



Lions

Draft Date 06-02-2026	Course HS H/CP Biology	Duration 16 Day(s)	Grades 10	Subjects Science	Team Tara Flick, Savannah Byers, Katherine Watson, James Hovan
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Focus

The Lions Storyline integrates **social behavior, energetics, and genetics**. Mathematics is used to model and demonstrate the **net energy benefits** of cooperative hunting. Students analyze molecular genetics, and microsatellite data/DNA sequencing to reveal geographic and phylogenetic relationships between populations. Finally, physiological studies are used to examine how lions digest prey on a physical and biochemical level.

Stage 1: Learning Goals

Established Goals	Transfer
Standards	Long-Term Transfer Goals
Pennsylvania Academic Standards Science (2023): 9-12 Standards 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. Clarifying Statement: N/A Assessment Boundary: Assessment does not include the identification of specific cell or tissue types, whole body systems, specific protein structures and functions, or the biochemistry of protein synthesis. (3.1.9-12.A)	What kinds of long-term, independent accomplishments are desired? Students will be able to independently use their learning to... - Approach science as a reliable and testable way of knowing and explaining the natural world and designed world. (Life-Long Learner) (T1) - Weigh evidence and use scientific approaches to ask questions, investigate, and make informed decisions. (Innovative Problem Solver) (T2) - Make and use observations to analyze relationships and patterns in order to explain phenomena, develop models, and make predictions. (Communicator) (T3) - Participate in respectful discourse with peers, teachers, and experts in the field to share ideas, perspectives, and findings. (Collaborator, Communicator) (T4)

- Develop and use a model to illustrate the hierarchical organization of interacting systems that provide specific functions within multicellular organisms.

Clarifying Statement: Emphasis is on functions at the organism system level, such as nutrient uptake, water delivery, and organism movement in response to neural stimuli. An example of an interacting system could be an artery depending on the proper function of elastic tissue and smooth muscle to regulate and deliver the proper amount of blood within the circulatory system.

Assessment Boundary: Assessment does not include interactions and functions at the molecular or chemical reaction levels. (3.1.9-12.B)

- 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.

Clarifying Statement: Emphasis is on using evidence from models and simulations to support explanations.

Assessment Boundary: Assessment does not include the details of specific chemical reactions or identification of macromolecules. (3.1.9-12.F)

Meaning	
Understandings	Essential Questions
What specifically do you want students to understand? What inferences should they make? Students will understand that... ■ Animals live in groups and the details of their social behavior is an adaptation for survival. (U1) ■ Mathematical models can analyze the benefits of group hunting, and demonstrate that hunting options offer differences in efficiency. (U2) ■ Analyzing karyotypes and alleles shows how genetic data can determine parentage and the composition and dynamics of animal populations. (U3) ■ Using microsatellite data and DNA sequencing, students explore how geographic proximity can influence the genetic relatedness of populations and demonstrate how gene flow occurs between them. (U4) ■ The structure of animal body systems can be used to determine the function of that system. (U5) ■ Organisms obtain energy and raw materials by breaking down biological macromolecules into monomers and then using those molecules for energy or reassembling them into more complex structures like muscle and collagen. (U6) ■ Specific enzymes are shaped to break down large macromolecules into	What thought-provoking questions will foster inquiry, meaning making, and transfer? Students will keep considering... ■ How do the structures of organisms enable life's functions? (A/B) (Q1) ■ How do organisms obtain and use the energy they need to live and grow? (F/G) (Q2) ■ How do organisms interact with the living and nonliving environments to obtain matter and energy? (H) (Q3) ■ How do matter and energy move through an ecosystem? (J/L) (Q4) ■ How do organisms interact in groups so as to benefit individuals? (O) (Q5) ■ Why do individuals of the same species vary in how they look, function, and behave? (R) (Q6) ■ What evidence supports the relationship between species? (S) (Q7) ■ How does genetic variation among organisms affect survival and reproduction? (T) (Q8)

- 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.

Clarifying Statement: Emphasis is on the conceptual understanding of the inputs and outputs of the process of cellular respiration.

Assessment Boundary: Assessment should not include identification of the steps or specific processes involved in cellular respiration. (3.1.9-12.G)

- Use mathematical representations to support claims for the cycling of matter and flow of energy among organisms in an ecosystem.

Clarifying Statement: Emphasis is on using a mathematical model of stored energy in biomass to describe the transfer of energy from one trophic level to another and that matter and energy are conserved as matter cycles and energy flows through ecosystems. Emphasis is on atoms and molecules such as carbon, oxygen, hydrogen, and nitrogen being conserved as they move through an ecosystem.

Assessment Boundary: Assessment is limited to proportional reasoning to describe the cycling of matter and flow of energy. (3.1.9-12.H)

smaller molecules that can be absorbed and used by the body. (U7)

- Organisms, when placed within the broader context of a food web, illustrate the flow of energy and the interactions between producers and various levels of consumers. (U8)

Acquisition of Knowledge & Skill

Knowledge

What facts and basic concepts should students know and be able to recall?
Students will know...

- All cells contain genetic information in the form of DNA. (A) (K1)
- DNA replication is semiconservative. (A) (K2)
- Genes are sections of DNA that contain instructions for a protein to be made through the processes of transcription and translation. (A) (K3)
- Multicellular organisms have levels or biological organization. (B) (K4)
- Differences between prokaryotic and eukaryotic cells. (B) (K5)
- Sugar molecules are made of oxygen, carbon, and hydrogen. (F) (K6)
- Oxygen, hydrogen, and carbon from sugar are used to build organic macromolecules. (F) (K7)
- Polymers consist of building blocks called monomers. (F) (K8)
- Cellular respiration uses sugar, oxygen, and ADP to produce water, carbon

Skills

What discrete skills and processes should students be able to use? Students can...

- I can explain based on valid and reliable evidence that DNA determines the structure of proteins. (A) (S1)
- I can develop and use a model to illustrate the levels of biological organization of multicellular organisms. (B) (S2)
- I can demonstrate using a model that illustrates how carbon, hydrogen, and oxygen from sugar may form other carbon-based molecules. (F) (S3)
- I can demonstrate using a model that illustrates how cellular respiration is a chemical process that results in a net transfer of energy from the formation of new bonds. (G) (S4)
- I can use mathematical models to explain and support claims about the flow of energy and the cycling of matter. (H) (S5)
- I can construct and revise an explanation based on evidence for the cycling of matter and flow of energy in

- Construct and revise an explanation based on evidence for the cycling of matter and flow of energy in aerobic and anaerobic conditions.

Clarifying Statement: Emphasis is on conceptual understanding of the role of aerobic and anaerobic respiration in different environments.

Assessment Boundary: Assessment does not include the specific chemical processes of either aerobic or anaerobic respiration. (3.1.9-12.J)

- Use mathematical representations to support and revise explanations based on evidence about factors affecting biodiversity and populations in ecosystems of different scales.

Clarifying Statement: Examples of mathematical representations include finding the average, determining trends, and using graphical comparisons of multiple sets of data.

Assessment Boundary: Assessment is limited to provided data. (3.1.9-12.L)

- Evaluate the evidence for the role of group behavior on individual and species' chances to survive and reproduce.

Clarifying Statement: Emphasis is on: (1) distinguishing between group and individual behavior, (2) identifying evidence supporting the outcomes of group

dioxide, and energy in the form of ATP. (G) (K9)

- Energy produced by cellular respiration is used to maintain body temperature, perform life functions, and is released as heat to the environment. (G) (K10)
- The amount of available energy decreases as you move up a food web. (H) (K11)
- While energy cannot be created or destroyed, it can move from one system to another. (H) (K12)
- Matter releases energy for life functions, is stored in newly made structures, or is discarded. (H) (K13)
- Matter cycles through biotic and abiotic parts of an ecosystem. (H) (K14)
- Matter is cycled interdependently between photosynthesis and respiration. (J) (K15)
- Cellular respiration can occur in aerobic and anaerobic conditions. (J) (K16)
- The availability of resources and habitat impacts the biodiversity of an ecosystem. (L) (K17)
- Group behavior has evolved because it can increase the chances of survival for individuals and their genetic relatives. (O) (K18)
- Environmental factors can cause mutations which can be inherited and affect expression of traits. (R) (K19)
- The distribution of some traits (genotype and phenotype) can be

aerobic and anaerobic conditions. (J) (S6)

- I can use evidence-based mathematical representations to explain factors that affect biodiversity and populations of different scales. (L) (S7)
- I can evaluate evidence of how group behavior can influence an individual's and a species's chances of survival. (O) (S8)
- I can apply statistics and probability to predict the distribution of traits using Punnett Squares. (R) (S9)
- I can communicate scientific information to support biological evolution and common ancestry. (S) (S10)
- I can explain that evolution is primarily caused by natural selection using evidence. (T) (S11)

behavior, and (3) developing logical and reasonable arguments based on evidence. Examples of group behaviors could include flocking, schooling, herding, and cooperative behaviors such as hunting, migrating, and swarming.

Assessment Boundary: N/A (3.1.9-12.O)

- Apply concepts of statistics and probability to explain the variation and distribution of expressed traits in a population.

Clarifying Statement: Emphasis is on the use of mathematics to describe the probability of traits as it relates to genetic and environmental factors in the expression of traits.

Assessment Boundary: Assessment does not include Hardy-Weinberg calculations. (3.1.9-12.R)

- Communicate scientific information that common ancestry and biological evolution are supported by multiple lines of empirical evidence.

Clarifying Statement: Emphasis is on a conceptual understanding of the role each line of evidence has relating to common ancestry and biological evolution. Examples of evidence could include similarities in DNA sequences, anatomical structures, and order of appearance of structures in embryological development.

Assessment Boundary: N/A (3.1.9-12.S)

predicted using Punnett Squares. (R) (K20)

- Fossils, anatomy, embryology, and genetics show evidence for evolution. (S) (K21)
- Natural selection only occurs when there is biodiversity through genetic variation (mutation and sexual reproduction), competition, and differences in gene expression. (T) (K22)

- 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.

Clarifying Statement: Emphasis is on using evidence to explain the influence each of the four factors has on number of organisms, behaviors, morphology, or physiology in terms of ability to compete for limited resources and subsequent survival of individuals and adaptation of species. Examples of evidence could include mathematical models such as simple distribution graphs and proportional reasoning.

Assessment Boundary: Assessment does not include other mechanisms of evolution, such as genetic drift, gene flow through migration, and co-evolution.
(3.1.9-12.T)

Environmental Literacy & Sustainability (2023): 9-12 Environmental Literacy & Sustainability

- Apply research and analytical skills to systematically investigate environmental issues ranging from local issues to those

that are regional or global in scope.
(3.4.9-12.D)

Profile of a CV Learner

- Collaboration: Students will be able to independently engage and meaningfully contribute to a team to reach a common goal, through mutual reflection, feedback, and shared responsibility. (PCVL.CO)
- Communication: Students will be able to independently and confidently adapt their writing and speaking in relation to audience, task, and purpose, as well as practice active listening to understand other perspectives, viewpoints, and cultures. (PCVL.CM)



Elephants

Draft Date 06-02-2026	Course HS H/CP Biology	Duration 14 Day(s)	Grades 10	Subjects Science	Team Tara Flick, Savannah Byers, Katherine Watson, James Hovan
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Focus

The Elephants Storyline examines **population** limits, focusing on water as a critical **abiotic factor**. Students investigate tusklessness as a **genetic response** to poaching, using DNA data to track ivory origins. Lessons highlight elephants as **keystone species** essential for seed dispersal and **biodiversity**. Finally, students explore **niche partitioning** and plant physiology to understand overall ecosystem survival. Students expand their understanding of concepts focusing on **energy** and **genetics** from the previous unit.

Stage 1: Learning Goals

Established Goals	Transfer
Standards	Long-Term Transfer Goals
Pennsylvania Academic Standards Science (2023): 9-12 Standards ■ Use a model to illustrate the role of cellular division (mitosis) and differentiation in producing and maintaining complex organisms. Clarifying Statement: N/A Assessment Boundary: Assessment does not include specific gene control mechanisms or rote memorization of the steps of mitosis. (3.1.9-12.D) ■ Use a model to illustrate how photosynthesis transforms light energy into stored chemical energy.	What kinds of long-term, independent accomplishments are desired? Students will be able to independently use their learning to... ■ Approach science as a reliable and testable way of knowing and explaining the natural world and designed world. (Life-Long Learner) (T1) ■ Weigh evidence and use scientific approaches to ask questions, investigate, and make informed decisions. (Innovative Problem Solver) (T2) ■ Make and use observations to analyze relationships and patterns in order to explain phenomena, develop models, and make predictions. (Communicator) (T3) ■ Participate in respectful discourse with peers, teachers, and experts in the field to share ideas, perspectives, and findings. (Collaborator, Communicator) (T4)

Clarifying Statement: Emphasis is on illustrating inputs and outputs of matter and the transfer and transformation of energy in photosynthesis by plants and other photosynthesizing organisms. Examples of models could include diagrams, chemical equations, and conceptual models.

Assessment Boundary: Assessment does not include specific biochemical steps. (3.1.9-12.E)

- 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.

Clarifying Statement: Emphasis is on using evidence from models and simulations to support explanations.

Assessment Boundary: Assessment does not include the details of specific chemical reactions or identification of macromolecules. (3.1.9-12.F)

- 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.

Clarifying Statement: Emphasis is on the

Meaning	
Understandings	Essential Questions
What specifically do you want students to understand? What inferences should they make? Students will understand that... ■ A species population density is strictly controlled by the availability of resources, specifically water. Population distribution correlates directly with water/other resource locations. (U1) ■ Human activities can act as a powerful selective pressure. This can lead to a genetic response in some populations where a mutation or a rare trait becomes more prevalent because of differential survival. (U2) ■ Keystone species are essential for maintaining ecosystem biodiversity. Their roles in supporting biodiversity can be varied, but their absence will result in a dramatic loss in biodiversity. (U3) ■ Organisms occupy a specific ecological niche by partitioning resources. For example, by eating different types of plants or different parts of the same plants, different species minimize direct competition. (U4) ■ Loss of natural habitat will result in increased pressure on the remaining organisms in an ecosystem. (U5) ■ Population sampling (such as transect sampling) is used by scientists to	What thought-provoking questions will foster inquiry, meaning making, and transfer? Students will keep considering... ■ How do organisms grow and develop? (D) (Q1) ■ How do organisms obtain and use the energy they need to live and grow? (G and E) (Q2) ■ How do organisms obtain and use the energy they need to live and grow? (F) (Q3) ■ How do organisms interact with the living and nonliving environments to obtain matter and energy? (H) (Q4) ■ How do matter and energy move through an ecosystem? (J and K) (Q5) ■ How do matter and energy move through an ecosystem? (L) (Q6) ■ Why do individuals of the same species vary in how they look, function, and behave? (R) (Q7) ■ How does genetic variation among organisms affect survival and reproduction? (T and U) (Q8) ■ How does the environment influence populations of organisms over multiple generations? (W) (Q9)

conceptual understanding of the inputs and outputs of the process of cellular respiration.

Assessment Boundary: Assessment should not include identification of the steps or specific processes involved in cellular respiration. (3.1.9-12.G)

- Use mathematical representations to support claims for the cycling of matter and flow of energy among organisms in an ecosystem.

Clarifying Statement: Emphasis is on using a mathematical model of stored energy in biomass to describe the transfer of energy from one trophic level to another and that matter and energy are conserved as matter cycles and energy flows through ecosystems. Emphasis is on atoms and molecules such as carbon, oxygen, hydrogen, and nitrogen being conserved as they move through an ecosystem.

Assessment Boundary: Assessment is limited to proportional reasoning to describe the cycling of matter and flow of energy. (3.1.9-12.H)

- Construct and revise an explanation based on evidence for the cycling of matter and flow of energy in aerobic and anaerobic conditions.

Clarifying Statement: Emphasis is on conceptual understanding of the role of aerobic and anaerobic respiration in

estimate the size and health of wildlife populations. (U6)

- The social structures that animals use are critical for survival, as the group collectively protects its members from predators especially during times of environmental stress like droughts. (U7)
- Animal physiology is adapted to various diets. There are differences in the digestive tracts of carnivores, herbivores, and omnivores. (U8)

Acquisition of Knowledge & Skill

Knowledge	Skills
What facts and basic concepts should students know and be able to recall? Students will know... ■ Multicellular organisms grow and differentiate cells via mitosis. (D) (K1) ■ Cell division and differentiation produce and maintain tissues and organs that work together. (D) (K2) ■ Mitosis produces two identical body cells from one parent cell. (D) (K3) ■ The cell cycle includes interphase, mitosis, and cytokinesis. (D) (K4) ■ Photosynthesis converts light energy into chemical energy using carbon dioxide and water to make sugar and oxygen. (E) (K5) ■ Sugar molecules are made of oxygen, carbon, and hydrogen. (F) (K6) ■ Oxygen, hydrogen, and carbon from sugar are used to build organic macromolecules. (F) (K7)	What discrete skills and processes should students be able to use? Students can... ■ I can use a model to illustrate the role of cellular division (mitosis) and differentiation in producing and maintaining complex organisms. (D) (S1) ■ I can use a model to show how photosynthesis transforms light energy into stored chemical energy. (E) (S2) ■ I can demonstrate using a model that illustrates how carbon, hydrogen, and oxygen from sugar may form other carbon-based molecules. (F) (S3) ■ I can demonstrate using a model that illustrates how cellular respiration is a chemical process that results in a net transfer of energy from the formation of new bonds. (G) (S4) ■ I can use mathematical models to explain and support claims about the

different environments.

Assessment Boundary: Assessment does not include the specific chemical processes of either aerobic or anaerobic respiration. (3.1.9-12.J)

- Develop a model to illustrate the role of photosynthesis and cellular respiration in the cycling of carbon among the biosphere, atmosphere, hydrosphere, and geosphere.

Clarifying Statement: Examples of models could include simulations and mathematical models.

Assessment Boundary: Assessment does not include the specific chemical steps of photosynthesis and respiration. (3.1.9-12.K)

- Use mathematical representations to support and revise explanations based on evidence about factors affecting biodiversity and populations in ecosystems of different scales.

Clarifying Statement: Examples of mathematical representations include finding the average, determining trends, and using graphical comparisons of multiple sets of data.

Assessment Boundary: Assessment is limited to provided data. (3.1.9-12.L)

- Apply concepts of statistics and probability to explain the variation and distribution of expressed traits in a population.

- Polymers consist of building blocks called monomers. (F) (K8)
- Cellular respiration uses sugar, oxygen, and ADP to produce water, carbon dioxide, and energy in the form of ATP. (G) (K9)
- Energy produced by cellular respiration is used to maintain body temperature, perform life functions, and is released as heat to the environment. (G) (K10)
- The amount of available energy decreases as you move up a food web. (H) (K11)
- While energy cannot be created or destroyed, it can move from one system to another. (H) (K12)
- Matter releases energy for life functions, is stored in newly made structures, or is discarded. (H) (K13)
- Matter cycles through biotic and abiotic parts of an ecosystem. (H) (K14)
- Matter is cycled interdependently between photosynthesis and respiration. (J) (K15)
- Cellular respiration can occur in aerobic and anaerobic conditions. (J) (K16)
- Carbon is exchanged within the biosphere among the atmosphere, hydrosphere, and geosphere. (K) (K17)
- The availability of resources and habitat impacts the biodiversity of an ecosystem. (L) (K18)
- Natural selection only occurs when there is biodiversity through genetic variation (mutation and sexual

flow of energy and the cycling of matter. (H) (S5)

- I can construct and revise an explanation based on evidence for the cycling of matter and flow of energy in aerobic and anaerobic conditions. (J) (S6)
- I can develop a model to illustrate the role of photosynthesis and cellular respiration in the cycling of carbon among the biosphere, atmosphere, hydrosphere, and geosphere. (K) (S7)
- I can use evidence-based mathematical representations to explain factors that affect biodiversity and populations of different scales. (L) (S8)
- I can apply statistics and probability to predict the distribution of traits using Punnett Squares. (R) (S9)
- I can explain that evolution is primarily caused by natural selection using evidence. (T) (S10)
- I can apply statistics and probability to study advantageous traits in populations. (U) (S11)
- I can explain how natural selection leads to adaptations of populations using evidence. (W) (S12)

Clarifying Statement: Emphasis is on the use of mathematics to describe the probability of traits as it relates to genetic and environmental factors in the expression of traits.

Assessment Boundary: Assessment does not include Hardy-Weinberg calculations. (3.1.9-12.R)

- 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.

Clarifying Statement: Emphasis is on using evidence to explain the influence each of the four factors has on number of organisms, behaviors, morphology, or physiology in terms of ability to compete for limited resources and subsequent survival of individuals and adaptation of species. Examples of evidence could include mathematical models such as simple distribution graphs and proportional reasoning.

Assessment Boundary: Assessment does not include other mechanisms of evolution, such as genetic drift, gene flow

reproduction), competition, and differences in gene expression. (T) (K19)

- Traits that positively affect survival are more likely to be reproduced and thus become more common. (U) (K20)
- Changes in allele frequency show that evolution has occurred. (U) (K21)
- Adaptations are traits that help an organism to survive and reproduce. (W) (K22)

through migration, and co-evolution.
(3.1.9-12.T)

- 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.

Clarifying Statement: Emphasis is on analyzing shifts in numerical distribution of traits and using these shifts as evidence to support explanations.

Assessment Boundary: Assessment is limited to basic statistical and graphical analysis. Assessment does not include allele frequency calculations. (3.1.9-12.U)

- Construct an explanation based on evidence for how natural selection leads to adaptation of populations.

Clarifying Statement: Emphasis is on using data to provide evidence for how specific biotic and abiotic differences in ecosystems (such as ranges of seasonal temperature, long-term climate change, acidity, light, geographic barriers, or evolution of other organisms) contribute to a change in gene frequency over time, leading to adaptation of populations.

Assessment Boundary: N/A (3.1.9-12.W)

Environmental Literacy & Sustainability (2023): 9-12 Environmental Literacy & Sustainability

- Apply research and analytical skills to systematically investigate environmental issues ranging from local issues to those that are regional or global in scope. (3.4.9-12.D)

Profile of a CV Learner

- Collaboration: Students will be able to independently engage and meaningfully contribute to a team to reach a common goal, through mutual reflection, feedback, and shared responsibility. (PCVL.CO)
- Innovative Problem Solving: Students will be able to independently use their learning to approach new problems with curiosity and creativity while consistently seeking growth through self-reflection and a willingness to accept constructive feedback. (PCVL.IPS)



Otters

Draft Date 06-02-2026	Course HS H/CP Biology	Duration 15 Day(s)	Grades 10	Subjects Science	Team Tara Flick, Savannah Byers, Katherine Watson, James Hovan
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Focus

The **Homeostasis** Storyline examines biological regulation across ecosystem, **population**, and cellular levels using sea otters as a focal point. Students investigate how **keystone species** maintain **community** stability and how **abiotic factors** like **ocean acidification** impact organisms. Finally, they explore physiological homeostasis through **gas exchange** and metabolic processes occurring within cells. Students gain an understanding of how **biological processes** from previous units are **maintained**.

Stage 1: Learning Goals

Established Goals	Transfer
Standards	Long-Term Transfer Goals
Pennsylvania Academic Standards Science (2023): 9-12 Standards Develop and use a model to illustrate the hierarchical organization of interacting systems that provide specific functions within multicellular organisms. Clarifying Statement: Emphasis is on functions at the organism system level, such as nutrient uptake, water delivery, and organism movement in response to neural stimuli. An example of an interacting system could be an artery depending on the proper function of elastic tissue and smooth muscle to regulate and deliver the proper amount of	What kinds of long-term, independent accomplishments are desired? Students will be able to independently use their learning to... - Approach science as a reliable and testable way of knowing and explaining the natural world and designed world. (Life-Long Learner) (T1) - Weigh evidence and use scientific approaches to ask questions, investigate, and make informed decisions. (Innovative Problem Solver) (T2) - Make and use observations to analyze relationships and patterns in order to explain phenomena, develop models, and make predictions. (Communicator) (T3) - Evaluate systems, in order to connect how form determines function and how any change to one component affects the entire system. (Global Citizen, Innovative Problem Solver) (T4) - Participate in respectful discourse with peers, teachers, and experts in the field to share ideas, perspectives, and findings. (Collaborator, Communicator) (T5)

blood within the circulatory system.

Assessment Boundary: Assessment does not include interactions and functions at the molecular or chemical reaction levels. (3.1.9-12.B)

- Plan and conduct an investigation to provide evidence that feedback mechanisms maintain homeostasis.

Clarifying Statement: Examples of investigations could include heart rate response to exercise, stomate response to moisture and temperature, and root development in response to water levels.

Assessment Boundary: Assessment does not include the cellular processes involved in the feedback mechanism. (3.1.9-12.C)

- 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.

Clarifying Statement: Emphasis is on using evidence from models and simulations to support explanations.

Assessment Boundary: Assessment does not include the details of specific chemical reactions or identification of macromolecules. (3.1.9-12.F)

- Use a model to illustrate that cellular respiration is a chemical process whereby

Meaning	
Understandings	Essential Questions
What specifically do you want students to understand? What inferences should they make? Students will understand that... ■ Life is regulated across multiple scales —ecosystem, community, population, cellular, and molecular. (U1) ■ Keystone species maintain the stability of an entire community. The removal of such a species causes a "trophic cascade" that disrupts the balance of the ecosystem. (U2) ■ Abiotic factors like temperature and atmospheric CO₂ impact marine life. (U3) ■ Biotic and abiotic factors limit population growth. Carrying capacity can help us to understand what a population must look like to maintain ecosystem homeostasis. (U4) ■ Selective pressure changes population traits like size or physiology over time. This is different from genetic drift, where trait prevalences change even when they are not the selective factor. (U5) ■ Photosynthesis and cellular respiration are crucial to the cycling of matter (i.e. carbon and nitrogen) through an ecosystem. (U6) ■ Homeostasis is maintained at the cellular level through membrane	What thought-provoking questions will foster inquiry, meaning making, and transfer? Students will keep considering... ■ How do the structures of organisms enable life's functions? (B and C) (Q1) ■ How do organisms obtain and use the energy they need to live and grow? (G) (Q2) ■ How do organisms obtain and use the energy they need to live and grow? (F) (Q3) ■ How do organisms interact with the living and nonliving environments to obtain matter and energy? (H and I) (Q4) ■ How do matter and energy move through an ecosystem? (J and K) (Q5) ■ How do matter and energy move through an ecosystem? (L) (Q6) ■ How do environmental changes impact ecosystems? (M and N) (Q7) ■ How does genetic variation among organisms affect survival and reproduction? (U) (Q8) ■ How does the environment influence populations of organisms over multiple generations? (V, W, and X) (Q9)

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.

Clarifying Statement: Emphasis is on the conceptual understanding of the inputs and outputs of the process of cellular respiration.

Assessment Boundary: Assessment should not include identification of the steps or specific processes involved in cellular respiration. (3.1.9-12.G)

- Use mathematical representations to support claims for the cycling of matter and flow of energy among organisms in an ecosystem.

Clarifying Statement: Emphasis is on using a mathematical model of stored energy in biomass to describe the transfer of energy from one trophic level to another and that matter and energy are conserved as matter cycles and energy flows through ecosystems. Emphasis is on atoms and molecules such as carbon, oxygen, hydrogen, and nitrogen being conserved as they move through an ecosystem.

Assessment Boundary: Assessment is limited to proportional reasoning to describe the cycling of matter and flow of energy. (3.1.9-12.H)

- Use mathematical and/or computational representations to support explanations of

transport mechanisms like diffusion and osmosis. (U7)

- Feedback loops illustrate how organisms maintain homeostasis under different conditions. (U8)
- On a molecular level, the respiratory and digestive systems deliver necessary molecules (like oxygen and glucose) to cells for metabolism. (U9)

Acquisition of Knowledge & Skill

Knowledge

What facts and basic concepts should students know and be able to recall?
Students will know...

- Multicellular organisms have levels or biological organization. (B) (K1)
- Differences between prokaryotic and eukaryotic cells. (B) (K2)
- Positive and negative feedback mechanisms maintain stable internal conditions and mediate behaviors as external conditions change. (C) (K3)
- Sugar molecules are made of oxygen, carbon, and hydrogen. (F) (K4)
- Oxygen, hydrogen, and carbon from sugar are used to build organic macromolecules. (F) (K5)
- Polymers consist of building blocks called monomers. (F) (K6)
- Cellular respiration uses sugar, oxygen, and ADP to produce water, carbon dioxide, and energy in the form of ATP. (G) (K7)

Skills

What discrete skills and processes should students be able to use? Students can...

- I can develop and use a model to illustrate the levels of biological organization of multicellular organisms. (B) (S1)
- I can plan and conduct an investigation to provide evidence that feedback mechanisms maintain homeostasis. (C) (S2)
- I can demonstrate using a model that illustrates how carbon, hydrogen, and oxygen from sugar may form other carbon-based molecules. (F) (S3)
- I can demonstrate using a model that illustrates how cellular respiration is a chemical process that results in a net transfer of energy from the formation of new bonds. (G) (S4)
- I can use mathematical models to explain and support claims about the flow of energy and the cycling of matter. (H) (S5)

factors that affect carrying capacity of ecosystems at different scales.

Clarifying Statement: Emphasis is on quantitative analysis and comparison of the relationships among interdependent factors including boundaries, resources, climate, and competition. Examples of mathematical comparisons could include graphs, charts, histograms, and population changes gathered from simulations or historical data sets.

Assessment Boundary: Assessment does not include deriving mathematical equations to make comparisons. (3.1.9-12.I)

- Construct and revise an explanation based on evidence for the cycling of matter and flow of energy in aerobic and anaerobic conditions.

Clarifying Statement: Emphasis is on conceptual understanding of the role of aerobic and anaerobic respiration in different environments.

Assessment Boundary: Assessment does not include the specific chemical processes of either aerobic or anaerobic respiration. (3.1.9-12.J)

- Develop a model to illustrate the role of photosynthesis and cellular respiration in the cycling of carbon among the biosphere, atmosphere, hydrosphere, and geosphere.

Clarifying Statement: Examples of models

- Energy produced by cellular respiration is used to maintain body temperature, perform life functions, and is released as heat to the environment. (G) (K8)
- The amount of available energy decreases as you move up a food web. (H) (K9)
- While energy cannot be created or destroyed, it can move from one system to another. (H) (K10)
- Matter releases energy for life functions, is stored in newly made structures, or is discarded. (H) (K11)
- Matter cycles through biotic and abiotic parts of an ecosystem. (H) (K12)
- Limiting factors such as predation, competition, and disease create carrying capacities for populations. (I) (K13)
- Populations can have exponential growth if resources are abundant. (I) (K14)
- Matter is cycled interdependently between photosynthesis and respiration. (J) (K15)
- Cellular respiration can occur in aerobic and anaerobic conditions. (J) (K16)
- Carbon is exchanged within the biosphere among the atmosphere, hydrosphere, and geosphere. (K) (K17)
- The availability of resources and habitat impacts the biodiversity of an ecosystem. (L/M) (K18)
- Complex interactions maintain relative consistency in an ecosystem. (M) (K19)

- I can use mathematical models to explain the factors that affect the carrying capacity of ecosystems at different scales. (I) (S6)
- I can construct and revise an explanation based on evidence for the cycling of matter and flow of energy in aerobic and anaerobic conditions. (J) (S7)
- I can develop a model to illustrate the role of photosynthesis and cellular respiration in the cycling of carbon among the biosphere, atmosphere, hydrosphere, and geosphere. (K) (S8)
- I can use evidence-based mathematical representations to explain factors that affect biodiversity and populations of different scales. (L) (S9)
- I can evaluate and discuss how factors maintain ecosystem stability and also lead to change. (M) (S10)
- I can design, evaluate, and refine a solution for reducing the impacts of human activities on the environment and biodiversity. (N) (S11)
- I can apply statistics and probability to study advantageous traits in populations. (U) (S12)
- I can use a simulation to analyze the negative impacts of human activity on biodiversity. (V) (S13)
- I can explain how natural selection leads to adaptations of populations using evidence. (W) (S14)
- I can evaluate the evidence supporting claims that changes in environmental

could include simulations and mathematical models.

Assessment Boundary: Assessment does not include the specific chemical steps of photosynthesis and respiration. (3.1.9-12.K)

- Use mathematical representations to support and revise explanations based on evidence about factors affecting biodiversity and populations in ecosystems of different scales.

Clarifying Statement: Examples of mathematical representations include finding the average, determining trends, and using graphical comparisons of multiple sets of data.

Assessment Boundary: Assessment is limited to provided data. (3.1.9-12.L)

- 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.

Clarifying Statement: Examples of changes in ecosystem conditions could include modest biological or physical changes, such as moderate hunting or a seasonal flood; and extreme changes, such as volcanic eruption or sea level rise.

Assessment Boundary: N/A (3.1.9-12.M)

- Small disturbances may cause an ecosystem to return to its original status (succession). (M) (K20)
- Habitat destruction, pollution, invasive species, over-exploitation, and climate change can disrupt and threaten an ecosystem. (N) (K21)
- Traits that positively affect survival are more likely to be reproduced and thus become more common. (U) (K22)
- Changes in allele frequency show that evolution has occurred. (U) (K23)
- Natural and manmade changes in the environment drive natural selection. (V) (K24)
- Natural selection can lead to the expansion, emergence, or decline/ extinction of new species through speciation. (V/X) (K25)
- Adaptations are traits that help an organism to survive and reproduce. (W) (K26)
- Species become extinct when they cannot survive in their environment. (X) (K27)

conditions may result in increases in the number of individuals of some species, the emergence of new species over time, and the extinction of other species. (X) (S15)

- Design, evaluate, and refine a solution for reducing the impacts of human activities on the environment and biodiversity.

Clarifying Statement: Examples of human activities can include urbanization, building dams, and dissemination of invasive species.

Assessment Boundary: N/A (3.1.9-12.N)

- 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.

Clarifying Statement: Emphasis is on analyzing shifts in numerical distribution of traits and using these shifts as evidence to support explanations.

Assessment Boundary: Assessment is limited to basic statistical and graphical analysis. Assessment does not include allele frequency calculations. (3.1.9-12.U)

- Create or revise a simulation to test a solution to mitigate the adverse impacts of human activity on biodiversity.

Clarifying Statement: Emphasis is on designing solutions for a proposed problem related to threatened or endangered species, or to genetic variation of organisms for multiple species.

Assessment Boundary: N/A (3.1.9-12.V)

- Construct an explanation based on evidence for how natural selection leads to adaptation of populations.

Clarifying Statement: Emphasis is on using data to provide evidence for how specific biotic and abiotic differences in ecosystems (such as ranges of seasonal temperature, long-term climate change, acidity, light, geographic barriers, or evolution of other organisms) contribute to a change in gene frequency over time, leading to adaptation of populations.

Assessment Boundary: N/A (3.1.9-12.W)

- 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.

Clarifying Statement: Emphasis is on determining cause and effect relationships for how changes to the environment such as deforestation, fishing, application of fertilizers, drought, flood, and the rate of change of the environment affect distribution or disappearance of traits in species.

Assessment Boundary: N/A (3.1.9-12.X)

Profile of a CV Learner

- Communication: Students will be able to independently and confidently adapt their

writing and speaking in relation to audience, task, and purpose, as well as practice active listening to understand other perspectives, viewpoints, and cultures. (PCVL.CM)

- Innovative Problem Solving: Students will be able to independently use their learning to approach new problems with curiosity and creativity while consistently seeking growth through self-reflection and a willingness to accept constructive feedback. (PCVL.IPS)



Melanin

Draft Date	Course	Duration	Grades	Subjects	Team
06-02-2026	HS H/CP Biology	15 Day(s)	10	Science	Tara Flick, Savannah Byers, Katherine Watson, James Hovan

Focus

The **Melanin** Storyline investigates the biological and evolutionary basis of pigmentation, focusing on how traits vary among individuals. Students examine **albinism** through **pedigrees** and **Punnett squares**, eventually exploring how DNA **mutations** alter protein structure to determine **phenotypes**. Finally, the curriculum analyzes **evolutionary trade-offs** involving UV radiation and nutrient synthesis across different species. Students expand their understanding of concepts focusing on **genetics** from the previous units.

Stage 1: Learning Goals

Established Goals	Transfer
Standards	Long-Term Transfer Goals
Pennsylvania Academic Standards Science (2023): 9-12 Standards 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. Clarifying Statement: N/A Assessment Boundary: Assessment does not include the identification of specific cell or tissue types, whole body systems, specific protein structures and functions, or the biochemistry of protein synthesis. (3.1.9-12.A)	What kinds of long-term, independent accomplishments are desired? Students will be able to independently use their learning to... - Approach science as a reliable and testable way of knowing and explaining the natural world and designed world. (Life-Long Learner) (T1) - Weigh evidence and use scientific approaches to ask questions, investigate, and make informed decisions. (Innovative Problem Solver) (T2) - Make and use observations to analyze relationships and patterns in order to explain phenomena, develop models, and make predictions. (Communicator) (T3) - Evaluate systems, in order to connect how form determines function and how any change to one component affects the entire system. (Global Citizen, Innovative Problem Solver) (T4) - Participate in respectful discourse with peers, teachers, and experts in the field to share ideas, perspectives, and findings. (Collaborator, Communicator) (T5)

- Plan and conduct an investigation to provide evidence that feedback mechanisms maintain homeostasis.

Clarifying Statement: Examples of investigations could include heart rate response to exercise, stomate response to moisture and temperature, and root development in response to water levels.

Assessment Boundary: Assessment does not include the cellular processes involved in the feedback mechanism. (3.1.9-12.C)

- Use mathematical and/or computational representations to support explanations of factors that affect carrying capacity of ecosystems at different scales.

Clarifying Statement: Emphasis is on quantitative analysis and comparison of the relationships among interdependent factors including boundaries, resources, climate, and competition. Examples of mathematical comparisons could include graphs, charts, histograms, and population changes gathered from simulations or historical data sets.

Assessment Boundary: Assessment does not include deriving mathematical equations to make comparisons. (3.1.9-12.I)

- Use mathematical representations to support and revise explanations based on evidence about factors affecting biodiversity and populations in ecosystems of different scales.

Meaning	
Understandings	Essential Questions
What specifically do you want students to understand? What inferences should they make? Students will understand that... ■ Traits vary among individuals and are passed through generations. Pedigrees and Punnett squares to model how recessive alleles lead to specific phenotypes. (U1) ■ DNA sequence (genotype) provides the instructions for building proteins that result in physical characteristics (phenotype). (U2) ■ Silent, missense, nonsense, and frameshift mutations can alter the amino acid sequence during transcription and translation. (U3) ■ A protein's structure dictates its function. Mutations can cause proteins to fold incorrectly, leading to varied phenotypes. (U4) ■ Human skin tone evolution is tied to geographic location and levels of UV radiation. (U5) ■ Proteins can provide a survival advantage for organisms through traits such as body color. While mutations are random, the environment exerts selective pressure that changes the frequency of body color traits in a population over time. (U6)	What thought-provoking questions will foster inquiry, meaning making, and transfer? Students will keep considering... ■ How do the structures of organisms enable life's functions? (A) (Q1) ■ How do the structures of organisms enable life's functions? (C) (Q2) ■ How do organisms interact with the living and nonliving environments to obtain matter and energy? (I) (Q3) ■ How do matter and energy move through an ecosystem? (L) (Q4) ■ How are the characteristics of one generation related to the previous generation? (P) (Q5) ■ Why do individuals of the same species vary in how they look, function, and behave? (Q and R) (Q6) ■ How does genetic variation among organisms affect survival and reproduction? (T and U) (Q7) ■ How does the environment influence populations of organisms over multiple generations? (V) (Q8)

Clarifying Statement: Examples of mathematical representations include finding the average, determining trends, and using graphical comparisons of multiple sets of data.

Assessment Boundary: Assessment is limited to provided data. (3.1.9-12.L)

- Ask questions to clarify relationships about the role of DNA and chromosomes in coding the instructions for characteristic traits passed from parents to offspring.

Clarifying Statement: N/A

Assessment Boundary: Assessment does not include the phases of meiosis or the biochemical mechanism of specific steps in the process. (3.1.9-12.P)

- 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.

Clarifying Statement: Emphasis is on using data to support arguments for the way variation occurs.

Assessment Boundary: Assessment does not include the phases of meiosis or the biochemical mechanism of specific steps in the process. (3.1.9-12.Q)

Acquisition of Knowledge & Skill	
Knowledge	Skills
What facts and basic concepts should students know and be able to recall? Students will know... ■ All cells contain genetic information in the form of DNA. (A) (K1) ■ DNA replication is semiconservative. (A) (K2) ■ Genes are sections of DNA that contain instructions for a protein to be made through the processes of transcription and translation. (A) (K3) ■ Positive and negative feedback mechanisms maintain stable internal conditions and mediate behaviors as external conditions change. (C) (K4) ■ Limiting factors such as predation, competition, and disease create carrying capacities for populations. (I) (K5) ■ Populations can have exponential growth if resources are abundant. (I) (K6) ■ The availability of resources and habitat impacts the biodiversity of an ecosystem. (L) (K7) ■ Chromosomes contain specific genes located on a long strand of DNA. (P) (K8) ■ Gene expression is regulated in different ways. (P) (K9) ■ Some parts of DNA do not code for proteins, can be involved in gene	What discrete skills and processes should students be able to use? Students can... ■ I can explain based on valid and reliable evidence that DNA determines the structure of proteins. (A) (S1) ■ I can plan and conduct an investigation to provide evidence that feedback mechanisms maintain homeostasis. (C) (S2) ■ I can use mathematical models to explain the factors that affect the carrying capacity of ecosystems at different scales. (I) (S3) ■ I can use evidence-based mathematical representations to explain factors that affect biodiversity and populations of different scales. (L) (S4) ■ I can examine models to clarify relationships between DNA and inherited traits. (P) (S5) ■ I can make and defend a claim based on evidence that inherited variation is caused by meiosis and mutations from either DNA replication or environmental factors. (Q) (S6) ■ I can apply statistics and probability to predict the distribution of traits using Punnett Squares. (R) (S7) ■ I can explain that evolution is primarily caused by natural selection using evidence. (T) (S8)

- Apply concepts of statistics and probability to explain the variation and distribution of expressed traits in a population.

Clarifying Statement: Emphasis is on the use of mathematics to describe the probability of traits as it relates to genetic and environmental factors in the expression of traits.

Assessment Boundary: Assessment does not include Hardy-Weinberg calculations. (3.1.9-12.R)

- 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.

Clarifying Statement: Emphasis is on using evidence to explain the influence each of the four factors has on number of organisms, behaviors, morphology, or physiology in terms of ability to compete for limited resources and subsequent survival of individuals and adaptation of species. Examples of evidence could include mathematical models such as simple distribution graphs and proportional reasoning.

expression, or have no known function. (P) (K10)

- Meiosis creates genetic diversity through independent assortment and crossing-over. (Q) (K11)
- Mutations can occur during replication and cause genetic variation. (Q) (K12)
- Environmental factors can cause mutations which can be inherited and affect expression of traits. (Q/R) (K13)
- The distribution of some traits (genotype and phenotype) can be predicted using Punnett Squares. (R) (K14)
- Natural selection only occurs when there is biodiversity through genetic variation (mutation and sexual reproduction), competition, and differences in gene expression. (T) (K15)
- Traits that positively affect survival are more likely to be reproduced and thus become more common. (U) (K16)
- Changes in allele frequency show that evolution has occurred. (U) (K17)
- Adaptations are traits that help an organism to survive and reproduce. (W) (K18)

- I can apply statistics and probability to study advantageous traits in populations. (U) (S9)
- I can explain how natural selection leads to adaptations of populations using evidence. (W) (S10)

Assessment Boundary: Assessment does not include other mechanisms of evolution, such as genetic drift, gene flow through migration, and co-evolution.

(3.1.9-12.T)

- 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.

Clarifying Statement: Emphasis is on analyzing shifts in numerical distribution of traits and using these shifts as evidence to support explanations.

Assessment Boundary: Assessment is limited to basic statistical and graphical analysis. Assessment does not include allele frequency calculations. (3.1.9-12.U)

- Construct an explanation based on evidence for how natural selection leads to adaptation of populations.

Clarifying Statement: Emphasis is on using data to provide evidence for how specific biotic and abiotic differences in ecosystems (such as ranges of seasonal temperature, long-term climate change, acidity, light, geographic barriers, or evolution of other organisms) contribute to a change in gene frequency over time, leading to adaptation of populations.

Assessment Boundary: N/A (3.1.9-12.W)

Profile of a CV Learner

- Collaboration: Students will be able to independently engage and meaningfully contribute to a team to reach a common goal, through mutual reflection, feedback, and shared responsibility. (*PCVL.CO*)
- Global Citizenship: Students will be able to mindfully and respectfully seek to understand the ideas and perspectives of others to responsibly participate in all facets of local and global society. (*PCVL.GC*)



Disease

Draft Date 06-02-2026	Course HS H/CP Biology	Duration 13 Day(s)	Grades 10	Subjects Science	Team Tara Flick, Savannah Byers, Katherine Watson, James Hovan
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Focus

The **Disease** Storyline investigates uncontrolled cell division, primarily focusing on **cancer** as the anchoring phenomenon. Students compare normal and cancerous cells, exploring the **cell cycle**, regulation checkpoints, and **apoptosis**. Through models of **DNA replication** and **mutations**, they analyze how genetic changes, environmental factors, and **viruses** disrupt biological stability. Students gain an understanding of how **biological processes** from previous units can be disrupted.

Stage 1: Learning Goals

Established Goals	Transfer
Standards	Long-Term Transfer Goals
Pennsylvania Academic Standards Science (2023): 9-12 Standards 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. Clarifying Statement: N/A Assessment Boundary: Assessment does not include the identification of specific cell or tissue types, whole body systems, specific protein structures and functions,	What kinds of long-term, independent accomplishments are desired? Students will be able to independently use their learning to... - Approach science as a reliable and testable way of knowing and explaining the natural world and designed world. (Life-Long Learner) (T1) - Weigh evidence and use scientific approaches to ask questions, investigate, and make informed decisions. (Innovative Problem Solver) (T2) - Make and use observations to analyze relationships and patterns in order to explain phenomena, develop models, and make predictions. (Communicator) (T3) - Evaluate systems, in order to connect how form determines function and how any change to one component affects the entire system. (Global Citizen, Innovative Problem Solver) (T4) - Explain how the natural and designed worlds are interrelated and the application of scientific knowledge and technology can have beneficial, detrimental, or unintended consequences. (Global Citizen, Communicator) (T5) - Participate in respectful discourse with peers, teachers, and experts in the field to share ideas, perspectives, and findings. (Collaborator, Communicator) (T6)

or the biochemistry of protein synthesis. (3.1.9-12.A)

- Plan and conduct an investigation to provide evidence that feedback mechanisms maintain homeostasis.

Clarifying Statement: Examples of investigations could include heart rate response to exercise, stomate response to moisture and temperature, and root development in response to water levels.

Assessment Boundary: Assessment does not include the cellular processes involved in the feedback mechanism. (3.1.9-12.C)

- Use a model to illustrate the role of cellular division (mitosis) and differentiation in producing and maintaining complex organisms.

Clarifying Statement: N/A

Assessment Boundary: Assessment does not include specific gene control mechanisms or rote memorization of the steps of mitosis. (3.1.9-12.D)

- Ask questions to clarify relationships about the role of DNA and chromosomes in coding the instructions for characteristic traits passed from parents to offspring.

Clarifying Statement: N/A

Assessment Boundary: Assessment does not include the phases of meiosis or the

Meaning	
Understandings	Essential Questions
What specifically do you want students to understand? What inferences should they make? Students will understand that... ■ Cancer cells divide faster and more frequently than healthy cells, spending less time in the cell cycle and signaling a dysregulation of mitosis. (U1) ■ Normal growth and repair in organisms are managed by a tightly regulated cell cycle containing specific checkpoints. (U2) ■ Mitosis and meiosis are the types of cell division that occur in eukaryotic cells. (U3) ■ DNA carries the essential instructions for cell division; replication ensures each daughter cell receives an identical copy of this genetic code. (U4) ■ Random DNA mutations—such as substitutions, insertions, or deletions—can alter the amino acid sequence during transcription and translation. These changes affect protein structure and function, which can disrupt cell regulation. (U5) ■ Specific genes, such as p53, act as regulators to prevent tumor growth. (U6) ■ Programmed cell death (apoptosis) is a vital process for maintaining constant cell numbers and preventing the perpetuation of damaged DNA. (U7)	What thought-provoking questions will foster inquiry, meaning making, and transfer? Students will keep considering... ■ How do the structures of organisms enable life's functions? (A and C) (Q1) ■ How do organisms grow and develop? (D) (Q2) ■ How are the characteristics of one generation related to the previous generation? (P) (Q3) ■ Why do individuals of the same species vary in how they look, function, and behave? (Q) (Q4)

biochemical mechanism of specific steps in the process. (3.1.9-12.P)

- 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.

Clarifying Statement: Emphasis is on using data to support arguments for the way variation occurs.

Assessment Boundary: Assessment does not include the phases of meiosis or the biochemical mechanism of specific steps in the process. (3.1.9-12.Q)

- Many issues surrounding disease and its treatment raise concerns about decisions that protect the humanity of all stakeholders. Bioethics is the branch of thought that opens up these discussions and guides decisions that are made regarding diseases, their treatment, and other biological questions. (U8)
- Beyond genetics, external factors like the viruses can cause cancer by integrating viral DNA into the host genome, thereby changing the genetic sequence. (U9)

Acquisition of Knowledge & Skill

Knowledge

What facts and basic concepts should students know and be able to recall?
Students will know...

- All cells contain genetic information in the form of DNA. (A) (K1)
- DNA replication is semiconservative. (A) (K2)
- Genes are sections of DNA that contain instructions for a protein to be made through the processes of transcription and translation. (A) (K3)
- Positive and negative feedback mechanisms maintain stable internal conditions and mediate behaviors as external conditions change. (C) (K4)
- Multicellular organisms grow and differentiate cells via mitosis. (D) (K5)

Skills

What discrete skills and processes should students be able to use? Students can...

- I can explain based on valid and reliable evidence that DNA determines the structure of proteins. (A) (S1)
- I can plan and conduct an investigation to provide evidence that feedback mechanisms maintain homeostasis. (C) (S2)
- I can use a model to illustrate the role of cellular division (mitosis) and differentiation in producing and maintaining complex organisms. (D) (S3)
- I can examine models to clarify relationships between DNA and inherited traits. (P) (S4)

Profile of a CV Learner

- Life-Long Learner: Students will be able to independently use their learning to analyze past and ongoing performance, adjust thinking processes to new contexts, and use information to make informed and conscientious decisions. (PCVL.LLL)

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| | <ul style="list-style-type: none"> ■ Cell division and differentiation produce and maintain tissues and organs that work together. (D) (K6) ■ Mitosis produces two identical body cells from one parent cell. (D) (K7) ■ The cell cycle includes interphase, mitosis, and cytokinesis. (D) (K8) ■ Chromosomes contain specific genes located on a long strand of DNA. (P) (K9) ■ Gene expression is regulated in different ways. (P) (K10) ■ Some parts of DNA do not code for proteins, can be involved in gene expression, or have no known function. (P) (K11) ■ Meiosis creates genetic diversity through independent assortment and crossing-over. (Q) (K12) ■ Mutations can occur during replication and cause genetic variation. (Q) (K13) ■ Environmental factors can cause mutations which can be inherited and affect expression of traits. (Q) (K14) | <ul style="list-style-type: none"> ■ I can make and defend a claim based on evidence that inherited variation is caused by meiosis and mutations from either DNA replication or environmental factors. (Q) (S5) |
|--|--|--|



Citizen Science at Outdoor School

Draft Date 06-03-2026	Course HS H/CP Biology	Duration 7 Day(s)	Grades 10	Subjects Science	Team Tara Flick, Savannah Byers, Katherine Watson, James Hovan
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Focus

The Citizen Science Unit allows students to be active participants in real-world science by investigating local ecological phenomena including freshwater aquatic and terrestrial biodiversity, aquatic abiotic systems, forest biodiversity and management, and **population biology** on local Lancaster Conservancy properties. Students use inquiry and application of prior knowledge of ecology and population biology to participate in what the Alliance for the Chesapeake Bay, the Chesapeake Bay Foundation, Stroud Water Research Center, PA-DEP, PA-DCNR, PA-FBC/GC, and NOAA call a **Meaningful Watershed Education Experience (MWEE)** (ACB,2000). As a result, students are able to use data to explain scientific phenomena in the real world, and offer research-based answers for scientific questions.

Stage 1: Learning Goals

Established Goals	Transfer
Standards	Long-Term Transfer Goals
Pennsylvania Academic Standards Environmental Literacy & Sustainability (2023): 9-12 Environmental Literacy & Sustainability ■ Analyze and interpret how issues, trends, technologies, and policies impact watersheds and water resources. (3.4.9-12.C) ■ Apply research and analytical skills to systematically investigate environmental issues ranging from local issues to those that are regional or global in scope. (3.4.9-12.D) ■ Plan and conduct an investigation utilizing environmental data about a local environmental issue. (3.4.9-12.E)	What kinds of long-term, independent accomplishments are desired? Students will be able to independently use their learning to... ■ Approach science as a reliable and testable way of knowing and explaining the natural world and designed world. (Life-Long Learner) (T1) ■ Weigh evidence and use scientific approaches to ask questions, investigate, and make informed decisions. (Innovative Problem Solver) (T2) ■ Make and use observations to analyze relationships and patterns in order to explain phenomena, develop models, and make predictions. (Communicator) (T3) ■ Evaluate systems, in order to connect how form determines function and how any change to one component affects the entire system. (Global Citizen, Innovative Problem Solver) (T4) ■ Explain how the natural and designed worlds are interrelated and the application of scientific knowledge and technology can have beneficial, detrimental, or unintended consequences. (Global Citizen, Communicator) (T5) ■ Participate in respectful discourse with peers, teachers, and experts in the field to share ideas, perspectives, and findings. (Collaborator, Communicator) (T6)

- Design and evaluate solutions in which individuals and societies can promote stewardship in environmental quality and community well-being. (3.4.9-12.H)

Profile of a CV Learner

- Global Citizenship: Students will be able to mindfully and respectfully seek to understand the ideas and perspectives of others to responsibly participate in all facets of local and global society. (PCVL.GC)
- Life-Long Learner: Students will be able to independently use their learning to analyze past and ongoing performance, adjust thinking processes to new contexts, and use information to make informed and conscientious decisions. (PCVL.LLL)

Meaning	
Understandings	Essential Questions
What specifically do you want students to understand? What inferences should they make? Students will understand that... ■ Water resources change based on movement and shape. Stagnant ponds and flowing streams hold different amounts of oxygen, minerals, and sediment. Calculating stream flow helps scientists track how a watershed handles heavy rain and pollution runoff. (U1) ■ Clear water isn't always healthy water. Chemical factors—like pH, alkalinity, nitrates, and phosphates—determine what can survive in a stream. Measuring these values reveals invisible threats, such as toxic fertilizer runoff or a lack of protection against acid rain. (U2) ■ Macroinvertebrates are living sensors of water health because different species have different limits for pollution. Calculating a Pollution Tolerance Index (PTI) indicates how healthy a stream is over time. (U3) ■ Healthy ecosystems rely on balanced, native food webs. When invasive species are introduced, they exploit the lack of natural predators and outcompete native wildlife for food and space, threatening local biodiversity and ecosystem stability. (U4)	What thought-provoking questions will foster inquiry, meaning making, and transfer? Students will keep considering... ■ How does water change as it moves from a still pond to a flowing stream, and what do these differences tell us about the health of the broader watershed? (Env- C and E) (Q1) ■ Why can a stream look perfectly clean and healthy to the human eye but be chemically or biologically in crisis? (Env-C and E) (Q2) ■ How can calculating a Pollution Tolerance Index (PTI) for a tiny stream segment give us a report card for the entire surrounding landscape? (Env-D) (Q3) ■ What happens to the delicate balance of a local ecosystem when an invasive plant or animal rewrites the rules of survival? (Env-D) (Q4) ■ How do environmental scientists balance the financial market value of natural resources with the invisible ecological services those resources provide to the planet? (Env-H) (Q5) ■ How can we use small-scale sampling methods (like quadrants) to accurately predict what a forest will look like 100 years into the future? (Env-H) (Q6)

- Trees hold financial value as timber, but they also provide free, vital ecosystem services. Sustainable land stewardship means balancing the market price of lumber with a tree's invisible benefits, like stopping bank erosion, trapping carbon, and providing wildlife habitats. (U5)
- Scientists cannot count every tree in a massive forest, so they use the quadrant method to sample small, defined areas. Scientists can estimate the population and predict how the forest will look in 100 years. (U6)

Acquisition of Knowledge & Skill

Knowledge	Skills
What facts and basic concepts should students know and be able to recall? Students will know... ■ Human activities—like habitat destruction, pollution, invasive species, overexploitation, and climate change—disrupt ecosystems and threaten species survival. (Env-C, E) (K1) ■ Biodiversity increases with speciation and decreases with the loss of species (extinction). Biodiversity is measurable with scientific tools such as the pollution tolerance index (PTI). (Env-C, E) (K2) ■ Humans rely on biodiversity for ecosystem services, resources, recreation, and inspiration. However, human actions—like overpopulation	What discrete skills and processes should students be able to use? Students can... ■ I can analyze and interpret how human actions—including environmental issues, new technologies, and government policies—shape the health of our watersheds and water resources (Env-C) (S1) ■ I can use research tools and data to investigate environmental problems, tracing their impacts from my own backyard to the rest of the world. (Env-D) (S2) ■ I can carry out a scientific study, using real data to investigate and solve an environmental problem in my local community (Env-E) (S3)

and pollution—threaten these systems, making biodiversity conservation essential for sustaining life on Earth. (Env-C,D) (K3)

- Stable ecosystems use complex internal relationships to keep population sizes steady over time. These relationships can be quantified and studied through scientific testing. (Env-D) (K4)
- Healthy ecosystems can bounce back from minor disruptions (resilience), but extreme changes can permanently shatter their balance, resources, and habitats. (Env-D) (K5)
- For human societies and nature to survive long-term, we must manage Earth's natural resources responsibly. This stewardship involves evaluating the in-situ and ex-situ values of the components of the natural world. (Env-D) (K6)
- Biodiversity increases when new species evolve (speciation) and decreases when species disappear forever (extinction). (Env-E) (K7)
- Humans rely on biodiversity for vital resources, recreation, and inspiration. However, our footprint (overpopulation, pollution, and overexploitation) damages these systems, making active conservation vital for supporting life on Earth. (Env-E) (K8)
- The sustainability of human societies and the biodiversity that supports them

- I can design a realistic plan to protect the environment and improve community life, and evaluate how well that plan actually works. (Env-H) (S4)

requires responsible management of natural resources. (Env-E, H) (K9)

- 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. (Env-D, H) (K10)