Educator Guide

Plant Science Lessons for Grades 3—5

PlantLab

student scientists

GROWING THE FUTURE

Missouri Botanical Garden

Tips for teaching outside of the traditional classroom

Plan Ahead

Decide where you want to go ahead of time and scan the area for potential hazards

Inform parents you plan to take children out on a given day, so that they can dress students for the weather

Set guidelines

When we explore…

We walk, so we can take our time and look around

We talk quietly so we respect animals or birds

We explore the area our teacher invites us to explore

We tell our teacher right away if we see something that frightens us

First time outside

Keep it short!

Taking students outside

Safety first!

Try to have at least two adults on hand when outdoors

Extra outdoor wear clothing on hand

Specific Strategies for Teaching in the Outdoor Classroom

- Teach in outside places that are authentic to the lesson
- Make sure students are comfortable—correct clothing, keep the wind at your back and the sun in your eyes
- Use visuals and a hands-on approach for demonstrations to promote a sense of doing
- Be flexible and look for teachable moments. Participant interests can be sparked by firsthand experiences necessary aspect of experiential learning process.
- Show enthusiasm yourself during the outdoor session (regardless of the weather) and model correct behaviors
- Develop a sense of community for a safe, fun, friendly environment for learning and practicing new skills
- Use simple words and phrases to ensure discussions are not long speeches

Why learn outdoors

- The more students equate the outdoors with learning, the more comfortable they become outdoors and the more in tune and familiar they become with outdoor environments. Students may have an understanding of nature in places around the world, but not in their own backyard or schoolyard. Questions flowing from experience and observation, are at the heart of early science.

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On the Cover:

The Woodland Spiderlily, *Hymenocallis occidentalis*, can primarly be found going throughout the Southeastern United States in moist forests, moist fields, and swamps. This Missouri native plant showcases a large showy and fragment flower with six narrow, outward-spreading segments with a daffodil-like staminal cup. If growing in a garden, spiderlily preferred locations include a naturalized area, pond, or woodland setting with soil that does not dry out in the summer months. The plant will bloom throughout July and August and gardeners can expect the fragment flower to last one day. Attracts butterflies and moths

Missouri Botanical Garden

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The PlantLab Student Scientists curriculum guide for educators was produced as part of Missouri Botanical Garden's commitment to celebrate plants via a hands-on approach designed around national standards. Creation of the PlantLab Student Scientists curriculum guide made possible by contributions from the following organizations:

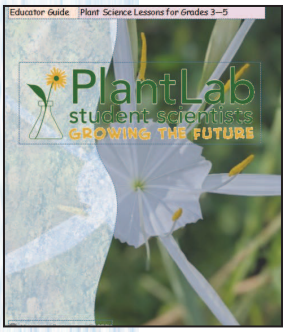
Boeing Corporation, Hertz, International Paper Foundation

More than 150 years ago, Henry Shaw founded Missouri Botanical Garden as a place of beauty and floral display, but also as an institution of scientific research and education. The Missouri Botanical Garden has continued in that tradition and, over time, has come to exemplify the nexus of conservation and quality of life.

Today, the Garden is a National Historic Landmark and a treasured part of the St. Louis community. We are also a critical partner in plant conservation throughout the world. **Our mission is to discover and share knowledge about plants and their environment in order to preserve and enrich life.** Today, our mission has never been more relevant or important. Plant diversity, the world's greatest renewable natural resource, is being lost at an alarming rate, and we must act with the greatest urgency to document and conserve it before it is too late. The Missouri Botanical Garden has recognized and accepted its responsibility to be an effective leader, mentor, advocate, and practitioner of environmental protection at home and throughout the world.

Plants are essential to sustaining the stability and quality of human life on this planet. At the Missouri Botanical Garden, we have dedicated ourselves to helping conserve biological diversity while there is still something left to protect. Our research provides scientific information essential to decision makers, from conservation and land use to social and environmental policy. We have taken the lead in making information widely accessible via the Internet, maintaining the world's largest botanical database and the premier botanical website, TROPICOS

The PlantLab Student Scientists curriculum guide provides standard correlated lessons that offer educators the ability to use plants and plant science techniques into their formal curriculum. PlantLab Student Scientists promotes the use of object based learning has a means to engage students in understating plants and collaborate by discussing plants on a peer level. There is no right or wrong way to use the PlantLab Student Scientists collection of lessons. The guide was created in order to provide educators with resource extensions and can and should be adapted to individual classroom needs



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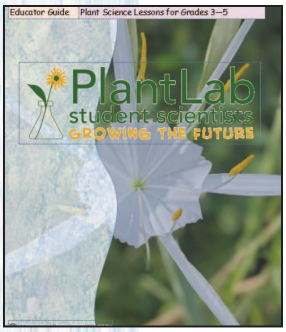

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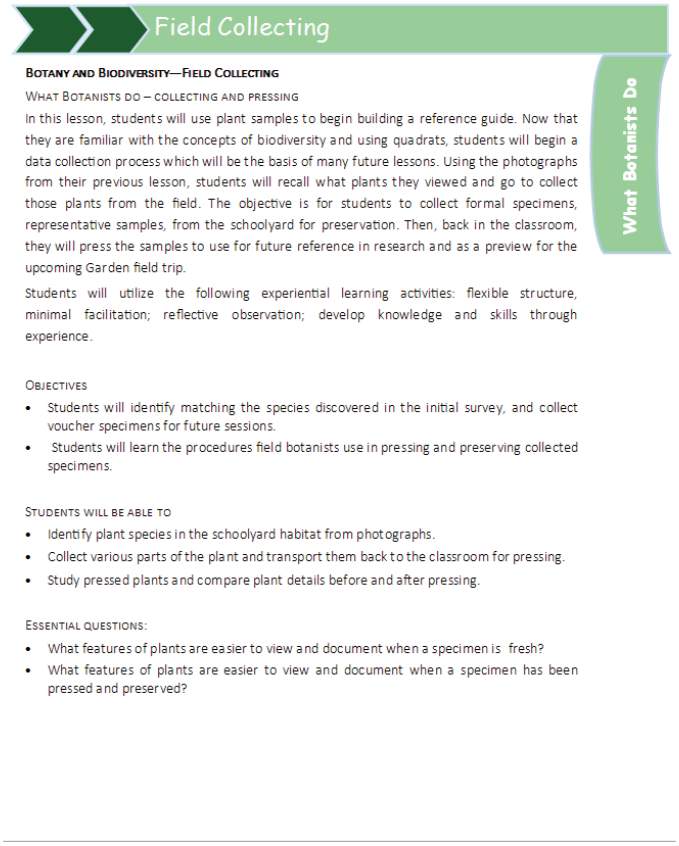
Curriculum Layout

Lesson overview

The PlantLab Student Scientists: Botany and Biodiversity curriculum guide is laid out in a manner to provide the students the opportunity to utilize their schoolyard grounds and the Missouri Botanical Garden to further enhance their experience engaging in plant science.



Field Collecting

What Botanists Do

Botany and Biodiversity—Field Collecting

What Botanists do – collecting and pressing

In this lesson, students will use plant samples to begin building a reference guide. Now that they are familiar with the concepts of biodiversity and using quadrats, students will begin a data collection process which will be the basis of many future lessons. Using the photographs from their previous lesson, students will recall what plants they viewed and go to collect those plants from the field. The objective is for students to collect formal specimens, representative samples, from the schoolyard for preservation. Then, back in the classroom, they will press the samples to use for future reference in research and as a preview for the upcoming Garden field trip.

Students will utilize the following experiential learning activities: flexible structure, minimal facilitation; reflective observation; develop knowledge and skills through experience.

Objectives

- Students will identify matching the species discovered in the initial survey, and collect voucher specimens for future sessions.
- Students will learn the procedures field botanists use in pressing and preserving collected specimens.

Students will be able to

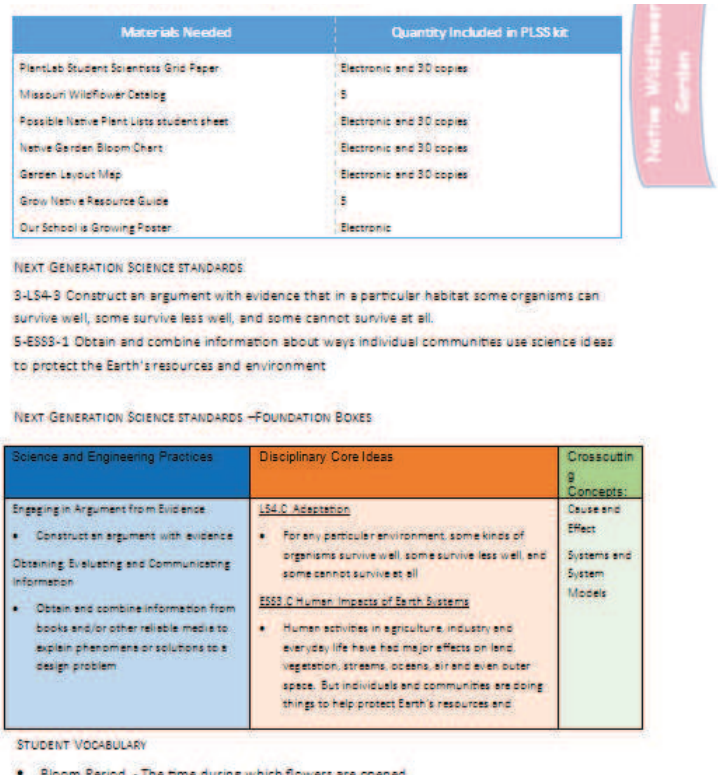
- Identify plant species in the schoolyard habitat from photographs.
- Collect various parts of the plant and transport them back to the classroom for pressing.
- Study pressed plants and compare plant details before and after pressing.

Essential questions:

- What features of plants are easier to view and document when a specimen is fresh?
- What features of plants are easier to view and document when a specimen has been pressed and preserved?

Each PlantLab Student Scientists unit includes the objectives of the lesson, correlates with the Next Generation Science Standards student expectations, and the essential questions students are striving to answer throughout the lesson.

Units also include student vocabulary introduced in the lesson and materials needed to conduct the lesson.



Native Wildflower Garden

Materials Needed	Quantity included in PLSS kit
PlantLab Student Scientists Grid Paper	Electronic and 30 copies
Missouri Wildflower Catalog	5
Possible Native Plant Lists student sheet	Electronic and 30 copies
Native Garden Bloom Chart	Electronic and 30 copies
Garden Layout Map	Electronic and 30 copies
Grow Native Resource Guide	5
Our School is Growing Poster	Electronic

Next Generation Science Standards

3-LS4-3 Construct an argument with evidence that in a particular habitat some organisms can survive well, some survive less well, and some cannot survive at all.

5-ESS3-1 Obtain and combine information about ways individual communities use science ideas to protect the Earth's resources and environment

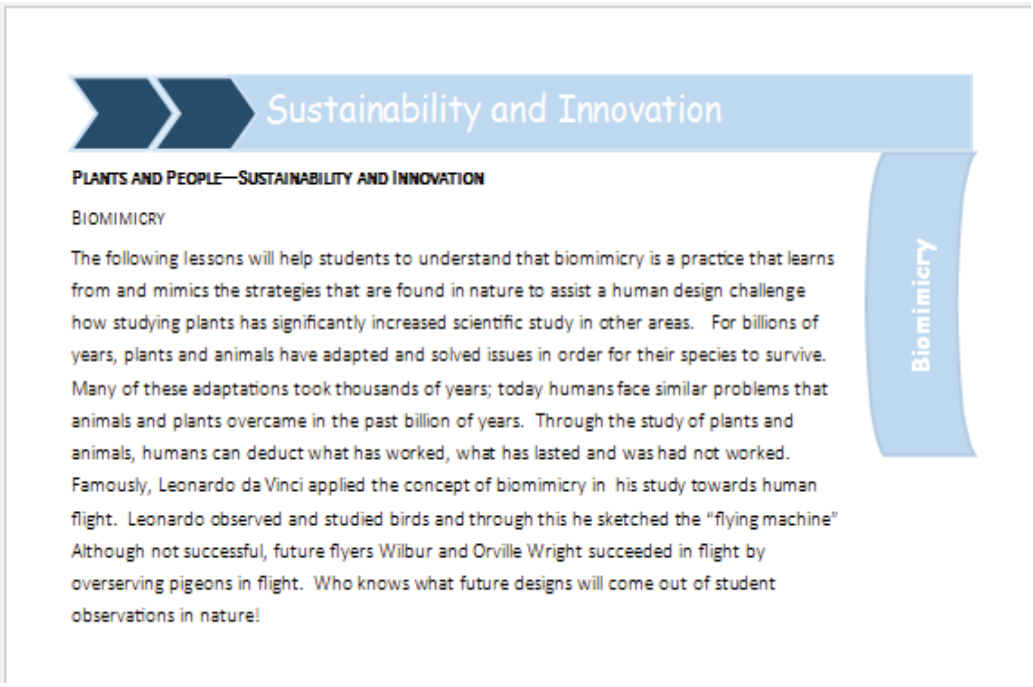
Next Generation Science Standards –Foundation Boxes

Science and Engineering Practices	Disciplinary Core Ideas	Crosscutting Concepts:
Engaging in Argument from Evidence • Construct an argument with evidence Obtaining, Evaluating and Communicating Information • Obtain and combine information from books and/or other reliable media to explain phenomena or solutions to a design problem	LS4.C Adaptation • For any particular environment, some kinds of organisms survive well, some survive less well, and some cannot survive at all ESS3.C Human Impacts of Earth Systems • Human activities in agriculture, industry and everyday life have had major effects on land, vegetation, streams, oceans, air and even outer space. But individuals and communities are doing things to help protect Earth's resources and	Cause and Effect Systems and System Models

Student Vocabulary

- Bloom Period - The time during which flowers are opened

Curriculum Layout



Sustainability and Innovation

PLANTS AND PEOPLE—SUSTAINABILITY AND INNOVATION

BIOMIMICRY

The following lessons will help students to understand that biomimicry is a practice that learns from and mimics the strategies that are found in nature to assist a human design challenge how studying plants has significantly increased scientific study in other areas. For billions of years, plants and animals have adapted and solved issues in order for their species to survive. Many of these adaptations took thousands of years; today humans face similar problems that animals and plants overcame in the past billion of years. Through the study of plants and animals, humans can deduct what has worked, what has lasted and was had not worked. Famously, Leonardo da Vinci applied the concept of biomimicry in his study towards human flight. Leonardo observed and studied birds and through this he sketched the "flying machine" Although not successful, future flyers Wilbur and Orville Wright succeeded in flight by overserving pigeons in flight. Who knows what future designs will come out of student observations in nature!

Biomimicry

Every lesson begins with an introduction to help provide the educator with background information needed to present the lesson.

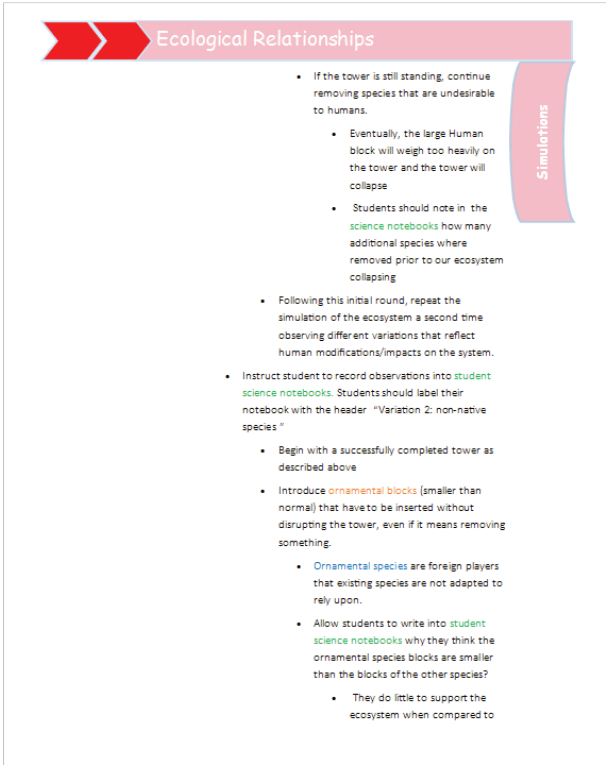
Each lesson activity designed for 45 minutes of instructional time either inside the classroom, outside in the schoolyard or a hybrid of both inside and outside instruction

Color codes within each lesson plan are designed to help draw attention to certain key aspects

Orange text indicates a material is needed

Blue text indicates student vocabulary word

Green text is a place where a student science notebook can be utilized



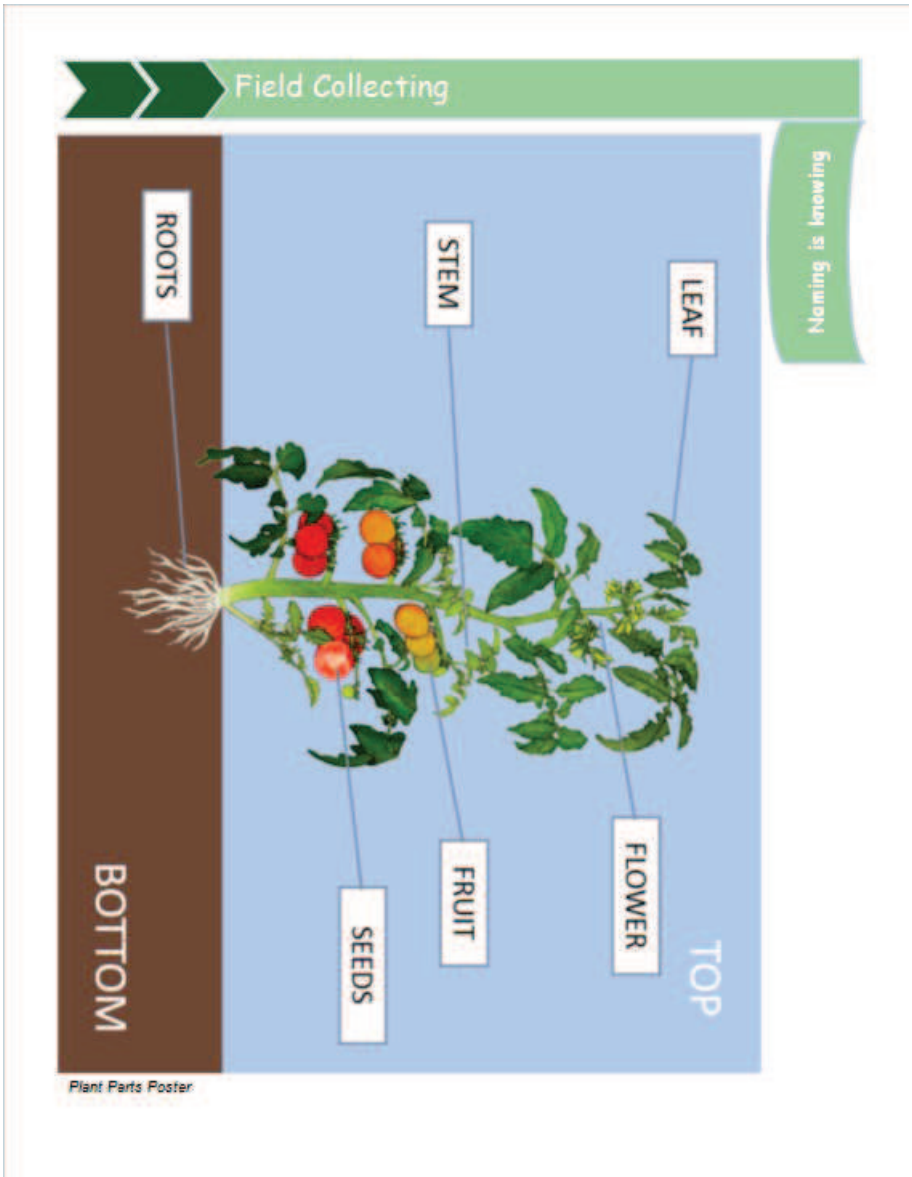
Ecological Relationships

- If the tower is still standing, continue removing species that are undesirable to humans.
  - Eventually, the large Human block will weigh too heavily on the tower and the tower will collapse
  - Students should note in the science notebooks how many additional species where removed prior to our ecosystem collapsing
- Following this initial round, repeat the simulation of the ecosystem a second time observing different variations that reflect human modifications/impacts on the system.
- Instruct student to record observations into student science notebooks. Students should label their notebook with the header "Variation 2: non-native species "
  - Begin with a successfully completed tower as described above
  - Introduce ornamental blocks (smaller than normal) that have to be inserted without disrupting the tower, even if it means removing something.
    - Ornamental species are foreign players that existing species are not adapted to rely upon.
    - Allow students to write into student science notebooks why they think the ornamental species blocks are smaller than the blocks of the other species?
      - They do little to support the ecosystem when compared to

Simulations

Curriculum Layout

Where applicable, student data collection sheets have been included for students to complete or to model what a data sheet could look like for the activity.



Correlation of Standards—Grades 3-5

Botany and Biodiversity correlations to Next Generation Science Standards

NGSS Standard	Field Collecting	Morphology and Classification	Range Mapping	Biodiversity Inventory
3-LS3-1 Analyze and interpret data to provide evidence that pants and ~~animals~~ have traits inherited from parents and that variation of these traits exists in a group of similar organisms		✓		
3-LS4-2 Use evidence to construct an explanation for how the variations in characteristics among individuals of the same species may provide advantages in surviving, finding mates, and reproducing.	✓			
3-LS4-3 Construct an argument with evidence that in a particular habitat some organisms can survive well, some survive less well and some cannot survive at all.	✓	✓	✓	
4-LS1-1 Construct an argument that plants ~~and animals~~ have internal and external structures that function to support survival, growth, behavior, and reproduction.	✓	✓	✓	
5-ESS3-1 Obtain and combine information about ways individual communities use science ideas to protect the Earth's resources and environment			✓	✓

Correlation of Standards—Grades 3-5

Plants and People correlations to Next Generation Science Standards

NGSS Standard	Ethnobotany	Plants We Need	Plants We Want	Sustainability and Innovation
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				✓
3-LS3-2 Use evidence to support the explanation that traits can be influenced by the environment				✓
3-LS4-2 Use evidence to construct an explanation for how the variations in characteristics among individuals of the same species may provide advantages in surviving, finding mates and reproducing			✓	
3-LS4-3 Construct an argument with evidence that in a particular habitat some organisms can survive well, some survive less well, and some cannot survive at all			✓	
4-PS4.2 Develop a model to describe that light reflecting from objects and entering the eyes allows objects to be seen			✓	
5-PS1-4 Conduct an investigation to determine whether the mixing of two or more substances results in new substances		✓		
5-PS3-1 Use models to describe that energy in animals food was once energy from the sun		✓		
5-LS1-1 Support an argument that plants get the materials they need for growth chiefly from air and water	✓			
5-LS1-2 Develop a model to describe the movement of matter among plants, animals and decomposers and the environment	✓	✓		
5-ESS3-1 Obtain and combine information about ways individual communities use science ideas to protect the Earth's resources and environment		✓		

Correlation of Standards—Grades 3-5

Ecology and Engineering correlations to Next Generation Science Standards

NGSS Standard	Ecological Restoration	Phenology	Asset Mapping	Disruption and Restoration
2-LS2-2 Develop a simple model that mimics the function of an animal in dispersing seeds or pollinating plants		✓		
3-LS1-1 Develop models to describe that organisms have unique and diverse life cycles but all have in common birth, growth, reproduction and death		✓		✓
3-LS4-2 Use evidence to construct an explanation for how the variations in characteristics among individuals of the same species may provide advantages in surviving , finding mates, and reproducing	✓			✓
3-LS4-3 Construct an argument with evidence that in a particular habitat some organisms can survive well, some survive less well, and some cannot survive at all	✓			✓
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	✓			
3-ESS2-1 Use evidence to construct an explanation for how the variations in characteristics among individuals of the same species may provide advantages in surviving, finding mates and reproducing			✓	
3-ESS2-2 Construct an argument with evidence that in a particular habitat some organisms can survive well, some survive less well, and some cannot survive at all			✓	

Science Notebooks

Student science notebooks are an effective way for students to observe, record, and process what they are learning through experiences. Student notebooks should be individualized for the learners - while there will be prompts for what to include, they are primarily open to whatever each student wants to record. It is important for students to organize their notebooks well, however, each student may choose his or her own way with the understanding that there are a variety of organizational methods.

Writing in student notebooks will help students build processing skills and critical thinking skills through writing, drawing, and recording thoughts. Student notebooks will also include data. Writing prompts within the notebook will encourage students to record some standard information each time: date; time; weather; location; temperature; season; the plants are; we see; we touch; we smell. These prompts will also help students form good habits and keep students on track. Instead of trying to remember what students saw, they can refer back to their detailed notes.

Ideas for science notebooks:

- Give students time to think about how they want to organize data and observations (record, compare, draw, list, etc.)
- Encourage students to share with each other (partner or whole group) how they are organizing their information or the type of data they plan to include.
- Allow students to decorate the cover however they wish.
- Encourage students to draw and sketch within the notebook and label their drawings.
- Students should include questions, predictions based on prior knowledge, reflections and conclusions.
- Great examples can be shared with the rest of the class on a “Wow!” board—with the permission of the students. By posting great examples of data tables or drawings, other students can be inspired.

Assessing science notebooks

As far as assessing the notebooks, it is more important to look for quantity over quality (at least at first). While it seems counterintuitive, you want your students to write a lot—any ideas or thoughts — without fear of “the wrong answer”. Notebooks are best reviewed by formative assessments—teachers can observe how the students use the notebooks by collecting them periodically.

Student science notebooks provide opportunities for learners to solidify understandings and they provide teachers with insight into each child’s conceptual understanding. Teachers can increase the value of the student science notebooks by using it as a way to communicate back with students. Teachers can write in or ask prompts such as, “Tell me about what you drew here” by writing in the notebook or using sticky notes.

Science Notebooks

Check for student mastery that can not be graded. Evaluate if students are learning the concepts and skills. Provide feedback and prompts and watch for improvements from the beginning of the notebook to the end.

Setting up the science notebook includes three main steps:

1) Table of Contents
2) Page numbering
3) Headings and entry titles

Setting Up the Table of Contents

- Starting with the first blank page and using both sides, have students create a table of contents or use the template below and glue in 3-4 double-sided Table of Contents pages.
- Skipping 1-2 full pages, number the remaining pages. Begin with the 1 and continue with sequencing until all remaining pages are numbered.
- Encourage students to be consistent, and to choose a place on the bottom or top edge of each page that they will consistently write the page number. This will make it easy for both teacher and student to find and reference.
- Remaining blank pages may be used later on as space for additional Table of Contents pages, or for other glue-in sheets students feel should go towards the front of their notebook.

Table of Contents		
Page #	Title	Entry description (a few short words)

Science Notebooks

Instructions for a first time science notebook entry prompt:

Science Notebooking is a "forced" opportunity to slow down, observe, and write. The Science Notebooks should be a focal point during an experience for students to record observations and to pose and investigate questions about the environments visited. The students should also be provided with opportunities to share their findings and conclusions following this experience. Who knows what our students will accomplish as a result of good scientific notebooking skills.

In this initial activity, ask students how many US pennies they have seen in their lifetimes? Next, invite the students to draw a US penny; and I'd like you to do this from memory. Try and not allow students the ability to look at a penny before you attempt this. Students can draw either the front or the back of a US penny, and once all students have completed the task (3-5 minutes) invite students to take a look at one US penny via in person or online to compare their memory to that of an actual penny

Inform students that instead of trying to remember what we saw or what we did, a science notebook allows us to record what we see in the moment. Later we can refer back to our detailed findings and notes in our science notebooks.

To conclude an initial lesson on science notebooking, Inform students that the class will be adding a new entry to the notebook and that it will be a reflection entry.

- Ask students to open their notebooks to the first blank, numbered page.
- Guide students using the class notebook to add the entry to their Table of Contents.
- Give students the following prompt, and 2-5 minutes to write or draw their response under the new heading:
    - What are you looking forward to most about your science notebook?
        - *I am looking forward to…*
    - What do you still wonder about your science notebook?
        - *I wonder…*
    - On the next numbered page, ask students to draw a picture of science in action.

Science Notebooks

Sample assessment rubric for science notebooks

Score	Organization	Grammar	Mechanics	Drawing
5	Writing is consistent and coherent. Includes clear sense of order. Elaborates on main idea. Uses specific and original details. Provides clear conclusion.	Grammar is appropriate and consistent. There is an effort to write complex sentences.	Punctuation and capitalization are correct in all but the most complex situations	Drawings are complete Uses many drawings Drawings are labeled
4	Writing is consistent with stimulus. Uses elaboration although some gaps occur. Includes specific details or examples.	Grammar is mostly appropriate and consistent. There is an attempt at complexity.	Punctuation and capitalization are mostly correct	Many drawings are used but not labeled
3	Writes bare essentials with little or no elaboration. Writing rambles and is off topic. Writing contains few specific details or examples, and may	Grammar is sometimes appropriate and may be inconsistent. Sentences tend to be simple.	Punctuation and capitalization are sometimes present	Some drawings are used
2	Writing may or may not state purpose. Writing is confusing, lacks coherence or is a simple list.	Grammar is often inappropriate. Sentences are simple.	Punctuation and capitalization are seldom used correctly	No drawings

Score _____

Material List

Materials Needed	Quantity Included in PLSS	Unit
Student Pre/Post Questionnaire	30	Botany and Biodiversity
All About Plants Poster	1	Botany and Biodiversity
Plant Parts Poster	5	Botany and Biodiversity
Digital Cameras with SD card	4	Botany and Biodiversity
Hula Hoops with quadrats	4	Botany and Biodiversity
U.S. Penny	10	Botany and Biodiversity
Naming is Knowing Data Sheet	30	Botany and Biodiversity
Plant Press w/ cardboard and straps	1	Botany and Biodiversity
Blotter Paper	4 sheets	Botany and Biodiversity
Plant Specimen Labels	30 labels	Botany and Biodiversity
Photograph Printer Paper	30 sheets	Botany and Biodiversity
Paper Towel Roll	1 roll	Botany and Biodiversity
Newspaper	1	Botany and Biodiversity
Primitive plant guide cards	5 sets	Botany and Biodiversity
Plastic Figurines	2 tubes	Botany and Biodiversity
Butcher paper	1	Botany and Biodiversity
Carl Linnaeus picture and facts	1	Botany and Biodiversity
Primitive Plant guide data sheet	30	Botany and Biodiversity
Peterson First Guide to Wildflowers	2	Botany and Biodiversity
Roadside Wildflower Pocket Guide	2	Botany and Biodiversity
Plant Plate Illustrations	5 per plant	Botany and Biodiversity
All About Plants Poster	1	Botany and Biodiversity
Plant anatomy guide sheet	5	Botany and Biodiversity
String in 60ft sections	5	Botany and Biodiversity
Measuring tape	5	Botany and Biodiversity
Ruler	5	Botany and Biodiversity
Compasses	1	Botany and Biodiversity
Graph Paper	5	Botany and Biodiversity
Range Map Data Sheet	30	Botany and Biodiversity
Observation Data Sheet	30	Botany and Biodiversity

Material List

Materials Needed	Quantity Included in PLSS kit	Unit
Edible Wild Plants: Eastern/Central North America	1	Plants and People
Field Guide to Medicinal Wild Plants	1	Plants and People
Generational Chart	5	Plants and People
Partner Practice Interview	25	Plants and People
Wild Edibles of Missouri	5	Plants and People
M+M Candy	1	Plants and People
Missouri Prairie Food Web Cards	1	Plants and People
Prairie Food Web Cards	1	Plants and People
Edible Plants Flash Cards	5	Plants and People
Purple , Green, Yellow Yarn	1 of each color	Plants and People
Skittles	1	Plants and People
Vegetable Seed Catalogs	2	Plants and People
Cornstarch	5	Plants and People
Bakers Yeast	1	Plants and People
Latex free surgical gloves	25	Plants and People
Regional Spices poster	1	Plants and People
Sugar	1	Plants and People
Spices	5 types	Plants and People
Bamboo skewers	10	Plants and People
Burlap	1	Plants and People
Cotton Balls	1	Plants and People
Denim	5	Plants and People
Jute twine	1	Plants and People
Straw hat	1	Plants and People
Toilet paper	5	Plants and People
Wood Block	5	Plants and People
Bookmarks	30	Plants and People
Strainer	1	Plants and People

Material List

Materials Needed	Quantity Included in PLSS kit	Unit
Glass jars	3	Plants and People
Small plates	10	Plants and People
Paper towels	1	Plants and People
Rubbing alcohol	1	Plants and People
Tomatoes	TBD	Plants and People
Plant Cards	Electronic	Plants and People
Bromelain	2	Plants and People
Container	2	Plants and People
Isopropyl alcohol	4	Plants and People
Liquid Dish detergent	1	Plants and People
Petri dishes	1	Plants and People
Spilt peas	5	Plants and People
Table salt	3	Plants and People
Toothpicks	2	Plants and People
Wisconsin FastPlants	25	Plants and People
Measuring cup	18	Plants and People
Artificial Plant Cards	2	Plants and People
Baking soda	1	Plants and People
Nature Cards	5	Plants and People
Pine Cones	4	Plants and People
Plastic Jars	10	Plants and People
Sheets of paper	3	Plants and People
Strips of paper	30	Plants and People
Tarp	2	Plants and People
Engineering design poster	4 rolls	Plants and People
Graphic organizers	Electronic	Plants and People
Biomimicry teacher cards	Electronic	Plants and People

Material List

Materials Needed	Quantity Included in PLSS kit	Unit
Ecosystem Jenga Green Blocks	24 blocks	Ecology and Engineering
Ecosystem Jenga Yellow Blocks	12 blocks	Ecology and Engineering
Ecosystem Jenga Orange Blocks	9 blocks	Ecology and Engineering
Ecosystem Jenga Red Blocks	3 blocks	Ecology and Engineering
Ecosystem Jenga Blank Blocks	1 block	Ecology and Engineering
Ecosystem Jenga Ornamental Species Blocks	3 blocks of yellow, green and orange	Ecology and Engineering
Ecosystem Jenga Invasive Species Blocks	1 block of yellow, green and orange	Ecology and Engineering
Paper Plates	5 plates	Ecology and Engineering
Mini Marshmallows	1 bag	Ecology and Engineering
Turtle Trot Grid 1	5 copies	Ecology and Engineering
Turtle Trot Grid 2	5 copies	Ecology and Engineering
Turtle Trot Grid 3	5 copies	Ecology and Engineering
Assorted Turtle Trot barrier pieces	1 container	Ecology and Engineering
Fruity Pebbles	1 bag	Ecology and Engineering
Fruit Loops	1 bag	Ecology and Engineering
Spoon	30	Ecology and Engineering
Bowls	10	Ecology and Engineering
Species Relationship Cards	2 Sets	Ecology and Engineering
Deciduous Tree Phenophases	Electronic a	Ecology and Engineering
Time Lapse video of Flower to Fruit	Electronic	Ecology and Engineering
Phenology—-Overserving changes over Time	30 copies	Ecology and Engineering
Hand lenses	8	Ecology and Engineering
Model Food	Assortment	Ecology and Engineering
Pollinator Survey—Graphing Pollinators	30 copies	Ecology and Engineering
Liquid Dish Soap	1	Ecology and Engineering
Gallon Jug	1	Ecology and Engineering
Plastic Cups	8 of each of the following colors: Red Blue, Yellow, Clear, White and Green	Ecology and Engineering Ecology and Engineering

Material List

Materials Needed	Quantity Included in PLSS kit	Unit
Missouri Bee Identification Sheet	30 copies	Ecology and Engineering
Project BudBurst one-time Report	Electronic and 5 copies of each plant type	Ecology and Engineering
Laser infrared thermometer temperature gun	5	Ecology and Engineering
Digital temperature and humidity meter	5	Ecology and Engineering
Digital illuminance meter	5	Ecology and Engineering
Understanding Microclimate in our Schoolyard	30	Ecology and Engineering
PlantLab Student Scientists Grid Paper	Electronic and 30 copies	Ecology and Engineering
Native, Ornamental, Naturalized and Invasive Species Simulation Pieces	Electronic and 30 copies	Ecology and Engineering
Primary Succession Display	4 game boards with pieces	Ecology and Engineering
Paint Brushes	Electronic and 1 print	Ecology and Engineering
Root Diggers	5	Ecology and Engineering
Terrarium Container with Soil	4	Ecology and Engineering
Cardboard Flats	3	Ecology and Engineering
Modeling Clay	3	Ecology and Engineering
Plain Yogurt	1 block	Ecology and Engineering
Native Seeds		Ecology and Engineering
PlantLab Student Scientists Grid Paper	1 container	Ecology and Engineering
Missouri Wildflower Catalog	Electronic and 30 copies	Ecology and Engineering
Possible Native Plant Lists student sheet	5	Ecology and Engineering
Native Garden Bloom Chart	Electronic and 30 copies	Ecology and Engineering
Garden Layout Map	Electronic and 30 copies	Ecology and Engineering
Our School is Growing Poster	Electronic and 30 copies	Ecology and Engineering
	Electronic	Ecology and Engineering

Glossary

Vocabulary

Abiotic - nonliving components of the environment that affect living organisms

Adaptation— the act or process of changing to better suit a situation

Adaptation— the act or process of changing to better suit a situation

Alpha diversity—the diversity at a single sampling site

Anthocyanin—soluble glycoside pigments producing blue to red coloring in flowers and plants

Antimicrobial—An agent that stops microorganism growth

Beta diversity—the difference in species between two quadrats or sampling areas

Biodiversity Inventory—an attempt to document and identify all biological species living in some defined area

Biodiversity—refers to the variety of life

Biological Phenomena—the series of reactions that result in a transformation. For example, water is absorbed by plant roots, followed by the water flowing through the plant and finally lost at the leaf surface by transpiration

Biology—the study of living organisms that cover organism morphology, physiology, anatomy, behavior, origin and distribution

BiomeSTL—citizen science and stewardship project. It not only is designed to aid urban planners, municipalities, counties, and developers in maximizing the benefits of biodiversity for their respective communities, it is also designed to equip citizens with a greater understanding and appreciation of local biodiversity in ways that strengthen place-based connections, promote healthy, active, nature-rich living, and advance a culture of community-driven land stewardship.

Biomimicry— the design and production of materials, structures, and systems that are modeled on biological processes. Comes from the Greek words bios meaning life and mimesis meaning to imitate

Biophilia— the tendency to interact or be closely associated with other forms of life in nature

Biotic - living organisms that are found in the environment

Bloom Period - The time during which flowers are opened

Cardinal Directions - Any of the four principal compass directions; north, east, south, west

Carrying Capacity - The quantity of organisms that can be supported in an ecological community

Cellulose— basic structural component of plant cell walls. It is the most abundant of all naturally occurring organic compounds: 90% of cotton and 50% of wood is cellulose.

Chlorophyll—a pigment plants use to trap sunlight (mainly red and blue, and some purple light) for photosynthesis, as it exposed to light some of it is used up but replaced by the plant over time.

Citizen Science - the collection and analysis of data relating to the natural world by

members of the general public as part of a collaborative project with professional scientists

Cladogram—Lines that branch off in different directions ending at a clade, a group of organisms with a last common ancestor

Class—A group of orders which have features in common

Climate - the average measurements of temperature, wind, humidity, and precipitation over the course of 30+ years

Climate—The average course of weather conditions for a particular location over a period of many years

Climax community - the populations of plant species remaining stable and exists within balance with each other and their environment. This is also the final stage in succession

Coefficient of Conservation - a ranking that represents an estimated probability that a plant is likely to occur in a landscape from what is believed to be pre-European settlement

Commons Area - An area that is available for use by more than one person

Competition - A relationship between organisms in which one is harmed when both are trying to utilize the same resource for growth and reproduction

Competitive Exclusion - Two species that compete for the exact same resource cannot stably coexist

Consumer— A living thing that must eat other organisms to obtain energy necessary for life

Crops—A plant or plant product that is grown and harvested

Cultivated Placement - Deliberate placement and pruining of wildflowers to achieve a particular ascetic

Dichotomous Key—a key for identification of organisms based on a series of choices between alternative characters

Dichotomous—dividing into two parts

Dispersal—the movement of one organism from their place of birth to a different location for breeding. Movement can be active, organism moves without assistance or passive, organism needs assistance.

Distribution — The way in which similar plants are spread over a defined area

Diversity– total number of different species in a community

Dye— is a substance produced by humans from some source in order to appear and retain a particular

Ecological Community - Groups of various species in an ecological system. Organisms can eat one another and are eaten by one another

Ecological Relationships—Interactions between organisms within their environment

Glossary

Vocabulary

Ecologically dominant species - thought of as the ones predominantly structuring the ecosystem (oak hickory forests and coral reefs are literally made of their dominant species) there are some species which have inordinately large effects structuring the ecology as well.

Ecology - the branch of biology that studies the relations of organisms to one another and to their physical surroundings.

Ecosystem—Biological community of interacting organisms and their physical environment

Ecotone - transitional area of vegetation between two different plant communities

Endemic—species which are unique and native to a limited range

Ethnobotany— The regional study of plants and their practical uses through the lens of local cultures and people

Family—similar genera which share limited characteristics with each other

Flowers— the part of a plant that blossoms and produces the seeds that can become new plants.

Food Cultures— A live bacteria, yeast or mold used in food production

Food web—A system of interlocking and interdependent food chains

Fundamental Niche—An organisms niche in the absence of competition of other species

Gama diversity—diversity of the greater landscape, in this case the entire schoolyard

Generalists - a species that is able to thrive in a wide variety of environmental conditions and utilize a variety of different resources

Generation — A group of people born and living during the same time

Genus—collection of very similar species; differ from other genera (plural)

Geography— The study of the Earth's surface, its climate, natural resources such as rivers, oceans and mountains

Glades - A harsh and dry environment found within an open area within a forest

Glade—The open space that is surrounded by woods

iNaturalist — A free observation platform that acts as a place for people to record biodiversity observations, interact with other enthusiasts, and to learn about organisms across the globe

Green space– an area of grass, trees, or other vegetation

Hardscapes - Human created architecture features. Examples include paths, walls or benches

Herbarium— a collection of dried plant specimens usually systematically arranged for reference

Hot spots—areas with very high true diversity

Glossary

Vocabulary

iNaturalist—free observation platform that acts as a place for people to record biodiversity observations, interact with other enthusiasts, and learn about organisms across the globe

Intermediate disturbance hypothesis- hypothesis that suggests local species diversity is maximized when disturbance is not too frequent or too rare

Interview — A meeting where people talk to each other asking a set of questions designed to provide information

Introduced species (non-native species)— Through human activity, an organism that is not native to a particular location and typically causes harm to the ecosystem

Invasive Species - Plant that causes ecological harm in a new environment where it is not naturally occurring

Island Biogeography (Theory) - The theory states that the larger an island is greater number of species it can hold in relation to a smaller island

Kingdom—Highest rank of classification, groups of similar living things split into six different sectors

Land use - the management and modification of natural environment into a built environment such as settlements and semi-natural habitats

Law of Dominance—A pair of inherited traits will be dominant and the other recessive, unless both factors are recessive

Law of Independent Assortment— Chromosomes seperates independently of the other pairs so the results are random

Law of Segregation– the genes that determine every characteristic are random from each parent

Leaves – lateral outgrowth from a plant stem

Living organism - able to grow, reproduce, move or breathe

Maximum Sustainable Yield - The largest amount a natural resource can be explored without long term depletion

Microbial—A characteristic of a microorganism that causes fermentation

Microclimate - Differences can occur over very small distances in relation to a larger habitat

Model organism —A species that has been widely studies due to its particular experimental advantage

Mulch - Material such as decayed leaves, bark or compost that is spread around a plant to assist in moisture retention and to enrich and insulate the soil

Mutualism - Interactions between organisms of two different species in which each organism benefits from the interaction in some way

Native Species - have existed within a range occupying an ecosystem long enough to have coevolved and become a part of it.

Glossary

Vocabulary

Native species—Plants or animals that originated or live in an area without any human intervention

Natural Placement - Grouping same species of wildflowers in clusters mimicking the natural growth of plants

Natural World - All the animals, plants and other organisms existing in nature and not made by humans

Naturalized Species - are also introduced, but capable of surviving in the environment on their own

Nectar - the sugary fruit secreted by plants to encourage pollination by insects and other animals

Niche Partitioning - process by which competing species use the environment differently that allows species to coexist

Nonliving - Things that can not grow, move, breathe and reproduce

Non-living organisms - unable to grow, move, breathe or reproduce

Non-native Species - are introduced or spread into an ecosystem relatively recently

Nutrients - the substance that provides nourishment that is essential for growth and the maintenance of life

Obligate - an organism that is unable to survive in the presence of oxygen

Order—Families of the same that share some of their basic features with each other

Organisms - An individual animal, plant or single celled life form

Ornamental Species - more often non-native species adapted to a range and ecosystems elsewhere but brought in by human favoritism

Phenology—The study of seasonal natural phenomena as it relates to climate and plant and animal life

Phenophases— an observable phase in the annual life cycle of a plant that is defined by a beginning and end point

Photosynthesis — The process in which green plants use sunlight to make their own food. The process requires sunlight, chlorophyll, water and carbon dioxide

Phylum—A group of similar orders

Pigment—substance produced by plants or animals to absorb a particular color of light.

Pioneer Species - species that are the first to colonize barren environments that have been disrupted

Pioneer stage - early stages of plant succession

Pollination - the transfer of pollen that allows fertilization

Pollinators - an organism that moves pollen from the male anther of a flower to the female stigma of a flower

Predators - An animal that preys on others

Preservation—the activity or process of keeping something valued alive, intact, or free from damage or decay

Prey - An animal that is hunted by another for food

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Vocabulary

Primary Consumers - an organism that feeds of on plants, a herbivore

Primary succession - the colonization by nature of a new or empty "bare rock" environment begins in nature mainly because of geological activity like rockslides or volcanic eruptions

Producer — Able to produce their own food. i.e plants

Projects—a collection of observations under a common purpose

Quadrat—our defined sampling space

Rainscaping—combination of plantings, water features permeable pavement and other activities that manage storm water as close as possible to where it falls

Relative humidity - the amount of water vapor present in air as expressed in a percentage of the amount needed for saturation at the same temperature

Research Grade—that the organism has been identified to a species and that two or more people have agreed on whether or not it is indeed that species

Resource needs - needs of an organisms for normal growth, maintenance and reproduction

Roots—underground part of a seed plant body that absorbs food and water and anchors and supports the plant

Schoolyard - the grounds of a school

Secondary Consumers—an organism that eat primarily primary consumers for their energy

Secondary succession - in which an existing community is disturbed by disasters like floods or fire, but there are some remnant resources such as developed soil and a few surviving individuals.

Seed dispersal - the movement, spread or transport of seeds away from the parent plant

Soil Organisms - An organism that inhibits the soils during part or all of its life

Soil seed Bank - the natural storage of seeds, often dormant within the soil

Specialists - Organisms that require a very unique resource. I.e. food or habitat conditions to survive

Specialization - the adaptation of a special function to survive in a particular environment

Species richness—the number of different species represented in a community

Species—basic unit of classification using Taxonomic Classification

Stems— the main trunk of a plant

Strains— Variations found within plant cultivars

Succession - the directional non seasonal change in the plant species that occupy an ecosystem through time

Sustainable - Able to be maintained at a determined rate or level

Glossary

Vocabulary

Taxonomic classification (hierarchy) - Using a hierarchical model, it moves from the point of origin and groups become more specific until one branch ends as a single species

Temperature - the measurement of the amount of heat present in an object

Tertiary Consumers - An animal that obtains its nutrition by eating primary consumers and secondary consumers

Tragedy of the Commons - Individuals have an incentive to consume a resource at the expense of every other individual while not being able to exclude anyone from consuming the resource

Traits— a distinguished quality or characteristic

Trophic Cascades - The addition or subtraction of top apex predators that results in the changes in the populations of predators and prey through the food chain

Trophic Level - comprises of organisms that share the same function in the food chain and the same nutritional relationship to the primary sources of energy

Varieties—-Regarding plants, it is the individual identity within a larger plant family or species

Voucher specimen—the most complete and undamaged representative that they can find

Weather - the current or daily atmospheric conditions

Weeds—A plant that tends to grow where not wanted to prevents the growth of more desirable plants by taking up space

Wetland—Land consisting of marshes or swamps, saturated land

Yeast—A microscopic organism that is able to convert sugar into carbon

Zero Sum - a situation I which whatever is gained by one side is lost by the other