







Rhode Island

# School Garden Science

K-8 curriculum

Dear Teacher,

Rhode Island School Garden Science helps to bring science lessons alive, using the school garden as a vibrant and engaging learning platform. This guide presents lessons for students in grades K-8, corresponding with the Rhode Island Model Science Curriculum aligned with the Next Generation Science Standards.

There is a tremendous wealth of school garden resources available today; and it is our hope that this introductory curriculum guide has piqued your interest and will inspire you to continue on this path of engaging students in memorable, hands-on lessons in the garden and school yard.

Enjoy the adventure!

From observations to hypotheses, experiments and analyses, science is a natural when it's performed outdoors. Bringing children into the school garden opens the gate, and minds, to a microcosm of life on Earth – right in their school yard. Take this opportunity to dive further into the Rhode Island Model Curriculum and Next Generation Standards, building connections through the sampling of lessons provided here. Consider engaging teachers of other disciplines as well. It goes without saying that just about any subject can benefit from all that a school garden has to offer. For more inspiration, please visit: [web.uri.edu/sgi](http://web.uri.edu/sgi).

**Let's get growing!**

*--URI Cooperative Extension*

# RI Model Science Curriculum Scope & Sequence by Unit

Gr	Unit 1	Unit 2	Unit 3	Unit 4	Unit 5	Unit 6	Unit 7	Unit 8
K	Weather	Plants	Animals	The Human Factor	Pushes and Pulls	Effects of the Sun		
1	Patterns in the Sky	Characteristics of Living Things	Mimicking Organisms to Solve Problems	Light and Sound	Communicating with Light and Sound			
2	Relationships in Habitats	Properties of Matter	Changes to Matter	The Earth's Land and Water	Changes to the Earth's Land			
3	Weather and Climate	Force and Motion	Electric and Magnetic Forces	Traits	Continuing the Cycle	Organisms and Environments	Using Evidence to Understand and Change Environments	
4	Weathering and Erosion	Earth Processes	Structures and Function	How Organisms Process Information	Transfer of Energy	Force and Motion	Using Engineering Design with Force and Motion Systems	Waves and Information
5	Properties of Matter	Changes to Matter	Energy and Matter in Ecosystems	Water on the Earth	Earth Systems	Interactions within the Earth, Sun and Moon System		
6	Growth and Development of Organisms	Ecosystems	Ecosystem Dynamics, Functioning and Resilience	Forces and Motion	Types of Interactions	Earth and Space	Weather and Climate	
7	Structure and Properties of Matter	Interactions of Matter	Chemical Reactions	Structure and Function	Body Systems	Inheritance and Variations of Traits	Organization for Matter and Energy Flow in Organisms	Earth Systems
8	Evidence of Common Ancestry	Selection and Adaptation	Stability and Change on Earth	Human Impacts on Earth Systems and	Relationships Among Forms of Energy	Thermal Energy	The Electro-magnetic Spectrum	

The RI Model Science Curriculum includes Year-at-a-Glance, Scope and Sequence and Units of Study for K-5 grade levels, grades 6-8 grade span and high school biology, chemistry and physics.

Matrix of units adapted from:

<http://www.ride.ri.gov/InstructionAssessment/Science/RIModelScienceCurriculum.aspx>

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## Resources:

### Check out our School Garden Initiative website!

<http://uri.edu/sgi>

Find garden help, resources, curriculum and information about our annual school garden conference.

### Contact our Gardening and Environmental Hotline!



401.874.4836 or [gardener@uri.edu](mailto:gardener@uri.edu)

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# Kindergarten

## Weather Watchers

RI Model Science Curriculum (RIMSC) Unit of Study: **1 – Weather; 2 – Plants**

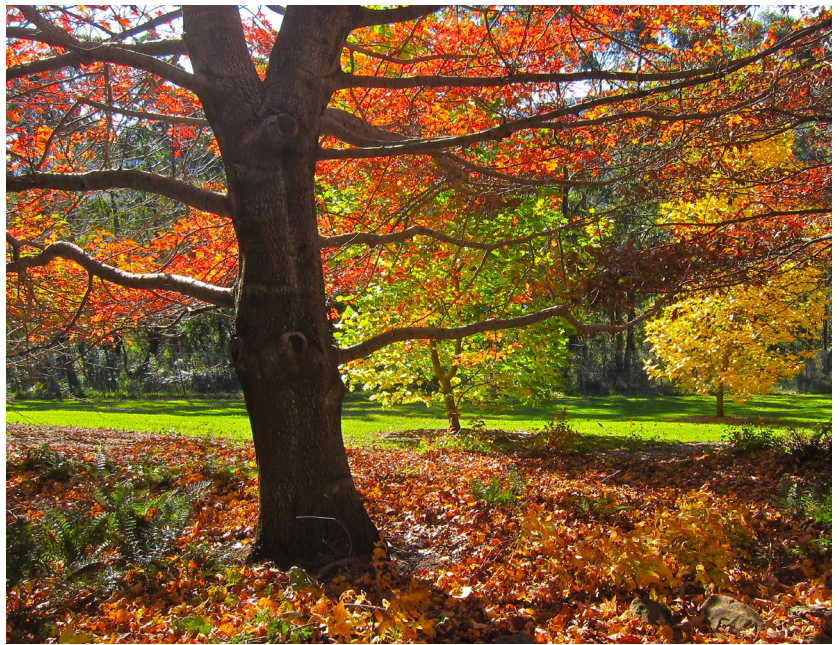
Timeframe: **Fall, Spring**

Next Generation Science Standards: **Weather and Climate: K-ESS2-1.** Use and share observations of local weather conditions to describe patterns over time; SEP – Analyzing and Interpreting Data; DCI – ESS2.D: Weather and Climate; CC – Patterns; **K-LS1-1.** Use observations to describe patterns of what plants and animals (including humans) need to survive; SEP – Analyzing and Interpreting Data; DCI – LS1.C - Organization of Matter and Energy Flow in Organisms; CC – Patterns

### LEARNING OBJECTIVES

Students should be able to:

- Describe the four seasons in Rhode Island; how changes in sunlight, temperature and rain can affect garden plants
- Describe what weather is; record qualitative observations to describe the local weather, including variations and patterns over time
- Explain what plants need to survive and how weather affects plants in the garden



### BACKGROUND

Rhode Island is located in the southeastern section of New England which experiences four distinct seasons. Warm summers, cold winters and fairly even year-round precipitation (RI DEM) are characteristic of this temperate climate. Climate is the long-term weather average over decades. Weather refers to current conditions, such as if it is rainy, windy, cloudy, sunny, warm or cold. These conditions in the atmosphere change over a short period of time, changing hour to hour, day to day and month to month. Ongoing observations can show variations in weather and unveil patterns over time, such as the discovery that mornings are cool and afternoons warm up. Plants need light and water to grow and survive. Rain helps a garden grow. Warm temperatures help plants grow, while cold weather can damage plants.



# Kindergarten

## LESSONS

### PART 1: TRACKING THE WEATHER

1. Bring the class outdoors and invite students to notice the weather. What is it like? How would you describe the day? Open the discussion to questions that students may have. These can be further investigated in class. Also address misperceptions to support scientific accuracy.
2. Begin each following school morning by asking students to make weather observations. Is it sunny, cloudy or rainy? Does it feel warm, cool or cold? Does it look windy or still? Are there several weather indicators? Ask several students to share observations that support their statements.
3. Introduce vocabulary such as cloud cover, precipitation and temperature. Elaborate with introduction of types of clouds and different forms of precipitation.
4. Hold a class discussion on weather, what it is and how it changes. Using a white or black board, felt board or other display, ask students to record each day's weather in the morning and afternoon, each week for one month.
5. Discuss phenomena and weather patterns observed each day and throughout the week. Were there differences between mornings and afternoons? How many sunny days and cloudy or rainy days were there during the week? Did rain follow after a heavy cloud cover? Can weather be predicted from observing the types of clouds?
6. What are some tools people can use to gain information about weather (e.g., outdoor thermometer, rain gauge, a wind sock or Beaufort Scale)? If possible, set up a rain gauge in the garden and monitor the amount of rain each week. To build one, see: <https://www.theecologycenter.org/resources/build-a-rain-gauge/>

### PART 2: AS SEASONS CHANGE

1. Show students a brief video (for example, <https://www.youtube.com/watch?v=E0eDT9rICTs>) of an apple tree through the seasons. Ask the students to share their observations. What changes occurred in the tree with each season? Repeat the video and ask students for additional observations.
2. Go outdoors with the students and into the school yard. Ask them each to share a couple of their observations about the weather, plants and animals. Is it windy? How do you know? Are there blossoms on plants or leaves on the trees? Invite students to make connections between plants and the weather. Ask students to think about the apple tree video again.
3. Discuss the seasons and how they experience them in Rhode Island. What does the weather feel like now? In the summer? What types of activities can you do outdoors in the summer?
4. Show a couple of images of each of the seasons and invite students to make observations. What do you notice in these images?
5. Print images of nature and activities by season, providing a set of eight cards to student partners along with four paper strips, each labelled one of the seasons: Winter, Spring, Summer, Fall.
6. Ask partners to work together to sort the cards by season. Together as a class discuss how they chose to sort the cards, providing explanations for these selections.
7. Invite students to think about garden plants. They need sunlight and water to grow and survive. How do they get water? If there is not much rain, how are plants affected? How does temperature change in fall?
8. Visit the school garden with students once a week or every other week, from fall into winter. Encourage the sharing of observations each time. What are some changes in the plants, as the season and weather change? Take photos to record changes in the garden to share with the class at the end of the unit.



# Grade 1

## Making Connections

RI Model Science Curriculum (RIMSC) Unit of Study: **2 – Characteristics of living things; 3 – Mimicking organisms to solve problems**

Timeframe: **Fall, Winter, Spring**

Next Generation Science Standards: **Structure, Function, & Information Processing: 1-LS1-1.** Use materials to design a solution to a human problem by mimicking how plants and/or animals use their external parts to help them survive, grow and meet their needs; SEP – Constructing explanations and designing solutions; DCI – LS1.A: Structure and function; CC: Structure and function; **K-2-ETS1-2.** Develop a simple sketch, drawing or physical model to illustrate how the shape of an object helps it function as needed to solve a given problem; SEP - Developing and using models; DCI - Developing possible solutions; CC - Structure and function

### LEARNING OBJECTIVES

Students should be able to:

- Describe and elaborate on the plant life cycle and ways plants survive and grow
- Describe biomimicry, comparing natural materials with human-made items to create design solutions.



### BACKGROUND

Plants have structures that serve specific functions, helping them to grow, survive and reproduce. These include underground roots and aboveground shoots. The shoot system is comprised of the stem, branches, leaves, flowers, fruits and seeds. Plants produce seeds for continued survival of their population. The plant life cycle begins with a seed containing an embryo. Under suitable conditions of warmth and water, the seed will germinate or sprout and produce a seedling. The root grows downward, anchoring the plant and taking up water and nutrients. Plants produce leaves containing chloroplasts for the production of food through photosynthesis. In order to survive and grow, plants require water, carbon dioxide and sunlight.

Plants and animals have external structures that help them protect themselves and grasp things, among other functions. Humans mimic nature by designing human-made products based on nature, to solve problems. This is referred to as biomimicry, the design and production of materials modeled on organisms and processes in nature.





# Grade 1

## LESSONS

### PART 1: PLANT PARTS

1. Provide students with tools to observe and record plant life in the mature fall garden. Groups of three or four can use hand lenses, clipboards, paper and pencils to investigate plants. What structures do they see? Encourage discussions of roots, stems, leaves, flowers, fruits and seeds. Have some plants progressed through their life cycle and “gone to seed”?
2. In the classroom, provide each small group with materials to create a physical model based on their observations and drawings. How do plants use their parts to help them survive, grow and meet their needs?
3. Introduce children to the plant parts we eat. Purchase produce from the grocery store or print pictures to show students. Ask them what part of the plant each is. For example, carrots = roots; asparagus = stem; broccoli = flower; cucumber = fruit; lettuce = leaf. What are some of their favorite plants to eat? Have a ‘plant party’! Offer children a snack with carrots, celery and other vegetables, perhaps even those harvested from the garden, and dipping sauce such as Ranch dressing.



### PART 2: DESIGNING WITH NATURE IN MIND

1. Bring students outdoors to gather natural materials in the school yard and garden. Their task is to look at the external parts of plants and think about how human products mimic these parts. For example, acorn caps and bicycle helmets; stems and straws.
2. Outdoors or in the classroom, encourage students to produce a drawing that illustrates how the shape helps it function to solve a problem in the natural world and when mimicked by humans creating objects, can help to solve problems.
3. Introduce the topic of biomimicry. Provide samples of human-made materials that mimic traits found in nature, for example, sand paper and shark skin. Invite students to share ideas of how other human-made items might mimic nature (e.g., straws, Velcro). Visit the Biomimicry Institute on-line ([biomimicry.org/biomimicry-examples/](http://biomimicry.org/biomimicry-examples/)), and share examples with students of other ways that humans use biomimicry to create solutions to human needs and problems.



# Grade 2

## Diversity and Change

RI Model Science Curriculum (RIMSC) Unit of Study: 1 – Relationships in habitats; 5 – Changes to the Earth’s land

Timeframe: **Fall, Spring**

Next Generation Science Standards: **Interdependent Relationships in Ecosystems: 2-LS4-1.** Make observations of plants and animals to compare the diversity of life in different habitats; SEP – Planning and carrying out investigations; DCI – LS4.D: Biodiversity and humans; CC – N/A; **2-ESS2-1.** Compare multiple solutions designed to slow or prevent wind or water from changing the shape of the land; SEP – Constructing explanations and designing solutions; DCI – ESS2.A: Earth materials and systems; ETS1.C: Optimizing the design solution; CC – Stability and change; Influence of engineering, technology and science on society and the natural world

### LEARNING OBJECTIVES

Students should be able to:

- Define the concepts of biological diversity, habitat and ecosystem
- Demonstrate an awareness of the diversity of life in different habitats and the significance of biodiversity
- Describe interdependent relationships between plants and animals
- Display how animals disperse seeds or pollinate plants through production of a model



### BACKGROUND

Biological diversity ('biodiversity') refers to the variety of life in a particular habitat or ecosystem and is essential to its health. Even if spaces seem to be lacking much life, there exists a world of bugs that lives and thrives just beneath the grass in that ecosystem. It just takes closer examination. An ecosystem refers to living things that interact with each other and their physical environment. Within that are habitats, or 'homes,' where plants, animals and other organisms live in parts of the ecosystem. Many different kinds of living things can co-exist and live in different places on land or water.

Animals and plants depend upon one another. Plants are often food for animals, such as a rabbit eating clover. Animals also support plants, playing a key role in plant reproduction. Birds, bees, butterflies and bats are some of the pollinators that help plants reproduce. Bees, for example, have special structures on their bodies, pollen sacs ('baskets'), where pollen is collected and carried as they move from plant to plant. If it sticks to the stigma in the flower, pollination can occur. If pollination doesn't occur, plants are not able to grow seeds; thus many plants depend on pollinators for population survival. Animals play another role in reproduction by dispersing seeds. Some seeds stick to animal fur ('hitchhikers') and are carried a distance before falling off; while other seeds are eaten in fruits and dispersed in animal waste.



## LESSONS

### PART 1: BACKYARD BIODIVERSITY

1. Bring students outdoors to undertake 'micro-hikes' in the school yard. Define areas (using string and sticks, quadrats or hula hoops) to focus small groups of students' attention on spaces in the school yard. Provide partners or small groups with a magnifying box ('bug box') and/or hand lenses, along with clipboards, paper and pencils, to observe and record life within that area. What do they notice? Are there different types and amounts of organisms observed? How would students describe this variety? Introduce the term biological diversity.
2. Next, bring the class to the garden, providing a new sheet of paper onto which student groups can record what they see. Are there differences in the type and number of organisms? Why might this be? Does the garden support greater biodiversity than the school yard? Note: For an adequate comparison (i.e., to minimize variables), perform these investigations simultaneously if possible, dividing the class in two with one at each location. Or, perform the study over two days at the same time of day when there are similar weather conditions.
3. Dive further into the concept of biodiversity with students by investigating and sharing examples of the variety of organisms that live in other Rhode Island ecosystems, such as Narragansett Bay.

### Part 2: BEE-CAUSE WE NEED YOU!

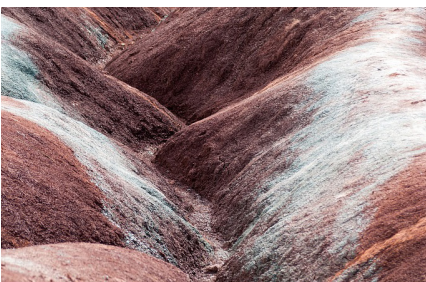
1. Share a book with students to introduce them to honeybees. Visit the website, <http://books.growingwithscience.com/2013/10/18/honey-bee-books-for-kids/> for suggestions.
2. Ask students where they think bees get their food? In The Life and Times of the Honeybee (by Charles Micucci), begin with Golden Treasures of the Beehive: Pollination (page 26), continuing through other interesting topics in the book. Discuss pollination and the varied structures and capabilities that make it possible for bees and other animals to pollinate plants.
3. Discuss the term 'interdependent.' This means to rely upon another individual or group. What are some ways that children rely on adults in their lives? How does a teacher rely on students? Other teachers? How are plants and animals interdependent? A lot of the food we eat began with pollination by honeybees.
4. To demonstrate how pollen grains can be transferred from one flower to another, hold a Pollen Relay Race. To set up, empty three different flavored/colored Pixie sticks into plastic petri dishes or bowls. Repeat this for a second set, with the sets on each of two tables. With children in two lines, provide each runner with a dampened cotton ball. The runner must run to the team table, dip the cotton ball into the first dish, then the next and, finally, the third dish. Then s/he should attempt to shake off the powder into the last empty dish before discarding the cotton ball. The next person in line should be given a damp cotton ball while waiting, only to be tagged by the preceding runner to start the process over again. The 'winning' team has the most pollen in the discard dish.



## PART 3: EROSION SIGNS AND SOLUTIONS

Soil (a.k.a. dirt) is made up of rocks, minerals and organic matter. It is home to many living creatures that live on or in it. Soil helps plant to survive by anchoring them in place and holding water and nutrients that are absorbed by the plants and help them grow. Often we see areas where rain has washed a top layer of soil downhill. This process of wearing away the soil is called erosion. Wind, water and ice can slowly shape the land by eroding rock, sand and soil and depositing it elsewhere, such as in nearby waterways. Soil erosion control methods include plantings, mulching, cover crops, buffer strips and contour plowing.

1. In the classroom, pour regular soil (rather than potting soil) into two aluminum baking trays. Approximately two weeks ahead of the time you will want to undertake this unit, plant rye grass in one of the trays. Or obtain sod with its matted roots.\*
2. Outdoors, ask students what the plants are growing in. What benefits do they think that plants get from soil? Investigate the garden soil. Provide small groups of children with a clipboard and blank white paper, along with a hand lens and spoon. Ask them to pour a couple of spoonfuls of soil onto their paper (for contrast) and examine its contents. Are there pieces of rock? Roots? Other parts of plants? Perhaps there is even a small creature; soil is a lively place! If there is a log near the garden or in the school yard, sow bugs might be found under it, along with ants and spiders.
3. Look for signs of soil erosion in the school yard. Ask children how they suppose the soil was carried away. Why does it matter? Did the shape of the land change at all?
4. \*In the classroom, ask students to make predictions about what will happen to the soil in each tray when water is poured onto them to simulate rain. With the trays side by side, create a slope for each by propping them up 2 - 3 inches at the far ends. Set up collection bins beneath each tray. Using a watering can, pour equal amounts of water from the same heights, for about 30 seconds each, at the raised ends of the trays. Connect this activity to the signs of erosion they may have seen outdoors. How much runoff is in each collection bin? Does one have more soil than the other? Ask students why less soil was in the runoff from the tray with rye grass. Plants play an integral role in retaining soil and soaking up water. This is good for gardens and farmlands.
5. Pair up students and present them with a problem: how to keep soil from running down a hillside. What are some ideas they have to control erosion? How might they plant crops on sloping land? Are there barriers that might keep soil from running downhill to a waterway? Ask students to share and defend their ideas with the class.
6. Host a Certified Professional in Erosion and Sediment Control (CPESC), landscape architect or landscaper to talk with the class about design solutions to control erosion.





## Grade 3

### Let's Join Together Now

RI Model Science Curriculum (RIMSC) Unit of Study: **4 – Traits; 6 – Organisms and Environments**

Timeframe: **Fall, Spring**

Next Generation Science Standards: **Inheritance and Variation of Traits: Life Cycles and Traits: 3-LS2-1.** Construct an argument that some animals form groups that help members survive; SEP: Engaging in argument from evidence; DCI – LS2.D: Social interactions and group behavior; CC – Cause and effect; **3-LS3-1.** Analyze and interpret data to provide evidence that plants and animals have traits inherited from parents and that variation of these traits exists in a group of similar organisms; SEP – Analyzing and interpreting data; DCI – LS3.A: Inheritance of traits; LS3.B: Variation of traits; CC – Patterns; **3-LS3-2.** Use evidence to support the explanation that traits can be influenced by the environment; SEP – Constructing explanations and designing solutions; DCI – LS3.A: Inheritance of traits; LS3.B: Variation of traits; CC – Cause and effect; **3-LS4-4.** Make a claim about the merit of a solution to a problem caused when the environment changes and the types of plants and animals that live there may change; SEP – Engaging in Argument from Evidence; DCI – LS2.c: Ecosystem dynamics, functioning and resilience; LS4.D: Biodiversity and humans; CC – Systems and System models

#### LEARNING OBJECTIVES

Students should be able to:

- Explain teamwork and why being part of a group can be helpful; how being in a group helps animals obtain food, defend themselves and cope with changes
- Describe how plants and animals have inherited traits, making them similar and unique to others in their groups, and that environmental factors can impact traits
- Describe how some plants and animals adapt to their environments and survive well; while others survive less well or not at all



#### BACKGROUND

“Birds of a feather flock together.” There are many benefits of animals being together in a group, such as avoiding a predator (e.g., a falcon chasing birds), hunting prey (e.g., a pack of wolves) and raising young (e.g., female lions in a pride). A large group, like a school of fish or herd of wildebeests, is safer together against predators. “Many hands also make light work.” When we work together, each individual contributes time, effort, knowledge and skill. In a bee colony, as in an ant colony, there are very specific roles that individuals play to help the colony function efficiently and effectively. Honeybees form a colony, each with its own bee hive. They are part of a very structured society that includes the queen bee, female worker bees and male drones. Each group has their own role to play that incorporates specific tasks. The queen bee is the largest in the colony and the only female with fully developed ovaries so that she produces many eggs. The others in the group support the queen bee. Worker bees care for the queen. They visit the flowers and make honey, keep the hive clean, tend to the young and perform other tasks. The drones mate with the queen to maintain and build the population of bees. Native southern New England flowers are appealing to native bees.



# Grade 3

## LESSONS

### PART 1: TEAMWORK!

1. Outdoors, provide small groups of eight students with 5m ropes. Have them stand in a circle evenly spaced, holding the rope over hand. Explain that they are to work together to ‘square the circle.’ To do this, each person takes a turn, asking someone to move forward, backward, to the right or left in order to shape the circle of rope into a square.
2. Discuss how well the group communicated. What were some challenges and what did they learn from them?
3. To survive in a group, individuals must communicate. To do this, honeybees dance! Visit [www.browningshoney.com/wp-content/uploads/2013/02/honey-files-a-bees-life.pdf](http://www.browningshoney.com/wp-content/uploads/2013/02/honey-files-a-bees-life.pdf) (pages 26 & 27) to engage your students in fun, non-verbally communicated bee dances!
4. Visit the school garden and ask students to observe how bees work. Do they appear to prefer certain types of flowers? Daisies, black-eyed Susans, marigolds, dandelion, clover and sunflowers may be favorites. Honeybees tend to like simple, showy and sweet-smelling flowers, especially those with petals of yellow or blue.

Just as we have similar physical qualities to our parents and siblings, other organisms have distinguishing characteristics that come from their parents. These genetically-inherited traits make each individual unique. This is why all family members don’t look alike. Different organisms vary in how they look (observable traits) and function (functional traits) because they have differently inherited information. Plant functional traits include seed size (few and robust vs. many with greater dispersal); leaf area (for light capture); and wood density and toughness (for protection from pests).

The environment in which organisms live can also affect their traits. Plants are affected by the environment at each stage of growth. Plants that might otherwise grow tall will have stunted growth if there is insufficient water. Plant height changes when growing in a space with limited light. Temperature, nutrients and atmosphere (including pollutants) are other factors that affect plant productivity. Grazers impact vegetation that also changes the land through reduced vegetative cover, the consequences of which can be increased runoff and erosion.

### PART 2: EYES ON ME

1. Invite students to stand in a circle facing each other. Ask them to observe and compare observable traits of other students. Examples include: eye color, freckles, curly or straight hair, dimples (presence or absence), earlobes (attached or unattached). Create a ‘sticky note bar graph’ on the board, comparing traits with the number of students. List traits across the board and ask students to place sticky notes above each trait they have. Discuss the results.
2. Show students various images of animals to compare and contrast observable traits such as eyes, ears, noses, mouths and feet.



## Grade 3

### PART 3: PLANTED TRAITS

1. Move to the garden where students can look for plants that are the same species. Are there variations in their appearance? With clipboards, paper and colored pencils, draw two or three plants of the same kind, using arrows to point out specific differences. Ask students to describe patterns (similarities and differences) they see.
2. In the garden or classroom, undertake an experiment where one different environmental factor is altered on each of several plants of the same species. For experimentation in the garden, select three flowers, such as daisies. Leave one daisy, the 'control variable' alone. Place a dark cloth over the second daisy that permits only diffuse light while enabling rain to penetrate. For a third daisy, increase the amount of water it receives with provision of one liter of water each morning. Students should track and analyze the results after a few weeks to see how these daisies might have characteristics that are different and possibly related to the environmental alterations. Ask students what they notice. Are there other changes in the environment that can affect how the plants grow? Encourage students to use evidence to support short responses.

### PART 4: CONTRIBUTION OF SOLUTIONS

A plant that is unwanted by humans in a particular area, such as a lawn or garden, is often referred to as a weed. This is a subjective matter. For instance, while some consider the dandelion to be a weed, others favor it as one of the first flowers of spring for bees. Elsewhere, dandelions are favored as a leaf vegetable or used in herbal medicine. Like other plants, weeds generally do well in gardens. However, a garden that is overrun with weeds transforms the space, often through overcrowding and displacement. Some plants such as vines crawl up plant stalks, using them to their advantage.

1. Present the scenario of a garden into which weeds have taken over (showing images) and ask students if they think this is a problem and, if so, how? Prompt them to consider parts of the problem (e.g., competition for space and light; populations of some species may decrease).
2. Print out Common Garden Weeds Identification Sheets (<http://web.uri.edu/sgi/files/Toolkit-for-RI-School-Gardens-1.pdf>) and provide to pairs of students. Visit the school garden to investigate the presence of weeds. Seek qualitative responses (few, many) on the amount of weeds found in the garden.
3. Provide students with tools and ask them to consider their uses and come up with solutions to tackling the garden weeds (e.g., hand-removal, cutting back weeds). Ask students to think about how well they address the problem, expressing claims about the merit of each solution.
4. Mention that just as honey bees communicate and work together, they can do the same to remove weeds in the garden if needed. Invite students to refer to the Common Garden Weeds ID sheets to identify and mark which plants to remove. They can mark these by putting popsicle sticks in the soil next to them. Many hands make light work! Repeat on a bi-weekly basis.



## Grade 4

### Structure Support

RI Model Science Curriculum (RIMSC) Unit of Study: **3 – Structures and function; 4 – How organisms process information**

Timeframe: **Fall, Spring**

Next Generation Science Standards: **Structure, Function, and Information Processing: 4-LS1-1.** Construct an argument that plants and animals have internal and external structures that function to support survival, growth, behavior and reproduction; SEP – Engaging in argument from evidence; DCI – LS1.A: Structure and function; CC – Systems and system models; **4-LS1-2.** Use a model to describe that animals receive different types of information through their senses, process the information in their brain, and respond to the information in different ways; SSEP: Developing and using models; DCI: LS1.D: Information processing; CC: Systems and System Models

#### LEARNING OBJECTIVES

Students should be able to:

- Identify parts and several key characteristics of plants
- Provide examples of internal and external structures of plants and animals and how they function
- Learn how to make a use and dichotomous key to identify garden plants
- Demonstrate knowledge of how several plant and animal structures support survival, growth, behavior and reproduction



#### BACKGROUND

Trees, shrubs, grasses, ferns, mosses, herbs, flowers, and more – these comprise organisms in the biological Kingdom Plantae. Plants are living organisms with systems of structures and processes. They have several key characteristics. For example, they are multicellular with a structural layer, cell walls, made of a specialized sugar called cellulose. Cell walls protect the cells and help plants maintain shape and grow tall. Plants are known as producers because they produce their own food through a process of photosynthesis, and have a green pigment known as chlorophyll. This enables the plant to convert the sun's energy into food that is stored as starch. Plants produce either seeds or spores to reproduce. They are immobile organisms, generally rooted in the ground or in fresh (aquatic) or salt (marine) water. A tool often used to identify plants is the dichotomous key. This type of guide branches into two choices, offering a relatively easy path to identification that requires attention to detail (See also Grade 1 in [School Garden Science](#)).

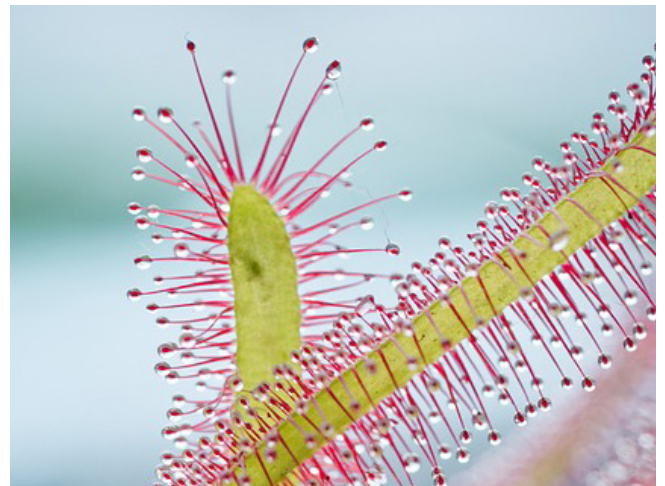




## LESSONS

### PART 1: GROWING UP GREEN

1. Bring students outdoors to look at the plants in the garden and describe the macroscopic external structures of plants. Invite discussion of how structures such as colored petals, thorns and other features help plants survive and reproduce. Discuss how insects depend on pollen and nectar as food for adults or young. How might insects' and other pollinators' mouthparts differ, depending on different types of flowers they select? Encourage students to construct arguments with evidence from their garden observations.
2. Draw a picture of a flowering plant on the board and ask students to label the parts. Discuss the functions of each part, such as how roots help a plant survive and grow by anchoring the plant and taking up water and nutrients.

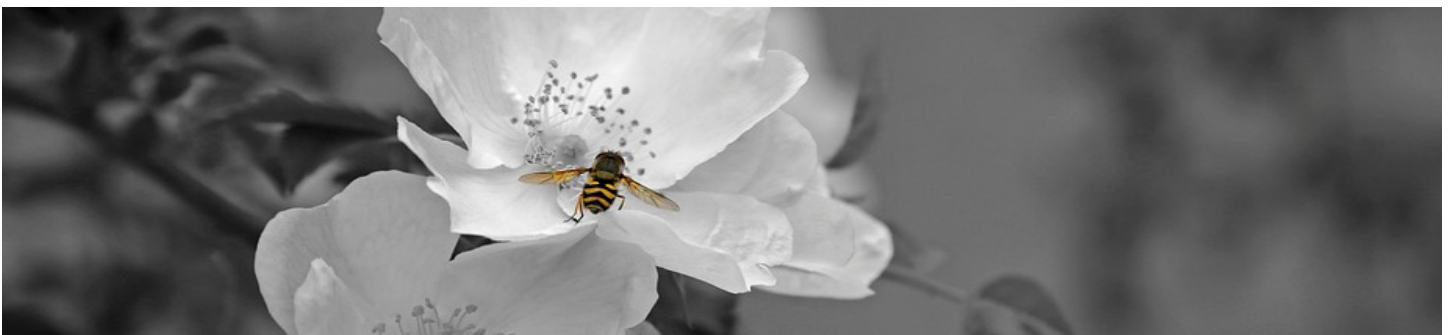




## PART 2: PART OF THE PROCESS

How do we process information? Very generally, processing can start with a stimulus, or ‘input,’ that triggers our sense receptors and is analyzed and stored in our brains. Our brains build on memories and perceptions, guiding our responses that are either reflexive or learned. Specialized anatomical structures help humans and other animals make sense of our world. Humans have specialized sensory nerve cells, such as taste buds and sense organs like our noses to detect, and respond to, chemicals in our environment. Chemoreceptors are abundant on some organisms, such as the butterfly. It has specialized chemoreceptors all over its body. They can experience the sense of smell through their antennae and feet. Female butterflies have spines on their legs that pierce leaves, releasing the plant juice. This helps them to select plants on which they depend. Some animals can even detect different types of energy in the environment. For example, honeybee workers have iron granules in their abdomens. This enables them to detect the Earth’s magnetic field. This magnetic sensing is useful for navigation. Insects’ ability to view ultraviolet light, typically invisible to humans, guides them to the ‘target’ in the center of flowers to obtain pollen and nectar.

1. Provide a sensory test! Ask students to put their heads on folded arms on the desks. Play a sound with your cell phone (e.g., a car starting, bicycle bell) or make a sound in the classroom (e.g., quietly shutting the door, writing on the blackboard, opening the window). Ask students to lift their heads and share their interpretations of the sound.
2. Invite pairs of students to spread out around the classroom and observe each other for a moment to remember how they appear. Next, ask them to stand with their backs turned from one another. Each person should change one thing (e.g., ponytail from the back to the side, eyeglasses taken off, an untied shoe). When everyone is done changing something, invite all to turn around and practice their observational skills to decipher what has changed.
3. After resuming their seats, ask students how animals use their senses and how this is connected to survival. Show a brief video of a red fox hunting mice deep beneath the snow in North America: <https://www.youtube.com/watch?v=D2SoGHFM18I>. Ask that each student discuss the video with the student next to them. How did the red fox find the mice that were deep beneath the snow? What features and skills does the fox have to help it locate mice? What are some challenges it experienced?
4. Present examples of how animals see color. (Visit: <https://www.colormatters.com/color-matters-for-kids/how-animals-see-color>). Show images obtained through the Internet that demonstrate how insects see a broader spectrum of light that includes ultraviolet light.
5. Provide paper and colored pencils to students to produce drawings that describe ways that insects receive, process and respond to information about plants.





## Grade 5

### All That Matters

RI Model Science Curriculum (RIMSC) Unit of Study: **3 – Energy and matter in ecosystems; 5 – Earth systems**

Timeframe: **Fall, Winter, Spring**

Next Generation Science Standards: **Matter and Energy in Organisms and Ecosystems**

**5-LS1-1.** Support an argument that plants get the materials they need for growth chiefly from air and water; SEP – Developing and using models; DCI – LS2.A: Interdependent relationships in ecosystems; LS2.B: Cycles of matter and energy transfer in ecosystems; CC: Systems and system models; **5-LS2-1.** Develop a model to describe the movement of matter among plants, animals, decomposers and the environment; SEP – Developing and using models; DCI – LS2.A: Interdependent relationships in ecosystems; LS2.B: Cycles of matter and energy transfer in ecosystems; CC – Systems and system models; **5-PS3-1.** Use models to describe that energy in animals' food (used for body repair, growth, motion and to maintain body warmth) was once energy from the sun; SEP - Developing and using models; DCI - PS3.D: Energy in chemical processes and everyday life; LS1.C: Organization for matter and energy flow in organisms

#### LEARNING OBJECTIVES

Students should be able to:

- Construct an argument that plants acquire what they need for growth and survival chiefly from the sun, water and air
- Describe feeding relationships in food chains, webs and an ecological pyramid
- Display an understanding of the movement of matter among plants, animals and the environment through creation of models



#### BACKGROUND

Plants depend on sunlight, water and carbon dioxide to survive. Plants obtain energy from the sun (through stomata in their leaves) that is needed for growth and cellular respiration. They convert the sun's energy to chemical energy used in living systems through the process of photosynthesis. For more on photosynthesis in plants, visit: <http://photosynthesiseducation.com/photosynthesis-for-kids/>. Plants are called autotrophs or producers because of their ability to make their own food. These producers form the base of the ecological pyramid (also called an energy or food pyramid), a graphic representation of energy transfer between the trophic levels in an ecosystem. Primary consumers (herbivores) feed on plants and, in turn, are fed upon by predators comprised of secondary and tertiary consumers (carnivores). The last of the trophic levels is comprised of decomposers (e.g., bacteria, fungi) that break down dead organisms through decomposition and detritivores (e.g., worms, millipedes, slugs) that break down dead and decaying plant and animal material (i.e., detritus). With the aid of these organisms, matter is recycled back to the soil. Energy is transferred when one organism is eaten by another in a food chain; however, this flow of energy decreases as it moves through the ecosystem. Only 10% of the energy is transferred from one trophic level to the next. The rest of the energy is used as metabolic heat and for processes such as respiration, movement, growth and reproduction. With less energy available at each trophic level, fewer organisms can be supported (thus the pyramid shape). Another graphic representation of what-eats-what is the food web, comprised of individual food chains that show the feeding relationships of organisms in an ecosystem.



# Grade 5

## LESSONS

### PART 1: WATER WORLD

1. Examine plants in the garden and ask students to think about and share what plants need for growth and survival. How do plants obtain what they need? Emphasize that plants need sunlight.
2. Invite ideas on how to test whether or not plants can grow without soil. Pursue viable ideas and, together, craft a class experiment, remembering to include a 'control' in the experiment. For example, planting 'like plants' in soil or in water only. Plants that grow well in water include houseplants such as pothos, philodendron, spider plants, coleus and English ivy. Better yet, choose plants that can be planted in the garden once they are rooted, such as herbs. Choices include mint, oregano, basil, rosemary, lavender and sage.
3. Create a data recording sheet for students to keep track of plant type and growth. Discuss results. Share the structure of lab reports and provide time for in-class lab report-writing.



### PART 2: DINING OUT

1. Visit the school garden to see and list the types of organisms resting on plants, flying amongst them, walking or hopping on, or wriggling through the soil.
2. In the classroom, assign students to work at computers to undertake an on-line investigation of the organisms they saw, to find out what-eats-what. Discuss energy transfer from one trophic level to the next. Provide students with materials to create two complete food chain models that include the sun. For example, monarch butterflies feed on a wide range of flowers; while a monarch caterpillar eats only milkweed plants. Spiders and ants attack young monarch larvae; and the adult monarch butterflies are preyed upon by birds, wasps and mice. With a bit more research, the food chain models can be connected. As a class, ask students to try to transform some of the food chains into a food web. The mouse that fed on the butterfly, for instance, eats other insects, seeds, berries and nuts. It may then be eaten by a hawk!

If computer access or time is limited, print out pictures of a sun, plants, and organisms similar to those seen in the garden along with other images that help to demonstrate several food chains. Cut out paper arrows. Randomly place the images and arrows on tables and encourage students to think about energy flow, sorting the images and placing them in order with arrows (e.g., sun → carrot → rabbit → fox). Together, identify limitations of models.

3. Provide students with materials to develop and present models showing that energy obtained by animals through their food (e.g., for growth, motion) began as energy from the sun, demonstrating the flow of energy in organisms.



## Grade 5

### PART 3: WORMS RECYCLE!

1. Refer to the guide, [How to Compost with Worms \(http://web.uri.edu/ceoc/files/Composting-with-Worms.pdf\)](http://web.uri.edu/ceoc/files/Composting-with-Worms.pdf), purchase red wiggler worms and set up a worm bin. This is referred to as vermicomposting. Note: You may need to obtain permission to have a bin in the classroom. It is best to set it up in the fall to harvest worm castings in 3-5 months. Be sure to label the bin so that it is not mistaken for trash.
2. What are red wigglers and how do they eat and process food? Introduce students to the worms by passing around a couple. Ask students to cup their hands and, when passing to the next person, create a 'trap door' that drops the worm in their hands. Note: Wash hands after holding the worms.
3. Invite students to contribute fresh fruit and vegetable scraps to the bin. Keep a classroom log of the date, material and amount of material (qualitative or quantitative) that goes into the bin.
4. Introduce the concept of biodegradation and the process of composting or turning decayed organic material into a soil amendment that acts like a plant fertilizer. Identify materials that can be composted (e.g., apple cores, coffee grounds) and those that should not be included (e.g., meat, oil).
5. Maintain the bin with assistance from students. Designate several 'Wiggler Aunties and Uncles' to check on the bins every couple of weeks to ensure its environment is moist but not wet, etc.
6. Ask students to investigate the bin. Hand lenses and sieves can be used for further investigation.
7. In the spring, bring the worm castings to the garden and invite students to mix it into the garden soil.

**Lesson alternative to vermicompost:** Provide students with materials (e.g., food remains such as fruit peels and bread, paper, wood, polystyrene or other plastic, aluminum foil) for them to consider and sort into two groups, predicting if the materials are biodegradable or non-biodegradable and why. Invite students to bury their materials in a bin with soil, checking progress for several weeks, tracking changes with qualitative descriptions of materials. What did the students discover? Invite them to share their findings and conclusions. Explain the difference between organic and inorganic materials. Share the books [Rot and Decay: Decomposing and Recycling](#) by Sarah Leveté (LIFESCIENCE) and [Compost Stew](#) by Mary McKenna Siddals.





## Grade 6

### It's a Game of Survivor

RI Model Science Curriculum (RIMSC) Unit of Study: 1 – Growth and development of organisms; 2 – Ecosystems

Timeframe: **Fall, Spring**

Next Generation Science Standards: **Growth, Development, and Reproduction of Organisms**

**MS-LS1-4.** Use argument based on empirical evidence and scientific reasoning to support an explanation for how characteristic animal behaviors and specialized plant structures affect the probability of successful reproduction of animals and plants respectively; SEP – Engaging in argument from evidence; DCI - LS1.B: Growth and development of organisms; CC – Cause and effect.; **Matter and Energy in Organisms and Ecosystems:**

**MS-LS2-1.** Analyze and interpret data to provide evidence for the effects of resource availability on organisms and populations of organisms in an ecosystem; SEP – Analyzing and interpreting data; DCI – LS2.A: Interdependent relationships in ecosystems; CC – Cause and effect.; **See also Grade 5: MS-LS2-3.** Develop a model to describe the cycling of matter and flow of energy among living and nonliving parts of an ecosystem; SEP – Developing and using models; DCI – LS2.B: Cycle of matter and energy transfer in ecosystems; CC– Energy and Matter.

#### LEARNING OBJECTIVES

Students should be able to:

- Understand how the environment and genetic factors determine the growth of an organism
- Display an understanding, and develop an argument, about how successful plant reproduction depends on cooperative animal behaviors and plant structures
- Produce a model that highlights plant characteristics to attract pollinators
- Explain interdependent relationships in an ecosystem including biotic and abiotic factors



#### BACKGROUND

Animals play a pivotal role in the reproduction of many kinds of plants. The probability of plant reproduction frequently depends upon animals transferring pollen or seeds, as when bees visit flowers for nectar and pollen adheres to their bodies or when seeds are carried to a new location for seed germination and growth, thanks to “hitch-hiking” a ride, attached to an animal’s fur (e.g., burrs). An advertisement has specific meaning in the consumer market world, traditionally attracting customers with paid announcements of goods for sale. In nature plants also advertise; however the goal is to attract pollinators so that plants can reproduce and survive. They generally do this with strong visual or scent (odor) appeal in addition to structural accommodations.



## LESSONS

### PART 1: NATURALLY APPEALING ADS

1. Visit the garden with students to view pollinators in action. Invite observation-sharing amongst students.
2. In the classroom, provide students with selected advertisements from magazines. What is being advertised? What is the advertiser trying to persuade the reader to do? In addition to discerning the purpose of the advertisement, invite students to consider the selection of images, color, positioning and appeal. Who is the target audience? Leave the advertisements on the desks.
3. Share several images of flowers such as lilies, columbine and black-eyed Susan and ask students to create flower advertisements for pollinators. For example, bees and butterflies like lilies while columbine is preferred by bees and birds (e.g., hummingbirds).
4. Ask students to think about and discuss the ways in which some garden flowers and their pollinators are a good match.
5. Supply student partners with colored pencils, paper and printed images of several kinds of flowers that are in the garden. Ask them to select a “target audience” (e.g., bees, birds) and create an advertisement to sell the flower as an appealing choice.
6. Invite students to post their ad creations around the classroom. Round #1, one of the partners rotates through the ad postings to hear a bit about each ad. Then in Round #2, the partners circulate to hear the stories behind the ads.
7. Ask students to share some highlights from their ad viewings. Which would appeal most to you as a bee? Butterfly?
8. Why is it so important for plants to attract pollinators? Ask students to develop arguments based on science and evidence to support claims about why some plants are more successful than others.
9. What would happen if populations of pollinators decreased? Consider honeybee Colony Collapse Disorder (CCD) when the majority of worker bees in the colony disappear. See: <https://www.epa.gov/pollinator-protection/colony-collapse-disorder>.





## PART 2: INTERWOVEN RELATIONSHIPS

An ecosystem is comprised of living organisms (biotic factors) and their physical or non-living environment (abiotic factors). Plants, animals and microorganisms interact with one another and with soil, rocks, minerals, water sources and the atmosphere within the system. Food webs exemplify interdependent relationships related to growth and survival in an ecosystem. This world of what-eats-what is an important part of the system as well, because it keeps organisms “in check” so that one population does not expand to the point that it dominates and throws the system out of balance. There is competition between organisms for food, water, oxygen or other resources in an ecosystem. Because resources are limited, the growth, reproduction and survival of organisms can be impacted, thus limiting populations.

1. Standing along the edges of the garden, ask students what organisms there need to live, grow, reproduce and survive. What might limit their capability to survive? Discuss competition for resources, such as when one plant type crowds out another. Why is water so important? What role do worms play in the soil?
2. Acquire four different colored balls of yarn and laminated photos of organisms as described below.
3. Bring students into the school yard. Discuss food chains and webs. Show a laminated photo of a red fox and share some of its natural history. The red fox is an omnivore, eating what is available, whether plant or animal. In the summer its varied diet includes berries, caterpillars, beetles, acorns and apples. In the winter, its diet includes rabbits, squirrels and other mammals.
4. Ask students to sit in a tight circle to display food chains and webs. Distribute laminated pictures (spacing out distribution) of several food chains related to the red fox: (food chain 1) acorn → Eastern gray squirrel → red fox; (food chain 2) grass and clover → grasshopper → bird (e.g., cardinal, bluebird, swallow) → red fox; (food chain 3) grass and clover → Eastern cottontail rabbit → red fox; (food chain 4) seeds → mouse → red fox → coyote.
5. Invite a student into the middle of the circle to hold up a laminated card of the sun, the source of energy and from which energy for living things flows. Provide this student with the end of the ball of yarn.
6. Ask the other students to hold up their cards for all to see and seek responses on where the center person should toss the yarn (still holding the end) (e.g., next to the acorn). Continue the process to complete food chain 1.
7. Provide the center person with the end of a different color ball of yarn and proceed with food chain 2.
8. Using the last ball of yarn, complete food chain 3. Viewing the web in the circle, talk further about the food relationships of animals and plants.
9. What happens if the red fox population declines (e.g., due to disease, hunting)? This could affect the rabbit and mouse populations which would increase. How might that affect other natural resources? Would the school garden experience changes from an increase in rabbits and mice?
10. If possible, show students the YouTube video, “How wolves change rivers”\* to demonstrate how ecosystems change when a top predator is removed, or in this case, is reintroduced.\*(<https://www.youtube.com/watch?v=ysa5OBhXz-Q>)





## Grade 7

### From One Generation to Another

RI Model Science Curriculum (RIMSC) Unit of Study: 4 – Structure and function; 6 – Inheritance and variation of traits

Timeframe: **Fall, Winter, Spring**

Next Generation Science Standards: **Structure, Function, and Information Processing: MS-LS1-1.** Conduct an investigation to provide evidence that living things are made of cells; either one cell or many different numbers and types of cells; SEP – Planning and carrying out investigations; DCI – LS1.A: Structure and function; CC – Scale, proportion and quantity; **Growth, Development, and Reproduction of Organisms: MS-LS3-2.** Develop and use a model to describe why asexual reproduction results in offspring with identical genetic information and sexual reproduction results in offspring with genetic variation; SEP – Developing and using models; DCI – LS1.B: Growth and development of organisms; LS3.A: Inheritance of traits; LS3.B: Variation of traits; CC – Cause and effect

#### LEARNING OBJECTIVES

Students should be able to:

- Understand that living things are made up of cells; plants and animals have many kinds of cells
- Define chromosomes and genes and the connections between them
- Provide examples of genetic factors that determine the growth and differences in functioning of organisms
- Explain how living organisms pass traits from one generation to the next



#### BACKGROUND

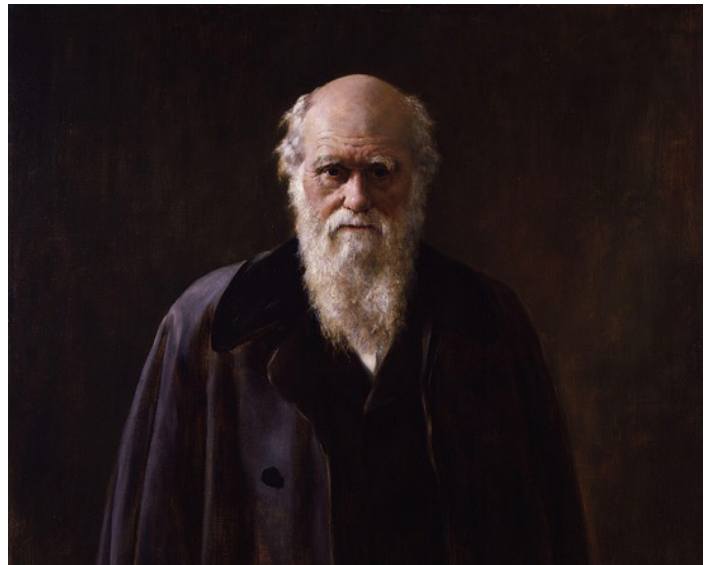
A cell is the smallest, microscopic biological, structural and functional unit of an organism. Cells are the “building blocks” of living things. Groups of cells make up tissues, organs and organ systems. While organisms are generally multicellular, some such as amoebas and bacteria are unicellular. Plants and animal cells contain similar structures. Plants also have cell walls that give plants structure and chloroplasts that help plants photosynthesize. A chromosome is a thread-like structure of nucleic acids (DNA and RNA) and protein found in the nucleus of plant and animal cells, carrying genetic information in the form of genes. A gene is a basic physical and functional unit of heredity (i.e., the instructions for a particular protein or function to build living cells), passed from parent to offspring. This part of the cell affects the appearance, growth and other distinguishing characteristics or traits of organisms. As we can see when we look at living creatures, genes are different between species and within species. Each gene is situated in a specific location on a chromosome. Each parent passes along one allele (different form of a gene) in sexual reproduction. Organisms thus have two alleles for a single, inherited trait. Differences between individuals also occur as a result when a developing organism is exposed to environmental factors during its life history.



## Grade 7

### BACKGROUND - CONTINUED

Genetic variation is fundamentally the result of mutations, the change in genes (DNA sequence), in a population and between populations. Changes to genes can result in changes to proteins, which can affect the structures and functions of the organism and thereby change traits. This variation is important because it results in diversity within and between populations, ultimately affecting natural selection. This is a process where some organisms are better adapted to the environment than others, enabling them to survive and reproduce, passing along genetic qualities. Gradual change in genetic composition comes with successive generations – the process of evolution as originally described by Charles Darwin.



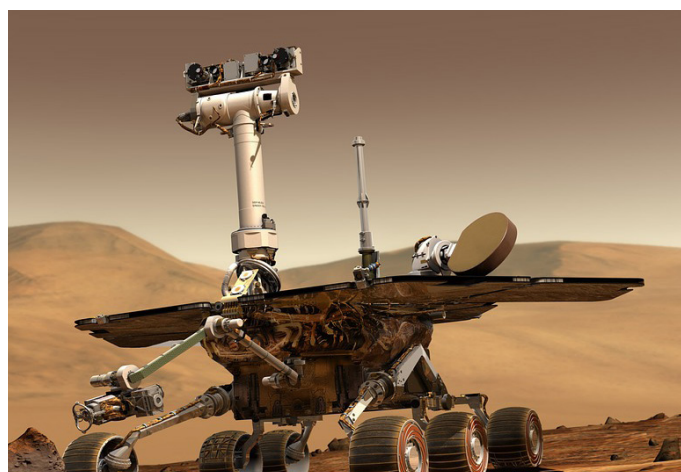
### LESSONS

#### PART 1: LIFE'S BUILDING BLOCKS

1. Provide student partners with clipboards, pencils and paper and go into the garden. Ask students to fold their papers in half lengthwise and then unfold. In the left column, they can write 'Living' and in the right column 'Non-living.' Invite them to list at least a half dozen things they see in the garden in each column. How can they determine if something is living (e.g., cellular structure; growth, development and reproduction; response to stimuli; use of energy - metabolism)? Ask students for examples, defending their statements with evidence.
2. Discuss what cells are and how they function. If available, provide slides of plant and animal cells to student partners to look at under microscopes. Ask students to observe and record what they see. What are some cell similarities and differences? Give partners some plant specimens from the garden and/or a piece of onion skin or a thin leaf of elodea\* to view under the scope. Cell walls and chloroplasts can be seen, the latter of which may even be moving due to cytoplasmic streaming around the nucleus. Note: Students may need help with microscopy skills.  
\*A freshwater plant that can be obtained at an aquarium supply store.
3. Next, discuss the structure and functions of the plant cell membrane and cell wall. Pass around celery sticks (with the ends freshly cut) and hand lenses so that students can see cross sections. In addition to vascular bundles containing xylem and phloem, celery has collenchyma tissue that helps to support the plant when the cells fill with water and the pressure on the cell walls that makes the celery stalks rigid. To further demonstrate the correlation between water and stalk stiffness, have half of the student pairs return their celery sticks to a container without water and the other half return them to a container with water. Invite students to compare the two samples the next morning.

## PART 2: THE EYES HAVE IT

1. In advance of this lesson, purchase certified seed potatoes. Note: Store-bought potatoes may be treated with a chemical to prevent them from sprouting.
2. Pass around potatoes. Ask students what part of the plant a potato is (tubers) and how they think potatoes grow and reproduce. Provide students with containers of soil to plant these “seed potatoes” in soil, being sure to include two or more sprouted eyes in each piece of planted potato.
3. Store some of the remaining potatoes in indirect sunlight, preferably in a slightly moist burlap bag to avoid having them dry out. They should be stored at least at 50 to 60 degrees F. When the “eyes” sprout (about 10 days), this is called chitting. These are nodes from which new plants will sprout, demonstrating asexual plant reproduction.
4. Using models and diagrams, show how genetic variation of organisms occurs through sexual and asexual reproduction. While the male and female parents together contribute (gametes through meiosis and the exchange of chromosome pieces) to the genes of offspring through sexual reproduction; in asexual reproduction, genes are passed along by a single parent (i.e., no mating and mixing of genes). This means that the offspring and parent have identical DNA. The only diversity between offspring and adult would be in a mutation in DNA (i.e., a change occurring during mitosis). Thus, natural selection does not apply to asexual reproduction as it does to sexual reproduction. All living things must reproduce for a population to survive. Discuss how sexual and asexual reproduction can both be efficient and effective (e.g., sexual reproduction - diversity and natural selection; asexual - not dependent upon finding a mate; efficient). Adaptations for asexual propagation of plants involves underground plant parts such as roots and modified underground stems (the difference being that the stems have nodes).
5. Consider showing students a video clip of actor Matt Damon attempting to grow potatoes on Mars in the movie, *The Martian*. This can be followed by discussion of actual research whereby NASA is attempting to grow Peruvian potatoes on Mars.



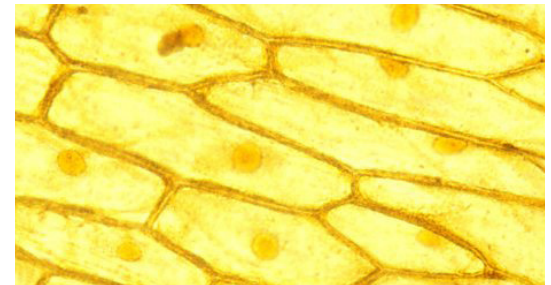
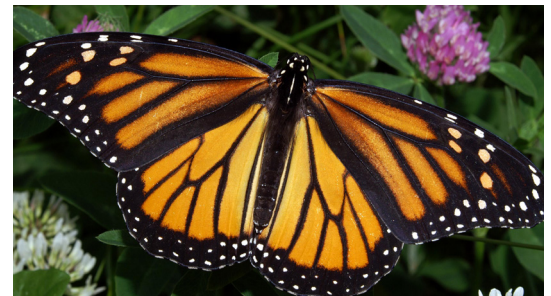


# Grade 7

## PART 3: ABLOOM WITH VARIETY

1. Bring students into the garden with field notebooks or journals and hand lenses, for a close look at flowering plants. Ask them to create detailed diagrams of flowers and to make side notes about their appearance, including structure and function. How do subsystems work together for specialized functioning in the flowering plant? Are there pollinators hovering around, or on, the flowers? Include notes and/or drawings. Watch. Where do they go? Can pollen be seen adhering to bees?
2. Sexual reproduction occurs in flowering plants (angiosperms) through pollination, where pollen is transferred (e.g., by a bee or butterfly) to the stigma of another plant. Self-pollination can also occur when pollen is transferred to the stigmas of the same plant. A useful worksheet on flower structure and reproduction can be found at [https://www.biologycorner.com/worksheets/flower\\_coloring.html](https://www.biologycorner.com/worksheets/flower_coloring.html).
3. In the garden, ask students if individuals of the same species of plant have variations in appearance. If the school garden has native plants, provide a plant guide to help them identify the plants. Native plants have natural defenses against some pests and diseases common to the area. They may have an advantage over other, non-native or introduced plants (e.g., attracting native birds and insects; surviving with normal rainfall). Are there small, developing plants near the parent plants, and can variation be seen in the offspring?
4. Invite responses from the class on what is meant by “native plants.” Native plants in Rhode Island are those species thought to be there prior to European settlement. For elaboration, visit: <http://web.uri.edu/rinativeplants/what-are-native-plants/>.
5. Introduce Punnett squares as a tool to predict offspring traits. See: <https://askabiologist.asu.edu/punnett-squares>.

The screenshot shows the 'RI NATIVE PLANT GUIDE' website. The header includes the title and 'College of the Environment and Life Sciences'. A navigation menu on the left lists 'Search', 'About', 'Glossary', 'Acknowledgements', 'Resources', and 'Contact'. The main content area features a search bar with a dropdown menu set to 'scientific or common name'. Below the search bar are several filter options: Type (T), Exposure, Moisture, Wildlife, Uses, Height, Coastal (CT), and Rhody Native™ (RN). Each filter has a dropdown menu currently set to 'All'. There are 'Search' and 'Clear Filter' buttons at the bottom of the filter section. On the right side of the search area, there is a 'Login' link and a text box explaining that 'Native' species are those believed to have been present in the state prior to European settlement, with a link to 'What are Native Plants?'. The footer of the page includes the 'RHODY NATIVE' logo and the text 'locally sourced | locally grown'.





## Grade 8

### Change Happens

RI Model Science Curriculum (RIMSC) Unit of Study: 2 – Selection and Adaptation; 4 – Human impacts on Earth systems and global climate change

Timeframe: Fall, Spring

Next Generation Science Standards: **Natural Selection and Adaptations: MS-LS4-4.** Construct an explanation based on evidence that describes how genetic variations of traits in a population increase some individuals' probability of surviving and reproducing in a specific environment; SEP –Constructing explanations and designing solutions; DCI – LS4.B: Natural selection; CC –Cause and effect **Growth, Development, and Reproduction of Organisms: MS-LS4-5.** Gather and synthesize information about the technologies that have changed the way humans influence the inheritance of desired traits in organisms; SEP – Obtaining, evaluating and communicating information; DCI – LS4.B: Natural selection; CC – Cause and effect; **Human Impacts MS-ESS3-3.** Apply scientific principles to design a method for monitoring and minimizing a human impact on the environment; SEP –Constructing explanations and designing solutions; DCI – ESS3.C: Human impacts on Earth systems; CC – Cause and effect

#### LEARNING OBJECTIVES

Students should be able to:

- Explain genetic variations in traits and how they influence survival and reproduction
- Communicate how organisms change over time in response to their environment
- Describe how human technology has affected inherited plant traits



#### BACKGROUND

Biological evolution refers to change in a species' heritable characteristics over many, successive generations. Genetic variation is fundamental to evolution. Genetic variation refers to the genetic differences among individual organisms of the same species (e.g., brown beetles and green beetles). Natural selection, which only occurs in nature, is one mechanism by which evolution occurs. When plants and animals are better able to survive in their environments than others due to heritable traits and pass on these genetic characteristics to offspring over generations, evolutionary change occurs. Favored are those organisms with characteristics for greater survival and reproduction. With natural selection, some traits dominate while others are suppressed, as when environmental conditions change. Plant and animal adaptations improve a species' chance of survival in their environment. Adaptations may be physical or behavioral. Physical adaptation in plants refers to structural adaptations and reproductive adaptations. Structural adaptations in plants refer to the way they are "made." For example, a large leaf in a shady space enables the plant to better absorb the sun's energy. Toxins in poison ivy discourage predators from eating the leaves. A reproductive adaptation example is the bright color of flower petals to attract pollinators such as birds and insects, while brightly colored fruits and vegetables attract animals. These animals help to perpetuate populations through pollen and seed dispersal. Some seeds are shaped so that they easily become airborne, permitting them to be distributed by wind (e.g., dandelion, maple tree). A behavioral adaptation refers to the way that an organism acts, such as seedlings leaning toward the sun. Sunflowers track the sun by turning their "faces" toward it, as it moves, throughout the day. This plant behavior is driven by gene expression via an internal clock in the sunflower.



## Grade 8

### LESSONS

#### PART 1: CHOOSEY EATERS

1. Show students a video of a hummingbird visiting a flower. What did they notice about the flower? What did the hummingbird do?
2. Flowering plants have sets of traits (e.g., flower color, scent, nectar) that appeal to specific pollinator types. Bees, hummingbirds and hawk moths are attracted to petunias. Ask students to think about the physical characteristics of a flower that depends upon bees to pollinate it. What attracts the bee? What shape of flower might be necessary for it to acquire nectar and pollen? In addition to the attractive purple flower, a wide floral tube allows the bee to walk in. Hawkmoth characteristics and behaviors are different from the bees. It is a night-time pollinator and has a long proboscis to reach nectar. What traits might this hawkmoth-pollinated flower have?  
The information above was obtained from: Petunia as a model system for the genetics and evolution of pollination syndromes (Gübitz, T., et al, 2009). Teachers are encouraged to view this scholarly research article on-line at [www.flower.enslyon.fr/PetuniaPlatform/monograph\\_files/sample.pdf](http://www.flower.enslyon.fr/PetuniaPlatform/monograph_files/sample.pdf).
3. Share natural history on bees, moths and hummingbirds and the types of flowers they tend to pollinate. Invite students to the school garden to consider which of the flowering plants might attract these pollinator types. What types of plants comprise pollinator gardens?

#### PART 2: AS YOU LIKE

1. Ask the class for a show of hands for those students who have dogs. Ask them to share their dogs' traits. Discuss 'designer dogs!' Humans have bred dogs, such as the English bulldog, for specific desired traits, such as stocky body shape and reduced snout (i.e., flat faced or brachycephalic)) resulting from generations of breeding for these recessive genes. This selective breeding can put dogs at risk for health and behavioral problems. Breathing problems result from the bulldog's flat face. Show images of change due to breeding for 'desirable characteristics:' <http://www.dailymail.co.uk/sciencetech/article-3480780/How-humans-changed-man-s-best-friend-pictures-100-years-breeding-changed-dog-breeds-not-better.html>.
2. Share information with the students about ways that humans have influenced the inheritance of desired traits in organisms through artificial selection. Vegetables that we commonly eat, such as broccoli, cabbage and kale, are also the result of artificial selection. Visit [www.evolution.berkeley.edu/evolibrary/article/evo\\_30](http://www.evolution.berkeley.edu/evolibrary/article/evo_30) for a diagram showing that these vegetables are cultivated from, and evolved from, wild mustard. The modified traits that resulted in kale are the leaves and for broccoli it is the flower buds and stem. The terminal leaf buds of the wild mustard plant were modified to produce cabbage. The mustard family also includes Brussel sprouts, collards, kohlrabi, turnips and watercress. Are any of these in the school garden? Discuss the pros and cons of artificial selection.
3. Introduce the issue of genetically-modified organisms (GMOs), where the genetic material of organisms has been altered. For plants, this genetic engineering was undertaken to increase plant resistance to certain pests and diseases for example. Share articles on the specifics and controversies over GMOs.
4. Ask students to consider how they might construct an experiment to compare GMO and non-GMO plants. Invite them to share their ideas, supported by evidence from articles, in class.
5. Have students research other examples of ways that humans have manipulated genetics and share these findings with the class.



## PART 3: A SOLUTION TO POLLUTION

As we know, human impacts on the land have been great, from depleting soil to polluting water and beyond. One approach to lessening human impact in a garden is to use practices that minimize or eliminate the need for pesticide application. A pesticide is a broad term meant for many types of “pests.” One type of pesticide that people often use is an insecticide to kill insects that are harmful to cultivated plants. Integrated pest management (IPM) is an environmentally-sensitive strategy for pest management in the garden, as well as in agriculture. This is a combined-practice approach where mechanical (e.g., lures and traps), targeted chemical and biological controls (e.g., using natural enemies to the pests) are employed rather than relying on broadcast (often non-specific) chemicals. IPM focuses on managing detrimental insects and pests with the least possible impact on people, property and the environment. It prevents pests from reaching unacceptable levels or reduces existing pest populations to acceptable levels. Techniques can include trapping and using bio-control methods and targeted chemical and biological pesticide applications. Another method to control pests is the use of crop rotation. The physical location of different crops is changed year by year in a planned sequence. With crop rotation, pesticide use may be reduced by naturally breaking the cycles of weeds, insects and diseases.

1. Discuss the traits of beneficial insects. There are pollinators; producers of honey, wax, lacquer and silk; food sources for cultures of the world (entomophagy). Also, insectivores control populations of pest insects. Ask students how ladybugs might be beneficial to plants. They act as biological controls; they eat scale insects and aphids which are sap-sucking insects that are a pest on many plants including agricultural crops.
2. Discuss the traits of “pest” insects. They can destroy products and crops (e.g., termites, locusts, weevils), spread disease (e.g., mosquitoes, flies), and may compete with other beneficial insects.
3. Ask students to define the criteria and constraints of the problem and how they can minimize human impact on the environment.
4. Introduce the concept of organic gardening, where synthetic fertilizers and pesticides are not used. This approach to gardening is meant to support holistic health of the garden. In what ways does organic gardening lessen human impact and build a healthier system?



