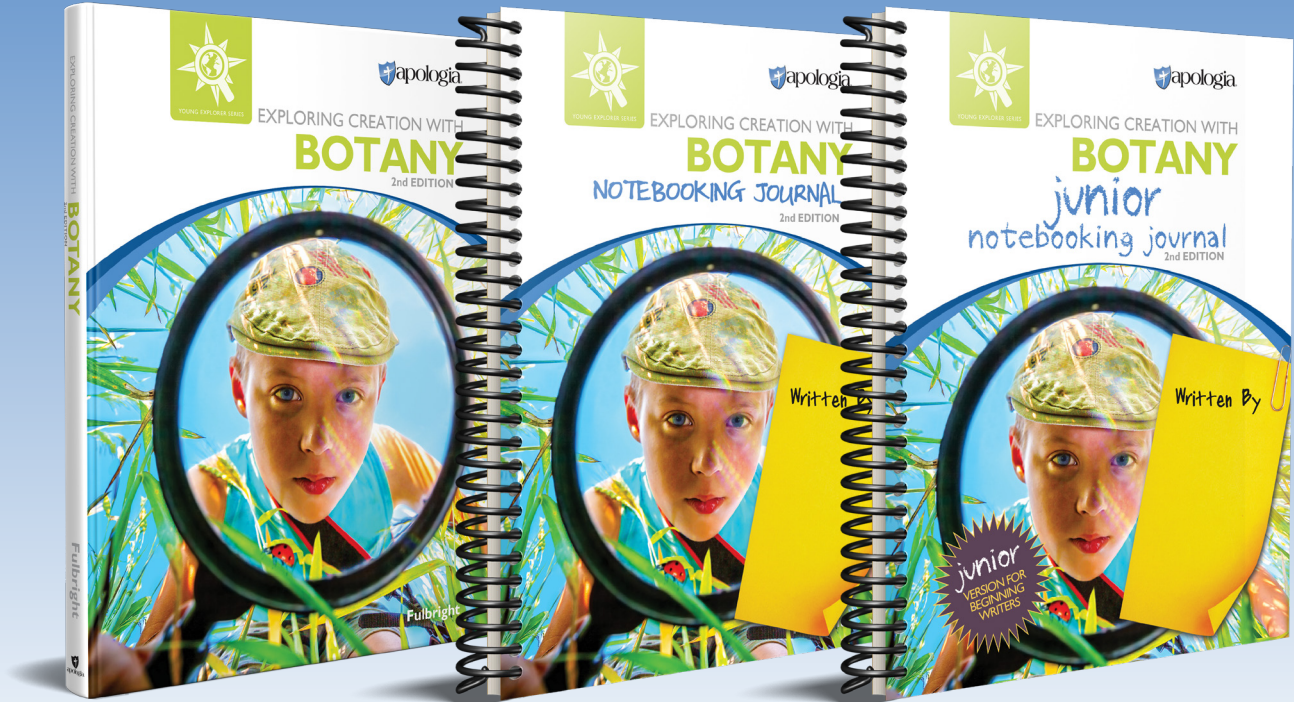


INTRODUCTION TO
BOTANY





TEXTBOOK TABLE OF CONTENTS

TEXTBOOK LESSON 1

LAB SUPPLY LIST

JUNIOR NOTEBOOKING JOURNAL SAMPLE

REGULAR NOTEBOOKING JOURNAL SAMPLE

FREQUENTLY ASKED QUESTIONS

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TABLE OF CONTENTS

INTRODUCTION TO BOTANY... 9

LESSON 1:

WHY BOTANY MATTERS? 13

Welcome	14
Creative Creator	16
Nature Journaling.....	17
Activity 1.1: Think Like a Scientist.....	18
Activity 1.2: Make a Nature Journal	19
Using Your Nature Journal Like a Scientist	19
Activity 1.3: Journal About Nature.....	21
Science of Botany	21
Activity 1.4: Observe Leaf Veins	25
Activity 1.5a: Observing Absorption	25
Activity 1.5b: Walking Water Without a Vascular System	26
Activity 1.6: Go on a Nature Hunt	27
To Seed or Not to Seed.....	27
Seedless Plants.....	28
What Do You Remember?.....	28
Activity 1.7: Grouping Plants	29
Activity 1.8: Make a Light Hut	29
Activity 1.9: Grow Edible Plants	30

LESSON 2:

SEEDS 31

Sleeping Seeds	32
Testae.....	33
Activity 2.1: Design a Seed	34
Activity 2.2: Examine Your Seeds.....	35
Anatomy of A Seed.....	35
Activity 2.3: Identify Dicots and Monocots...37	
Germination	38
What Do You Remember.....	39
Activity 2.4: Label the Parts of a Seed.....39	
Activity 2.5: Compare Germination Conditions	40

LESSON 3:

ANGIOSPERMS 43

Flowering Plants.....	44
Activity 3.1: Disect a Flower.....	46
Activity 3.2: Label a Flower	49
Activity 3.3: Walk in Nature.....	49
Flower Families	50
Activity 3.4: Plant a Sunflower	51
Think About This	53
Activity 3.5: Label an Orchid	54
Flesh Eating Flowers.....	55
What Do You Remember?.....	58
Activity 3.6: Design a Flower.....	59
Activity 3.7: Preserve a Fresh Flower.....	59

LESSON 4:

POLLINATION 61

Pollination.....	62
Think About This	63
Bees.....	63
Other Insects.....	67
Activity 4.1: Explore Flower Pollination.....	68
Bird Pollinators	68
Activity 4.2: Build a Hummingbird Feeder	69
Mammal Pollinators	70
Activity 4.3: Illustrate Animal Pollinators	71
Wind Pollination.....	71
Why Most Flowers Don't Self-Pollinate	72
Self-Pollination.....	73
The Pollinated Flower.....	73
What Do You Remember?.....	74
Activity 4.4: Illustrate What You Learned ...74	
Activity 4.5: Create a Comic Strrip.....74	
Activity 4.6: Make a Butterfly Garden75	

LESSON 5:

FRUIT 77

A Flower's Fruit	78
Fruits and Veggies.....	79
Fruit Kinds.....	79
Activity 5.1: Observe Insects on a Banana	80
Activity 5.2: Categorize Fleshy Fruits	81
Activity 5.3: Split a Squash.....	82
Think About This	82
Dry Fruits	83
Activity 5.4: Find and Illustrate Fruits	84
Seed Scattering	85
Activity 5.5: Examine Burrs.....	88
What Do You Remember?.....	91
Activity 5.6: Describe Seed Dispersal	91
Activity 5.7: Preserve the Color of Fruit ...	92

LESSON 6:

LEAVES 93

Leaf Mouths	94
Making Food.....	96
Photosynthesis.....	97
Sunshine Energy.....	97
Activity 6.1: Burn a Candle in a Jar	98
Color-Fill	98
Activity 6.2: Block the Sun.....	99
Activity 6.3: Sprout Potatoes	100
Transpiration.....	100
Activity 6.4: Test Transpiration.....	101
Falling Leaves	102
Activity 6.5 Preserve Leaf Color	103
Anatomy of a Leaf	103
Simple Leaves and Compound Leaves ...	104
Leaf Arrangement.....	104
Leaf Venation	104
Leaf Shapes	105
Leaf Margins	107
What Do You Remember	107
Activity 6.6 Illustrate the Anatomy of a Leaf	107
Activity 6.7 Make a Leaf Storybook.....	108
Activity 6.8 Collect Leaves	108

LESSON 7:

ROOTS 109

Good Soil.....	110
Nutritious Soil	111
Activity 7.1: Make a Quick Compost ...	112
Root Hairs	114
Root Growth	114
Preventing Erosion	115
Floating Roots.....	116
Geotropism	116
Activity 7.2: Discover Geotropism.....	117
Root Systems.....	118
Geophytes	118
Rooting.....	119
What Do You Remember?.....	120
Activity 7.3: Illustrate Roots	120
Activity 7.4: Classify Roots.....	121
Activity 7.5: Clone Vegetables Through Rooting.....	121

LESSON 8:

STEMS 123

Plant Structure	124
Activity 8.1: Explore Xylem	125
Woody and Herbaceous Stems	126
Activity 8.2: Draw Woody and Herbaceous Stemmed Plants	127
Succulent Plants	128
Auxins	128
Activity 8.3: Imitate Phototropism	129
Examples of Phototropism	129
What Do You Remember?.....	130
Activity 8.4: Color a Flower	130
Activity 8.5: See Auxins in Action	131

LESSON 9:

GARDENING

133

Your Edible Garden.....	134
Gardening Power.....	134
Better Foods.....	135
Activity 9.1: Create a Garden Journal ..	136
Activity 9.2: Plan Your Garden	136
Tools for Gardening	137
Raised Bed Garden.....	137
Location.....	138
Building Your Bed.....	138
Width and Length of Garden	138
Activity 9.3: Build Your Raised Bed	139
Soil	139
Mixing Your Soil	140
When to Plant.....	140
Image of USDA Hardiness Map.....	141
Growing Seasons by Zone	141
What to Plant When.....	142
Activity 9.4: Journal Your Plan	142
Planting Seedlings	142
Spacing Plants	142
Tall to Small.....	143
Activity 9.5: Map Your Garden.....	143
Watering Your Garden.....	144
Activity 9.6: Make an Irrigation System.....	144
Maintaining Your Garden.....	145
Fall and Winter Ideas	148
What Do You Remember	149
Activity 9.7: Draw Your Garden	149

LESSON 10:

TREES

151

Trees are Special	152
Trees are Important	153
Activity 10.1: Identify Things Made From Trees	153
Animal Shelter	153
More Tree Facts	155
Activity 10.2: Plant Some Trees	155
Seed Making	155
Tree Growth.....	156
Twig Anatomy.....	157
Activity 10.3: Measure Twig Growth	158
Activity 10.4: Estimate the Height of a Tree.....	158
Growing Outward.....	159
Tree Trunks	160
Trunk Layers	160
Tree Bark Patterns	161
Activity 10.5: Make a Bark Rubbing	161
Thirsty Trees.....	162
What Do You Remember?.....	162
Activity 10.6: Diagram a Tree's Layers.....	163
Activity 10.7: Make a Tree Field Guide.....	163

LESSON 11:

GYMNOSPERMS 165

Uncovered Seeds.....	166
Conifers	166
Activity 11.1: Measure General	
Sherman.....	167
Activity 11.2: Compare Transpiration...	169
Activity 11.3: Identify and Illustrate	
Leaves.....	170
Cycads.....	172
Ginko Biloba.....	172
Forests.....	173
Forest Fires	175
What Do You Remember	176
Activity 11.4: Write a Bristlecone	
Pine Story	176
Activity 11.5: Opening and Closing	
Pinecones	176

LESSON 12:

SEEDLESS VASCULAR PLANTS 177

Sporangium.....	178
Fern Anatomy	179
Fern Lifecycle	180
Pteridomania.....	182
Activity 12.1: Create Fern Artwork.....	183
Type of Ferns.....	184
What Do You Remember?.....	185
Activity 12.2: Illustrate a Fern	185
Activity 12.3: Build a Small Fern	
Terrarium	186

LESSON 13:

NONVASCULAR PLANTS 187

Brophytes	188
Mosses.....	189
Uses for Mosses	189
Liverworts	191
Activity 13.1: Hunt for Moss and	
Liverwort	192
Lichens.....	192
What Do You Remember?.....	195
Activity 13.2: Illustrate the Moss	
Life Cycle.....	195
Activity 13.3: Build a Lichenometer	196
Activity 13.4: Create Moss Graffiti	197

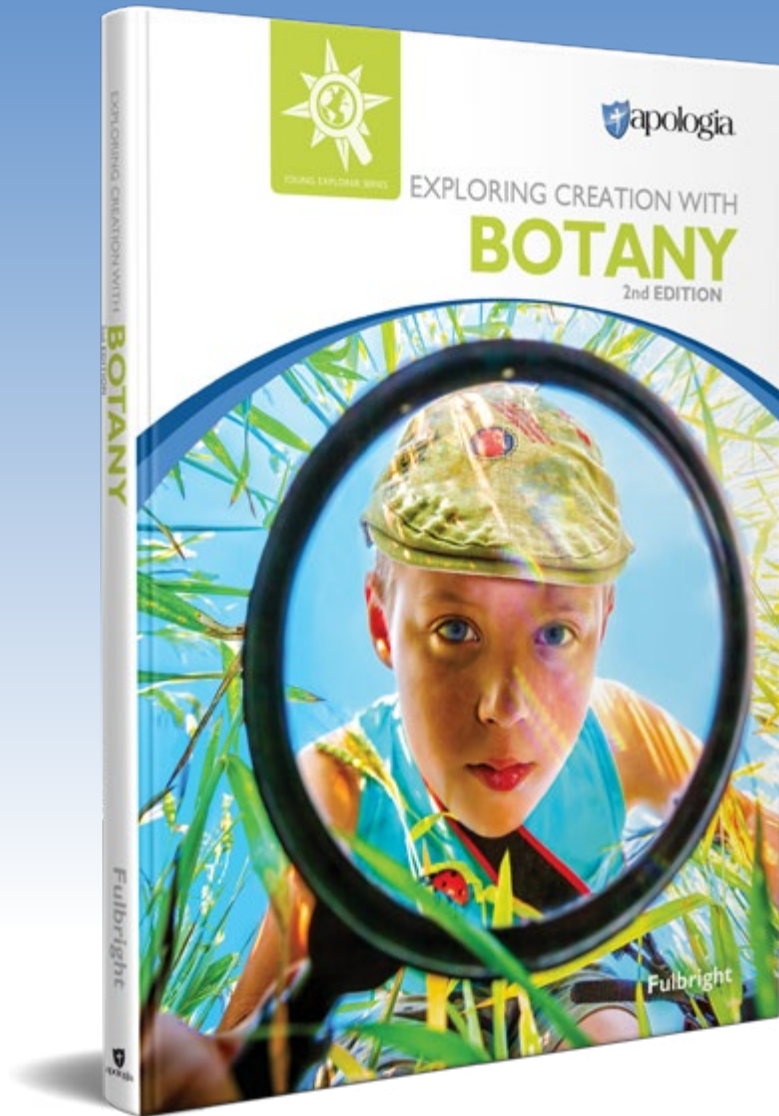
LESSON 14:

MYCOLOGY 199

Fungi.....	200
Consumers.....	201
Fungus Among Us.....	201
Yeasts.....	201
Activity 14.1: Experiment with Sugar	
and Yeast	203
Molds.....	204
Activity 14.2: Test Mold	
Environments.....	206
Mushrooms	207
Mushroom Lifecycle.....	208
Dust in the Wind.....	211
Spore Dispersal.....	212
Saprotrophs.....	212
Fairy Rings	213
Parasitic Mushrooms	213
Mycorrhizal Mushrooms	214
What Do You Remember?.....	214
Activity 14.3: Mycorrhizal Mission	
Story	215
Activity 14.4: Hunt Mushrooms	215
Activity 14.5: Grow Edible	
Mushrooms	216

APPENDIX 219

Supply List	220
Answer Key	223
Index.....	231
Photo Credits.....	237



THIS IS THE START OF TEXTBOOK SAMPLE

THIS IS A PREVIEW. THE NUMBER OF PAGES DISPLAYED IS LIMITED.



LESSON I

WHY BOTANY MATTERS



digging deeper

Then God said, “Let the earth produce vegetation: seed-bearing plants and fruit trees on the earth bearing fruit with seed in it according to their kinds.” And it was so. The earth produced vegetation: seed-bearing plants according to their kinds and trees bearing fruit with seed in it according to their kinds. And God saw that it was good. Evening came and then morning: the third day.
Genesis 1:11–13



All animals that live in the rainforest depend on plants for survival.

must eat, the medicines that make us well, and many other items we use every single day. In fact, this book you are reading is made from plants! And let us not forget that plants also make Earth a more beautiful place to live. Imagine a world without any plants. What would you eat? Think about that. Did you know that virtually everything you eat is either a plant or something that depends on plants for survival?

Think about pizza, for example. Every part of a pizza requires plants to exist. The crust is made from wheat. The tomatoes sauce is made from the

WELCOME

As you embark on this year’s science course, discovering the secrets of all God created on the third day, remember that the Earth is the Lord’s and everything belongs to Him—including you!

Your journey into the wonderful world of **botany** begins right here, right now. All that you learn this year will be important for the rest of your life. Why? Well, let’s find out.

Botany, as you probably know, is the study of plants. It is one of the most important fields of science in the whole world. Why? It’s because our very survival depends on plants. You see, plants produce the air we need to breathe, the food we



Humans are dependent on the food crops that farmers grow such as this orange grove.



This pizza could not exist without plants.

By understanding the secret world of botany, you'll become an expert on what it takes to grow and nourish plants and help them flourish in this world. When you're done with this first lesson, you will create a special structure called a light hut that's designed to grow plants from seeds any time of the year. You can plant any seeds you want, but I recommend herbs if you're starting in the fall because herbs can be grown indoors through the winter. If you are beginning in the spring, plan for fruits and vegetables because you'll be planting an edible garden outside! That means you'll grow food like

strawberries, blueberries, carrots, pumpkins, tomatoes, lettuce, and so much more. If you live in the southern United States and are starting this book in the spring, you may want to go directly to Lesson 9 to begin building your outdoor garden.

In addition to these important projects, you'll do experiments, dissections, activities, and much more. As you can see, you're going to learn a lot of important information this year, and I'm quite certain you'll be a brilliant botany student by the end of this course!

But botany isn't all we have planned for this year. In addition to learning about plants, you'll also learn about **fungi** (fun' jye). What on earth are fungi? Have you ever seen mushrooms growing outside? They are fungi. Because fungi also grow outdoors alongside plants, sometimes even helping plants, we're going to take one lesson to dive into the fascinating world of fungi. I think you'll find this special creation of God quite interesting.



This mushroom is a fungus.

fruit of the tomato plant. Several other fruits and vegetables add to the taste and flavor. But what about the pepperoni? It's made from pork and beef. Pork comes from a pig, and beef comes from a cow. Well, can you guess what pigs and cows eat? Plants! Without plants, there is no pork or beef. Indeed, almost every animal you eat—such as a chicken and fish—lives on plants. Of course, some people eat alligators, frogs, and such. However, even though those animals eat other animals, the animals they eat actually live on plants. So it all comes down to plants. We need them. And we should learn as much as we can about them because they are a vital part of life on Earth.



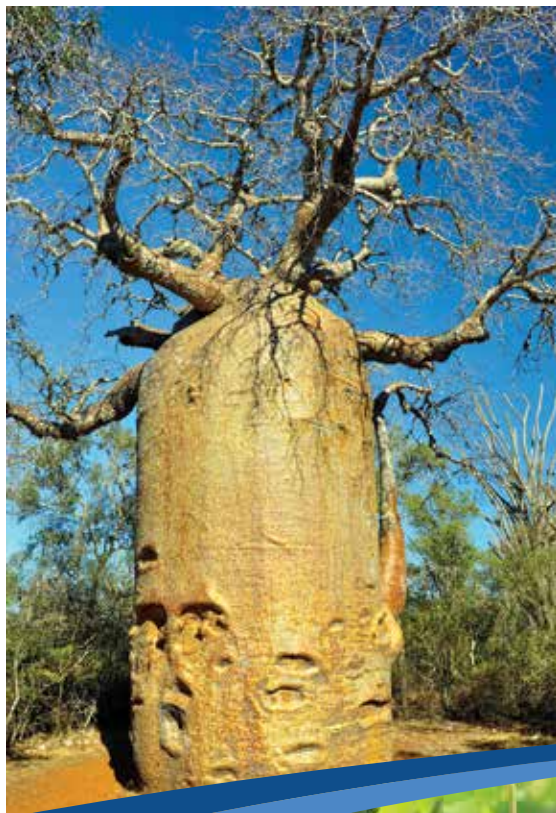
Herbs are easy to grow indoors and can be used for cooking.



CREATIVE CREATOR

Genesis 1:11–13 tells us that God created plants on the third day of creation. And boy oh boy, did He do an amazing job! In fact, we might say that plants truly magnify the Lord. Are you wondering what it means to magnify the Lord? Have you ever looked through a magnifying glass? A magnifying glass makes things look bigger so we can see them better, and that's exactly what God's beautiful world does. It magnifies God so we can see Him better. When we study the flowers—their beauty and how perfectly they were created—we know that God is also beautiful, perfect, and creative. But of course our Creator is creative! He used unbelievable imagination when creating Earth. Did you know that God even gave you the gift of creativity when He designed you in His image? Do you have an imagination? Of course you do! You were made in the image of God. Did you know that it magnifies God when you do creative things? It certainly does. That's because you're using the gift of creativity He gave you. What are some creative things you like to do? Do you like to draw pictures, tell stories, or build things? Do you imagine new adventures or design new ways of doing things? Don't ever forget that God loves you and specially designed you with your own unique way of expressing your creativity.

In addition to creating the wonderful person that you are, God created so many different and amazing kinds of plants. In fact, there are thousands of unusual plants in God's kingdom. For example, some plants capture insects or small creatures and consume them for food. One kind of plant grows a flower that's three feet long (probably as long as you are) and smells like rotten meat. Some flowers love the sun so much that they turn around throughout the day to always face it. Other flowers don't like the sun, staying closed during the day and opening only at night. A few flowers are specially designed for only one single kind of animal to drink their nectar. God even created flowers that look like animals. Did you know that a special tree in Madagascar drinks in water, storing it in its trunk like a giant water bottle? God created some trees to grow so tall they seem to reach the sky. Would you be surprised to learn that the oldest living thing we know of on Earth is actually a plant?



You can see from this Madagascar tree's swollen trunk why it's named the water bottle tree.



Just as you do when you create things,
God cares about His creation.



The design of these flowers is perfect for giving the hummingbird food.

As you journey through this book, you'll learn about soil, seeds, roots, leaves, flowers, creatures that help plants grow, trees, and so much more. You'll do projects like create a miniature indoor greenhouse (the light hut I mentioned earlier) and make a field guide of plants in your area. You'll do experiments with plants, like changing the color of flowers. You'll also record what you learn in your Botany Notebooking Journal. Very soon, you'll make a special book called a nature journal and, like a true scientist, you will record your scientific observations of the outdoor world on its pages. I think you'll enjoy digging into the natural world of plants and fungi, don't you?

Now let's learn about nature journaling and get started on our scientific studies.



Birds will feed on the nectar in these bleeding heart flowers.



This cradle orchid is sometimes called a swaddled baby orchid.



NATURE JOURNALING

Throughout history scientists, naturalists, inventors, and explorers have kept detailed accounts of what they see, experience, wonder about, and learn. Most of these people put their thoughts, ideas, and observations in a special book called a log or journal. Much of what we know about the world today we've learned from these scientists and explorers who shared their books with us. People such as Leonardo da Vinci, Lewis and Clark, Alexander Graham Bell, and James John Audubon left us amazing journals filled with their drawings and writings. These recordings have taught us a great deal about nature, inventions, territories, cultures, and human beings. We see from their journals how they took the time to study with great care what they saw.

Leonardo da Vinci made many kinds of sketches in his notebooks, from technology and animals to human anatomy. This is a page from one of his notebooks.

Usually, when we go outside, we don't take time to focus on the details around us. But if we do this, we will learn the skills of observation that gave them such great insight.

Like many great scientists from the past, you will keep a journal this year. It will be a nature journal. To start, let's try an activity that will help you become more observant so you will be a better nature observer and nature journalist.

ACTIVITY 1.1

THINK LIKE A SCIENTIST

Go outside in nature and begin looking around. Notice a plant as you walk past it. Take a leaf from that plant and look at it very closely. Notice its shape. How does it feel? Is it soft or hard? What color is it? Do you know what color it will be in another season? Do you know if it survives through the winter or if it will fall from the plant and die? How big is it compared to other leaves? What kind of plant does it grow on? A tree, a bush, a vine? Think about the answers to these questions and come up with other questions about it. Make your own unique observations about this particular leaf. If you have a magnifying glass, see if there is anything more to observe that you didn't notice when looking with your naked eye. Save your leaf for the next activity.



During the last activity, were you surprised at how much detail there was in that single leaf? Do you now see the plant a bit differently, understanding a little more about it than you did before? Even if you don't, that activity helped you observe a leaf the way a scientist does. You were training your eye to see and your mind to think critically, with more attention to detail, just like a scientist. That's what we will be doing a lot of during this course. By keeping a nature journal, you'll spend some of your time outdoors thinking hard about what you see. Instead of frolicking around the whole time, playing and enjoying the outdoors like a child, you'll take some time to enjoy the outdoors like a scientist.

So what exactly are you going to do with your nature journal? You'll take it on walks and hikes or to botanical gardens and nature nurseries. This journal will become your very own record of the things you see in nature—the plants and animals you find interesting.



The next time you are outdoors, I want you to slow down and pay close attention to what is around you. You'll be training your eyes to see, teaching your ears to hear, and schooling your mind to be still so you can notice the smallest details around you. It's when you begin to really see the elements of nature that you start thinking like a true scientist! After looking carefully at nature, you will begin recording your observations.



ACTIVITY 1.2

MAKE A NATURE JOURNAL

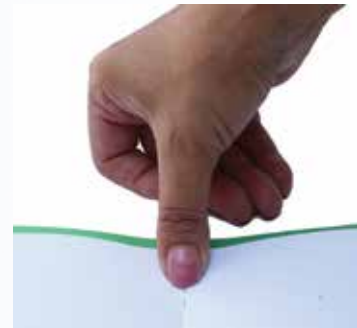
You will need:



- Cover paper (construction paper, colored card stock, or scrapbook paper)
- Copy paper (10–12 sheets)
- Stapler
- Stack of cardboard (or substitute a kitchen cutting board)

You will do:

1. Stack your copy papers on top of the cover paper.
2. Fold the papers in half and make a crease down the middle.
3. Turn the pages over and lay them flat on top of the cardboard stack with the cover paper facing upward.
4. Open the stapler and position it so that the staples will align with the crease in the center of the cover paper.
5. Staple three or four staples down the center of the papers to create the journal.
6. Pull the journal off the cardboard.
7. Turn it over so that the inside middle pages with the staples are facing upward. Ask an adult to flatten the staples in the center (You can use a butter knife to aid in this).
8. Decorate the cover however you wish. You may want to glue the leaf you studied earlier to the cover or make a drawing of it.
9. After you fill this journal with your thoughts and observations, just come back and make another one!
10. You will create a special pocket to store your nature journal inside the cover of your Botany Notebooking Journal.



USING YOUR NATURE JOURNAL LIKE A SCIENTIST

ILLUSTRATIONS, SKETCHES, AND DIAGRAMS

Illustrations are drawings. You can illustrate a part of something you see, such as a petal. Or you can illustrate the whole plant, or even the entire scenery, such as a waterfall and all the rocks and trees around it. Don't forget to bring a set of colored pencils for your illustrations. It might be helpful to get a book on how to draw. This will help improve your illustration skills more quickly.

Sketches are a little different from illustrations. They are often drawn quickly with only a pencil. You can also diagram what you observe, including labels with lines and arrows pointing to different parts of your sketch.

DATE, TIME, PLACE, AND WEATHER

The most important information to put on each page of your journal is the day, the time, and the place where you are observing nature. Be sure to include the time of year, the temperature, and what the weather is like that day.

Remember, good science begins by asking questions. This will be your first scientific inquiry for this course. It is my hope that sometime during this course you will discover the answers to your questions and learn secret things about the plant world that you didn't know before.

SPECIMENS

Very occasionally, and with your parents' approval, you can include in your nature journal samples of the leaves and bits of nature you find outdoors (as long as they are not too bulky). However, be careful not to disturb too much of nature when taking a specimen. You wouldn't want to remove the only flower in a field. You could disrupt the natural cycle of that plant's growth.



Press flowers for several days between two heavy books to flatten them before adding them to your nature notebook.

DESCRIPTIONS AND THOUGHTS

In their nature journals, scientists make detailed notes about what they see. They observe things carefully and notice small changes and differences in nature. In order to journal like these scientists, you'll need to make yourself think very carefully, asking questions about what you are observing. Is there anything special about the plant or animal that you notice? What does it look like? Does it have any special features that seem interesting or different from other plants or animals? If it is a plant, can you describe the shape of the leaves, the look of the stem, or the number of petals on the flower? What color is it? Look at it through a magnifying glass. Describe what you see in your journal. You may also want to write down what you think about while you are outside in nature. What can you note about the day, the weather, or the time of year?

LISTS

Sometimes it is helpful to make lists of things you see in nature. Simply write down every kind of tree you see on your nature walk through a certain park or record the name of every bird that comes into your backyard on a particular day.

Your lists will prove to be an interesting and important aspect of scientific study. With lists, you can begin to notice things that change in your area. Perhaps you remember always seeing a certain flower or bird in the spring, but later on you notice that it isn't present anymore. These are the kinds of observations that genuine scientists make.



ACTIVITY 1.3

JOURNAL ABOUT NATURE



Go outdoors and spend some time closely studying the plants in your yard. Be sure to ask lots of questions as you consider what you are seeing. Even if you don't know the answer, questions are a great way to begin thinking like a scientist. When you find something that seems interesting to you, illustrate it and write about it in your nature journal. Be sure to record the date, time, and place where you observed it.

SCIENCE OF BOTANY

You are certainly off to a great start in your science studies this year. I hope you are getting the knack of closely observing nature and recording your findings in your nature journal. Let's talk a little more about the science of botany.

VOCABULARY OF BOTANY

As it is with all sciences, you will learn the special vocabulary for the field of botany. Most often, the words you will learn come from ancient Latin or Greek languages. Since those languages are no longer spoken, they are great choices for science words. That's because the meaning of the words will never change. You see, in languages that are still in use, meanings change quite a bit. For example, many years ago, the word awful meant something that inspired a sense of awe. However in the language of our day, the word awful means something that is terrible. And we now use the word awesome to mean a sense of awe. So that's why you will find a lot of Latin and Greek words in science. They don't change and you will never be confused about what they mean. Don't worry about remembering all the vocabulary words you learn. The most important thing is that you develop a strong understanding of the science of botany and build memories of your learning through lots of hands-on experiences. Nevertheless, I am going to teach you a lot of new words this year. Let's take a look at some of these special words and find out more about the science of botany.



This is a Latin inscription on an ancient stone.





Botanists are scientists who specialize in the study of plants.

BIOLOGY OF BOTANISTS

Did you know that botany is a biological science?

What's a biological science? Let's take a look. Have you ever heard the word **biology** (by ahl' uh jee)? It sounds like a complicated word. In Greek, **bio** means life and **ology** means "the study of." So biology just means "the study of living things or life." Plants are living things, so botany is also biology. A botanist is a biologist who studies plants. So if someone asks what you are studying in science this year, it would be correct to say you are studying biology. Zoology is the study of animals. It's also a biological science. So is human anatomy. There are many other fields of biology. After you learn botany, perhaps you'll want to study another biological science.

So what do botanists actually do? Well, have you ever taken medicine that healed you of an illness? Some botanists study plants that are used to make medicines that cure diseases. In fact, many different medicines are made from plants. Before modern medicine, people relied on healers who knew which plants helped to cure which diseases. They weren't officially called doctors, nor were they called pharmacists. But they were actually both. A doctor figures out what's wrong and then prescribes medicine that a pharmacist prepares for the patient. Many years ago, the healer figured out the problem and prepared the medicine using mostly plants. For example, if someone came down with a bad cold, a healer might make a tea from the sage plant. Sage is an herb that has many healing properties. Not only does it help with colds, but it also fights bacteria and helps with breathing problems. In fact, its scientific name is *Salvia Officinalis*, a word which means "the plant saves people."



For thousands of years, herbs have been used for healing as in this sage tea.

Hundreds of years ago, healers had a vast knowledge of botany. Even today, many people use plants to help with healing. When I was a child, my mother would slice open an Aloe vera cactus and rub the pulp on my sunburn to heal it. Today, I use oil from the tea tree plant to heal my children's cuts and keep the mosquitoes away by rubbing it on our skin. Chamomile is an herb that helps stomach pain, fevers, colds, and asthma. It also helps people sleep. Echinacea is used to fight off a cold. Many people use oils from plants to help with different complaints and problems. However, most of us do not rely on plants anymore to heal us directly.



Today we rely on pharmacy companies to make medicines, and many of those medicines come from plants. Why would we rely on others when we could use the plant ourselves? Because

The leaves of the Aloe vera plant contain healing properties and are especially helpful for burned skin.



modern medicine has taken the science of healing plants and improved it in many ways. Instead of using the entire sage plant, a pharmacist might determine what element of the plant is helpful and try to isolate that element to put into a pill form that people can take. So pharmacists use botany to make medicines and find cures for diseases.

Some botanists experiment with plants to learn more about them and how they can make specific crops grow faster, stronger, and better. They hope to produce plants that will grow more fruit that is bigger and more nutritious. They want the crops that we eat, like corn and wheat, to resist disease and be less attractive to pests. In areas where water is scarce, botanists attempt to produce crops that need less water. There are so many ways botanists can help farmers and improve the foods we eat.

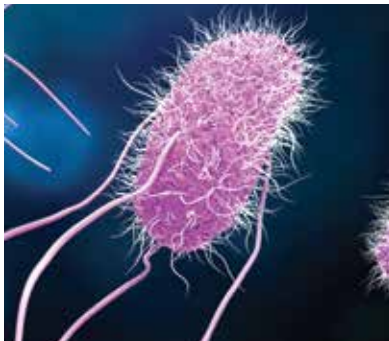
As you can see, there are many ways botanists help the world. Since plants are so useful and essential to humans, the study of botany will always be a very important field of science.

Before we look at how a biologist organizes the world, tell someone everything you have just learned about botanists.



TAXONOMY

Do you like to have things organized? Do you like it when all your shirts are in one drawer, your socks are in another drawer, and your pants are in yet a different drawer? It makes life a lot easier when we are organized. Well, biologists like to organize things too. Living things. God created so many different



Kingdom Monera includes bacteria.



Kingdom Fungi includes mushrooms.



Kingdom Protista includes algae.



Kingdom Animalia includes all the animals.

living things that biologists have spent a great deal of time separating them into different groups, called kingdoms. This helps biologists keep things organized. They've put plants in one huge group, called the plant kingdom, or **Kingdom Plantae** (plan' tay). They've also put mushrooms and other similar growths in their own group called **Kingdom Fungi**. We will study these two kingdoms this year. But there are other living things, aren't there? Can you think of a living thing you've seen recently? You might have mentioned some kind of animal. Maybe next year you will begin studying the creatures in **Kingdom Animalia** (an uh

mal' ee uh), otherwise known as the animal kingdom. But there are other kingdoms as well. Some kingdoms involve life that is so small that you can only see it with the help of a microscope!

But the organizing doesn't stop after dividing up the plants, animals, and other living things. Nope. Biologists like to place living things into even smaller groups. Let's take a look at a few of the ways they divide up plants.

VASCULAR PLANTS AND NONVASCULAR PLANTS

There are two main groups of plants, vascular and nonvascular. Before we discuss these two groups, I want to ask you a question. After you wash your hands in the sink, do you know where the water goes? Do you know where it comes from to get into the faucet? Well, it travels through tubes that are inside your house. Those tubes, or pipes, bring the water in and take the water out. You might say water is transported through these tubes. Guess what? That's one of the things botanists look at when dividing up plants: whether they have tubes in them or not. The plants with tubes are called **vascular plants** and the ones without tubes are called **nonvascular plants**. The word vascular just means a hollow container. The tubes are vessels inside the plant that transport fluids, like water.



Inside your body are tubes filled with blood.

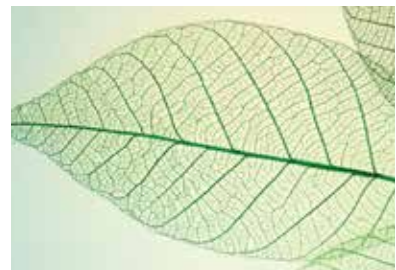
You're probably trying to imagine tubes in a plant and what they look like. Do you think you might have tubes inside you? Look at your wrist. Do you see blue streaks? Those are tubes called **veins** (vaynes). They contain fluid. What do you think that fluid is called? It's called blood, of course! You see, then, that you and I are vascular, similar to vascular plants!

As you'll discover over and over again when learning science, God made many living things in a similar way; plants and people both have tubes inside them. This shows us that God is consistent in His design of the world. Think about the pictures you draw. All of your pictures are similar to one another because they are made by the same artist—you! This is how it is with God's world. We can see that everything in the world was made by the same artist—God!

Look at the leaf in the picture. Do you see the veins? These veins carry water and other important nutrients throughout the plant. Although you can actually see many of the tubes in a plant by just looking at its leaves or flowers, many are also hidden inside the plant and are hard to see. That's the way it is with the tubes inside you, too!



Behind the walls of your house are pipes and tubes where water and gas flow.



This leaf skeleton shows us the veins that are under the surface of the leaf.



Each part of a vascular plant, even the flower, has tubes that transport fluid.

ACTIVITY 1.4

OBSERVE LEAF VEINS

Get a leaf from a nearby plant. Look at it very carefully. Can you see the veins? Do you see one vein in the very middle that is thicker than the rest? That's called the **midrib**. It gets water from the stem and carries it to all of the smaller veins in the leaf. Did you know there are even more veins under the green part of the leaf? They are hard to see right now. But perhaps you've walked through nature and have seen leaves that have lost most of the green and are left with just the veins. If you haven't, begin looking for these leaves when you walk around outside. If you find one, be sure to take it home and put it in your nature journal.



NONVASCULAR PLANTS

The truth is, most plants have veins, so most plants are vascular. The most obvious way you can tell if a plant is vascular is by looking to see if the plant has roots, stems, and leaves. If so, it is always a vascular plant. Can you think of any plant that doesn't have roots, stems, and leaves? It's hard to imagine plants without roots, stems, and leaves, but they do exist! One that you've probably seen is moss. Moss grows where it is moist, such as the north side of trees or on rocks and land near rivers and streams. Moss, as you've probably already figured out, is a nonvascular plant.

Nonvascular plants don't have inside tubes to transport water through the plant. Instead, they simply absorb water and spread it around as much of the plant as they can the way a paper towel does.

As you might have guessed, nonvascular plants need a lot of water around them to live. They can't store water inside themselves the way vascular plants do. Let's look at how nonvascular plants distribute water throughout the plant.

ACTIVITY 1.5a

OBSERVING ABSORPTION

Here's an activity to help you understand how nonvascular plants get the water they need to survive. You will need a paper towel and some water. Do you think a paper towel has veins or tubes inside it to transport water? No, it doesn't. It absorbs water. That's how it gets wet all over.

Spill some water on a counter and place the edge of the paper

Like nonvascular plants, paper towels absorb water.



towel in the water. Notice how the water spreads through the paper towel. If there is enough water, a lot of the paper towel will get wet. If not, only a small part of it will get wet. That's similar to the way moss and other nonvascular plants get the water they need. There must be a lot of water present in order for water to spread throughout the whole plant. If they don't get enough water, they will dry up. Places that have a lot of humidity (which is water vapor floating in the air) have a lot of nonvascular plants. Why? Because if there is a lot of moisture present in the air, the plants can absorb the water through their leaves. Record what you observed in your Botany Notebooking Journal.



ACTIVITY 1.5b

WALKING WATER WITHOUT A VASCULAR SYSTEM

You will need:

- 4 standard-sized paper towels
- Red, blue, and yellow food coloring
- 5 small, clear cups
- Spoon
- Water



You will do:

1. Line up the cups next to one another and fill every other cup with an equal amount of water.
2. Place a teaspoon of red in the left cup with water, yellow in the middle cup with water, and blue in the right cup with water.
3. Stir the cups of water with the spoon to distribute the coloring.
4. Fold one of the paper towels in half (lengthwise), and repeat two more times.
5. Repeat step 4 with the four other paper towels.
6. Place one end of each paper towel in one cup and the other end in the cup next to it.
7. Check back in a few hours to see how the water has walked.
8. Record what you did and learned in your Botany Notebooking Journal.



Before doing the next activity, explain what you've learned so far about botany.



ACTIVITY 1.6

GO ON A NATURE HUNT

There are not very many nonvascular organisms to be found, but you are going to hunt for them and draw them in your nature journal. Look carefully at the pictures below of the main kinds of nonvascular organisms you may find.



Lichen



Liverwort



Hornwort



Moss

Now, go outside and see if you can find any of the organisms pictured above. If you find one, use a magnifying glass to look at it closely. You may be surprised that it appears to have a stem or little leaves. But they are not true leaves because they don't have tubes inside. Draw in your nature journal the nonvascular plants you found on your hunt.

TO SEED OR NOT TO SEED

So far you learned that biologists separate all living things into different kingdoms. Do you remember the scientific name for the plant kingdom? You got it—Kingdom Plantae. You also learned that botanists separate plants by whether or not they have tubes inside. Did you know biologists also look at whether or not a plant has seeds? Some plants produce seeds. Other plants do not.

Here's a bit of Latin for you: seed-making plants are called **Spermatophyta**. That's because in Latin the word *sperm* means seed and the word *phyta* means plant. So *Spermatophyta* means seed plants. Biologists divide spermatophytes into even more groups, such as those that make pinecones and those that make flowers. We'll discuss those later in this book.

Stop and think about seeds for a minute. What exactly are seeds good for? Why does a plant



need to make seeds? If you guessed to make new plants, you are right! Seeds grow into a new plant. You would think that all plants make seeds but that's not the way it is. There is a group of plants called spore plants. Plants in this group make spores instead of seeds.

SEEDLESS PLANTS

Have you ever seen a plant called a fern? At certain times of the year, the backside of the fern leaf will be covered with little brown clumps. These clumps are called **sporangia** (spuh ran' jee uh). Inside the sporangia are millions of tiny little bodies called spores. These spores, in the right conditions, can one day grow into a new plant.

Even though seeds and spores both grow into plants, spores are not seeds. You see, a seed is



These moss spores are tiny because they don't contain food for the baby plant.



Each of the clumps on this fern contains millions of spores.

a very special plant package. It contains a baby plant, food for the baby plant, and a protective covering. You can think of a seed as a baby plant in a box with its lunch. A spore is just the baby plant and a protective coating. There is no food for the baby plant. Since there is no food in a spore, spores are much smaller than seeds. They also need extra special conditions to grow. We'll learn all about that in a later lesson.



Before you move on to the notebooking activities, let's review what you've learned so far.

WHAT DO YOU REMEMBER?

Why do scientists use Latin and Greek words to name things? What is a biologist? What is a botanist? What are some helpful or interesting things that botanists do? What do vascular plants have that nonvascular plants do not have? What is a Spermatophyta? Can you name one? Can you name a plant that is a sporophyte?

ACTIVITY 1.7

GROUPING PLANTS

In your Botany Notebooking Journal, you will find a special page to help you remember how plants are divided. In each circle, draw or paste a picture of some of the plants found in each group. Below each circle, record what features plants in that group have.

You have already learned a great deal of botany so far. Now it's time to build our special plant growing structure called a light hut. Then we'll start growing our own edible plants!

ACTIVITY 1.8

MAKE A LIGHT HUT

You will need:

- Large, empty, open cardboard box (see image)
- Aluminum foil
- Single socket pendant lamp cord (for lanterns)
- LED full spectrum grow light bulb
- Glue
- Scissors



You will do:

1. Cut a 1-inch hole in the top center of the box.
2. Cut ventilation slots in the top, upper sides, and back of the box to allow the air to flow and the heat to escape.
3. Use glue to cover the entire inside of the box with aluminum foil. This will make the inside of the box very shiny.
4. Cut a hole through the aluminum foil where the hole in the top of the box is and cut slits in the foil where the ventilation slots are.
5. Position the light bulb inside the center of the box, pushing the base of the light bulb through the top of the box.
6. Secure the light by attaching the socket from the outside of the box.
7. Tape an aluminum foil curtain to the top front edge of the box so that it hangs down over the opening of the box. This curtain is designed to keep light from escaping the box. However, it needs to hang loosely so there is plenty of ventilation. If your plants seem to be drying out or if the inside of the box gets hot, you will want to lift the curtain for a bit.



ACTIVITY 1.9

GROW EDIBLE PLANTS

If you are beginning your seeds in the fall, grow herbs to keep indoors for the winter. Herbs are a great way to enjoy the plants you grow. Three months before the last frost (you can go online to find out when the last frost is for your area), using the same supplies, pick the seeds you will plant in your edible garden.

You will need:

- Seeds
- Small flowerpots
- Vermiculite
- Peat moss
- Compost
- Your light hut
- Water
- Timer (optional)

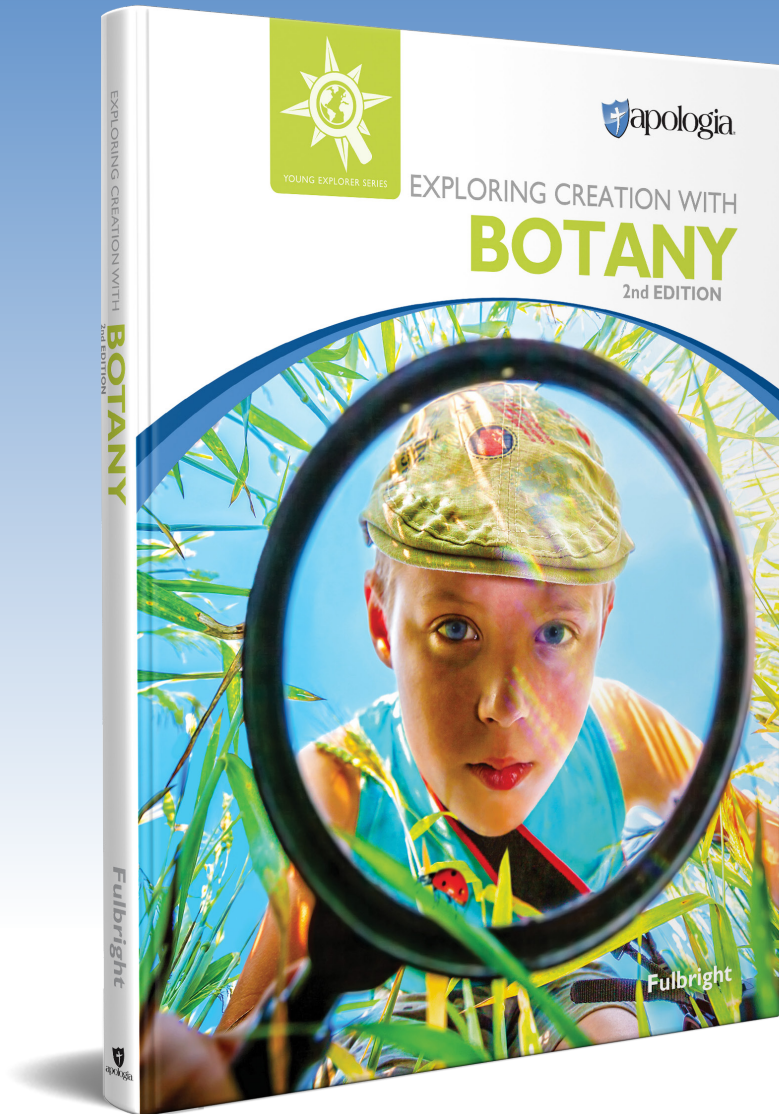
You will do:

1. Fill each small pot with equal parts vermiculite, peat moss, and compost.
2. Following the instructions on your seed packet, plant a few seeds in each pot.
3. Water the pots well.
4. Place the pots under the grow light.
5. Keep the light on for 12–14 hours a day, turning it on in morning and off in the evening. You can also put the light on a timer. Make sure you check your box regularly to ensure it isn't too hot or too dry.
6. Water your seeds daily to ensure the soil does not dry out.
7. Check the seed packet to determine the number of days it will take for your seeds to sprout. Make note of this in your notebooking journal. Be sure to note if the seeds sprout on time or if the light hut speeds their sprouting.
8. When the plants begin growing, thin them out so you have only one or two plants in each pot, or follow the seed packet instructions.

Once the seeds have sprouted into seedlings and get too big for the original pots, transplant them into bigger pots that contain equal parts vermiculite, compost, and peat moss. Keep the plants on a sunny windowsill and enjoy the herbs in your cooking!

You can also use your light hut to start fruits and vegetables from seeds. You can then plant them in your edible garden.





THIS IS THE START OF THE LABORATORY LIST

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SUPPLY LIST

Lesson 1

- Cover paper (construction paper, colored card stock, or scrapbook paper)
- Copy paper (10–12 sheets)
- Stapler
- Stack of cardboard (or substitute a kitchen cutting board)
- Standard-sized paper towels
- Red, blue, and yellow food coloring
- 5 small, clear cups
- Spoon
- Water
- Large, empty, open cardboard box
- Aluminum foil
- Single socket pendant lamp cord (for lanterns)
- LED full spectrum grow light bulb
- Glue
- Scissors
- Seeds
- Small flowerpots
- Vermiculite
- Peat moss
- Compost
- Your light hut
- Water
- Timer (optional)

Lesson 2

- Seeds (bean and sunflower work best)
- 3 plastic Ziploc® bags
- 3 paper towels
- 3 or more turnip seeds (or bean seeds)
- Tape
- Ruler (should read centimeters)
- Scientific Speculation Sheet

Lesson 3

- Flower (A lily works best because all parts of the flower are easily visible.)
- Flower dissection page of your Botany Notebooking Journal
- Glue or tape
- Adult to use a knife in this activity
- Cup of soil
- Sunny windowsill
- Sunflower seed
- Fresh flower
- Container with a lid
- Borax

Lesson 4

- 2 flowers that are still on their plants. They should be on separate plants of the same type.
- Cotton swab (like a Q-tip®)
- Small mason jar with lid
- Red spray paint
- Adult with a drill or hammer and nail (to punch holes in the lid)
- 1 yard of wire (cut in three equal pieces)
- 1 small piece of wire (for fastening other wires)
- Water and sugar
- Vermiculite
- Compost
- Peat moss
- Flowering plants that produce the kind of nectar most butterflies enjoy eating (butterfly bush, lantana, zinnia, bee balm, purple coneflower, penta, sage, milkweed or butterfly weed, lilac, sunflower, marjoram)

Lesson 5

- 1 Really ripe banana
- 1 fresh banana
- Squash or medium-sized pumpkin
- Adult with a sharp knife
- Burr
- Magnifying Glass
- Apple cut into 5 slices
- 4–5 cups filled with different substances: lime juice, vinegar, olive oil, water, and/or saltwater. You can also add more cups and try other substances you think may be helpful in preserving the fruit's color.

Lesson 6

- 2 identical candles
- Matches or lighter
- Adult
- 2 large jars
- Small plant
- Plank of wood
- Large glass jar
- Organic potato (regular potatoes are sprayed with a substance to keep them from growing roots)
- 2 bamboo skewers
- Water
- Plastic sandwich bag
- Clothespin
- Living plant that is not an evergreen
- Mod Podge®
- Card stock or blank canvas
- Fall leaves
- Paintbrush
- Multiple different leaves

Lesson 7

- Black bucket with lid
- Adult
- Hammer and nail (or drill)
- Compostable material
- 5–8 paper towels
- Water
- 5–10 bean seeds
- Romaine lettuce scrap (the bottom two inches of the base)
- Celery scrap (the bottom two inches of the base)
- Glasses or jars
- Planter big enough for two vegetables
- Garden soil

Lesson 8

- Celery
- Cup
- Water
- Blue food coloring
- Clay or Play-Doh®
- Yellow, green, red, and blue food coloring
- 4 tall glasses
- 4 white roses or white carnations (If neither of these flowers are available at your local store, you can try to use another variety of white flower.)
- 2 paper or Styrofoam® cups with a lid
- 4 bean seeds
- Mixture of vermiculite and compost for soil
- Sharpened pencil
- Black paint

Lesson 9

- Materials to build a raised garden bed
- Compass
- Empty plastic bottle with lid (sturdier energy drink bottles with a wide mouth work best)
- Drill or hammer and nail



Lesson 10

- Ruler
- Colored pencils
- Twig on a tree
- Someone to help you
- Measuring tape or yardstick to measure the height of your helper
- 12-inch ruler
- Tall tree
- Crayon with all the paper removed
- Plain white paper
- Tacks (optional)

Lesson 11

- Tape measure
- Chalk
- 2 plastic sandwich bags
- 2 clothespins
- Deciduous tree
- Conifer tree
- Pinecone
- Oven preheated to 250 degrees
- Bucket of cold water

Lesson 12

- Paper
- Several fern fronds
- Several colors of paint
- Paintbrush or sponge
- Large glass container with a lid
- Pea-Ver-Comp mixture
- Miniature fern

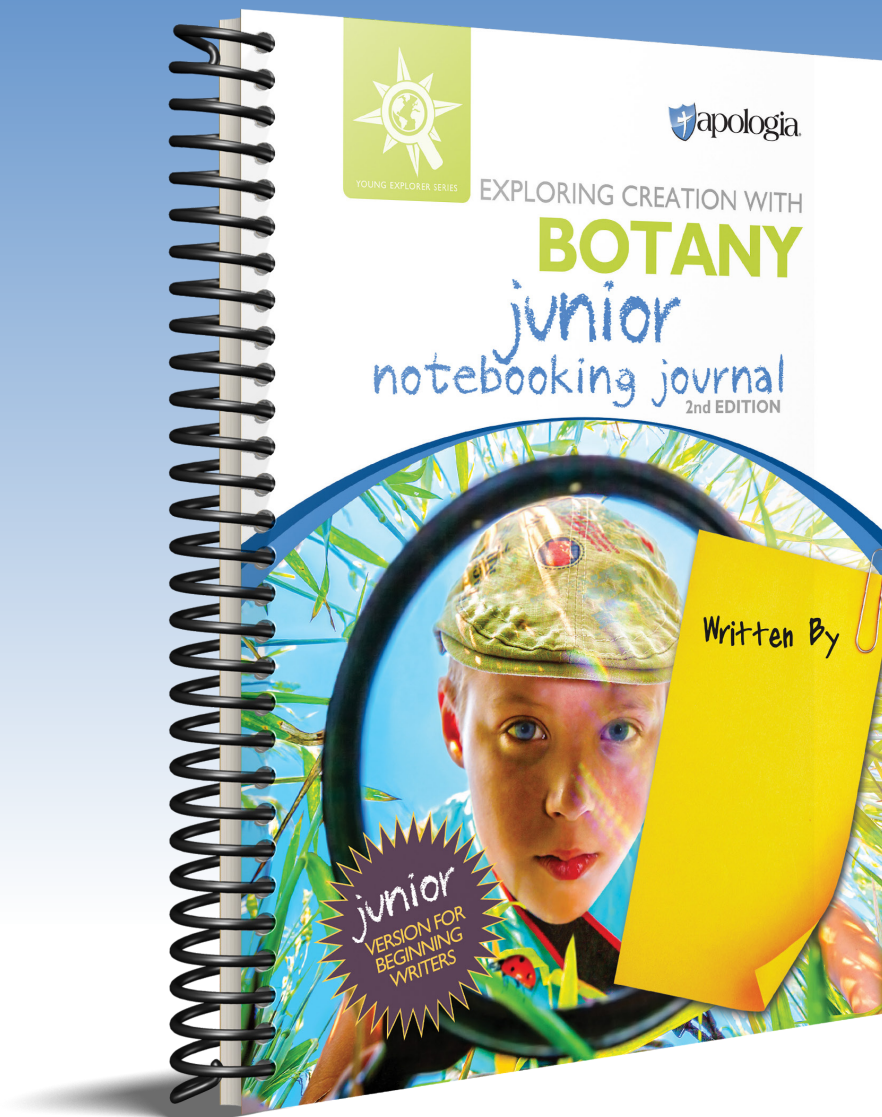
Lesson 13

- Coat hanger
- Yarn
- Tape
- Trees with lichens on them, preferably in different places (Lichens prefer oak trees because they can keep the water locked into the deep ridges of the oak bark better than in the bark of most trees.)
- 3 handfuls of moss

- 2 tablespoons of water retention gel
- Half cup buttermilk
- Blender
- Bucket
- Paintbrush (2 inch)
- Spray bottle with water
- Piece of plywood or another surface where you want your moss to grow (Ideally you want the surface to be located in a shady area.)

Lesson 14

- 5 bottles
- 12 tsp yeast
- 10 tsp sugar
- 5 balloons
- Funnel
- Measuring cups
- Measuring spoons
- Warm water
- 3 slices of bread
- Water
- 3 plastic Ziploc® bags
- Permanent marker
- Ruler
- Store-bought mushrooms with stems in place
- Brightly colored cardstock (don't use black or white as some spores are black or white)
- Plastic cup
- Pitcher of water
- Woodchip mulch (do not use pine mulch or cedar mulch)
- Plastic tub with lid
- Colander
- Compost
- Scissors
- Spray bottle filled with distilled water



THIS IS THE START OF THE JUNIOR NOTEBOOKING JOURNAL

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EXPLORING CREATION WITH **BOTANY** 2nd EDITION

Two Days a Week Suggested Schedule

Please feel free to adjust this schedule to fit your family's needs.

WEEK 1

- ☐ **LESSON 1 – WHY BOTANY MATTERS**
Read **T p. 14–16** and narrate what you learned
Begin working on the Botany Coloring Page **NJ p. 26**
Add a sentence or drawing to Fascinating Facts About Botany **NJ p. 27**
Begin the Botany Minibook **NJ p. 43**

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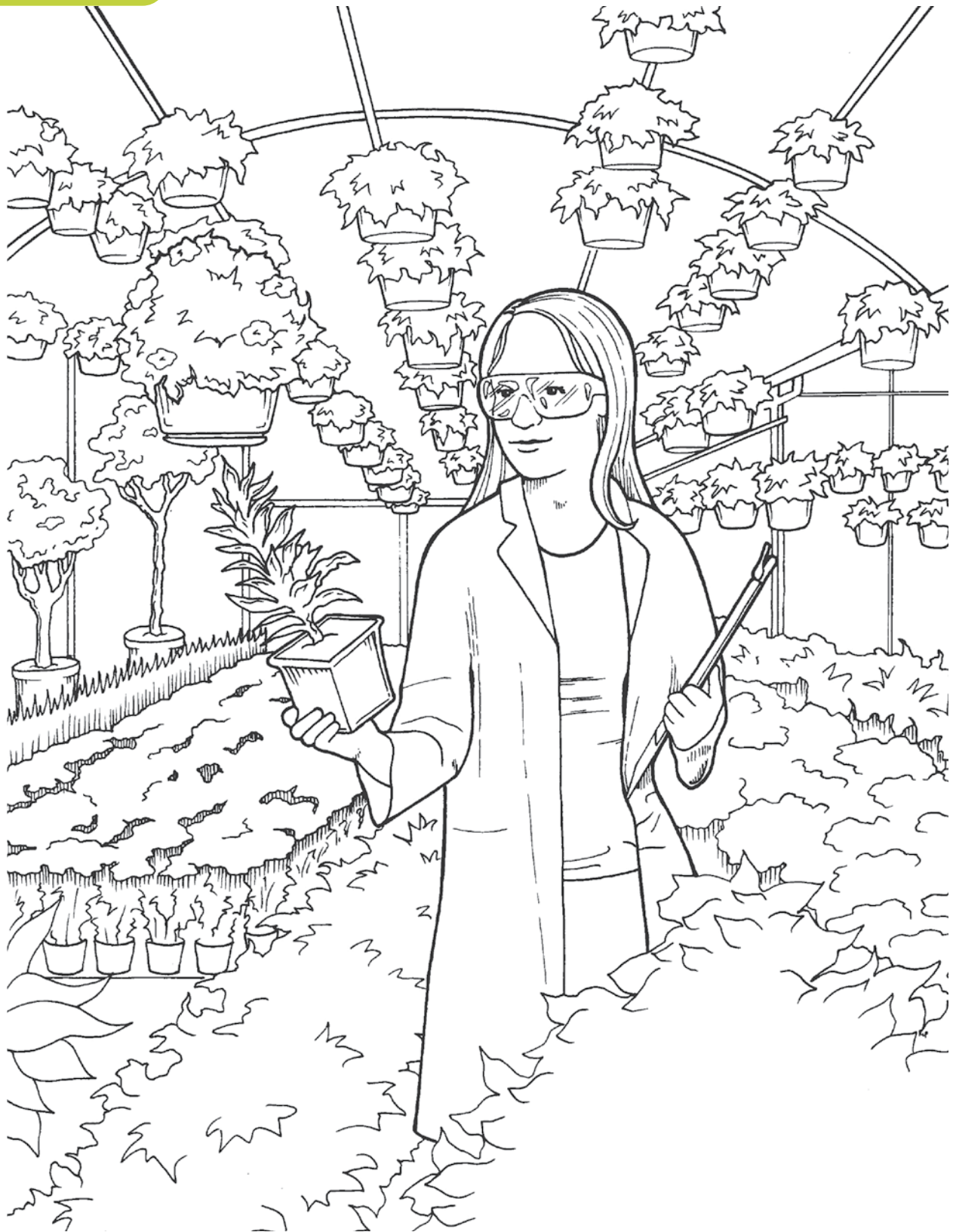
WEEK 2

- ☐ **LESSON 1 – WHY BOTANY MATTERS**
Read **T p. 21–25** and narrate what you learned
Add more information to Fascinating Facts About Botany **NJ p. 27**
Do Activity 1.4: Observe Leaf Veins **T p. 25, NJ p. 31**
Do Activity 1.5a: Observing Absorption **T p. 25, NJ p. 32**
Read **T p. 26** and narrate what you learned
Do Activity 1.5b: Walking Water Without a Vascular System **T p. 26, NJ p. 32**
Do Activity 1.6: Go on a Nature Hunt **T p. 27, NJ p. 33**
Add creative work to the Creativity Page **NJ p. 48**

LESSON I

WHY BOTANY MATTERS





He causes grass to grow for the livestock and provides crops for man to cultivate, producing food from the earth.

Psalm 104:14



BOTANY

FASCINATING FACTS AND PERSONAL REFLECTIONS

The form consists of a large blue-bordered area. On the left side, there is a dotted-line box. To the right of this box, there are ten sets of horizontal lines for writing, each set consisting of a solid top line, a dashed middle line, and a solid bottom line. Below this entire section, there are another ten sets of similar horizontal lines for writing.



ACTIVITIES AND OBSERVATIONS

ACTIVITY 1.1: THINK LIKE A SCIENTIST

what I did

what I learned

Draw your leaf below.



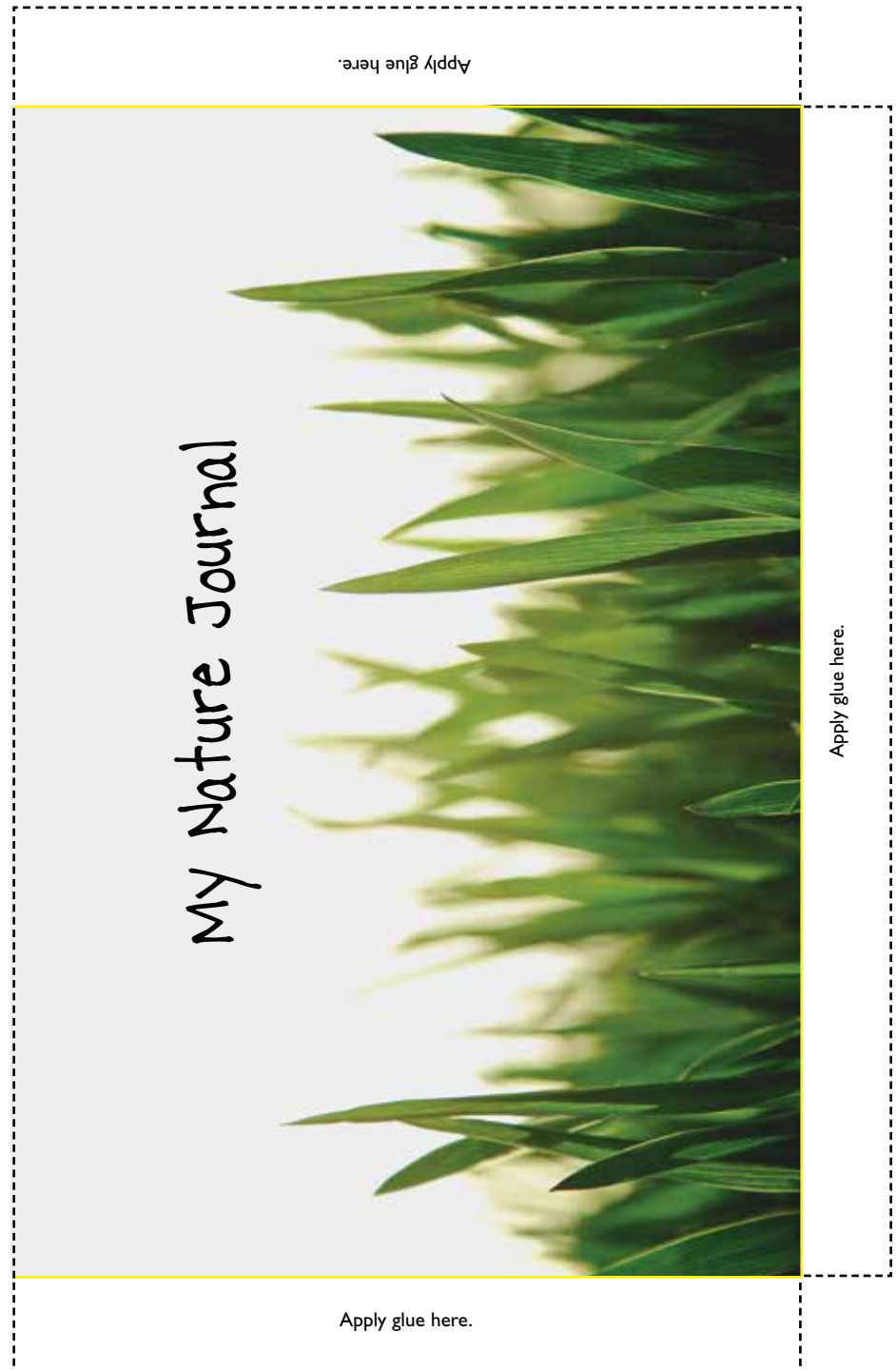
ACTIVITIES AND OBSERVATIONS

ACTIVITY 1.2: MAKE A NATURE JOURNAL

Create a pocket to store your Nature Journal.

INSTRUCTIONS:

1. Remove this page from your notebook.
2. Cut along the dotted lines.
3. Fold along the solid yellow lines.
4. Apply glue where indicated.
5. Attach to the inside cover of your notebooking journal 1–2 inches from the bottom to make a pocket.
6. Leave notebooking journal open while the glue dries.
7. Store your Nature Journal in the pocket.



ACTIVITIES AND OBSERVATIONS

ACTIVITY 1.3: JOURNAL ABOUT NATURE

My favorite thing journaling about nature was...

ACTIVITY 1.4: OBSERVE LEAF VEINS

Draw a picture or do a rubbing of your leaf here. Be sure to mark the midrib.



ACTIVITIES AND OBSERVATIONS

ACTIVITY 1.5a: OBSERVING ABSORPTION

Draw how the water absorbed with your paper towel.



ACTIVITY 1.5b: WALKING WATER WITHOUT A VASCULAR SYSTEM

Color your cups in the colors you used and show how the colors mixed.



what I learned



ACTIVITIES AND OBSERVATIONS

ACTIVITY 1.6: GO ON A NATURE HUNT

I found the following nonvascular plants on my nature hunt:



ACTIVITIES AND OBSERVATIONS

ACTIVITY 1.7: GROUPING PLANTS

In each circle, draw a picture of some of the plants found in each group. Below the circle, record what features plants in that group have.

Vascular Plants

Nonvascular Plants

Spermatophyta (seed-making plants)

Sporophytes (spore-making plants)





WHAT DO YOU REMEMBER?

Why do scientists use Latin and Greek words to name things?

What is a biologist?

What is a botanist?

What are some helpful or interesting things that botanists do?

What do vascular plants have that nonvascular plants do not have?

What is a spermatophyta? Can you name one? Can you name a plant that is a sporophyte?



VOCABULARY LIFT THE FLAP

Tear out this page. Cut out each word and match it to the correct definition on the following page. Then, place glue along the top edge of the back of each word and glue above the line on each definition. Once the glue is dry, fold back the word to reveal the definition.

**Vascular
Plants**

**Nonvascular
Plants**

**Kingdom
Plantae**

**Kingdom
Fungi**

Biology

Taxonomy

Botany

Sporangia





VOCABULARY

LIFT THE FLAP

<p>Glue correct word above this line, then fold back.</p> <p>The study of plants.</p>	<p>Glue correct word above this line, then fold back.</p> <p>The clumps on the underside of ferns containing spores</p>
<p>Glue correct word above this line, then fold back.</p> <p>The process of placing living things into different groups</p>	<p>Glue correct word above this line, then fold back.</p> <p>The Study of Life</p>
<p>Glue correct word above this line, then fold back.</p> <p>Plants with tubes that carry liquid inside.</p>	<p>Glue correct word above this line, then fold back.</p> <p>Plants that do not have tubes inside but instead absorb liquid</p>
<p>Glue correct word above this line, then fold back.</p> <p>The kingdom that contains all plants.</p>	<p>Glue correct word above this line, then fold back.</p> <p>The kingdom that contains mushrooms.</p>



ACTIVITIES AND OBSERVATIONS

ACTIVITY 1.8: MAKE A LIGHT HUT

what I did

what I learned

Draw a picture of your light hut.



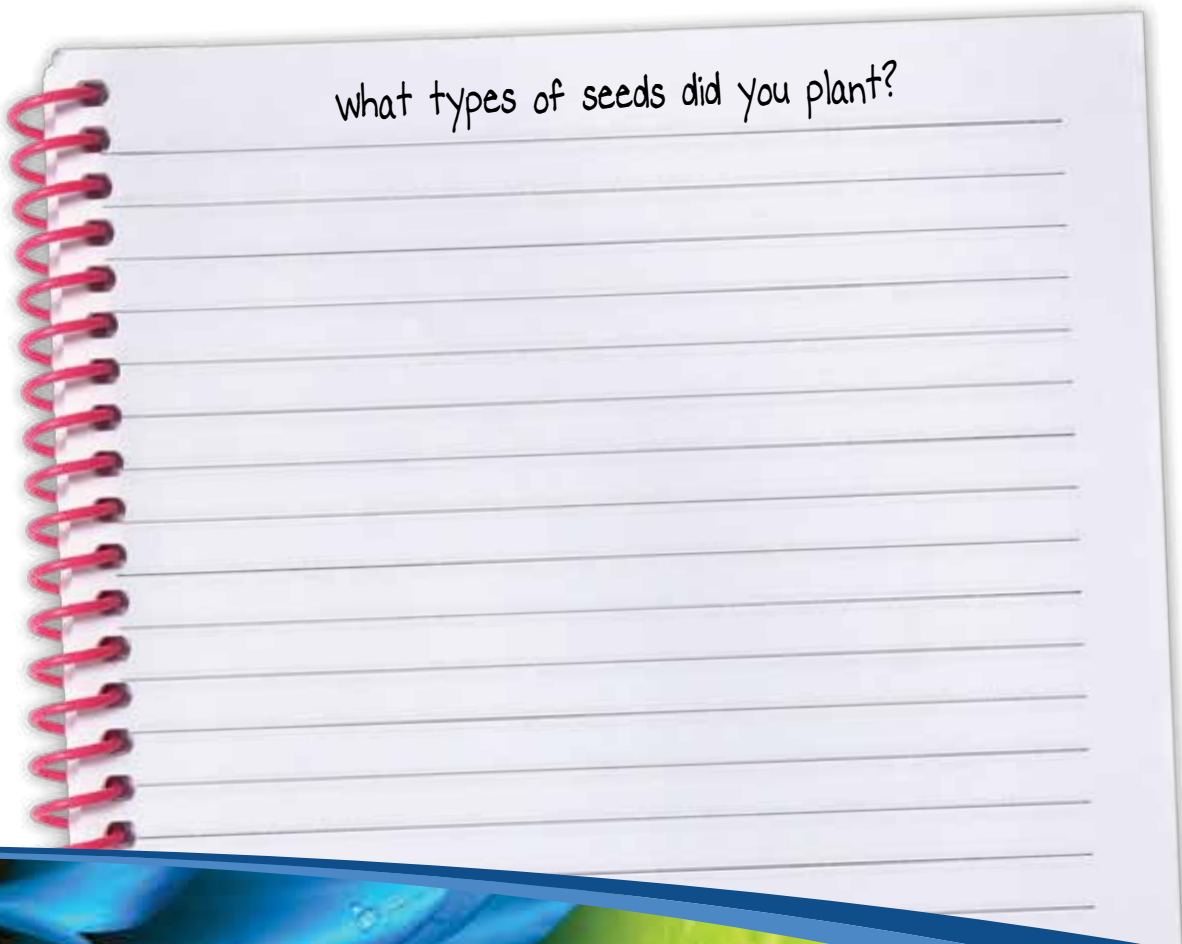
ACTIVITIES AND OBSERVATIONS

ACTIVITY 1.9: GROW EDIBLE PLANTS

what I did

what I learned

what types of seeds did you plant?



botany wheel
MINIBOOK

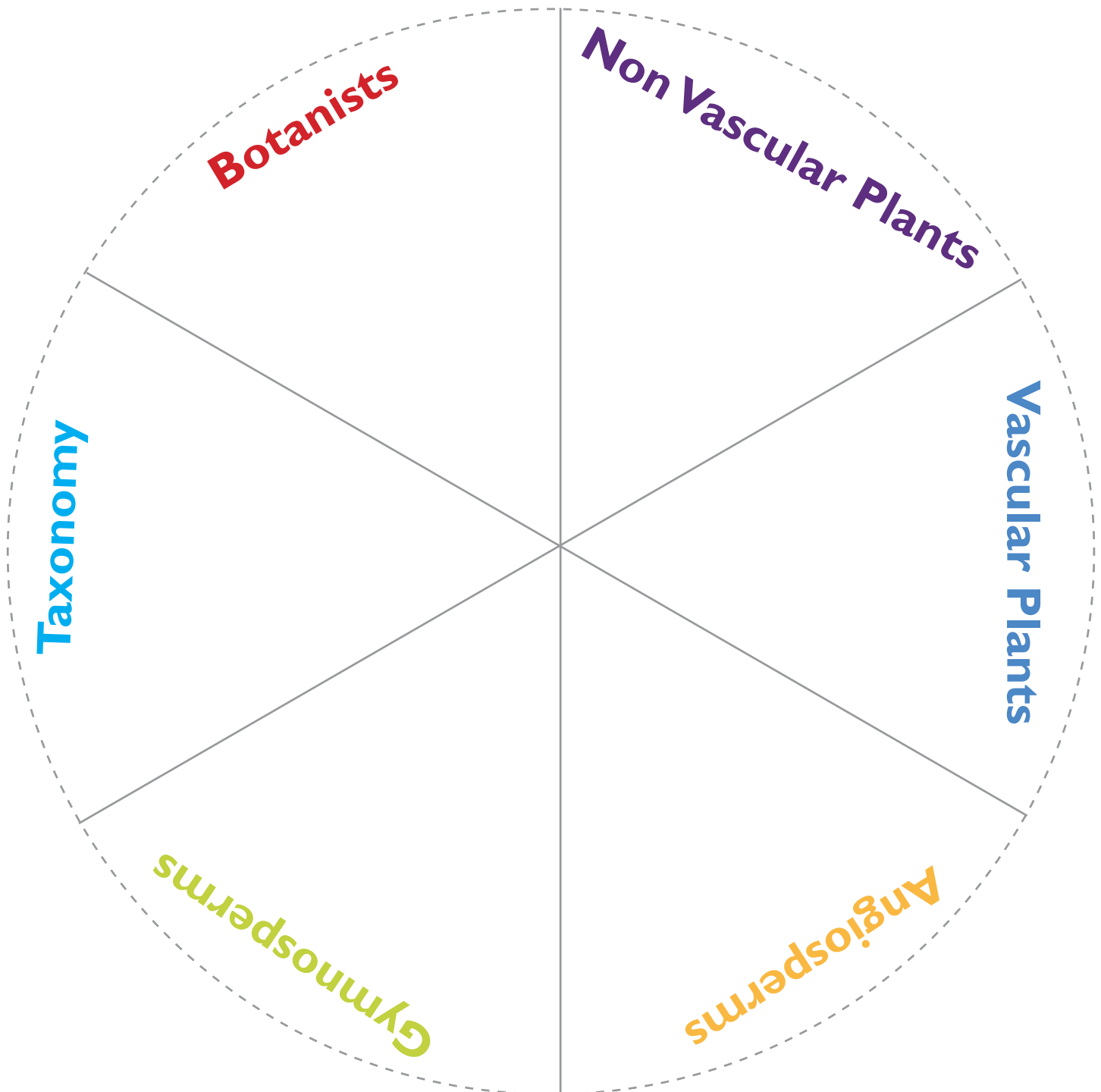
Green Leaf Circle



BOTANY

Instructions:

1. Write something interesting you learned about each topic listed in the Fact Circle.
2. Cut out both the Fact Circle and the Green Leaf Circle. Be sure to cut out the white empty space in the Green Leaf Circle.
4. Place the Green Leaf Circle on top of the Fact Circle, and insert a brass fastener in the center to secure the two circles.
5. Dab glue on the bottom of the Fact Circle and glue your Botany Wheel onto the “Botany Minibook” paste page.
6. Turn the Green Leaf Circle around to reveal the different facts about each topic.



botany wheel
MINIBOOK

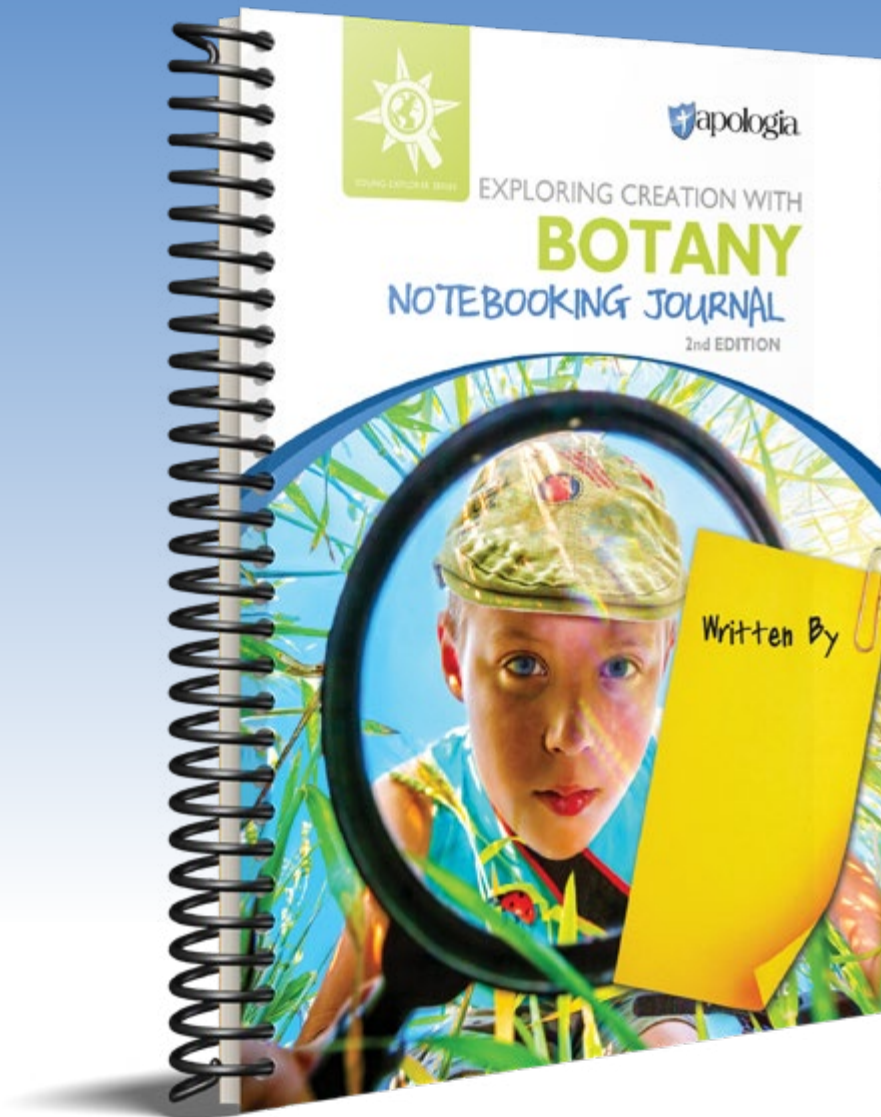
Attach your botany wheel below.



CREATIVITY PAGE

Make a scrapbook page of your journey learning about why botany matters.





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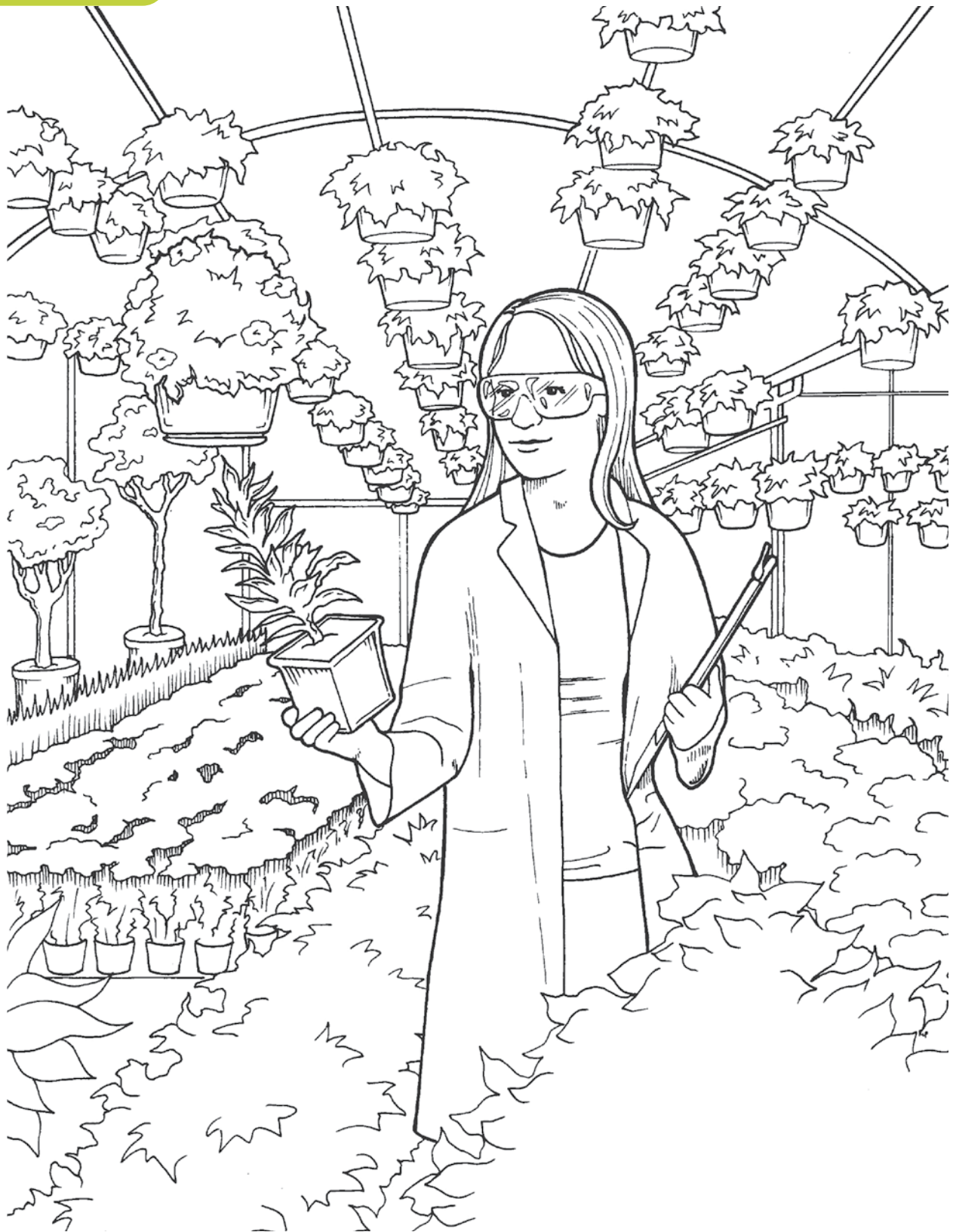
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WEEK 2

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Do Activity 1.4: Observe Leaf Veins **T p. 25, NJ p. 31**
Do Activity 1.5a: Observing Absorption **T p. 25, NJ p. 32**
Read **T p. 26** and narrate what you learned
Do Activity 1.5b: Walking Water Without a Vascular System **T p. 26, NJ p. 32**
Do Activity 1.6: Go on a Nature Hunt **T p. 27, NJ p. 33**
Add creative work to the Creativity Page **NJ p. 48**



He causes grass to grow for the livestock and provides crops for man to cultivate, producing food from the earth.

Psalm 104:14



BOTANY

FASCINATING FACTS AND PERSONAL REFLECTIONS



A large blue-bordered area with a dotted line on the left side, containing horizontal lines for writing. The background is a blurred image of laboratory glassware with plants inside.



ACTIVITIES AND OBSERVATIONS

ACTIVITY 1.1: THINK LIKE A SCIENTIST

what I did

what I learned

Draw your leaf below.



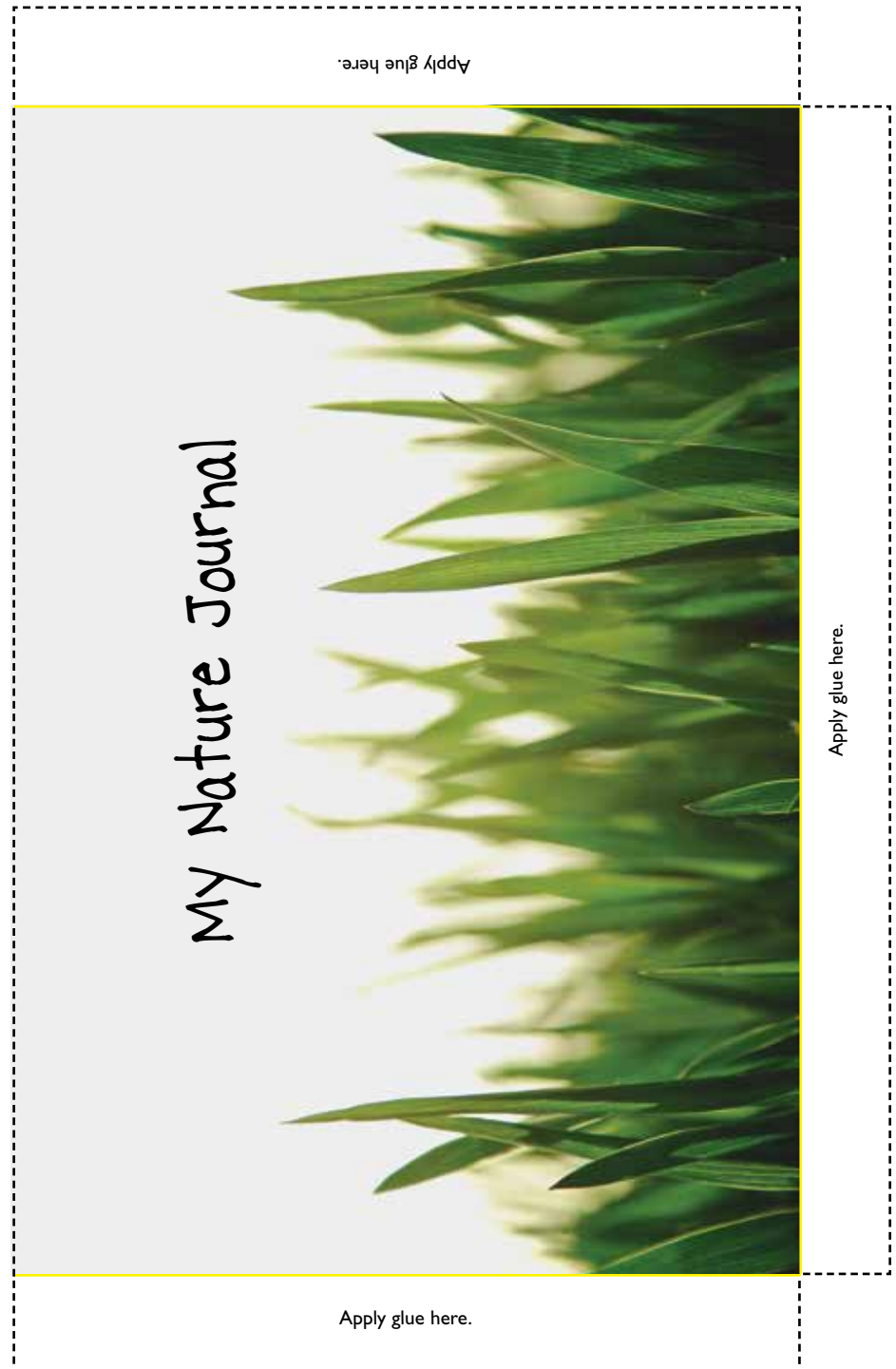
ACTIVITIES AND OBSERVATIONS

ACTIVITY 1.2: MAKE A NATURE JOURNAL

Create a pocket to store your Nature Journal.

INSTRUCTIONS:

1. Remove this page from your notebook.
2. Cut along the dotted lines.
3. Fold along the solid yellow lines.
4. Apply glue where indicated.
5. Attach to the inside cover of your notebooking journal 1–2 inches from the bottom to make a pocket.
6. Leave notebooking journal open while the glue dries.
7. Store your Nature Journal in the pocket.



Apply glue here.



ACTIVITIES AND OBSERVATIONS

ACTIVITY 1.3: JOURNAL ABOUT NATURE

My favorite thing journaling about nature was...

ACTIVITY 1.4: OBSERVE LEAF VEINS

Draw a picture or do a rubbing of your leaf here. Be sure to mark the midrib.



ACTIVITIES AND OBSERVATIONS

ACTIVITY 1.5a: OBSERVING ABSORPTION

Draw how the water absorbed with your paper towel.



ACTIVITY 1.5b: WALKING WATER WITHOUT A VASCULAR SYSTEM

Color your cups in the colors you used and show how the colors mixed.



what I learned



ACTIVITIES AND OBSERVATIONS

ACTIVITY 1.6: GO ON A NATURE HUNT

I found the following nonvascular plants on my nature hunt:



ACTIVITIES AND OBSERVATIONS

ACTIVITY 1.7: GROUPING PLANTS

In each circle, draw a picture of some of the plants found in each group. Below the circle, record what features plants in that group have.

Vascular Plants

Nonvascular Plants

Spermatophyta (seed-making plants)

Sporophytes (spore-making plants)





WHAT DO YOU REMEMBER?

Why do scientists use Latin and Greek words to name things?

What is a biologist?

What is a botanist?

What are some helpful or interesting things that botanists do?

What do vascular plants have that nonvascular plants do not have?

What is a spermatophyta? Can you name one? Can you name a plant that is a sporophyte?



VOCABULARY LIFT THE FLAP

Tear out this page. Cut out each word and match it to the correct definition on the following page. Then, place glue along the top edge of the back of each word and glue above the line on each definition. Once the glue is dry, fold back the word to reveal the definition.

**Vascular
Plants**

**Nonvascular
Plants**

**Kingdom
Plantae**

**Kingdom
Fungi**

Biology

Taxonomy

Botany

Sporangia





VOCABULARY

LIFT THE FLAP

<p>Glue correct word above this line, then fold back.</p> <p>The study of plants.</p>	<p>Glue correct word above this line, then fold back.</p> <p>The clumps on the underside of ferns containing spores</p>
<p>Glue correct word above this line, then fold back.</p> <p>The process of placing living things into different groups</p>	<p>Glue correct word above this line, then fold back.</p> <p>The Study of Life</p>
<p>Glue correct word above this line, then fold back.</p> <p>Plants with tubes that carry liquid inside.</p>	<p>Glue correct word above this line, then fold back.</p> <p>Plants that do not have tubes inside but instead absorb liquid</p>
<p>Glue correct word above this line, then fold back.</p> <p>The kingdom that contains all plants.</p>	<p>Glue correct word above this line, then fold back.</p> <p>The kingdom that contains mushrooms.</p>



ACTIVITIES AND OBSERVATIONS

ACTIVITY 1.8: MAKE A LIGHT HUT

what I did

what I learned

Draw a picture of your light hut.



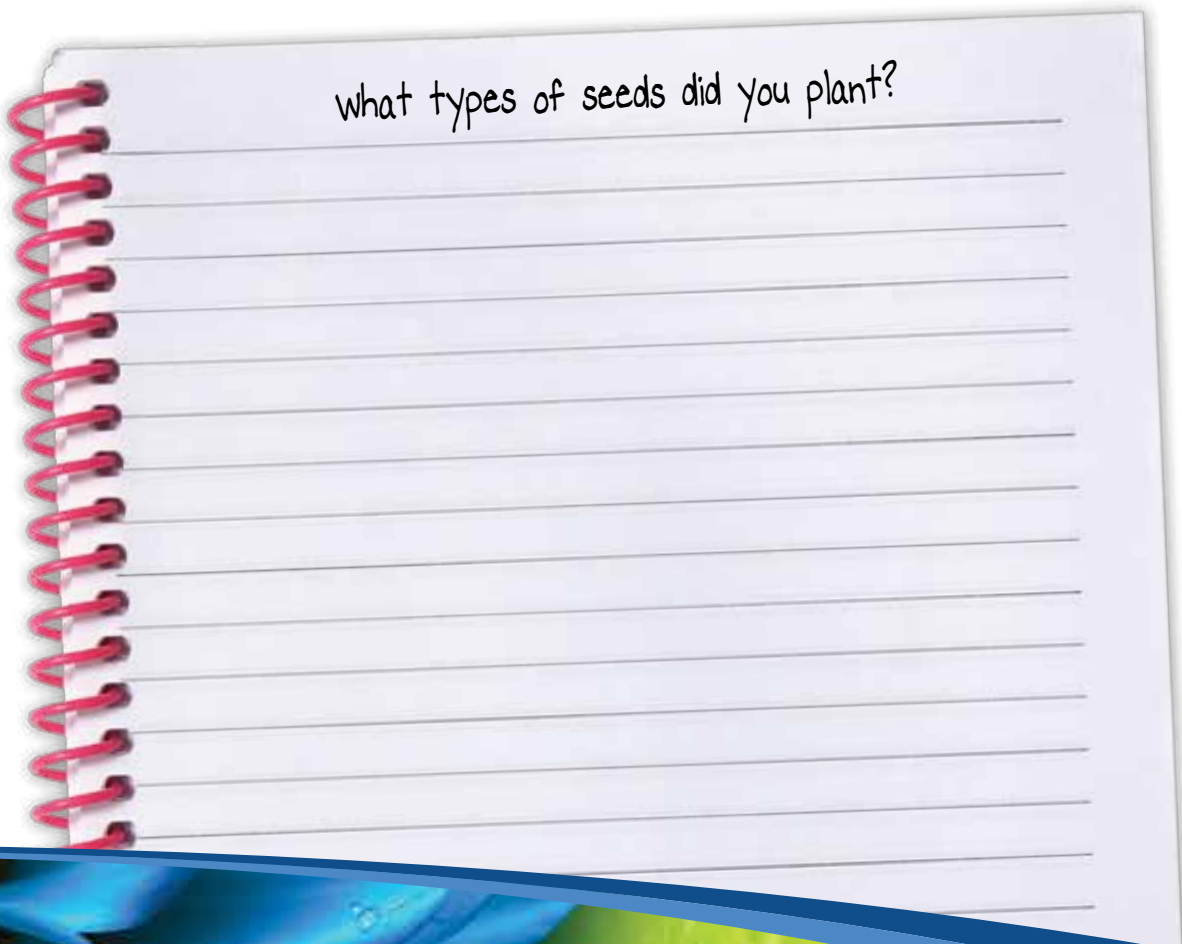
ACTIVITIES AND OBSERVATIONS

ACTIVITY 1.9: GROW EDIBLE PLANTS

what I did

what I learned

what types of seeds did you plant?



botany wheel
MINIBOOK

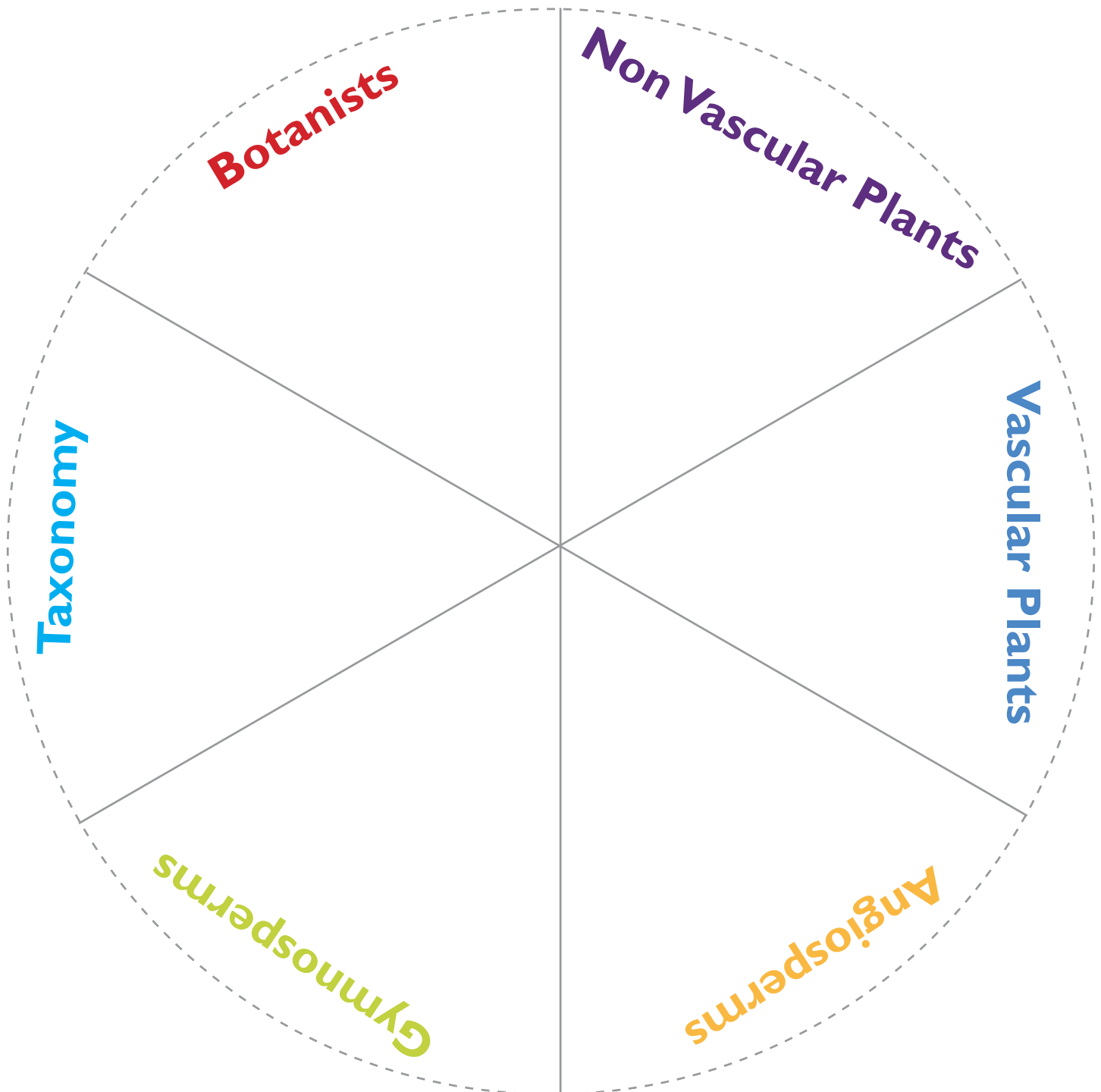
Green Leaf Circle



BOTANY

Instructions:

1. Write something interesting you learned about each topic listed in the Fact Circle.
2. Cut out both the Fact Circle and the Green Leaf Circle. Be sure to cut out the white empty space in the Green Leaf Circle.
4. Place the Green Leaf Circle on top of the Fact Circle, and insert a brass fastener in the center to secure the two circles.
5. Dab glue on the bottom of the Fact Circle and glue your Botany Wheel onto the “Botany Minibook” paste page.
6. Turn the Green Leaf Circle around to reveal the different facts about each topic.



botany wheel
MINIBOOK

Attach your botany wheel below.



CREATIVITY PAGE

Make a scrapbook page of your journey learning about why botany matters.





ELEMENTARY SCIENCE FAQs

What ages can use the Young Explorer Series?

Apologia's elementary science is written for students in kindergarten through sixth grades, typically ages 5 to 12. The content can be understood by a kindergartener but can also be thoroughly enjoyed by a sixth-grader. Whatever their ages, your young explorers will become real scientists by observing nature, participating in hands-on activities, and documenting what they learn.

Should we do the elementary science books in a particular order?

No, and that's the beauty of the Young Explorer Series. We recommend you begin with the topic you and your students believe to be most interesting right now. Download the first lesson of each title at apologia.com to explore them in more depth before choosing. Some parents find that teaching the more complicated Anatomy & Physiology and Chemistry & Physics courses are best reserved for upper-elementary students. Apologia offers regular and junior notebooking journals for Young Explorer titles.

Can I use both the regular and junior notebooking journals with multiple students?

Yes, the two can be used together. The junior notebooking journal includes the same mini-books and covers the same topics, but activities that require more writing have been replaced with coloring pages. You can compare the regular and junior notebooking journals and decide which is right for your child by downloading samples of each at apologia.com.

We just started homeschooling and won't finish all the Young Explorer titles before moving on to middle school. Is that okay?

Absolutely! In addition to promoting a foundational understanding of the scientific method, the primary goals in elementary science should be to foster a love of learning and to point the student to the Creator of all things. All the Young Explorer books are written and designed with this end in mind.

Do these courses come with a lesson plan?

A recommended schedule is provided inside every notebooking journal. However, each course is designed to be flexible and can be adapted to your child's unique learning style and your family's schedule. Our lesson plan is only a guideline to help you plan for your child's pace of learning.

Do the Young Explorer books cover a full year or just a semester?

That's entirely up to you and your student. Our recommended schedule covers a full year for each title and assumes that you will do science twice a week. However, some students jump right in and immerse themselves in the subject, while other students enjoy a more deliberate pace. Again, each title in the series is designed for maximum flexibility to fit with your family's needs.

Can my elementary and middle school students both use the Young Explorer Series so that all my students can work together?

While the elementary series are wonderful books, seventh- and eighth-grade students need to move up to more challenging curriculum, especially in science. But that doesn't mean your kids can't keep learning together. Experiments are fun at any age, and older students can always help their younger siblings do the activities while explaining some of the concepts.

Will I need to supplement the Young Explorer Series with other materials?

We do recommend the companion notebooking journals, which are specifically designed to help students begin learning how to document their work. The hands-on activities found in the textbook mostly require common household items.

Do I need to purchase a lab kit to complete the activities in the Young Explorer Series?

Most of the activities utilize common household items, and each textbook includes a list of all the items you'll need so that you can prepare. To save you time, however, Apologia now offers an official science kit for the Astronomy course. This outstanding kit features high-quality materials and includes a full-color workbook with additional activities. Some outside companies sell kits designed to work with Apologia's other Young Explorer books, and you may also find these helpful in gathering materials.

If my child is interested in a specific topic—the moon, for example—where can we find additional materials?

Each Young Explorer title comes with free access to a unique website containing a wealth of additional information and online links to help your family explore topics in greater depth. These book extras are available on Apologia's website, and a password to access these materials can be found inside each textbook.