, and media reports on tissue engineering
- Vernier Go Direct sensors for analyzing environmental conditions in simulated cell growth environments (temperature, pH, etc.)
- Digital simulation tools for stem cell differentiation and tissue growth modeling
- Google Slides or equivalent for collaborative presentation development
- Online databases or curated science news sources for evaluating real-world applications of tissue engineering

Equipment Needed:

- Modeling materials (clay, beads, pipe cleaners, foam, or paper) for tissue engineering models
- Printed or digital case study packets on stem cell research
- Chart paper or digital templates for organizing arguments and evidence
- Optional lab simulation kits for “growth environment” modeling (nutrient diffusion or scaffold analogs)

Goals/Objectives	Learning Activities/ Instructional Strategies	Formative Assessment Tasks
Students will: • Construct scientific arguments for and against stem cell research and tissue engineering applications • Develop and revise models of tissue growth and cellular specialization	Lesson Sequence Anchoring Phenomenon: “Can we grow replacement body parts in a lab?” 1. Students are introduced to real-world case studies: ○ Growing vocal cords in a lab	• Source evaluation notes (credibility and validity of media/scientific texts) • Tissue engineering model checkpoint (accuracy of structure-function representation)



● Evaluate the validity and reliability of scientific claims from multiple sources ● Synthesize information from media, research summaries, and data-based sources ● Explain how stem cell differentiation contributes to tissue formation and medical applications ● Communicate scientific reasoning clearly through models and presentations	○ Tissue-engineered skin and organs ○ Experimental regenerative medicine applications 2. Students record initial ideas about whether and how this is biologically possible 3. Students analyze multimedia source material: ○ Podcast or article on vocal cord tissue engineering ○ Short science news summaries on stem cell applications 4. Students identify claims, evidence, and unanswered questions in the sources 5. Students research tissue engineering applications: ○ Medical uses (burn treatment, organ repair, regenerative therapy) ○ Ethical considerations and limitations ○ Technical requirements (cell scaffolds, differentiation control, growth conditions) 6. Students evaluate reliability of different sources (news vs scientific summaries vs research reports)	● Argument development draft (claim + evidence + reasoning) ● Peer review feedback form on scientific presentation ● Final CER-style argument supporting a position on stem cell research
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| | <ol style="list-style-type: none">7. Students construct a physical or digital model of tissue engineering:<ul style="list-style-type: none">○ Represent stem cell differentiation pathways○ Show scaffold structures and growth conditions○ Model how undifferentiated cells become specialized tissues8. Students revise models based on peer feedback and new evidence9. Students analyze real-world constraints:<ul style="list-style-type: none">○ Cost of tissue engineering procedures○ Accessibility of medical treatments○ Limitations of current technology and research gaps10. Students connect biological feasibility with societal and economic impact11. Students develop a structured scientific argument:<ul style="list-style-type: none">○ Should stem cell research be expanded, limited, or regulated?○ What evidence supports different positions?12. Students use evidence from models, readings, | |
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- and case studies to support claims
13. Students present findings to peers:
- Share models and arguments
 - Critique scientific reasoning and evidence quality
14. Groups revise explanations based on peer discussion and feedback

Differentiation:

- Choice of model format (physical, digital, diagrammatic, or hybrid)
- Scaffolded argument templates (CER frames for support)
- Extension analysis of ethical policy debates or real biomedical case studies
- Tiered reading materials (simplified summaries to advanced articles)
- Structured group roles (researcher, model builder, analyst, presenter)
- Sentence frames for scientific argumentation and evaluation

Resources Provided:

- Podcast: Growing vocal cords in tissue engineering
- Curated stem cell and tissue engineering article set
- Argument scaffold (CER template)
- Model-building templates
- Source evaluation checklist
- Presentation guidelines



Lesson Plan 3 Template

Content Area: Honors Biology Lesson Title: Genes and You: Weighing the Pros and Cons

Time Frame: 1 day

Lesson Components

21st Century Themes

- ☒ Global Awareness ☐ Financial, Economic, Business and Entrepreneurial Literacy
☐ Civic Literacy ☐ Health Literacy

21st Century Skills

- ☐ Creativity and Innovation ☒ Critical Thinking and Problem Solving ☐ Information Literacy
☐ Life and Career Skills ☒ Communication and Collaboration ☐ Media Literacy ☐ ICT Literacy

Interdisciplinary Connections:

Genetics

Integration of Technology:

- iPads for accessing case study materials, genetic screening scenarios, and supporting resources
- Online genetic counseling simulations or interactive decision-making tools related to inherited disorders
- Vernier Go Direct (used for data interpretation activities involving probability modeling or simulated screening accuracy rates)
- Digital collaboration tools for constructing and presenting arguments (shared slides or documents)
- Video-based case studies from medical genetics and counseling contexts

Equipment Needed:

- Printed or digital genetic condition case study packets
- Genetic disorder information cards (carrier status, inheritance patterns, symptoms, probabilities)
- Argument planning templates (CER or structured debate framework)
- Visual inheritance charts and pedigree references
- Debate preparation notes sheets or digital organizers

Goals/Objectives	Learning Activities/ Instructional Strategies	Formative Assessment Tasks
Students will: • Analyze real-world case studies involving inherited genetic disorders • Interpret genetic risk information using	Lesson Sequence Anchoring Phenomenon: "If you could know your genetic future, would you want to?"	• Case study analysis notes for each genetic condition • Pedigree or probability model for inheritance risk



inheritance patterns and probability • Evaluate the benefits, limitations, and ethical implications of genetic screening • Construct and defend a scientifically supported argument regarding genetic testing • Synthesize biological evidence with societal, ethical, and economic considerations • Communicate reasoning clearly in both written and oral formats	1. Students are presented with real-world inspired scenarios: ○ Individuals who discover they are carriers of genetic disorders ○ Families facing decisions about prenatal or predictive genetic screening 2. Students record initial reactions and questions about genetic knowledge and decision-making 3. Students analyze three case studies of individuals or families with genetic conditions: ○ Carrier status and inheritance risk ○ Likelihood of passing conditions to offspring ○ Real-life impacts on health, family planning, and lifestyle 4. Students identify key biological and ethical issues in each case 5. Students interpret genetic condition cards: ○ Mode of inheritance (dominant, recessive, sex-linked if applicable) ○ Probability of inheritance outcomes ○ Severity and variability of expression 6. Students construct visual models (pedigrees or probability diagrams) for each case	• Structured argument draft (claim + evidence + reasoning) • Peer debate feedback form evaluating reasoning strength • Final written or oral argument on genetic screening
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| | <ol style="list-style-type: none">7. Students engage in structured analysis of genetic screening:<ul style="list-style-type: none">○ How screening tests work○ Accuracy, false positives/negatives (conceptual level)○ Implications for individuals and families8. Students evaluate strengths and limitations of genetic screening technologies9. Students develop a formal argument:<ul style="list-style-type: none">○ Position: support or oppose widespread genetic screening for inherited conditions○ Evidence: case studies, inheritance patterns, probability reasoning○ Reasoning: biological mechanisms and real-world consequences10. Students incorporate economic and healthcare system considerations (cost of testing, access, insurance implications, biotech industry role)11. Students participate in structured peer debate:<ul style="list-style-type: none">○ Present arguments and counterarguments○ Evaluate strength of reasoning and use of evidence○ Revise or refine positions based on peer input | |
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| | <p>12. Students produce a final written or recorded justification:</p> <ul style="list-style-type: none">○ Clearly stated position○ Biological evidence (inheritance + probability)○ Ethical, social, and economic reasoning○ Reflection on uncertainty and decision complexity | |
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Differentiation:

- Choice of argument format (debate, written essay, recorded explanation, visual model)
- Scaffolded CER templates for structured reasoning
- Simplified vs advanced case study packets (varying genetic complexity)
- Partner-based discussion support for analysis of ethical implications
- Sentence frames for argument construction and rebuttal
- Extension option: exploration of advanced topics like gene editing or personalized medicine

Resources Provided:

- Genetic condition case study packets
- Inheritance and probability reference sheets
- Genetic screening explanation materials
- CER / argumentation scaffold
- Debate preparation templates
- Peer evaluation rubric



Lesson Reflection

Reflect on the lesson you have developed and rate the degree to which the lesson **Strongly, Moderately or Weakly** meets the criteria below.

Lesson Activities	Strongly	Moderately	Weakly
Are challenging and require higher order thinking and problem solving skills	☒	☐	☐
Allow for student choice	☐	☒	☐
Provide scaffolding for acquiring targeted knowledge/skills	☒	☐	☐
Integrate global perspectives	☒	☐	☐
Integrate 21st century skills	☒	☐	☐
Provide opportunities for interdisciplinary connection and transfer of knowledge and skills	☒	☐	☐
Foster student use of technology as a tool to develop critical thinking, creativity and innovation skills	☒	☐	☐
Are varied to address different student learning styles and preferences	☒	☐	☐
Are differentiated based on student needs	☒	☐	☐
Are student-centered with teacher acting as a facilitator and co-learner during the teaching and learning process	☒	☐	☐
Provide means for students to demonstrate knowledge and skills and progress in meeting learning goals and objectives	☒	☐	☐
Provide opportunities for student reflection and self- assessment	☒	☐	☐
Provide data to inform and adjust instruction to better meet the varying needs of learners	☒	☐	☐

Curriculum Design Template

Content Area: Science
Variation of Traits

Grade Level: 9

Unit Title: Heredity: Inheritance and

Created: 2026

Board Approved on:



Unit Overview Template

Content Area: Honors Biology **Grade Level:** 9 **Unit Title:** Biological Evolution: Unity and Diversity

Unit Summary: In this unit of study, students construct explanations for the processes of natural selection and evolution and then communicate how multiple lines of evidence support these explanations. Students evaluate evidence of the conditions that may result in new species and understand the role of genetic variation in natural selection. Students also develop an understanding of the factors causing natural selection of species over time. Additionally, students can apply concepts of probability to explain trends in populations as those trends relate to advantageous heritable traits in a specific environment. Students demonstrate an understanding of these concepts by obtaining, evaluating and communicating information and constructing explanations and designing solutions.

Primary Interdisciplinary Connections: Geology, Mathematics

21st Century Themes ☒ Creativity and Innovation ☒ Critical Thinking and Problem Solving ☐ ICT Literacy
☐ Information Literacy ☐ Life and Career Skills ☐ Communication and Collaboration ☐ Media Literacy

Unit Rationale: Students will analyze and interpret data, use mathematical and computational thinking, and construct explanations as they demonstrate understanding of the causes of natural selection that leads to evolution of a species. Students also use the science and engineering practices to demonstrate understanding of the disciplinary core ideas.

Career Readiness (Standard 9):

9.2.12.CAP.4: Evaluate different careers and develop various plans.

9.2.12.CAP.5: Assess and modify a personal plan to support current interests and postsecondary plans.

9.2.12.CAP.13: Analyze how the economic, social, and political conditions of a time period can affect the labor market.

9.4.12.CI.1: Demonstrate the ability to reflect, analyze, and use creative skills and ideas.

9.4.12.CI.2: Identify career pathways that highlight personal talents, skills, and abilities.

9.4.12.DC.8: Explain how increased network connectivity and computing capabilities of everyday objects allow for innovative technological approaches to climate protection.

9.4.12.GCA.1: Collaborate with individuals to analyze a variety of potential solutions to climate change effects and determine why some solutions (e.g., political, economic, cultural) may work better than others.

9.4.12.IML.1: Compare search browsers and recognize features that allow for filtering of information.

9.4.12.IML.2: Evaluate digital sources for timeliness, accuracy, perspective, credibility of the source, and relevance of information, in media, data, or other resources.

9.4.12.IML.3: Analyze data using tools and models to make valid and reliable claims, or to determine optimal design solutions.

9.4.12.TL.2: Generate data using formula-based calculations in a spreadsheet and draw conclusions about the data.

9.4.12.TL.4: Collaborate in online learning communities or social networks or virtual worlds to analyze and propose a resolution to a real-world problem.



Learning Targets

Standards: HS-LS4

Content Statements: HS4: Biological Evolution: Unity and Diversity

CPI#: **Cumulative Progress Indicator (CPI):**

HS-LS4-1	Communicate scientific information that common ancestry and biological evolution are supported by multiple lines of empirical evidence.
HS-LS4-2	Construct an explanation based on evidence that the process of evolution primarily results from four factors: (1) the potential for a species to increase in number, (2) the heritable genetic variation of individuals in a species due to mutation and sexual reproduction, (3) competition for limited resources, and (4) the proliferation of those organisms that are better able to survive and reproduce in the environment.
HS-LS4-3	Apply concepts of statistics and probability to support explanations that organisms with an advantageous heritable trait tend to increase in proportion to organisms lacking this trait.
HS-LS4-4	Construct an explanation based on evidence for how natural selection leads to adaptation of populations.
HS-LS4-5	Evaluate the evidence supporting claims that changes in environmental conditions may result in: (1) increases in the number of individuals of some species, (2) the emergence of new species over time, and (3) the extinction of other species.
HS-LS4-6	Create or revise a simulation to test a solution to mitigate adverse impacts of human activity on biodiversity.
Math.S-ID.A.1	Represent data with plots on the real number line (dot plots, histograms, and box plots).
Math.S-ID.A.2	Use statistics appropriate to the shape of the data distribution to compare center (median, mean) and spread (interquartile range, standard deviation) of two or more different data sets.
8.2.12.EC.3	Synthesize data, analyze trends, and draw conclusions regarding the effect of a technology on the individual, culture, society, and environment and share this information with the appropriate audience.

Science and Engineering Practices:

Analyzing and Interpreting Data

Analyzing data in 9–12 builds on K–8 experiences and progresses to introducing more detailed statistical analysis, the comparison of data sets for consistency, and the use of models to generate and analyze data.

- Apply concepts of statistics and probability (including determining function fits to data, slope, intercept, and correlation coefficient for linear fits) to scientific and engineering questions and problems, using digital tools when feasible. (HS-LS4-3)



Using Mathematics and Computational Thinking

Mathematical and computational thinking in 9–12 builds on K–8 experiences and progresses to using algebraic thinking and analysis, a range of linear and nonlinear functions including trigonometric functions, exponentials and logarithms, and computational tools for statistical analysis to analyze, represent, and model data. Simple computational simulations are created and used based on mathematical models of basic assumptions.

- Create or revise a simulation of a phenomenon, designed device, process, or system. (HS-LS4-6)

Constructing Explanations and Designing Solutions

Constructing explanations and designing solutions in 9–12 builds on K–8 experiences and progresses to explanations and designs that are supported by multiple and independent student-generated sources of evidence consistent with scientific ideas, principles, and theories.

- Construct an explanation based on valid and reliable evidence obtained from a variety of sources (including students' own investigations, models, theories, simulations, peer review) and the assumption that theories and laws that describe the natural world operate today as they did in the past and will continue to do so in the future. (HS-LS4-2), (HS-LS4-4)

Engaging in Argument from Evidence

Engaging in argument from evidence in 9–12 builds on K–8 experiences and progresses to using appropriate and sufficient evidence and scientific reasoning to defend and critique claims and explanations about the natural and designed world(s). Arguments may also come from current or historical episodes in science.

- Evaluate the evidence behind currently accepted explanations or solutions to determine the merits of arguments. (HS-LS4-5)

Obtaining, Evaluating, and Communicating Information

Obtaining, evaluating, and communicating information in 9–12 builds on K–8 experiences and progresses to evaluating the validity and reliability of the claims, methods, and designs.

- Communicate scientific information (e.g., about phenomena and/or the process of development and the design and performance of a proposed process or system) in multiple formats (including orally, graphically, textually, and mathematically). (HS-LS4-1)

Disciplinary Core Ideas (DCIs):

LS4.A: Evidence of Common Ancestry and Diversity

- Genetic information provides evidence of evolution. DNA sequences vary among species, but there are many overlaps; in fact, the ongoing branching that produces multiple lines of descent can be inferred by comparing the DNA sequences of different organisms. Such information is also derivable from the similarities and differences in amino acid sequences and from anatomical and embryological evidence. (HS-LS4-1)



LS4.B: Natural Selection

- Natural selection occurs only if there is both (1) variation in the genetic information between organisms in a population and (2) variation in the expression of that genetic information—that is, trait variation—that leads to differences in performance among individuals. (HS-LS4-2), (HS-LS4-3)
- The traits that positively affect survival are more likely to be reproduced, and thus are more common in the population. (HS-LS4-3)

LS4.C: Adaptation

- Evolution is a consequence of the interaction of four factors: (1) the potential for a species to increase in number, (2) the genetic variation of individuals in a species due to mutation and sexual reproduction, (3) competition for an environment's limited supply of the resources that individuals need in order to survive and reproduce, and (4) the ensuing proliferation of those organisms that are better able to survive and reproduce in that environment. (HS-LS4-2)
- Natural selection leads to adaptation, that is, to a population dominated by organisms that are anatomically, behaviorally, and physiologically well suited to survive and reproduce in a specific environment. That is, the differential survival and reproduction of organisms in a population that have an advantageous heritable trait leads to an increase in the proportion of individuals in future generations that have the trait and to a decrease in the proportion of individuals that do not. (HS-LS4-3), (HS-LS4-4)
- Adaptation also means that the distribution of traits in a population can change when conditions change. (HS-LS4-3)
- Changes in the physical environment, whether naturally occurring or human induced, have thus contributed to the expansion of some species, the emergence of new distinct species as populations diverge under different conditions, and the decline—and sometimes the extinction—of some species. (HS-LS4-5), (HS-LS4-6)
- Species become extinct because they can no longer survive and reproduce in their altered environment. If members cannot adjust to change that is too fast or drastic, the opportunity for the species' evolution is lost. (HS-LS4-5)

LS4.D: Biodiversity and Humans

- Humans depend on the living world for the resources and other benefits provided by biodiversity. But human activity is also having adverse impacts on biodiversity through overpopulation, overexploitation, habitat destruction, pollution, introduction of invasive species, and climate change. Thus, sustaining biodiversity so that ecosystem functioning and productivity are maintained is essential to supporting and enhancing life on Earth. Sustaining biodiversity also aids humanity by preserving landscapes of recreational or inspirational value. (HS-LS4-6) (Note: This Disciplinary Core Idea is also addressed by HS-LS2-7.)

ETS1.B: Developing Possible Solutions

- When evaluating solutions, it is important to take into account a range of constraints, including cost, safety, reliability, and aesthetics, and to consider social, cultural, and environmental impacts. (secondary to HS-LS4-6)



- Both physical models and computers can be used in various ways to aid in the engineering design process. Computers are useful for a variety of purposes, such as running simulations to test different ways of solving a problem or to see which one is most efficient or economical; and in making a persuasive presentation to a client about how a given design will meet his or her needs. (secondary to HS-LS4-6)

Crosscutting Concepts:

Patterns

- Different patterns may be observed at each of the scales at which a system is studied and can provide evidence for causality in explanations of phenomena. (HS-LS4-1), (HS-LS4-3)

Cause and Effect

- Empirical evidence is required to differentiate between cause and correlation and make claims about specific causes and effects. (HS-LS4-2), (HS-LS4-4), (HS-LS4-5), (HS-LS4-6)

Connections to Nature of Science

Scientific Knowledge Assumes an Order and Consistency in Natural Systems

- Scientific knowledge is based on the assumption that natural laws operate today as they did in the past and they will continue to do so in the future. (HS-LS4-1), (HS-LS4-4)

Connections to Nature of Science Science

Models, Laws, Mechanisms, and Theories Explain Natural Phenomena

- A scientific theory is a substantiated explanation of some aspect of the natural world, based on a body of facts that have been repeatedly confirmed through observation and experiment and the science community validates each theory before it is accepted. If new evidence is discovered that the theory does not accommodate, the theory is generally modified in light of this new evidence. (HS-LS4-1)

Unit Essential Questions:

- How is evidence related to the understanding of common ancestry and biological evolution?
- How do factors influence the number of organisms, behaviors, morphology and physiology of a species and affect their ability to compete?
- How can the shift in the numerical distribution of traits be analyzed and used as evidence of evolution?
- How can data be used to provide evidence for how specific biotic and abiotic differences in ecosystems contribute to a change in gene frequency over time, leading to adaptation of populations?



- What is the cause and effect relationship of changes in environments and distribution or disappearance of traits in species?
- What solutions can be designed for a proposed problem related to threatened or endangered species or to genetic variation of organisms?

Unit Enduring Understandings:

- Genetic information provides evidence of evolution. DNA sequences vary among species, but there are many overlaps; in fact, the ongoing branching that produces multiple lines of descent can be inferred by comparing the DNA sequences of different organisms. Such information is also derivable from the similarities and differences in amino acid sequences and from anatomical and embryological evidence.
- Natural selection occurs only if there is both (1) variation in the genetic information between organisms in a population and (2) variation in the expression of that genetic information—that is, trait variation—that leads to differences in performance among individuals.
- Evolution is a consequence of the interaction of four factors: (1) the potential for a species to increase in number, (2) the genetic variation of individuals in a species due to mutation and sexual reproduction, (3) competition for an environment's limited supply of the resources that individuals need in order to survive and reproduce, and (4) the ensuing proliferation of those organisms that are better able to survive and reproduce in that environment. Natural selection leads to adaptation, that is, to a population dominated by organisms that are anatomically, behaviorally, and physiologically well suited to survive and reproduce in a specific environment. That is, the differential survival and reproduction of organisms in a population that have an advantageous heritable trait leads to an increase in the proportion of individuals in future generations that have the trait and to a decrease in the proportion of individuals that do not.
- Adaptation also means that the distribution of traits in a population can change when conditions change.
- Changes in the physical environment, whether naturally occurring or human induced, have thus contributed to the expansion of some species, the emergence of new distinct species as populations diverge under different conditions, and the decline—and sometimes the extinction—of some species.
- Species become extinct because they can no longer survive and reproduce in their altered environment. If members cannot adjust to change that is too fast or drastic, the opportunity for the species' evolution is lost.
- Humans depend on the living world for the resources and other benefits provided by biodiversity. But human activity is also having adverse impacts on biodiversity through overpopulation, overexploitation, habitat destruction, pollution, introduction of invasive species, and climate change. Thus sustaining biodiversity so that ecosystem functioning and productivity are maintained is essential to supporting and enhancing life on Earth. Sustaining biodiversity also aids humanity by preserving landscapes of recreational or inspirational value.
- When evaluating solutions, it is important to take into account a range of constraints, including cost, safety, reliability, and aesthetics, and to consider social, cultural, and



environmental impacts. Both physical models and computers can be used in various ways to aid in the engineering design process. Computers are useful for a variety of purposes, such as running simulations to test different ways of solving a problem or to see which one is most efficient or economical; and in making a persuasive presentation to a client about how a given design will meet his or her needs.

Unit Learning Targets:

- Students will...
- Apply concepts of statistics and probability (including determining function fits to data, slope, intercept, and correlation coefficient for linear fits) to scientific and engineering questions and problems, using digital tools when feasible.
- Create or revise a simulation of a phenomenon, designed device, process, or system.
- Construct an explanation based on valid and reliable evidence obtained from a variety of sources (including students' own investigations, models, theories, simulations, peer review) and the assumption that theories and laws that describe the natural world operate today as they did in the past and will continue to do so in the future.
- Evaluate the evidence behind currently accepted explanations or solutions to determine the merits of arguments.
- Communicate scientific information (e.g., about phenomena and/or the process of development and the design and performance of a proposed process or system) in multiple formats (including orally, graphically, textually, and mathematically).



Evidence of Learning

Summative Assessment: Unit Assessment and Labs

Equipment Needed: Teacher laptop, lab equipment

Teacher Resources: Textbook, lab activities and supplies

Formative Assessments:

- Quizzes
- Assignments
- Activities
- Labs
- Project



Lesson Plans

Lesson	Time Frame
Lesson 1 The Linnaean Branding Challenge	3 days
Lesson 2 The Finch Island Simulation – Survival of the Best-Fit	1 day
Lesson 3 The Evidence of Evolution Hexagon Challenge	1 day

Teacher Notes: Students will submit their work individually for grading purposes, but will work in groups of three to conduct the lab data gathering and analyze the results. Peer review of projects will be used to provide feedback to students.

Curriculum Development Resources/Technology Resources:

Click the links below to access additional resources used to design this unit:

<http://www.ucmp.berkeley.edu/help/timeform.php>

<http://www.ucmp.berkeley.edu/exhibit/histgeoscale.html>

<http://earthsci.org/fossils/youngp/periods/periods.html>

<http://www.ucmp.berkeley.edu/education/explorations/tours/stories/middle/intro.html>

<http://www.pbs.org/wgbh/evolution/educators/teachstuds/svideos.html>

http://blast.ncbi.nlm.nih.gov/Blast.cgi?CMD=Web&PAGE_TYPE=BlastHomeNew

<http://www.hhmi.org/biointeractive/great-transitions-origin-birds>



Lesson Plan 1 Template

Content Area: Honors Biology Lesson Title: The Linnaean Branding Challenge

Time Frame: 3 days

Lesson Components

21st Century Themes

- ☒ Global Awareness ☐ Financial, Economic, Business and Entrepreneurial Literacy
☐ Civic Literacy ☐ Health Literacy

21st Century Skills

- ☐ Creativity and Innovation ☐ Critical Thinking and Problem Solving ☒ Information Literacy
☐ Life and Career Skills ☐ Communication and Collaboration ☒ Media Literacy ☐ ICT Literacy

Interdisciplinary Connections:

Geology

Integration of Technology:

Google Sheets, iPads, Vernier GoDirect

Equipment Needed:

iPads, Vernier GoDirect

Goals/Objectives	Learning Activities/ Instructional Strategies	Formative Assessment Tasks
Students will: - Create a mnemonic device to master the hierarchical order of the classification system. - Attribute specific terminology (Domain through Species) to a real-world organism. - Explain the "Nested Hierarchy"—how moving down the levels increases relatedness but decreases total population.	Lesson Sequence Anchoring Phenomenon: Humans share nearly 99% of their DNA with chimpanzees and still share genes with organisms as different as mushrooms and bananas. How can organisms that appear so different be related, and why do scientists classify all life into a single hierarchical system? The "Drunken King" Hook (5 mins): Introduce the concept of a mnemonic. Share the "classic" (e.g., "Dear King Philip Came Over For Good Soup") but challenge them to create something more modern	- The "What's Missing?" Quick-Fire: Display a classification string with one level missing (e.g., Kingdom, Phylum, _____, Order...). Students must use their mnemonic to shout out the missing level. - The Relatedness Check: Present two organisms (e.g., a Dog and a Wolf). Students must identify at which level their "paths diverge" (The Genus level) using their knowledge of the order.



- or relevant to their own lives (e.g., using sports, gaming, or music references).
3. The "Taxonomic Sort" (10 mins): Working individually, students must develop two unique mnemonics for the eight levels: Domain, Kingdom, Phylum, Class, Order, Family, Genus, Species. * CP
Modernization: They must ensure Domain is included, as modern taxonomy always starts with the three Domains.
 4. The "Pitch" Session: Students share their best mnemonic aloud. Instead of just writing it down, the class votes on the "Most Memorable Brand" using a quick digital poll or show of hands.
 5. The Organelle-to-Organism Link: To reinforce the "nested" nature, students choose one "Celebrity Organism" (e.g., a Great White Shark, a Lion, or a Redwood Tree). They must "un-nest" the organism by listing every level of its classification.
 6. The "Inverted Triangle" Model: On the back of their handout, students draw an inverted triangle. They must place their mnemonic levels inside and explain why "Species" is at the tiny



point while "Domain" is
at the wide top.

Differentiation:

- Students may access information in multiple formats including visual models, written texts, diagrams, and digital simulations to support comprehension of scientific concepts.
- Students may demonstrate understanding through multiple modalities including written explanations, verbal presentations, visual models, diagrams, or digital products.
- Instruction includes scaffolded supports such as guided notes, sentence starters for scientific explanations, and partially completed models or data tables for students who need additional structure.
- Extension opportunities are provided through open-ended investigations, analysis of real-world case studies, or application of concepts to novel or complex scenarios.

Resources Provided:

- iPads



Lesson Plan 2 Template

Content Area: Honors Biology Lesson Title: The Finch Island Simulation – Survival of the Best-Fit Time Frame: 1 day

Lesson Components

21st Century Themes

- ☒ Global Awareness ☐ Financial, Economic, Business and Entrepreneurial Literacy
☐ Civic Literacy ☐ Health Literacy

21st Century Skills

- ☐ Creativity and Innovation ☒ Critical Thinking and Problem Solving ☐ Information Literacy
☐ Life and Career Skills ☐ Communication and Collaboration ☐ Media Literacy ☐ ICT Literacy

Interdisciplinary Connections:
 Mathematics

Integration of Technology:
 Google Sheets, iPads, Vernier GoDirect

Equipment Needed:
 iPads

Goals/Objectives	Learning Activities/ Instructional Strategies	Formative Assessment Tasks
Students will: - Simulate natural selection by mimicking the beak adaptations of Darwin's finches. - Explain the mechanism of evolution (Variation, Selection, Inheritance). - Graph population shifts over three "Generations" to see evolution in real-time.	Lesson Sequence Anchoring Phenomenon: During periods of drought in the Galápagos Islands, the average beak size of finch populations measurably changed within only a few generations. How can environmental changes alter the traits of an entire population in such a short period of time? The Variation Hook: Group students in pairs. Instead of random tools, explain that each group represents a sub-species of finch. Distribute "Beak Types": The Tongs (Large	- The "Fitness" Hypothesis: Before Generation 2 starts, students must write a one-sentence prediction: "I hypothesize that the [Beak Type] will increase in frequency because..." - The Adaptation Sketch: Students draw their "Modern Organism" and must label three Selective Pressures (e.g., Predation, Climate, Food Scarcity) that drove its evolution.



- Ground Finch), The Tweezers (Cactus Finch), The Spoon (Large Tree Finch), and The Chopstick (Warbler Finch).
3. Generation 1 (The Drought): Spread a mixture of "seeds" (beans, rubber bands, and paperclips) on butcher paper.
- Task: Students have 45 seconds to gather as many "seeds" as possible into their "Stomach" (cup).
 - The Rule: To "survive" to the next round, a finch must collect at least 20 units of food.
4. Data & Reproduction: Students record their catch.
- If they survived: They "reproduce." A new student pair joins their beak phenotype.
 - If they "died": That beak type is removed from the island.
 - Math Link: Use the "Percent Change" to show how the population of Tweezer-beaks increased while Spoon-beaks decreased.



5. Generation 2 (The Shift):
Change the environment!
Remove the beans and leave only the rubber bands (simulating a change in available food due to weather). Repeat the simulation.
6. Graphing the Shift:
Students create a Multi-Line Graph. The X-axis is "Generation" (1, 2, 3) and the Y-axis is "Number of Individuals." Students will see the lines cross as one trait becomes dominant.
7. The Naturalist's Journal:
Instead of a PowerPoint, students act as Charles Darwin. They research a Galapagos organism (like the Marine Iguana) and write a 1st-person journal entry comparing it to a mainland relative (the Green Iguana), illustrating the specific adaptations that allowed it to survive in its unique environment.

Differentiation:

- Students may access information in multiple formats including visual models, written texts, diagrams, and digital simulations to support comprehension of scientific concepts.
- Students may demonstrate understanding through multiple modalities including written explanations, verbal presentations, visual models, diagrams, or digital products.
- Instruction includes scaffolded supports such as guided notes, sentence starters for scientific explanations, and partially completed models or data tables for students who need additional structure.
- Extension opportunities are provided through open-ended investigations, analysis of real-world case studies, or application of concepts to novel or complex scenarios.

Resources Provided:

- Google Sheets online tutorial



- Dried beans or other organisms to measure.



Lesson Plan 3 Template

Content Area: Honors Biology Lesson Title: The Evidence of Evolution Hexagon Challenge

Time: 1 day

Lesson Components

21st Century Themes

- ☒ Global Awareness ☐ Financial, Economic, Business and Entrepreneurial Literacy
☐ Civic Literacy ☐ Health Literacy

21st Century Skills

- ☐ Creativity and Innovation ☒ Critical Thinking and Problem Solving ☒ Information Literacy
☐ Life and Career Skills ☐ Communication and Collaboration ☐ Media Literacy ☐ ICT Literacy

Interdisciplinary Connections:

Mathematics

Integration of Technology:

Google Sheets, iPads, Vernier GoDirect

Equipment Needed:

iPads

Goals/Objectives	Learning Activities/ Instructional Strategies	Formative Assessment Tasks
Students will: - Match key vocabulary (Natural Selection, Homologous Structures, Vestigial Organs, etc.) with definitions and real-world examples. - Analyze the "Lines of Evidence" for evolution, including embryology, the fossil record, and molecular biology. - Explain how specific structures demonstrate common ancestry or environmental adaptation.	Lesson Sequence - Anchoring Phenomenon: The arm of a human, the wing of a bat, the flipper of a whale, and the forelimb of a cat all contain nearly identical bone arrangements despite serving completely different functions. Why would organisms occupying vastly different environments share the same underlying anatomical blueprint? - The "Line of Evidence" Hook: Group students in pairs. Show a series of images (e.g., the arm of a human, the wing of a bat, and the flipper of a	- The "Odd One Out" Challenge: Display three terms and one definition (two of which match). Students must use their mnemonic or puzzle knowledge to identify the "imposter" term that doesn't belong in that line of evidence. - The Case Study Sketch: On the back of their puzzle guide, students must choose one "Evidence" term (like Fossil Record) and sketch a transition (like the evolution of the horse or the whale) to show



	whale). Ask: "If these animals live in different environments, why is their bone structure nearly identical?" 3. The Hexagon Puzzle Construction: Provide students with a "Genome Bag" containing hexagonal puzzle pieces. ○ Side A: Vocabulary Term (e.g., Vestigial Structure). ○ Side B: Scientific Definition (e.g., A structure that has lost its original function through evolution). ○ Side C: Real-world Case Study (e.g., Pelvic bones in a whale or the human appendix). 4. Collaborative Sorting: Students must link the hexagons together on their desks so that all touching sides match correctly. ○ CP Modernization: Instead of just using a textbook, students use a "Digital Evidence Board" (a curated Padlet or site list) to verify the case studies for terms like Biogeography or Comparative Embryology. 5. The "Gallery Audit": Once a group completes	"Descent with Modification."
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- their geometric puzzle, they must "Audit" another group's puzzle. If they find a mismatch, they must provide the correct definition as "Evidence."
6. Digital Reinforcement: Students take a photo of their completed puzzle to use as a visual study guide. This photo is then used as the "answer key" for a gamified review like a Gimkit or Blooket.

Differentiation:

- Students may choose the type of model they select to communicate evidence.
- Students may access information in multiple formats including visual models, written texts, diagrams, and digital simulations to support comprehension of scientific concepts.
- Students may demonstrate understanding through multiple modalities including written explanations, verbal presentations, visual models, diagrams, or digital products.
- Instruction includes scaffolded supports such as guided notes, sentence starters for scientific explanations, and partially completed models or data tables for students who need additional structure.
- Extension opportunities are provided through open-ended investigations, analysis of real-world case studies, or application of concepts to novel or complex scenarios.

Resources Provided:

- <http://www.hhmi.org/biointeractive/great-transitions-origin-birdsq>
- <http://blast.ncbi.nlm.nih.gov/Blast.cgi>



Lesson Reflection

Reflect on the lesson you have developed and rate the degree to which the lesson **Strongly, Moderately** or **Weakly** meets the criteria below.

Lesson Activities	Strongly	Moderately	Weakly
Are challenging and require higher order thinking and problem solving skills	☒	☐	☐
Allow for student choice	☒	☐	☐
Provide scaffolding for acquiring targeted knowledge/skills	☐	☒	☐
Integrate global perspectives	☐	☒	☐
Integrate 21st century skills	☐	☒	☐
Provide opportunities for interdisciplinary connection and transfer of knowledge and skills	☒	☐	☐
Foster student use of technology as a tool to develop critical thinking, creativity and innovation skills	☒	☐	☐
Are varied to address different student learning styles and preferences	☒	☐	☐
Are differentiated based on student needs	☒	☐	☐
Are student-centered with teacher acting as a facilitator and co-learner during the teaching and learning process	☒	☐	☐
Provide means for students to demonstrate knowledge and skills and progress in meeting learning goals and objectives	☒	☐	☐
Provide opportunities for student reflection and self- assessment	☒	☐	☐
Provide data to inform and adjust instruction to better meet the varying needs of learners	☒	☐	☐

Curriculum Design Template

Content Area: Science

Grade Level: 9

Unit Title: Biological Evolution: Unity and Diversity

Created: 2026

Board Approved on:



Unit Overview Template

Content Area: Honors Biology **Grade Level:** 9 **Unit Title:** Biology of Earth Systems and Biodiversity

Unit Summary: This unit explores how living organisms interact with each other and with Earth's atmosphere, hydrosphere, geosphere, and biosphere through the cycling of matter and flow of energy. Students investigate biodiversity, ecosystem stability, carbon cycling, evolution, and the coevolution of life and Earth systems while analyzing the impacts of human activities on natural systems. Through modeling, data analysis, simulations, and engineering design, students evaluate solutions that promote biodiversity, sustainability, and the long-term health of Earth systems.

Primary Interdisciplinary Connections: Environmental Science

21st Century Themes ☒ Creativity and Innovation ☒ Critical Thinking and Problem Solving ☒ ICT Literacy
☒ Information Literacy ☒ Life and Career Skills ☒ Communication and Collaboration ☒ Media Literacy

Unit Rationale: Understanding the interactions between biological systems and Earth systems enables students to explain how life influences and is influenced by environmental change while developing evidence-based solutions to sustainability and biodiversity challenges.

Career Readiness (Standard 9):

9.2.12.CAP.4: Evaluate different careers and develop various plans.

9.2.12.CAP.5: Assess and modify a personal plan to support current interests and postsecondary plans.

9.2.12.CAP.13: Analyze how the economic, social, and political conditions of a time period can affect the labor market.

9.4.12.CI.1: Demonstrate the ability to reflect, analyze, and use creative skills and ideas.

9.4.12.CI.2: Identify career pathways that highlight personal talents, skills, and abilities.

9.4.12.DC.8: Explain how increased network connectivity and computing capabilities of everyday objects allow for innovative technological approaches to climate protection.

9.4.12.GCA.1: Collaborate with individuals to analyze a variety of potential solutions to climate change effects and determine why some solutions (e.g., political, economic, cultural) may work better than others.

9.4.12.IML.1: Compare search browsers and recognize features that allow for filtering of information.

9.4.12.IML.2: Evaluate digital sources for timeliness, accuracy, perspective, credibility of the source, and relevance of information, in media, data, or other resources.

9.4.12.IML.3: Analyze data using tools and models to make valid and reliable claims, or to determine optimal design solutions.

9.4.12.TL.2: Generate data using formula-based calculations in a spreadsheet and draw conclusions about the data.

9.4.12.TL.4: Collaborate in online learning communities or social networks or virtual worlds to analyze and propose a resolution to a real-world problem.

Learning Targets

Standards: HS-LS1, HS-LS2, HS-LS4, HS-ESS2, HS-ESS3, HS-ETS1



Content Statements: From Molecules to Organisms: Structures and Processes; Ecosystems: Interactions, Energy, and Dynamics; Biological Evolution: Unity and Diversity; Earth's Systems; Earth and Human Activity; Engineering Design

CPI#:	Cumulative Progress Indicator (CPI):
HS-LS1-5	Use a model to illustrate how photosynthesis transforms light energy into stored chemical energy.
HS-LS1-7	Use a model to illustrate that cellular respiration is a chemical process whereby the bonds of food molecules and oxygen molecules are broken and the bonds in new compounds are formed resulting in a net transfer of energy.
HS-LS2-5	Develop a model to illustrate the role of photosynthesis and cellular respiration in the cycling of carbon among the biosphere, atmosphere, hydrosphere, and geosphere.
HS-LS2-7	Design, evaluate, and refine a solution for reducing the impacts of human activities on the environment and biodiversity.
HS-LS4-5	Evaluate the evidence supporting claims that changes in environmental conditions may result in: (1) increases in the number of individuals of some species, (2) the emergence of new species over time, and (3) the extinction of other species.
HS-ESS2-6	Develop a quantitative model to describe the cycling of carbon among the hydrosphere, atmosphere, geosphere, and biosphere.
HS-ESS2-7	Construct an argument based on evidence about the simultaneous coevolution of Earth's systems and life on Earth.
HS-ESS3-3	Create a computational simulation to illustrate the relationships among management of natural resources, the sustainability of human populations, and biodiversity.
HS-ESS3-6	Use a computational representation to illustrate the relationships among Earth systems and how those relationships are being modified due to human activity (i.e., climate change).
HS-ETS1-2	Design a solution to a complex real-world problem by breaking it down into smaller, more manageable problems that can be solved through engineering.
HS-ETS1-4	Use a computer simulation to model the impact of proposed solutions to a complex real-world problem with numerous criteria and constraints on interactions within and between systems relevant to the problem.
Math.S-ID.A.1	Represent data with plots on the real number line (dot plots, histograms, and box plots).
Math.S-ID.A.2	Use statistics appropriate to the shape of the data distribution to compare center (median, mean) and spread (interquartile range, standard deviation) of two or more different data sets.
8.2.12.EC.3	Synthesize data, analyze trends, and draw conclusions regarding the effect of a technology on the individual, culture, society, and environment and share this information with the appropriate audience.

Science and Engineering Practices:



Developing and Using Models

Modeling in 9–12 builds on K–8 experiences and progresses to using, synthesizing, and developing models to predict and show relationships among variables between systems and their components in the natural and designed worlds.

- Use a model based on evidence to illustrate the relationships between systems or between components of a system. (HS-LS1-5), (HS-LS1-7)
- Develop a model based on evidence to illustrate the relationships between systems or components of a system. (HS-LS2-5), (HS-ESS2-6)

Engaging in Argument from Evidence

Engaging in argument from evidence in 9–12 builds on K–8 experiences and progresses to using appropriate and sufficient evidence and scientific reasoning to defend and critique claims and explanations about the natural and designed world(s). Arguments may also come from current or historical episodes in science.

- Evaluate the evidence behind currently accepted explanations or solutions to determine the merits of arguments. (HS-LS4-5)
- Construct an oral and written argument or counter-arguments based on data and evidence. (HS-ESS2-7)

Using Mathematics and Computational Thinking

Mathematical and computational thinking in 9–12 builds on K–8 experiences and progresses to using algebraic thinking and analysis, a range of linear and nonlinear functions including trigonometric functions, exponentials and logarithms, and computational tools for statistical analysis to analyze, represent, and model data. Simple computational simulations are created and used based on mathematical models of basic assumptions.

- Create a computational model or simulation of a phenomenon, designed device, process, or system. (HS-ESS3-3)
- Use a computational representation of phenomena or design solutions to describe and/or support claims and/or explanations. (HS-ESS3-6)
- Use mathematical models and/or computer simulations to predict the effects of a design solution on systems and/or the interactions between systems. (HS-ETS1-4)

Constructing Explanations and Designing Solutions

Constructing explanations and designing solutions 9–12 builds on K – 8 experiences and progresses to explanations and designs that are supported by multiple and independent student-generated sources of evidence consistent with scientific ideas, principles and theories.

- Design a solution to a complex real-world problem, based on scientific knowledge, student-generated sources of evidence, prioritized criteria, and tradeoff considerations. (HS-ETS1-2)

Disciplinary Core Ideas (DCIs):



LS1.C: Organization for Matter and Energy Flow in Organisms

- The process of photosynthesis converts light energy to stored chemical energy by converting carbon dioxide plus water into sugars plus released oxygen. (HS-LS1-5)
- As matter and energy flow through different organizational levels of living systems, chemical elements are recombined in different ways to form different products. (HS-LS1-7)

LS2.B: Cycles of Matter and Energy Transfer in Ecosystems

- Photosynthesis and cellular respiration are important components of the carbon cycle, in which carbon is exchanged among the biosphere, atmosphere, oceans, and geosphere through chemical, physical, geological, and biological processes. (HS-LS2-5)

LS2.C: Ecosystem Dynamics, Functioning, and Resilience

- Moreover, anthropogenic changes (induced by human activity) in the environment—including habitat destruction, pollution, introduction of invasive species, overexploitation, and climate change—can disrupt an ecosystem and threaten the survival of some species. (HS-LS2-7)

LS4.C: Adaptation

- Changes in the physical environment, whether naturally occurring or human induced, have thus contributed to the expansion of some species, the emergence of new distinct species as populations diverge under different conditions, and the decline—and sometimes the extinction—of some species. (HS-LS4-5)
- Species become extinct because they can no longer survive and reproduce in their altered environment. If members cannot adjust to change that is too fast or drastic, the opportunity for the species' evolution is lost. (HS-LS4-5)

LS4.D: Biodiversity and Humans

- Biodiversity is increased by the formation of new species (speciation) and decreased by the loss of species (extinction). (secondary to HS-LS2-7)
- Humans depend on the living world for the resources and other benefits provided by biodiversity. But human activity is also having adverse impacts on biodiversity through overpopulation, overexploitation, habitat destruction, pollution, introduction of invasive species, and climate change. Thus sustaining biodiversity so that ecosystem functioning and productivity are maintained is essential to supporting and enhancing life on Earth. Sustaining biodiversity also aids humanity by preserving landscapes of recreational or inspirational value. (secondary to HS-LS2-7)

PS3.D: Energy in Chemical Processes

- The main way that solar energy is captured and stored on Earth is through the complex chemical process known as photosynthesis. (secondary to HS-LS2-5)

ESS2.D: Weather and Climate



- Gradual atmospheric changes were due to plants and other organisms that captured carbon dioxide and released oxygen. (HS-ESS2-6), (HS-ESS2-7)
- Changes in the atmosphere due to human activity have increased carbon dioxide concentrations and thus affect climate. (HS-ESS2-6)

ESS2.E: Biogeology

- The many dynamic and delicate feedbacks between the biosphere and other Earth systems cause a continual co-evolution of Earth's surface and the life that exists on it. (HS-ESS2-7)

ESS3.C: Human Impacts on Earth Systems

- The sustainability of human societies and the biodiversity that supports them requires responsible management of natural resources. (HS-ESS3-3)

ESS3.D: Global Climate Change

- Through computer simulations and other studies, important discoveries are still being made about how the ocean, the atmosphere, and the biosphere interact and are modified in response to human activities. (HS-ESS3-6)

ETS1.C: Optimizing the Design Solution

- Criteria may need to be broken down into simpler ones that can be approached systematically, and decisions about the priority of certain criteria over others (tradeoffs) may be needed. (HS-ETS1-2)

ETS1.B: Developing Possible Solutions

- When evaluating solutions, it is important to take into account a range of constraints including cost, safety, reliability and aesthetics and to consider social, cultural and environmental impacts. (secondary to HS-LS2-7).
- Both physical models and computers can be used in various ways to aid in the engineering design process. Computers are useful for a variety of purposes, such as running simulations to test different ways of solving a problem or to see which one is most efficient or economical; and in making a persuasive presentation to a client about how a given design will meet his or her needs. (HS-ETS1-4)

Crosscutting Concepts:

Energy and Matter

- Changes of energy and matter in a system can be described in terms of energy and matter flows into, out of, and within that system. (HS-LS1-5)
- Energy cannot be created or destroyed—it only moves between one place and another place, between objects and/or fields, or between systems. (HS-LS1-7)
- The total amount of energy and matter in closed systems is conserved. (HS-ESS2-6)

Systems and System Models



- Models (e.g., physical, mathematical, computer models) can be used to simulate systems and interactions—including energy, matter, and information flows—within and between systems at different scales. (HS-LS2-5), (HS-ETS1-4)
- When investigating or describing a system, the boundaries and initial conditions of the system need to be defined and their inputs and outputs analyzed and described using models. (HS-ESS3-6)

Stability and Change

- Much of science deals with constructing explanations of how things change and how they remain stable. (HS-LS2-7), (HS-ESS2-7)
- Change and rates of change can be quantified and modeled over very short or very long periods of time. Some system changes are irreversible. (HS-ESS3-3)

Cause and Effect

- Empirical evidence is required to differentiate between cause and correlation and make claims about specific causes and effects. (HS-LS4-5)

Connections to Engineering, Technology, and Applications of Science

Influence of Engineering, Technology, and Science on Society and the Natural World

- Modern civilization depends on major technological systems. (HS-ESS3-3)
- New technologies can have deep impacts on society and the environment, including some that were not anticipated. (HS-ESS3-3)

Connections to Nature of Science

Science is a Human Endeavor

- Science is a result of human endeavors, imagination, and creativity. (HS-ESS3-3)

Unit Essential Questions:

- How do organisms capture, transform, and transfer energy and matter within living systems and across Earth systems?
- How are ecosystems and Earth systems interconnected through the cycling of carbon and other materials?
- How do changes in environmental conditions influence the stability, diversity, and evolution of life on Earth?
- In what ways do human activities modify Earth systems and biodiversity?
- How can scientific understanding and engineering design be used to address environmental challenges and promote sustainability?

Unit Enduring Understandings:

- Energy and matter are continuously cycled through biological and Earth systems, connecting all living and nonliving components of the planet.



- Photosynthesis and cellular respiration are fundamental processes that drive the flow of energy and carbon through ecosystems.
- Ecosystems can remain stable over time but are sensitive to changes in environmental conditions that may disrupt balance and biodiversity.
- Evolution and natural selection are influenced by environmental change and contribute to the coevolution of life and Earth systems.
- Human activities can significantly alter Earth systems, biodiversity, and resource availability, often across multiple scales.
- Scientific modeling, data analysis, and engineering design are essential tools for understanding and addressing complex environmental challenges.

Unit Learning Targets:

Students will...

- Explain how photosynthesis and cellular respiration transfer energy and matter within biological systems.
- Model how carbon cycles through organisms and Earth systems, including the atmosphere, biosphere, hydrosphere, and geosphere.
- Analyze how ecosystem stability can change in response to environmental disturbances.
- Use evidence to explain how changes in environmental conditions can lead to adaptation, speciation, or extinction.
- Construct explanations for how biodiversity and ecosystem health are influenced by natural and human-driven changes.
- Evaluate the impacts of human activity on Earth systems and propose ways to reduce negative effects.
- Use computational or conceptual models to represent interactions among organisms and Earth systems.
- Develop and evaluate solutions to environmental problems using scientific and engineering principles.
- Communicate scientific explanations using evidence from models, data, and investigations.



Evidence of Learning

Summative Assessment: Unit Assessment and Labs

Equipment Needed: Teacher laptop, lab equipment

Teacher Resources: Textbook, lab activities and supplies

Formative Assessments:

- Quizzes
- Assignments
- Activities
- Labs
- Project



Lesson Plans

Lesson	Time Frame
Lesson 1 The Carbon Pathway — From Sunlight to Life	3 days
Lesson 2 When Systems Break Balance — Biodiversity and Environmental Change	3 days
Lesson 3 Designing for a Changing Planet — Engineering Sustainability Solutions	3 days

Teacher Notes: This unit is built around the idea that biological systems cannot be separated from Earth systems—carbon cycling, energy flow, and ecosystem stability are interconnected across scales from molecules to global systems. Students should be consistently pushed to connect cellular processes (photosynthesis and respiration) to large-scale phenomena such as climate change, biodiversity loss, and resource management. Emphasis should be placed on modeling, data analysis, and argumentation from evidence, with frequent opportunities for students to engage in collaborative problem-solving and design thinking. The engineering components of the unit are intended to be authentic and open-ended, allowing students to evaluate trade-offs in real-world sustainability challenges that involve environmental, economic, and societal considerations.

Curriculum Development Resources/Technology Resources:

Click the links below to access additional resources used to design this unit:

<https://www.biointeractive.org/>

<https://www.ck12.org/student/>

<https://phet.colorado.edu/en/simulations/filter?subjects=biology&type=html>

<http://www.pbs.org/wgbh/evolution/educators/teachstuds/svideos.html>



Lesson Plan 1 Template

Content Area: Honors Biology Lesson Title: The Carbon Pathway — From Sunlight to Life

Time Frame: 3 days

Lesson Components

21st Century Themes

- ☒ Global Awareness ☒ Financial, Economic, Business and Entrepreneurial Literacy
☒ Civic Literacy ☒ Health Literacy

21st Century Skills

- ☒ Creativity and Innovation ☒ Critical Thinking and Problem Solving ☒ Information Literacy
☒ Life and Career Skills ☒ Communication and Collaboration ☒ Media Literacy ☒ ICT Literacy

Interdisciplinary Connections:

Environmental Science

Integration of Technology:

- Google Sheets for carbon flow data tracking and graphing (photosynthesis vs respiration models)
- PhET simulation: Photosynthesis and Greenhouse Effect
- Vernier Go Direct CO₂ sensors to measure CO₂ changes in respiration/plant activity demonstrations
- Google Slides for group modeling presentations of carbon pathways
- Short video analysis using HHMI BioInteractive carbon cycle clips

Equipment Needed:

- iPads
- Elodea or similar aquatic plants (or spinach leaf disks for floating disk lab)
- Baking soda solution (CO₂ source for plants)
- Clear cups or beakers
- Desk lamps or light sources
- CO₂ probes (Vernier if available) or alternative indicator setup (BTB solution)
- Stopwatch/timers (or phones)
- Graph paper
- Printed carbon cycle diagram templates

Goals/Objectives	Learning Activities/ Instructional Strategies	Formative Assessment Tasks
Students will: • Model how photosynthesis and cellular respiration move carbon and energy through living systems • Collect and analyze experimental data showing changes in CO₂	Lesson Sequence Anchoring Phenomenon: “Why is CO ₂ rising in places full of plants?” 1. Students observe a short data set and video showing:	• Initial hypothesis (written explanation of phenomenon) • Lab data accuracy and participation checklist • Google Sheets graph (trend + labeling check)



under different environmental conditions • Explain how biological processes connect to global carbon cycling and climate systems • Use models and simulations to connect cellular-level processes to Earth system-scale phenomena • Evaluate how human and industrial activity influences natural carbon cycles	◦ CO₂ levels increasing in a sealed terrarium containing plants ◦ Nighttime spikes in CO₂ in plant-rich environments ◦ Global atmospheric CO₂ trends over time 2. Students individually record initial explanations for how CO₂ can increase in systems with abundant plant life 3. Class discussion surfaces competing ideas and establishes the guiding question: How can biological systems both remove and release carbon dioxide? Building Initial Explanations 4. Students share and compare initial models or explanations in small groups 5. Class constructs a working list of “what we think we know” about plants, photosynthesis, and gas exchange 6. Teacher introduces the idea that systems may behave differently depending on conditions (light, time, inputs, outputs)	• PhET simulation reflection questions • Carbon model (must show at least 3 accurate carbon pathways) • Exit ticket: ◦ Explain why CO₂ can increase even when plants are present ◦ Identify one human activity that affects carbon cycling and explain how
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	Investigation: Testing Carbon Exchange in Living Systems - Students conduct a controlled investigation using Elodea or leaf disks - One setup exposed to light - One setup kept in dark conditions - Students measure changes in oxygen or CO₂ using probes or indicator solution - Data is collected systematically and entered into Google Sheets Making Sense of Data - Students graph and analyze experimental results - Comparing light vs dark conditions - Identifying when carbon dioxide is being used or produced - Students reconcile results with initial explanations and identify where their thinking needs revision Connecting to System-Level Behavior - Students use PhET simulations to manipulate variables in photosynthesis and carbon cycling - Light intensity - CO₂ concentration	
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	○ Number of producers 13. Students compare simulation behavior to lab data and identify what the model helps explain and what it does not Constructing a Carbon Flow Model 14. Students build a visual model of carbon movement through: ○ Atmosphere ○ Producers ○ Consumers ○ Decomposers 15. Students revise models after peer critique and new evidence from investigation and simulation Extending to Real-World Systems 16. Students examine real-world carbon data showing: ○ Industrial CO₂ emissions ○ Fossil fuel energy production ○ Natural carbon cycling processes 17. Students analyze how human activity alters the balance of carbon movement in Earth systems 18. Students evaluate a scenario comparing energy production	
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	choices and their environmental impacts Final Synthesis 19. Students revise and finalize carbon cycle models 20. Students write an explanation of the phenomenon using evidence from: ○ Lab investigation ○ Simulation results ○ Real-world data 21. Class discussion connects cellular processes to global carbon cycling and system-level change	
Differentiation: ● Scaffolded carbon cycle diagrams (partial → full modeling progression) ● Sentence frames for explanations of energy vs matter flow ● Optional extension: quantify emissions using simplified datasets ● Choice of model format (digital, physical, diagrammatic) ● Structured lab roles (data collector, analyzer, presenter, model builder) ● Enrichment: real NASA/NOAA carbon datasets for advanced analysis		
Resources Provided: ● Carbon cycle modeling templates (leveled) ● Lab procedure handouts ● Google Sheets graphing template ● PhET simulation guide sheet ● Exit ticket prompts ● Anchor phenomenon data set (CO₂ time-series) ● Model rubric/checklist		



Lesson Plan 2 Template

Content Area: Honors Biology Lesson Title: When Systems Break Balance — Biodiversity and Environmental Change Time Frame: 3 days

Lesson Components

21st Century Themes

- ☒ Global Awareness ☒ Financial, Economic, Business and Entrepreneurial Literacy
☒ Civic Literacy ☒ Health Literacy

21st Century Skills

- ☒ Creativity and Innovation ☒ Critical Thinking and Problem Solving ☒ Information Literacy
☒ Life and Career Skills ☒ Communication and Collaboration ☒ Media Literacy ☒ ICT Literacy

Interdisciplinary Connections:

Environmental Science

Integration of Technology:

- Google Sheets for analyzing ecosystem population data and graphing trends over time
- PhET simulation (Natural Selection / ecosystem balance simulations) for modeling population changes under environmental stress
- NOAA / NASA ecosystem and climate data sets accessed via student devices
- Google Slides for constructing and revising ecosystem interaction models
- Short video/data sets from HHMI BioInteractive (coral bleaching, invasive species, ecosystem shifts)

Equipment Needed:

- Student iPads
- Printed or digital ecosystem data sets (predator-prey, invasive species, population collapse scenarios)
- Ecosystem simulation access (PhET or equivalent)
- Chart paper or digital modeling tools
- Colored markers (for system models if done on paper)
- Model templates (ecosystem interaction diagrams)
- Sticky notes for peer feedback on models

Goals/Objectives	Learning Activities/ Instructional Strategies	Formative Assessment Tasks
Students will: • Analyze real and simulated data to identify patterns of stability and change in ecosystems • Explain how interactions among organisms and	Lesson Sequence Anchoring Phenomenon: “Why do ecosystems collapse suddenly after appearing stable?”	• Initial written explanation of ecosystem collapse phenomenon • Data analysis checks during Google Sheets



environmental conditions influence ecosystem balance • Use models to represent relationships within ecosystems, including feedback effects • Evaluate how disturbances (natural or human-caused) affect biodiversity and population stability • Develop evidence-based explanations for ecosystem collapse or recovery	1. Students observe multiple real-world cases: ◦ Coral reef bleaching events ◦ Algal blooms in freshwater systems ◦ Invasive species rapidly overtaking ecosystems ◦ Sudden population crashes in predator-prey systems 2. Students record observations about what changes across all systems and what remains consistent 3. Class discussion generates initial ideas about what causes ecosystem instability 4. Students develop initial explanations for why ecosystems can shift rapidly 5. Groups compare explanations and identify common proposed causes (resource change, species interaction, external disturbance) 6. Teacher introduces guiding question: What determines whether an ecosystem stays stable or changes dramatically? 7. Students analyze multiple ecosystem data sets showing population changes over time: ◦ Predator-prey cycles	graphing (accuracy, trends, labeling) • Simulation response questions (predict → test → revise cycle) • Ecosystem model checkpoint (must show interactions + at least one feedback loop) • Exit task: ◦ Explain one reason ecosystems can remain stable and one reason they can rapidly change ◦ Use evidence from data or simulation to support response
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- Invasive species growth curves
- Ecosystem recovery vs collapse scenarios
- 8. Students graph data in Google Sheets and identify patterns of stability and disruption
- 9. Students compare across ecosystems to identify similarities in system behavior
- 10. Students use ecosystem simulation tools to manipulate variables such as:
 - Resource availability
 - Introduction/removal of species
 - Reproduction or survival rates
- 11. Students compare simulation outcomes to real-world case studies and adjust explanations based on results
- 12. Students construct a systems model of an ecosystem showing:
 - Organism interactions
 - Energy and resource flow
 - Feedback loops (stabilizing and destabilizing)
- 13. Students revise models based on peer feedback and evidence from data and simulations
- 14. Students analyze a scenario involving human impact on ecosystems



- (e.g., deforestation, overfishing, nutrient runoff, urban expansion)
15. Students evaluate how human activity alters system stability and biodiversity
 16. Students propose potential responses or mitigation strategies and discuss trade-offs in each option
 17. Students finalize ecosystem models and write an explanation of:
 - Why ecosystems remain stable in some conditions
 - Why they shift rapidly in others
 - How human activity can accelerate or reduce these changes
 18. Class discussion connects ecosystem stability to broader Earth system interactions and long-term environmental change

Differentiation:

- Scaffolded ecosystem data sets (simplified vs complex)
- Guided graphing templates in Google Sheets for support learners
- Extension datasets including multi-variable ecosystem interactions
- Choice of representation (digital model, paper model, or hybrid)
- Structured roles in group work (data analyst, model builder, discussion leader)
- Sentence frames for explaining cause-and-effect relationships

Resources Provided:

- Ecosystem data sets (tiered complexity)
- Simulation instruction guide
- Google Sheets graphing template
- Ecosystem modeling templates (blank and scaffolded)



- Exit ticket prompts
- Case study handouts (coral bleaching, invasive species, algal blooms)
- Model rubric/checklist



Lesson Plan 3 Template

Content Area: Honors Biology Lesson Title: Designing for a Changing Planet — Engineering Sustainability Solutions Time: 3 days

Lesson Components

21st Century Themes

- ☒ Global Awareness ☒ Financial, Economic, Business and Entrepreneurial Literacy
☒ Civic Literacy ☒ Health Literacy

21st Century Skills

- ☒ Creativity and Innovation ☒ Critical Thinking and Problem Solving ☒ Information Literacy
☒ Life and Career Skills ☒ Communication and Collaboration ☒ Media Literacy ☒ ICT Literacy

Interdisciplinary Connections:

Environmental Science

Integration of Technology:

- Google Sheets for comparing energy use, emissions data, and environmental impact across different energy sources
- PhET simulations (Greenhouse effect / energy forms and changes) to model climate impacts of different energy choices
- Vernier Go Direct sensors to explore temperature or CO₂ changes in controlled demonstrations
- Google Slides or Canva for designing and presenting engineering solutions
- Online data sets from NOAA or NASA for real-world climate and emissions analysis
- Video case studies from HHMI BioInteractive or National Geographic on climate impacts and mitigation strategies

Equipment Needed:

- Student iPads
- Printed or digital climate data sets (CO₂ levels, temperature trends, energy use by source)
- Engineering design templates (problem, criteria, constraints, solution planning)
- Graph paper or digital spreadsheet tools
- Materials for prototype modeling (cardboard, markers, tape)
- Simulation access (PhET or equivalent)
- Sticky notes for peer feedback and iteration cycles

Goals/Objectives	Learning Activities/ Instructional Strategies	Formative Assessment Tasks
Students will: • Analyze real-world data to evaluate the impact of human energy use on Earth systems • Model how energy choices influence Earth	Lesson Sequence Anchoring Phenomenon: “Why do some communities experience more severe climate impacts than others?”	• Initial written explanation of Earth system impact phenomenon



systems and carbon cycling • Identify and define criteria and constraints for engineering solutions to climate-related problems • Develop and compare multiple design solutions to reduce environmental impact • Evaluate trade-offs among economic, environmental, and societal factors • Communicate and defend an evidence-based engineering solution	1. Students observe case studies showing: ○ Coastal flooding differences between regions ○ Urban heat island effects in cities ○ Drought severity variations across agricultural regions ○ Energy use and emissions differences between countries 2. Students record initial observations about patterns and differences across regions 3. Class discussion develops initial ideas about why climate impacts are unevenly distributed 4. Students develop initial explanations for how energy use might influence Earth system impacts 5. Groups compare ideas and identify key factors (energy sources, geography, population density, infrastructure) 6. Teacher introduces guiding question: how can human energy choices reduce impacts on Earth systems? 7. Students analyze data sets showing: ○ CO₂ emissions by energy source ○ Temperature trends over time	• Data analysis checks in Google Sheets (graphs, trends, and interpretations) • Simulation response prompts (prediction, testing, revision cycle) • Engineering design checkpoints: ○ Defined problem statement ○ Identified criteria and constraints ○ Draft solution concepts • Exit task: ○ Explain how energy choices affect Earth systems ○ Justify a proposed solution using evidence from data or models
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- Energy consumption patterns across regions
- 8. Students use Google Sheets to graph and compare trends
- 9. Students identify relationships between energy use and Earth system changes
- 10. Students use PhET simulation to model greenhouse gas effects and energy flow in Earth's atmosphere
- 11. Students manipulate variables such as greenhouse gas concentration and energy input
- 12. Students compare simulation results to real-world climate data
- 13. Students begin engineering design challenge:
 - Design a system, policy, or technology to reduce Earth system impacts from energy use
- 14. Students identify criteria and constraints including:
 - Cost
 - Efficiency
 - Environmental impact
 - Feasibility
 - Scalability
- 15. Students develop at least two possible solutions



- | | | |
|--|---|--|
| | <ol style="list-style-type: none">16. Students evaluate and compare solutions using evidence from data and simulation17. Students revise designs based on peer feedback and trade-off analysis18. Students refine one final proposed solution19. Students create a visual or digital presentation of their engineering solution20. Students present and defend their solution using evidence from:<ul style="list-style-type: none">○ Climate data○ Simulation results○ Scientific models of energy and Earth systems21. Class discussion connects individual solutions to broader system-level impacts on Earth | |
|--|---|--|

Differentiation:

- Scaffolded data sets with simplified or advanced climate information
- Guided engineering design templates for structured support
- Extension opportunities using NASA or NOAA climate modeling data
- Choice of final product format (slide deck, poster, prototype model, or written proposal)
- Structured group roles (data analyst, designer, presenter, facilitator)
- Sentence frames for explaining trade-offs and justifying decisions

Resources Provided:

- Climate and energy data sets (tiered complexity)
- Engineering design process templates
- Google Sheets graphing template
- PhET simulation guide sheets
- Case study handouts (climate impacts by region)
- Exit ticket prompts
- Presentation rubric for engineering solution



Lesson Reflection

Reflect on the lesson you have developed and rate the degree to which the lesson **Strongly, Moderately** or **Weakly** meets the criteria below.

Lesson Activities	Strongly	Moderately	Weakly
Are challenging and require higher order thinking and problem solving skills	☒	☐	☐
Allow for student choice	☒	☐	☐
Provide scaffolding for acquiring targeted knowledge/skills	☒	☐	☐
Integrate global perspectives	☒	☐	☐
Integrate 21st century skills	☒	☐	☐
Provide opportunities for interdisciplinary connection and transfer of knowledge and skills	☒	☐	☐
Foster student use of technology as a tool to develop critical thinking, creativity and innovation skills	☒	☐	☐
Are varied to address different student learning styles and preferences	☒	☐	☐
Are differentiated based on student needs	☐	☒	☐
Are student-centered with teacher acting as a facilitator and co-learner during the teaching and learning process	☒	☐	☐
Provide means for students to demonstrate knowledge and skills and progress in meeting learning goals and objectives	☒	☐	☐
Provide opportunities for student reflection and self- assessment	☒	☐	☐
Provide data to inform and adjust instruction to better meet the varying needs of learners	☐	☒	☐

Curriculum Design Template

Content Area: Science **Grade Level:** 9 **Unit Title:** Biology of Earth Systems and Biodiversity

Created: 2026

Board Approved on:



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GLOBAL SKILLS

IEP AND 504 ACCOMMODATIONS AND MODIFICATIONS FOR EARLY CHILDHOOD AND ELEMENTARY SCHOOL STUDENTS:

Large print textbooks
Textbooks for at-home use
Additional time for assignments
Review of directions
Use of mnemonics
Have student restate information
Concrete examples
Adaptive writing utensils
Support auditory presentations with visuals
Use of a study carrel
Assistance in maintaining uncluttered space
Weekly home-school communication tools (notebook, daily log, phone calls or email messages)
Space for movement or breaks
Study sheets and teacher outlines
Extra visual and verbal cues and prompts
Math sheets with highlighted instructions
Graph paper to assist in organizing or lining up math problems
Use of computers and calculators
Books on tape
Graphic organizers
Quiet corner or room to calm down and relax when anxious
Preferential seating
Alteration of the classroom arrangement
Reduction of distractions
Answers to be dictated
Hands-on activities
Use of manipulatives
No penalty for spelling errors or sloppy handwriting
Follow a routine/schedule
Alternate quiet and active time
Teach time management skills
Rest breaks
Verbal and visual cues regarding directions and staying on task
Agenda book and checklists
Adjusted assignment timelines
Visual daily schedule



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**ENGAGING STUDENTS • FOSTERING ACHIEVEMENT • CULTIVATING 21ST CENTURY
GLOBAL SKILLS**

Varied reinforcement procedures
Immediate feedback
Work-in-progress check
Personalized examples

TESTING AND ASSESSMENT ACCOMMODATIONS AND MODIFICATIONS:

Answers to be dictated
Frequent rest breaks
Additional time
Oral testing
Untimed tests
Choice of test format (multiple-choice, essay, true-false)
Alternate ways to evaluate (projects or oral presentations instead of written tests)
Accept short answers
Open-book tests
Read test and directions to student
Provide study outline prior to tests
Highlight key directions
Test in alternative site
Use of calculator
Extra credit option
Preview test procedures
Simplified test wording; rephrased test questions and/or directions

GENERAL ACCOMMODATIONS AND MODIFICATIONS:

Use of alternative books or materials on the topic being studied
Computerized spell-check support
Word bank of choices for answers to test questions
Provision of calculator and/or number line for math tests
Reworded questions in simpler language
Projects instead of written reports
Highlighting important words or phrases in reading assignments
Modified workload or length of assignments/tests
Modified time demands
Modified grades based on IEP

BEHAVIOR ACCOMMODATIONS MODIFICATIONS:



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GLOBAL SKILLS

Breaks between tasks
Cue expected behavior
Daily feedback to student
Have contingency plans
Use de-escalating strategies
Use positive reinforcement
Use proximity/touch control
Use peer supports and mentoring
Model expected behavior by adults
Have parent sign homework
Have parent sign behavior chart
Set and post class rules
Chart progress and maintain data



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GLOBAL SKILLS

IEP AND 504 ACCOMODATIONS AND MODIFICATIONS FOR MIDDLE AND HIGH SCHOOL STUDENTS:

- Large print textbooks
- Textbooks for at-home use
- Additional time for assignments
- A locker with adapted lock
- Review of directions
- Review sessions
- Use of mnemonics
- Have student restate information
- Provision of notes or outlines
- Concrete examples
- Adaptive writing utensils
- Support auditory presentations with visuals
- Weekly or bi-weekly home-school communication
- Space for movement or breaks
- Study sheets and teacher outlines
- Extra visual and verbal cues and prompts
- Lab and math sheets with highlighted instructions
- Graph paper to assist in organizing or lining up math problems
- Use of tape recorder for lectures
- Use of Interactive notebook
- Use of a scribe
- Use of computers and calculators
- Books on tape
- Graphic organizers
- Quiet corner or room to calm down and relax when anxious
- Preferential seating
- Alteration of the classroom arrangement
- Reduction of distractions
- Answers to be dictated
- Hands-on activities
- Ability to type all assignments
- Follow a routine/schedule
- Teach time management and organizational skills
- Rest breaks
- Verbal and visual cues regarding directions and staying on task
- Agenda book and checklists
- Daily check-in with case manager or special education teacher
- Adjusted assignment timelines
- Visual daily schedule



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**ENGAGING STUDENTS • FOSTERING ACHIEVEMENT • CULTIVATING 21ST CENTURY
GLOBAL SKILLS**

Varied reinforcement procedures
Immediate feedback
Work-in-progress check
Personalized examples

TESTING AND ASSESSMENT ACCOMMODATIONS AND MODIFICATIONS:

Answers to be dictated
Frequent rest breaks
Additional time
Oral testing
Choice of test format (multiple-choice, essay, true-false)
Alternate ways to evaluate (projects or oral presentations instead of written tests)
Accept short answers
Open-book or open-note tests
Read test and directions to student
Provide study guides prior to tests
Highlight key directions
Test in alternative site
Use of calculator
Extra credit option
Pace long-term projects
Preview test procedures
Simplified test wording; rephrased test questions and/or directions

GENERAL ACCOMMODATIONS AND MODIFICATIONS:

Allow outlining, instead of writing for an essay or major project
Use of alternative books or materials on the topic being studied
Computerized spell-check support
Word bank of choices for answers to test questions
Provision of calculator for math tests
Film or video supplements in place of reading text
Reworded questions in simpler language
Projects instead of written reports
Highlighting important words or phrases in reading assignments
Modified workload or length of assignments/tests
Modified time demands



SPRINGFIELD PUBLIC SCHOOLS

**ENGAGING STUDENTS • FOSTERING ACHIEVEMENT • CULTIVATING 21ST CENTURY
GLOBAL SKILLS**

Pass/no pass option
Modified grades based on IEP

BEHAVIOR ACCOMMODATIONS FOR STUDENTS:

Breaks between tasks
Cue expected behavior
Daily feedback to student
Have contingency plans
Use de-escalating strategies
Use positive reinforcement
Use proximity/touch control
Use peer supports and mentoring
Model expected behavior by adults
Have parent sign homework
Set and post class rules
Chart progress and maintain data



Accommodations and Modifications for ESL Students

- Give tests orally
- Give instructions/directions in writing and orally
- Assign a peer tutor, same language or English speaking
- Allow use of bilingual/translation dictionary
- Provide summaries of text or study guides of particular chapters
- Allow errors in speaking
- Allow errors in writing
- Accept writing in first language
- Highlight key vocabulary
- Reduce amount of work required
- Assess comprehension through demonstration or other alternative means (gestures, drawings)
- Rephrase questions, directions, and explanations
- Reduce multiple choices on assessments
- Provide study guides and/ or outlines
- Shorten reading assignments
- Allow extended time for test/project completion
- Use of audio books
- Use of graphic organizers
- Use reduced text, so that print is not dense
- Use visuals/pictures throughout lesson/unit/assignment
- Adapt homework to reflect language proficiency/home support
- Adapt homework to reflect home support
- Provide hands-on activities and explanations
- Allow extended time to answer questions, and permit drawing, as an explanation
- Use of translation dictionaries to locate words in the native language
- Use anecdotal records and portfolio of work as forms of assessment
- Use story retellings to assess comprehension



Cultivating compassionate and extraordinary learners!

What Does the Gifted and Talented Experience Look Like?

Springfield Public Schools

Mission Statement

The Gifted and Talented Program of the Springfield Public Schools aims to provide a meaningful and rigorous education that instills the value of lifelong learning and empowers all students to reach their full potential and become self-fulfilled creative leaders in accordance with the comprehensive standards of our state. We accomplish this by offering challenging, real-world experiences in a student-centered environment.

We recognize that students come from diverse socioeconomic, cultural, and ethnic backgrounds, and the mission of the gifted and talented program is to provide opportunities for students to explore their intellectual, creative, and artistic gifts and talents within the classroom and with beyond-the-classroom experiences. It is essential to provide diverse, appropriate, and ongoing learning experiences and environments that incorporate students' academic, psychological, and social needs. Our responsibility is to provide students with educational alternatives that teach, challenge, and expand their knowledge, while simultaneously stressing the development of independent and self-directed learners who continuously generate questions, analyze, synthesize, and evaluate information and ideas.

New Jersey Administrative Code 6A:8-3.1 defines students who are gifted and talented as those students who possess or demonstrate high levels of ability in one or more content areas when compared to their chronological peers in the local district and who require modification of their educational program if they are to achieve in accordance with their capabilities.

Goals:

To support our mission, we have established the following goals to guide our work:

- To infuse into the general education program a broad range of activities for high-level learning that will challenge all students to perform at advanced levels, and provide extended opportunities, resources, and support in particular areas where student interest or talent is demonstrated.
- To provide a continuum of gifted education services that will strengthen the total school program, offer enriching and challenging learning opportunities for all students, and provide specialized learning experiences
- To promote achievement of students' best potentials and increased ability.

Through a productive and collaborative relationship among the building principals, classroom teachers, and the Gifted and Talented teacher, our schools can create programming that will enhance the learning experience for every student and serve the unique and specialized needs of students currently demonstrating gifted behaviors.

Elements of the Schoolwide Enrichment Model, W.I.N (What I Need), differentiated instruction, advanced classes, or individual programs into a student's regular instruction program are integral to this overarching framework for gifted education in the Springfield School District.

Reference Board Policy and Regulation 2464 – Gifted and Talented Pupils (M)

Early Childhood Center **Edward V. Walton**

Schoolwide Virtual Enrichment

All first and second grade students have access to the [Gifted and Talented Virtual Classroom](#). This virtual classroom is a space for students to complete various challenges and enrichment opportunities at their own pace. Students can receive feedback and additional adaptable resources to meet their individual learning needs. The virtual classroom design expands accessibility to enrichment resources and allows students to choose learning activities according to their unique interests and abilities. The purpose of the activities is to encourage problem-solving, develop critical thinking

skills, and expand curiosity and imagination. Activities are aligned to the New Jersey Student Learning Standards.

Gifted and Talented Teacher as a Resource

The Gifted and Talented teacher serves as a resource to all teachers within Edward V. Walton School. Teachers seeking resources for their high-ability learners will receive additional support from the Gifted and Talented teacher in various ways. This support may include additional units of study, challenging resources, and student projects.

Elementary Schools

James Caldwell

Thelma L. Sandmeier

The goal is to engage small groups of students in intensive learning experiences through standards-based, rigorous, and relevant units of study that supplement, not supplant, the grade-level curriculum and support students' unique learning needs.

Enrichment Experience Grade 3

Beginning in third grade, the G&T teacher will cycle through all classrooms to work on problem-solving and enrichment tasks with students. Driven by assessment data, academic performance, student interest, and teacher observation, small groups of students will meet with the G&T teacher during W.I.N. (What I Need) periods throughout the week that the teacher is assigned to their classroom teacher. Groupings will be flexible and monitored to best meet each student's needs throughout the school year. Activities will include brain teasers, puzzles, strategic thinking, problem-solving, and STEM challenges.

Targeted Gifted and Talented Programing Grades 4-5

Students may become identified as Gifted and Talented in fourth grade. Students that are identified may receive support from the G&T Teacher for up to five periods (200 minutes) a week during W.I.N. (What I Need) periods. Identified students will meet to explore grade-level content while incorporating depth and complexity in a student-centered, problem-based environment. The Gifted and Talented Program aims to provide students with various advanced and challenging learning experiences across content areas to promote independent thinking skills, refine critical thinking and communication skills, cultivate joy in learning, and expand student interests through problem-solving. The instruction that students receive incorporates 21st Century Skills and advanced content that is challenging, hands-on, and relevant to the real world.

Strategies and Practices that Support Gifted and Talented Students

- Adjusted Pace of Lessons
- Inquiry-Based Instruction
- Higher-Order Thinking Activities
- Interest-Based Content
- Real World Problem Solving/Problem Based Learning
- Independent Study/Passion Projects
- Units of Study with Like-Minded Peers

Schoolwide Virtual Enrichment

All JCS and TLS students have access to grade level-specific [Gifted and Talented Virtual Classrooms](#). These virtual classrooms are a space for students to complete various challenges and enrichment opportunities at their own pace. Students are able to receive feedback and additional opportunities based on their needs. The virtual classrooms have expanded the accessibility of enrichment resources directly to the students and allows for students to choose opportunities according to their interests and abilities. The purpose of the activities is to encourage problem solving, develop critical thinking skills, and expand curiosity and imagination in conjunction with the New Jersey Student Learning Standards.

Gifted and Talented Teacher as a Resource

In addition to classroom support, the Gifted and Talented teacher also serves as a resource to all teachers in the building. Teachers that are seeking resources for their high ability learners will receive additional support from the Gifted and Talented teacher in various ways. This may include additional units of study, challenging resources, student projects, and meeting with the G&T teacher as needed.

Additional Enrichment Opportunities

Across all grade levels 3-5, as recommended by the classroom teacher, students exhibiting a need for additional enrichment may have the opportunity to meet with the G&T teacher as the schedule allows. Groupings will be flexible and monitored to best meet the students' needs throughout the school year. Activities will include, brain teasers, puzzles, strategic thinking activities, problem-solving challenges, and STEM challenges. Students engage in an extended process of asking questions, using resources, and developing answers that lead to thinking about what and how they are learning. Students are held accountable for how they work and use their time by demonstrating their learning through products or presentations.

Students self-select to participate in individual and/or group projects based on interest and commitment. The classroom teacher and/or the enrichment teacher will help guide and monitor student exploration of chosen topics, facilitating their learning with resources and teaching of needed skills.

Secondary Schools
Florence M. Gaudineer Middle School
Jonathan Dayton High School

Grades 6-12: Access to specific content programs with higher levels of academic challenges (i.e. Pre-Algebra, Accelerated Communication Arts, and Advanced Placement Classes)

Dual Credit Courses provide students the opportunity to obtain high school credit, and college credit, simultaneously through partnerships with several institutions.

Project Lead the Way (PLTW) students become builders of technology by engaging in real world activities. Students are empowered as design thinkers collaborating on real world projects.

Gifted and Talented Identification Criteria

The Springfield Schools Gifted and Talented Program recognizes that students require differentiated learning experiences beyond the core curriculum being taught because of their advanced abilities in one or more content areas. These students may also have other cognitive qualities such as curiosity, creativity, motivation, leadership, and passion that require modifications to their academic experience.

Multiple Measures of Eligibility

Kindergarten through grade twelve identification process for gifted and talented students includes multiple measures. Multiple measures may include but are not limited to: achievement test scores; grades; student performance or products; intelligence testing; parent, student, and/or teacher recommendation; and other appropriate measures. The identification methodology is developmentally appropriate, non-discriminatory, and related to the programs and services offered by the Springfield School District. The identification procedures are reviewed annually.

According to N.J.A.C. 6A:8-3.1, all public school districts must have a board-approved gifted and talented identification process and provide services for identified students enrolled in the grades of that school district. The regulations require that identification and services be made available to students in grades K-12.

When students are recommended for the Gifted and Talented Program there are multiple measures that are considered to determine if services are necessary and appropriate. The assessments used are as follows:

- Cognitive Abilities Test (CogAT)
- Classroom Performance/Student Portfolios
- DRA2 Level
- iReady Diagnostic Scores
- Gifted Indicators Checklist
- Start Strong/NJSLA Assessment Data

The N.J.A.C. requires that students be compared to their chronological peers in the local school district. The New Jersey Department of Education has not established state-level criteria for identifying students who are gifted, such as mandated tests or assessments, grade point averages, or IQ scores. Local school districts must use multiple measures to identify students.

Procedures

<https://www.straussesmay.com/seportal/Public/DistrictPolicy.aspx?policyid=2464&id=b8a33a9f505e4998a6db3fb8e1de778b>

Gifted and Talented Program Identification Matrix

Minimum Score Required for Consideration: 14 Points

1 Point	2 Points	3 Points
Cogat Assessment Overall Stanine Score of a 7	Cogat Assessment Overall Stanine Score of an 8	Cogat Assessment Overall Stanine Score of a 9
iReady Math Assessment Just Below Current Grade Level	iReady Math Assessment On Grade Level	iReady Math Assessment ½ Year + Above Current Level
iReady ELA On Grade Level	iReady ELA ½ Year Above Current Level	iReady ELA One Full Grade Level + Above Current Level
NJSLA Math Approaching Expectations	NJSLA Math Met Expectations	NJSLA Math Exceed Expectations
NJSLA ELA Approaching Expectations	NJSLA ELA Met Expectations	NJSLA ELA Exceed Expectations
HOPE Teacher Rating Scale Raw Score: 11 - 29	HOPE Teacher Rating Scale Raw Score: 30 - 49	HOPE Teacher Rating Scale Raw Score: 50-66

Team meetings present the opportunity to review data and assess the educational needs of all students. Teacher provides examples of student work exhibiting above and beyond grade level expectations, creativity, leadership, critical and abstract thinking. Programs for gifted and talented students will be periodically evaluated for their continuing efficacy and adjusted accordingly. The parent of any student identified as gifted or talented shall be consulted regarding any program designed to address the student's particular needs.

Resource Links

https://riversideinsights.com/cognitive_abilities_test

<https://www.curriculumassociates.com/programs/i-ready-learning>

<https://www.nj.gov/education/assessment/resources/>

<https://www.routledge.com/HOPE-Teacher-Rating-Scale-Involving-Teachers-in-Equitable-Identification/Gentry-Pereira-Peters-McIntosh-Fugate/p/book/9781618214522#:~:text=The%20HOPE%20Teacher%20Rating%20Scale,making%20it%20easy%20to%20use.>

Gifted and talented student: The "[*Strengthening Gifted and Talented Education Act*](#)" defines a gifted and talented student as a "student who possesses or demonstrates a high level of ability in one or more content areas when compared to their chronological peers in the school district and who require modifications of their educational program if they are to achieve in accordance with their capabilities."

Twice-exceptional (2E) students: A twice-exceptional (2E) student is defined as "a student who is both gifted and a student with a disability. These students may also be referred to as having dual exceptionalities or as being gifted with learning disabilities (GT/LD). This also applies to students who are gifted with ADHD or gifted with autism" (New Jersey Association for Gifted Children, www.nagc.org).

Instructional adaptation: An adjustment or modification to instruction enabling a student who is gifted and talented to participate in, benefit from, and demonstrate knowledge and application of the New Jersey Student Learning Standards in one or more content areas at the instructional level of the student, not just the student's grade level.

Identifying gifted and talented students: The focus of identification is to provide programming and services in which students' specific learning needs and potential are appropriately addressed and met. In every New Jersey school district, there are students who require modifications to the general education curriculum if they are to achieve in accordance with their abilities. By identifying a student's general intellectual ability, creativity, or specific academic area aptitudes, we are acknowledging that they need programming and services outside of the general education/grade level curriculum to advance their learning.

NJDOE Fast Facts

<https://www.nj.gov/education/standards/gifted/>

<https://www.nj.gov/education/standards/gifted/legislation.shtml>

Supplemental Resources/Programming for Gifted Students

Edward V. Walton

- PETS Program – Primary Education Thinking Skills
- Group Solutions/Group Solutions 2 – Cooperative Logic Activities
- Lollipop Logic
- Beginning Thinking Skills
- AIMS Education Programming

James Caldwell and Thelma L. Sandmeier

Math/ELA

- Project M3: Mentoring Mathematical Minds
- Junior Great Books
- AIMS Education Programming
- Borenson Hands on Equations
- BizWorld
- Perplexors
- Advanced Math Explorations grade 3-5
- Challenging Units for Gifted Learners (ELA and Math)
- Creative Curriculum Extenders
- Differentiated Lessons & Projects
- Challenge Math Grades 4+
- Differentiating Instruction with Menus (All Content Areas)
- Jacob's Ladder
- Genius Hour/Passion Project
- Spatial Reasoning
- Logic Puzzles, Brain Games, Analogies

STEM

- Engineering is Elementary
- Engineer Throughout the Year
- PBS Design Squad
- DefinedSTEM
- Project Lead the Way (PLTW)

Enrichment Events

Experience for all students to be enriched through events related to the curricular or extracurricular activities. Examples include after school clubs, PTA-sponsored events, leadership opportunities, visual and performing arts, and community service opportunities.