# Kenilworth Public Schools

## Curriculum Guide

Content Area: Biology
Grade: 9
BOE Approved: 5/11/15

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Submitted by: Kelsey Logan
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# Biology – Grade 9 – Scope and Sequence

| Unit 1-<br>Ecosystems: Interactions, Energy, and Dynamics | Unit 2-<br>From Molecules to Organisms: Structure & Processes | Unit 3-<br>Heredity: Inheritance and Variation of Traits | Unit 4-<br>Biological Evolution: Unity and Diversity |
|---|---|---|---|
| Weeks 1-11 | Weeks 12-23 | Weeks 24-31 | Weeks 32-35 |
| *Unit Description*:<br>All organisms are interdependent upon one another. They interact with other living and nonliving factors in their environment. Before engaging in experiments, scientific practices and investigations will be conducted. In this unit, the basic ecology concepts will be reviewed. Current ecological issues, such as global climate change, will be considered and eventually connect to the main problem of the exponential growth of the human population. Solutions to these ecological issues will be devised, stable feeding relationships in the form of food webs and trophic levels will be developed, and the fragility of ecosystems will be discussed. | *Unit Description:*<br>Cells are the basic units of life. In this unit, the structure and function of a cell and its specialized organelles, as well as its organic molecules that make up cells, contribute to the homeostasis of an organism. The chemical building blocks of cells will be modeled, cell classified based on the principles of taxonomy, and changes that cells will undergo under different environmental conditions are predicted. Energy production and break down will be explored through the processes of cellular respiration and photosynthesis. | *Unit Description:*<br>All living things contain genetic material. Genetic material must be passed from parent to offspring in order for life to continue through generations. In this unit, the importance of DNA will be stressed. It carries the encoded instructions for synthesis of cellular products and is distributed appropriately to the new cells created by each reproductive event. Cells can be compared at different stages of the life cycle, the consequences of various changes in the genetic code assessed, and the rules of probability used to predict the inheritance of certain traits. | *Unit Description:*<br>Evolution takes place when new species arise from preexisting species. In this unit, the process by which species evolve will be emphasized. The main points behind natural selection as well as its impact on the environment will be discussed. The process by which natural selection eliminated unfavorable traits and gives rise to new adaptations will be illustrated. |

| *Unit Targets:* | *Unit Targets:* | *Unit Targets:* | *Unit Targets:* |
|---|---|---|---|
| • Categorize different types of species interactions.<br>• Predict the paths of energy flow and matter cycling in the environment.<br>• Evaluate possible solutions to current ecological issues.<br>• Design a food web for a given ecosystem.<br>• Explain why almost all organisms depend on photosynthesis.<br>• Explore the correlation between global climate change and the increase in human population.<br>• Predict how global climate change affects biodiversity on the planet.<br>• Participate in the scientific community of the classroom.<br>• Design and analyze scientific investigations.<br>• Develop claims, evidence, and reasoning for specific scientific scenarios. | • Compare the four major classes of organic molecules: carbohydrates, lipids, proteins, and nucleic acids.<br>• Identify the major elements composing cells.<br>• Differentiate between animal and plant cells in their structure and/or function.<br>• Experiment with the different organic molecules found in cells.<br>• Create and analogy for the functional parts of a cell.<br>• Summarize the main steps of cellular respiration.<br>• Compare anaerobic respiration with aerobic respiration.<br>• Summarize how the light reactions and the Calvin cycle work together to create the continuous cycle of photosynthesis.<br>• Explain how environmental factors, such as climate change, influence photosynthesis.<br>• Discuss how photosynthesis and cellular respiration are used to power ecosystems. | • DNA molecules contain information that determines the sequence of amino acids added to a growing protein.<br>• View how random alterations in the genetic code may help, harm, or have no effect on the organism.<br>• Distinguish between cell growth, division, and differentiation.<br>• Compare and contrast sexual and asexual reproduction.<br>• Evaluate the cellular consequences of different types of genetic mutations.<br>• Predict the possible offspring of a genetic cross.<br>• Predict the probability of inheriting a trait or disorder.<br>• Discuss the ethical and social issues about the use of genetic technology. | • Estimate how closely relation species are based on scientific evidence.<br>• Explain the different categories of evidence that support the theory of evolution.<br>• Summarize the results of experiments that led to the disproval of spontaneous generation.<br>• Outline the modern scientific understanding of the formation of Earth.<br>• List the characteristics that describe the first form of life on Earth.<br>• Explain how modern cells have evolved.<br>• Describe Charles Darwin's contributions to scientific thinking about evolutions.<br>• Relate the concepts of adaptation and fitness to the theory of natural selection. |

# Biology – Grade 9 – Unit 1

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|---|---|
| **Unit Title:** Ecosystems: Interactions, Energy, and Dynamics | |
| **Unit Summary:** All organisms are interdependent upon one another. They interact with other living and non-living factors in their environment. In this unit, the basic ecology concepts will be reviewed. Current ecological issues will be considered and eventually connected to the main problem of the exponential growth of the human population. Solutions to ecological issues will be devised, stable feeding relationships in the form of food webs and tropic hierarchies will be developed, and the fragility of ecosystems will be discussed. | |
| **Primary Interdisciplinary Connections:** Mathematics, Social Studies, Philosophy | |
| **Career Readiness, Life Literacies, and Key Skills:** Global Awareness, Civic Literacy, Health Literacy, LGBTQ Awareness | |
| | |
| **Learning Targets** | |
| **NJSLS Standards:** HS-LS2-1, HS-LS2-2, HS-LS2-3, HS-LS2-4, HS-LS2-5, HS-LS2-6, HS-LS2-7, HS-LS2-8 | |
| **Computer Science and Design Thinking Standards:** 8.2.12.ED.4, 8.2.12.ED.5, 8.2.12.ETW.3, | |
| **Climate Change Standards:** HS-ESS3-4 | |
| **ELA Companion Standards:** NJSLSA.R1, WHST.9-10.6, NJSLSA.R8 | |
| **Content Statements:** | |
| 1 | Use mathematical and/or computational representations to support explanations of factors that affect carrying capacity of ecosystems at different scales. |
| 2 | Use mathematical representations to support and revise explanations based on evidence about factors affecting biodiversity and populations in ecosystems of different scales. |
| 3 | Construct and revise an explanation based on evidence for the cycling of matter and flow of energy in aerobic and anaerobic conditions. |
| 4 | Use mathematical representations to support claims for the cycling of matter and flow of energy among organisms in an ecosystem. |
| 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. |
| 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. |
| 7 | Design, evaluate, and refine a solution for reducing the impacts of human activities on the environment and biodiversity. |
| 8 | Evaluate the evidence for the role of group behavior on individual and species' chances to survive and reproduce. |
| | |
| **Big Idea:** All organisms depend on their environment to meet their basic needs. Biological communities in ecosystems are based on stable interrelationships and interdependence of organisms. | |

| **Unit Essential Questions:** | **Unit Enduring Understandings:** |
|---|---|
| • How is ecosystem stability disrupted by human intervention?<br>• How can you change your lifestyle to conserve natural resources?<br>• Why is it important to understand challenges in a species' environment in order to understand the species' evolution?<br>• How has the LGBTQ community aided to the advances in science?<br>• How does the human population influence global climate change?<br>• How does matter cycle through an ecosystem? | • Evidence is used for building, refining, and/or critiquing scientific explanations.<br>• All animals and most plants depend on both other organisms and their environment to meet their basic needs.<br>• All ecosystems depend on all factors of the environment to meet their basic needs and to survive. If the ecosystem changes, an organism's needs may not be met.<br>• Biological communities in ecosystems are based on stable interrelationships and interdependence of organisms.<br>• Stability in an ecosystem can be disrupted by natural or human interactions.<br>• Energy flows through an ecosystem through a series of nutrient cycles, as well as through feeding relationships between members of a community. |

**Unit Learning Targets**
*Students will…*

- Evaluate the possible solutions to current ecological problems.
- Predict the paths of energy flow and matter cycling in the environment.
- Categorize the different types of species interactions.
- Design a food web for a given ecosystem.
- Explain why almost all organisms depend on photosynthesis.
- Explore the correlation between global climate change and the increase in human population.
- Predict how global climate change affects biodiversity on the planet.
- Participate in the scientific community of the classroom.
- Design and analyze scientific investigations.
- Develop claims, evidence, and reasoning for specific scientific scenarios.
- Construct and evaluate population graphs.

## 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)

## Disciplinary Core Ideas

**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)

**LS2.D: Social Interactions and Group Behavior**

- Group behavior has evolved because membership can increase the chances of survival for individuals and their genetic relatives. (HS-LS2-8)

**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).*

## 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-LS2-5)

**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)

## Evidence of Learning

**Summative Assessment:** Chapter Tests, Labs

**Formative Assessments:**

- Quizzes
- Mini-labs
- Group projects
- Homework (independent practice from classwork)
- Peardeck embedded questions
- Station activities
- Surveys – using hand signals, agree/disagree signs, red-yellow-green cups

## Lesson Plans

| *Activities/Interdisciplinary Connections* | *Timeframe* |
|---|---|
| • Explore scientists in the LGBTQ community<br>• Trophic pyramid constructions<br>• Designing food webs<br>• Species interaction lab<br>• Population size simulation<br>• Graphing predator and prey population size<br>• Ecosystem videos<br>• Peardeck notes slides<br>• Ecological Solution Project<br>• Comparing human population and global climate change rates | 1-11 |

| *Teacher Resources* | *Teacher Note* |
|---|---|
| • Textbook<br>• Google Slides presentations<br>• Laboratory materials<br>• Technology Tools:<br>-Google Classroom<br>-Pear Deck<br>-YouTube<br>-Quizizz<br>-Kami | |

## Differentiating Instruction: Students with Disabilities, English Language Learners, and Gifted & Talented Students

Examples of Strategies and Practices that Support Students with Disabilities:
• Use of visual and multisensory formats
• Use of assisted technology
• Use of prompts
• Modification of content and student products
• Testing accommodations
• Authentic assessments

Examples of Strategies and Practices that Support Gifted & Talented Students:
• Adjusting the pace of lessons
• Curriculum compacting
• Inquiry-based instruction
• Independent study
• Higher-order thinking skills
• Interest-based content
• Student-driven instruction
• Real-world problems and scenarios

Examples of Strategies and Practices that Support English Language Learners:
• Pre-teaching of vocabulary and concepts
• Visual learning, including graphic organizers
• Use of cognates to increase comprehension
• Teacher modeling
• Pairing students with beginning English language skills with students who have more advanced English language skills
• Scaffolding

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| •Word walls<br>•Sentence frames<br>•Think-pair-share<br>•Cooperative learning groups |

# Biology – Grade 9 – Unit 2

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|---|---|
| **Unit Title:** From Molecules to Organisms: Structure & Processes | |
| **Unit Summary:** Cells are the basic units of life. In this unit, the structure and function of a cell and its specialized organelles, as well as its organic molecules that make up cells, contribute to the homeostasis of an organism. The chemical building blocks of cells will be modeled, cell classified based on the principles of taxonomy, and changes that cells will undergo under different environmental conditions are predicted. Energy production and break down will be explored through the processes of cellular respiration and photosynthesis. | |
| **Primary Interdisciplinary Connections:** Mathematics, Social Studies, Philosophy | |
| **Career Readiness, Life Literacies, and Key Skills:** Global Awareness, Civic Literacy, Health Literacy, LGBTQ Awareness | |
| | |
| **Learning Targets** | |
| **NJSLS Standards:** HS-LS1-1, HS-LS1-2, HS-LS1-3, HS-LS1-4, HS-LS1-5, HS-LS1-6, HS-LS1-7 | |
| **Computer Science and Design Thinking Standards:** 8.2.12.ED.4, 8.2.12.ED.5, 8.2.12.ETW.3 | |
| **Climate Change Standards:** HS-ESS3-4 | |
| **ELA Companion Standards:** NJSLSA.R1, WHST.9-10.6, NJSLSA.R8 | |
| **Content Statements:** | |
| 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. |
| 2 | Develop and use a model to illustrate the hierarchical organization of interacting systems that provide specific function within multicellular organisms. |
| 3 | Plan and conduct and investigation to provide evidence that feedback mechanisms maintain homeostasis. |
| 4 | Use a model to illustrate the role of cellular division (mitosis) and differentiation in producing and maintaining complex organisms. |

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|---|---|
| 5 | Use a model to illustrate how photosynthesis transforms light energy into stored chemical energy. |
| 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. |
| 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. |

**Big Idea:** An organism is made up of cells, which carry out all the functions of life.

| **Unit Essential Questions:** | **Unit Enduring Understandings:** |
|---|---|
| • Why is chemistry such an integral part of biological science?<br>• How does structure relate to function in living systems from the organism to the cellular level?<br>• How are cells classified?<br>• How do enzymes regulate chemical interactions?<br>• What are the 4 main types of carbon-based molecules found in living things?<br>• How do materials move into and out of cells?<br>• How do photosynthesis and respiration relate to the oxygen-carbon dioxide cycle?<br>• What occurs during photosynthesis and cellular respiration?<br>• Why can't humans survive without oxygen? | • Living systems, from the organisms to the cellular level, demonstrate the corresponding nature of structure and function.<br>• Cellular processes are carried out by many different types of molecules.<br>• One of the most important molecules for living organisms is enzymes, a type of protein.<br>• The internal and external environment of a cell can affect its functionality and efficiency of the cell, or the whole organism.<br>• Organisms can be classified into a hierarchical system.<br>• Energy flows through plant and animals using the processes of photosynthesis and cellular respiration. Together they help supple ecosystems. |

**Unit Learning Targets**

*Students will…*

- Identify the major elements composing cells.
- Compare the four major classes of organic molecules: carbohydrates, lipids, proteins, and nucleic acids.
- Differentiate between animal and plant cells in their structure and/or function.
- Experiment with the different organic molecules found in cells.
- Create an analogy for the functional parts of a cell.
- Predict how a cell will react when exposed to a new environment.
- Explain how environmental conditions, such as global climate change, influence photosynthesis.
- Compare anaerobic respiration with aerobic respiration.

- Discuss how photosynthesis and cellular respiration work together to power ecosystems.

## 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

**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) *(Note: This Disciplinary Core Idea is also addressed by HS-LS3-1.)*
- 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)

## Evidence of Learning

**Summative Assessment:** Chapter Tests, Labs

**Formative Assessments:**

- Quizzes
- Mini-labs
- Group projects
- Homework (independent practice from classwork)
- Peardeck embedded questions
- Station activities
- Surveys – using hand signals, agree/disagree signs, red-yellow-green cups

## Lesson Plans

| *Activities/Interdisciplinary Connections* | *Timeframe* |
|---|---|
| • Carbohydrate testing lab<br>• Enzyme function lab<br>• Microscope tutorial<br>• Animal and plant cell microscopic comparison<br>• Parts of the Cell choice project<br>• Cell analogies<br>• Diffusion and osmosis demonstration<br>• Dialysis Tubing Lab<br>• Cellular Respiration Exercise Lab<br>• Pigmentation Lab<br>• Cellular Respiration & Photosynthesis desk manipulations | 12-23 |
| *Teacher Resources* | *Teacher Note* |
| • Textbook<br>• Google Slides presentations<br>• Laboratory materials<br>• Technology Tools:<br>-Google Classroom<br>-Pear Deck<br>-YouTube<br>-Quizizz<br>-Kami | |

| Differentiating Instruction:<br>Students with Disabilities, English Language Learners,<br>and Gifted & Talented Students |
|---|
| Examples of Strategies and Practices that Support Students with Disabilities:<br>• Use of visual and multisensory formats<br>• Use of assisted technology<br>• Use of prompts<br>• Modification of content and student products<br>• Testing accommodations<br>• Authentic assessments<br><br>Examples of Strategies and Practices that Support Gifted & Talented Students:<br>• Adjusting the pace of lessons<br>• Curriculum compacting<br>• Inquiry-based instruction<br>• Independent study<br>• Higher-order thinking skills<br>• Interest-based content<br>• Student-driven instruction<br>• Real-world problems and scenarios<br><br>Examples of Strategies and Practices that Support English Language Learners:<br>• Pre-teaching of vocabulary and concepts<br>• Visual learning, including graphic organizers<br>• Use of cognates to increase comprehension<br>• Teacher modeling<br>• Pairing students with beginning English language skills with students who have more advanced English language skills<br>• Scaffolding<br>•Word walls<br>•Sentence frames<br>•Think-pair-share<br>•Cooperative learning groups |

# Biology – Grade 9 – Unit 3

| **Unit Title:** Heredity: Inheritance and Variation of Traits |
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| **Unit Summary:** All living things contain genetic material. Genetic material must be passed from parent to offspring in order for life to continue through generations. In this unit, the importance of DNA will be stressed. It carries the encoded instructions for synthesis of cellular products and is distributed appropriately to the new cells created by each reproductive event. Cells can be compared at different stages of the life cycle, the consequences of various changes in the genetic |

code assessed, and the rules of probability used to predict the inheritance of certain traits.

**Primary Interdisciplinary Connections:** Mathematics, Social Studies, Philosophy

**Career Readiness, Life Literacies, and Key Skills:** Global Awareness, Civic Literacy, Health Literacy, LGBTQ Awareness

## Learning Targets

**NJSLS Standards:** HS-LS3-1, HS-LS3-2, HS-LS3-3

**Computer Science and Design Thinking Standards:** 8.2.12.ED.4, 8.2.12.ED.5, 8.2.12.ETW.3,

**Climate Change Standards:** HS-ESS3-4

**ELA Companion Standards:** NJSLSA.R1, WHST.9-10.6, NJSLSA.R8

**Content Statements:**

| | |
|---|---|
| 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. |
| 2 | Use a model to illustrate the role of cellular division (mitosis) and differentiation in producing and maintaining complex organisms. |
| 3 | Ask questions to clarify relationships about the role of DNA and chromosomes in coding the instructions for characteristic traits passed from parent to offspring. |
| 4 | 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. |

**Big Idea:** Organisms contain genetic information that influences their traits, and they pass this information to their offspring during reproduction.

**Unit Essential Questions:**

- How does a multicellular organism develop from just a single cell?
- How is DNA replicated?
- How has the Human Genome Project benefitted from the field of biology?
- How is genetic information passed through generations?
- What happens in replication, transcription, and translation?
- How does genotype affect phenotype?
- What are the different patterns of inheritance?
- What role does the environment play on gene expression?

**Unit Enduring Understandings:**

- All living organisms have DNA. DNA contains information (genes) that determine a sequence of amino acids which result in specific proteins.
- Cells divide through the process of mitosis resulting in daughter cells that have the same genetic composition as the original cell.
- The differentiation/specialization of cells in multicellular organisms is due to the different patterns of gene expression, not because of differences of the genes themselves.
- Changes in DNA (mutations) occur spontaneously, during DNA replication or due to the environment.
- Inserting, deleting, or substituting DNA segments can alter the genetic code.
- An altered gene may be passed on to every cell that develops from it. The resulting features may help, harm, or have little or no effect on

| | |
|---|---|
| | the offspring's success in its environment.<br>• Genetic disorders may result in a malfunction of a system, organ, or cell. Genetic disorders are not curable, but some may be treatable.<br>• There are predictable patterns of inheritance and the variation that exists within a species is related to its mode of reproduction (asexual or sexual). Sexually produced offspring are never identical to either of their parents.<br>• Sorting and recombination of genes in sexual reproduction result in a great variety of possible gene combinations from the offspring of any two parents.<br>• New traits may result from new combinations of existing genes or from mutations of genes in reproductive cells within a population. More combinations can occur in a sexually reproducing species. |

**Unit Learning Targets**
*Students will…*

- Explain how DNA molecules contain information that determines the sequence of amino acids added to a growing protein.
- View how random alterations in the genetic code may help, harm, or have little to no effect on the organism.
- Distinguish between cell growth, division, and differentiation.
- Compare and contrast sexual and asexual reproduction.
- Evaluate the cellular consequences of different types of genetic mutations.
- Predict the possible offspring of a genetic cross.
- Predict the probability of inheriting a trait of disorder.
- Discuss the ethical and social issues about the use of genetic technology.
- Explore how environmental factors, such as climate change, can influence gene expression.

**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

**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 chromosomes 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)

## Evidence of Learning

**Summative Assessment:** Chapter Tests, Labs

**Formative Assessments:**

- Quizzes
- Mini-labs
- Group projects
- Homework (independent practice from classwork)
- Peardeck embedded questions
- Station activities
- Surveys – using hand signals, agree/disagree signs, red-yellow-green cups

## Lesson Plans

| *Activities/Interdisciplinary Connections* | *Timeframe* |
|---|---|
| • DNA Extraction lab<br>• Building a DNA molecules<br>• Mitosis/Meiosis on the table<br>• Transcription/Translation simulation<br>• Coin-toss inheritance simulation<br>• Predicting genotypes and phenotypes<br>• Create a family pedigree<br>• Genetic disorder research project<br>• Virtual genetics activity<br>• Exploration of gene technology<br>• Group Punnett square lab | 24-31 |
| *Teacher Resources* | *Teacher Note* |
| • Textbook<br>• Google Slides presentations<br>• Laboratory materials<br>• Technology Tools:<br>-Google Classroom<br>-Pear Deck<br>-YouTube<br>-Quizizz<br>-Kami | |

## Differentiating Instruction: Students with Disabilities, English Language Learners, and Gifted & Talented Students

Examples of Strategies and Practices that Support Students with Disabilities:
- Use of visual and multisensory formats
- Use of assisted technology
- Use of prompts
- Modification of content and student products
- Testing accommodations
- Authentic assessments

Examples of Strategies and Practices that Support Gifted & Talented Students:
- Adjusting the pace of lessons
- Curriculum compacting
- Inquiry-based instruction
- Independent study
- Higher-order thinking skills
- Interest-based content
- Student-driven instruction
- Real-world problems and scenarios

Examples of Strategies and Practices that Support English Language Learners:
- Pre-teaching of vocabulary and concepts
- Visual learning, including graphic organizers
- Use of cognates to increase comprehension
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- Pairing students with beginning English language skills with students who have more advanced English language skills
- Scaffolding
- Word walls
- Sentence frames
- Think-pair-share
- Cooperative learning groups

# Biology – Grade 9 – Unit 4

**Unit Title:** Biological Evolution: Unity and Diversity

**Unit Summary:** Evolution takes place when new species arise from preexisting species. In this unit, the process by which species evolve will be emphasized. The main points behind natural selection as well as its impact on the environment will be discussed. The process by which natural selection eliminated unfavorable traits and gives rise to new adaptations will be illustrated.

**Primary Interdisciplinary Connections:** Mathematics, Social Studies, Philosophy

**Career Readiness, Life Literacies, and Key Skills:** Global Awareness, Civic Literacy, Health Literacy, LGBTQ Awareness

## Learning Targets

**NJSLS Standards:** HS-LS4-1, HS-LS4-2, HS-LS4-3, HS-LS4-4, HS-LS4-5, HS-LS4-6

**Computer Science and Design Thinking Standards:** 8.2.12.ED.4, 8.2.12.ED.5, 8.2.12.ETW.3,

**Climate Change Standards:**

**ELA Companion Standards:** NJSLSA.R1, WHST.9-10.6, NJSLSA.R8

**Content Statements:**

| | |
|---|---|
| 1 | Communicate scientific information that common ancestry and biological evolution are supported by multiple lines of empirical evidence. |
| 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. |
| 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. |
| 4 | Construct an explanation based on evidence for how natural selection leads to adaptation of populations. |
| 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. |
| 6 | Create or revise a simulation to test a solution to mitigate adverse impacts of human activity on biodiversity. |

**Big Idea:** Genetic differences between organisms of the same kind are the basis on which evolution is founded on. It provides advantages for surviving and reproducing in different environments.

| **Unit Essential Questions:** | **Unit Enduring Understandings:** |
|---|---|
| • How do organisms of the same species differ from one another?<br>• How does variation help some organisms survive and reproduce?<br>• How can cells within a multicellular organism be very different in structure and | • We can estimate how closely related species are, based on scientific evidence (e.g., anatomical similarities, similarities of DNA bases and/or amino acid sequences).<br>• Adaptations can hard, help, or have little or no effect on an offspring's success in its |

| | |
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| function, if they all came from the same original cell?<br>• How are natural selection and species adaptations related? | environment. Changes in DNA may be passed down to offspring if occurring in a gamete.<br>• Differences between organisms of the same species may provide advantages for surviving and reproducing in different environments. These difference may lead to dramatic changes in phenotypes of the population over a very long period of time.<br>• The fossil record and principles of evolution (natural selection and common descent) provide a scientific explanation for the history of life on Earth. |

**Unit Learning Targets**
*Students will…*

- Estimate how closely relation species are based on scientific evidence.
- Explain the different categories of evidence that support the theory of evolution.
- Summarize the results of experiments that led to the disproval of spontaneous generation.
- Outline the modern scientific understanding of the formation of Earth.
- List the characteristics that describe the first form of life on Earth.
- Explain how modern cells have evolved.
- Describe Charles Darwin's contributions to scientific thinking about evolutions.
- Relate the concepts of adaptation and fitness to the theory of natural selection.

**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

**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)

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- Surveys – using hand signals, agree/disagree signs, red-yellow-green cups

## Lesson Plans

| *Activities/Interdisciplinary Connections* | *Timeframe* |
|---|---|
| • Evolution timeline<br>• Comparing and contrasting fossil records<br>• Natural selection simulation lab<br>• Mechanisms for evolution lab<br>• Identifying and exemplifying the different adaptations<br>• Mapping Charles Darwin's *HMS Beagle* expedition<br>• Videos | 24-35 |
| *Teacher Resources* | *Teacher Note* |
| • Textbook<br>• Google Slides presentations<br>• Laboratory materials<br>• Technology Tools:<br>-Google Classroom<br>-Pear Deck<br>-YouTube<br>-Quizizz<br>-Kami | |

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