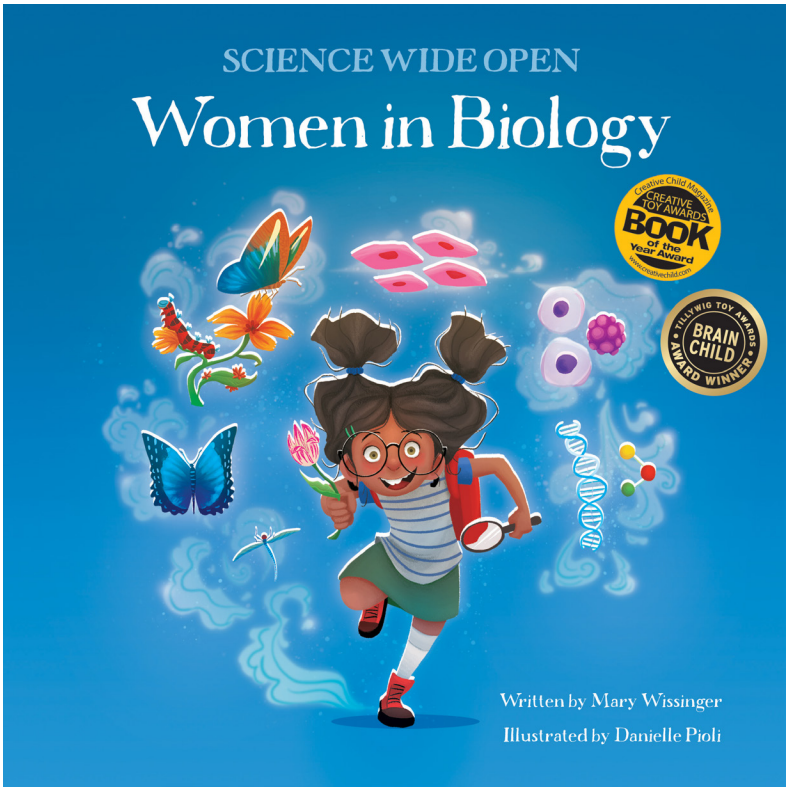
Women in Biology
Teacher's Guide

Written and designed by Emma Ferdinandi



To be used with *Women in Biology* and *Las Mujeres en la biología*
Written by Mary Wissinger
Illustrated by Danielle Pioli

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Sparking curiosity through reading

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Table of Contents

Words that can be found in the glossary will be shown throughout this guide as bold italic and as a color other than black. Example: ***biology.***

Introducing the Science Wide Open series

Dear Reader,

We're excited to introduce you to *Women in Biology/Las mujeres en la biología*, part of our Science Wide Open series. These beautifully illustrated, information-packed titles introduce children to the fascinating world of science through important female figures in history.

Scientific curiosity begins in childhood, with young minds thirstily absorbing information about the world around them. Exposure to biology—whether in nature or in a book—is often at the root of a child's interest in science. Biology is a gateway to many important conversations, including health, the human body, climate change, evolution, genetics, and biodiversity. As the many activities in this Guide will prove, it also provides the perfect opportunity for education to become hands-on and interactive.

Biology might be a complex subject, but introducing children to challenging subjects early in life makes it easier to succeed early on. Young Jane Goodall loved to observe the wildlife near her home, a passion that inspired her groundbreaking chimpanzee research. Charles Turner spent hours reading about ants in the pages of his father's books before growing into a trailblazing entomologist. Spark curiosity in a child and watch them develop a lifelong enthusiasm for learning.

More than an educational primer, these stories also illustrate and explore the vital role female scientists have played in history. Showing young girls such role models empowers them to follow their passions and enter a field typically dominated by men. But regardless of gender, Science Wide Open books encourage all children to make real-world connections that sharpen their analytical skills and give them a head start in STEM (science, technology, engineering, and math).

An easy choice for the home, library, or classroom, our Science Wide Open series has something to spark or sustain budding curiosity in any child.

We love to hear from our readers. Please feel free to email us your thoughts or comments about the books or Teacher's Guides.

Happy reading!

Dia

Dia L. Michels
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Meet the Women

Women in Biology/Las mujeres en la biología introduces children to the fascinating world of biology through the lens of some of the most important women in scientific history. As all readers learn about each of the woman's accomplishments and their methods of research, they will be able to see the immense impact biologists have had on everyday life. Readers will discover the diverse subjects in biology and become confident to start their own experiments that satisfy their own curiosities.

Women in Biology/Las mujeres en biología explores the discoveries of the following women:

Maria Sibylla Merian

Germany, 1647-1717

A scientific illustrator whose drawings documented the process of metamorphosis.

Hildegard of Bingen

Germany, 1098-1179

A Benedictine abbess whose work with plants informed her many medical discoveries.

Jane Cooke Wright

United States, 1919-2013

Wright's work in cell biology led to breakthroughs in cancer research and treatment.

Linda Buck

United States, 1947-Present

Buck won a Nobel Prize for her discovery of olfactory receptors in the nose.

Barbara McClintock

United States, 1902-1992

By studying the DNA of corn, McClintock discovered new information about genes.

About the Author: Mary Wissinger

Mary was born in Wisconsin where she spent most of her childhood singing, reading, and daydreaming. She dove into storytelling through acting, singing, and writing (and writing and writing).

While spending time as a classroom teacher sharing the magic of music, she saw firsthand the incredible life-changing power of stories. The stories children read become the stories they play, and then the stories they tell.

Mary can now be found at her standing desk in St. Louis, MO, writing stories that inspire curiosity about the world and connection with others. (But don't worry, she still sings with the Saint Louis Symphony Chorus.)

Mary is also the author of *Women in Chemistry /Las mujeres en química and Women in Physics/Las mujeres en física. She can be reached at Mary.Wissinger@ScienceNaturally.com.*

About the Illustrator: Danielle Pioli

As children usually do, Danielle Pioli always loved drawing. The idea of creating a whole universe—from her mind to paper—made her fall in love with art and storytelling. She also always felt like a healer at some level. As a child in Sao Paulo, Brazil, she was so drawn to magic —what she calls Quantum Physics now—that she was certain she could heal and help people. Because of this, she grew up to become an Artist and Hypnotherapist/Energy Healer.

Danielle is the illustrator of *Women in Chemistry /Las mujeres en química and Women in Physics/Las mujeres en física. She can be reached at Danielle.Pioli@ScienceNaturally.com.*

Women in Biology:
Contributors

Science Naturally would like to thank the following people for their hard work, invaluable insight, and dedicated time in creating *Women in Biology* and its accompanying Teacher's Guide:

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Section 1: Book-based Activities

The activities in this section use only the book and conversation as tools to take advantage of the diversity of subjects in biology and to explore key concepts about biology and the natural world at large.

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Pre-Reading: English Book Glossary

Women in Biology delves into the many different disciplines in biology, introducing children to complex subjects such as cells, DNA, medicine, and the scientific method. With these new concepts comes a new set of vocabulary. Over the course of reading this book, children will become familiar with these words and the content they represent.

An expanded glossary can be found at the end of this guide. See next page for Spanish glossary.

Biology
The scientific study of life in all its forms.

Cells
Small compartments that hold the biological equipment that keeps an organism alive and working. Cells are the basic structural unit for all organisms.

DNA (Deoxyribonucleic Acid)
The written plan in the cells of living things (like plants, animals, and people) which tells each cell, and as a consequence, the body, how to grow and function.

Experiment
A test to collect information about the world to see if a hypothesis, or educated guess, is correct.

Genes
Smaller sections of DNA that contribute to how specific parts of living things (like the color of corn or our hair and eyes) will look and grow.

Hypothesis
A scientific guess that a scientist makes to explain something they think is true or they think will happen.

Linnaean System
A way to organize all living things into groups based on traits that living things have in common.

Metamorphosis
The process of transformation from an immature form to an adult form in 2 or more distinct stages.

Nobel Prize
A set of very prestigious annual awards in recognition of academic, cultural, and scientific advances. The awards are named for Swedish scientist, Alfred Nobel, and were first awarded in 1895.

Observation
Using our senses to collect information about the world around us.

Receptor
A small part of a cell that allows the cell to sense and respond to things around it.

Research
To investigate and study something to learn new things about it.

Transposons (Jumping Genes)
Genes that can switch places with other genes in a DNA strand.

Ask kids what they know about each word before giving them the definitions, looking for educated guesses. The list does not need to be mastered before reading—*Women in Biology* will provide context and information which will clarify these terms—but familiarity with the vocabulary will improve initial reading comprehension. Many of the activities in these books will also delve deeper into these terms and their relevance to biology and the greater world.

Pre-Reading: Spanish Book Glossary

Las mujeres en la biología delves into the many different disciplines in biology, introducing children to complex subjects such as cells, DNA, medicine, and the scientific method. With these new concepts comes a new set of vocabulary. Over the course of reading this book, children will become familiar with these words and the content they represent.

An expanded glossary can be found at the end of this guide. See previous page for English glossary

ADN (ácido desoxirribonucleico):
El plan escrito en las células de los seres vivos (como las plantas, animales, y personas) que le dice a cada célula y, como consecuencia, al cuerpo, cómo crecer y funcionar.

Biología
El estudio científico de los seres vivos.

Células
Compartimientos pequeños que contienen el equipo biológico que mantiene a un organismo vivo y funcionando. Las células son la unidad estructural básica para todos los organismos.

Experimento
Prueba para recopilar información sobre el mundo para ver si una hipótesis es correcta.

Genes
Secciones más pequeñas del ADN que contribuyen a cómo se ven y crecen algunas partes específicas de los seres vivos (como el color del maîz o de nuestro cabello y ojos).

Hipótesis
Suposición científica que hace un científico para explicar algo que cree que es cierto o que va a pasar.

Sistema de Linneo
Forma de organizar a todos los seres vivos en grupos con base en las características que tienen en común.

Metamorfosis
Es el proceso de transformación de una forma inmadura a una forma adulta en dos o tres distintos estados.

Premio Nobel
Es un conjunto de prestigiosos premios internacionales que ocurren anualmente y son reconocidos por la academia, cultura y los avances científicos. Los premios son nombrados por el científico Suizo Alfred Nobel, y fueron premiados por primera vez en 1895.

Observación
Usar nuestros sentidos para recopilar información sobre el mundo.

Receptor
Una parte pequeña de una célula que deja la célula sienta y responda a las cosas a su alrededor.

Investigación
Es un estudio para aprender nuevas cosas de algo.

Transposones (genes saltarines)
Genes que pueden cambiar de lugar con otros genes en una cadena de ADN.

Ask kids what they know about each word before giving them the definitions, looking for educated guesses. The list does not need to be mastered before reading—*Las mujeres en la biología* will provide context and information which will clarify these terms—but familiarity with the vocabulary will improve initial reading comprehension. Many of the activities in these books will also delve deeper into these terms and their relevance to biology and the greater world.

Pre-Reading: Book Walk

Grades: K–5
Subject: Reading, language arts
Skills: Active listening, critical thinking, making predictions
Common Core English Language Arts: CCSS.ELA-LITERACY.CCRA.R: Key Ideas and Details

A book walk is a pre-reading activity that aids in reading comprehension and builds curiosity and enthusiasm about reading this book. It prepares students to think about the important questions they should be asking as they read. For younger students, this book walk (or picture walk) also helps develop their reading skills. They learn to use the visual text of the pictures to understand what the story means and make educated guesses about unfamiliar words.

Get set up for story time! Have students sit in a circle so they can all see you and can talk with one another.

Tell your students that you will be reading a book called *Women in Biology/Las mujeres en la biología*. Discuss and ask them: What do you think this book will be about?

If you have reviewed the terms first, this is a perfect time to go over them again. Ask your students questions. What is biology? What words do you know that are related to biology?

Then, show them the book's cover and ask them new questions. Now what do you think it will be about? Can they be more specific than before? Can you name the objects on the cover? What is the girl holding? What do these items have to do with biology?

Slowly flip through the book, page by page (or looking at a few pages you selected in advance), without reading any of the words. Ask your students questions about the pictures they see. What is going on here? What are the women doing on the page? What animals and plants do you see? What objects do you recognize? What relationship do all of these things have with science? What don't you recognize?

Give vague responses that don't give away the story. Say things like, "Are you sure about that?" or "That's possible!" or "What makes you think that?" This will plant the seed for an enthusiastic discussion while you read the book or when the reading is done.

Flip the book over and read the back cover, then start your usual read-aloud session.

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Activity: Exploring Biology

Grades: 2–5

Subject: Organisms and their relations, life sciences, cells, types of biology

Skills: Identifying, sorting, observation, active reading

Materials: *Women in Biology/Las mujeres en la biología*

Next Generation Science Standards
LS1.A: Structure and Function
1-LS1-2: From Molecules to Organisms: Structures
and Processes
ETS1.B: Developing Possible Solutions

Common Core English Language Arts
CCSS.ELA-LITERACY.CCRA.R: Key Ideas and Details

Background

Biology is the study of life. All living things—from the smallest blade of grass to the largest animal—are made of cells and use energy to grow and reproduce. Biology not only studies these ***organisms*** individually, but also as groups and systems that interact with each other. Because there are so many forms of life and so many ways organisms interact, there are many subdisciplines in biology. Here is a list of eight primary categories.

Biochemistry
The study of chemical and physiochemical process that occur in living organisms.

Botany
The study of plants, including their structure, genetics and ***ecology***.

Cellular Biology
This science studies cell structure and function. Cells are the building blocks of all life.

Genetics
The study of genes and heredity helps explain why you look like you do. This subject is closely related to cell biology, as genes are located in cells.

Medicine
Different branches of medicine, such as immunology and virology, use biology to keep good organisms healthy and fight off bad ones.

Microbiology
The study of microscopic organisms.

Physiology
This science studies the functions and processes of parts and wholes of organisms. This subject is closely related to anatomy.

Zoology
The study of everything related to animals, including behavior, classification, and physiology.

Activity

1. Review the background information with your students.

2. Read through the book together, paying special attention to the images and the stories of the women. Ask the following questions: What kind of biology would study this organism? Is it more than one? Which woman would study which discipline?

3. Return to the Teacher's Guide for possible answers.

Answers

Botanist - flowers, greenery, corn etc. - Hildegard of Bingen
Biochemistry - cells, lipids, proteins - Barbara McClintock and Jane Cooke Wright
Cellular Biology - cells, DNA, genes - Jane Cooke Wright, Barbara McClintock, Linda Buck
Genetics - genes, DNA, chromosomes, transposons - Barbara McClintock
Medicine - the human body, bacteria, cells, germs, medicinal herbs - Hildegard of Bingen
Microbiology - parasites, algae, bacteria, fungus - Hildegard of Bingen
Physiology - cells, body parts, animal parts, (anything that has a function) - everyone
Zoology - insects and other animals - Maria Sibylla Merian

Discussion

Talk to your students about the ease or difficulty of the activity. The distinctions between the different groups are not always clear, and the scientists can fit into several categories. Is this overlap a good thing? Can your students think of ways that different organisms interact with each other?

Discuss how every action has an impact on an environment or organism because of these relationships. Do your students have pets or plants at home? Do they have a garden or go to farmer's market? What living organisms are in their classroom or house (don't forget to include mosquitoes, mold, dust mites, etc as well as the obvious items)? Do those organisms affect their lives? What other examples can they come up with?

Did you find any relationships that we don't have listed? We'd love to hear from you super sleuths! Tweet us @ScienceNaturally using the hashtag #WomenInBiology or post on our Facebook wall (Facebook.com/Science-Naturally).

Activity: Careers in Biology

Grades: 2-5

Subjects: Biology, research, compare and contrast

Skills: Researching and organizing

Materials: *Women in Biology/Las mujeres en la biología*, worksheet

NGSS: ETS1:B Developing Possible Solutions

Background

All of the women featured in Women in Biology/La mujeres en la biología are biologists. They all study living organisms, but different organisms at that. This is because there are several branches of biology, such as botany and cell biology, which means there are a variety of career paths for biologists. Below is a list of just some career paths/jobs for biologists:

Zookeeper
Animal Caretaker
Veterinarian
Environmental Consultant
Scientific/Medical Writer
Biology Teacher
Research and Laboratory Technician
Medical Doctor
Surgeon
Medical Sales Representative
Nurse
Dentist
Physical Therapist
Forensic Scientist
Food and Drug Inspector
Pharmacologist

Activity

1. Read *Women in Biology/Las mujeres en la biología* to your students, as well as the background information above.

2. Have students choose and research two careers from the list above. Tell them they should take notes on how the two careers are similar, and how they are different. Some categories to pay attention to are educational requirements, skills needed, and branch of biology.

3. Tell students to fill out the template, found on the next page, to compare and contrast the two careers.

Discussion

Ask your students why they chose those two particular careers. What did they find that was similar between the two, what was different? What did they like or dislike about both careers? Do they think either career is one they would want to pursue when they grow up?

Information and Activity adapted from BioExplorer.net

Name_____ Date:_____

Compare and Contrast: Careers in biology!

_____ and _____ are similar because...

_____

_____

_____

_____

_____

_____ and _____ are different because...

_____

_____

_____

_____

_____

_____

Activity: Branches of Biology

Grades: 2-5

Subjects: Biology, research, sorting

Skills: Researching and organizing

Materials: *Women in Biology/Las mujeres en la biología*

NGSS: ETS1:B Developing Possible Solutions

Background

Biology is the scientific study of living things, and as you may have guessed, there are a lot of different living things. Rarely is there one biologist that studies all living things, just like the women in *Women in biology/Las mujeres en la biología.* There are different disciplines of biology that scientists can specialize or work in. Take a look at the list below:

Anatomy: the study of the structure of an organism and it's parts
Biochemistry: the study of chemical and physiochemical process that occur in living organisms
Biophysics: the study of the relationship between the laws of physics and biological phenomenon
Biotechnology: the technology used on living organisms to study and discover products to create a better life
Botany: the study of plants, their structure, their genetics, and ecology
Cell biology: the study of cell structure and function
Ecology: the study of relations or organisms to one another and their physical surroundings
Genetics: the study of genes, genetic variation, and hereditary in living organisms
Immunology: the study of immunity
Marine biology: the study of living organisms in bodies of water
Microbiology: the study of microscopic organisms
Molecular biology: the study of the structure and function of proteins and nucleic acid
Mycology: the study of fungi
Parasitology: the study of parasitic organisms
Photobiology: the study of interactions between light and living organisms
Phycology: the study of algae
Physiology: the study that deals with normal structures of living organisms and their parts
Radiobiology: the study of the action of ionizing radiation on living things
Structural Biology: the study of molecular structure of biological macro-molecules
Virology: the study of viruses
Zoology: the study of animals

Activity

1. Read *Women in Biology/Las mujeres en la biología* to your students, as well as the background information above.
2. Tell students to get into pairs or groups to discuss the different branches of biology. Specifically, ask them to come up with different careers for each branch. Once they have had time to come up with specific careers, ask them to work together to gather information about one career for one branch. Ask them to present their findings to the class.

Discussion

Ask your students why they chose that particular career. What did they like or dislike about their chosen career, and what did they like or dislike about the other careers discussed? What did they find similar or different between their career and the others?

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Activity: Tools of the Trade

Grades: 2–5

Subject: Problem solving, scientific tools, variety of organisms, biology

Skills: Identifying, sorting, observation, active reading

Materials: *Women in Biology/Las mujeres en la biología*

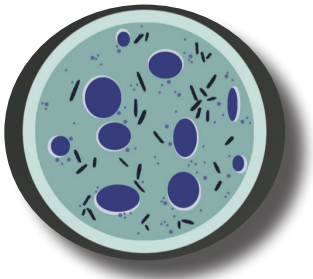
Next Generation Science Standards
LS4.D: Biodiversity and Humans
ETS1.A: Defining and Delimiting an Engineering Problem
ETS1.B: Developing Possible Solutions

Common Core English Language Arts
CCSS.ELA-LITERACY.CCRA.R: Key Ideas and Details

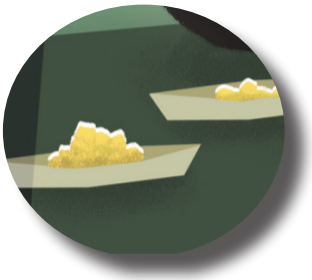
Background

All science is about solving problems. Part of that process is deciding on which tools will help scientists find the solution. Organisms must be studied in ways that don't affect their normal behavior or contaminate the sample. Tools help with this. A tool is an object used to extend the ability of an individual to modify features of the surrounding environment. A number of species can use tools including monkeys, apes, elephants, birds, and sea otters. There are many types of equipment to help scientists observe, measure, collect and gather data. Once all of the data have been gathered, different tools are used to make sure the information is logical, clear, and concise, so that it can be shared with the world.

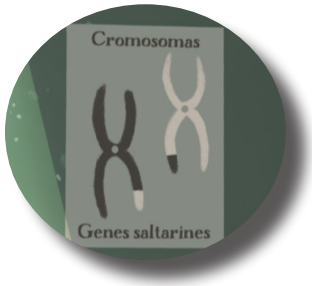
Forceps, Probes, Scalpels, and Eye Droppers
These tools are used for cutting or moving a sample without contaminating it.



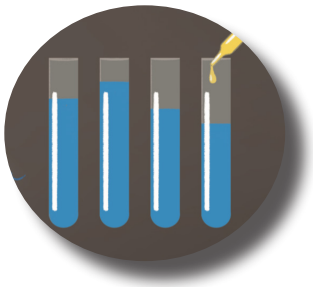
Petri Dish
If a sample needs to grow for observation, it is placed in a petri dish.



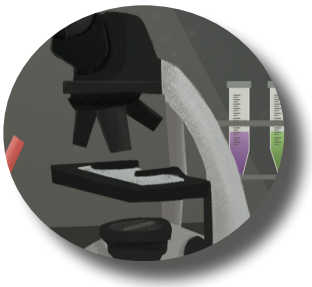
Sample
Biologists take a sample, or small part of something, in order to study it.



Charts, Diagrams, Drawings, Journals
Biologists use these to record, organize, and present their research.



Test Tubes
If solutions need to be added to a sample, they are most likely placed in a test tube.



Microscope and Slides
Microscopes help scientists look closely at an organism by magnifying it, even something as small as a cell.

Activity

1. Go over the background information and types of tools with your students.

2. Read *Women in Biology/Las mujeres en la biología,* paying specific attention to the kinds of tools the scientists are using. Ask your students the following questions: What tool is this? How and why is it being used? Do we have the tools in our school? Could a different tool be used here? How does this tool help you?

Expand the Activity

To cement the students' knowledge, name organisms or objects not in the book and ask what tool they would use to study it. Try to get them to think out of the box and use tools that weren't in the book either. For example, pick something in the room that is high up and too big to move. Can your students recognize that they will need some sort of ladder?

More Tools of the Trade

Scale, Autoclave, Centrifuge, Hotplate,
Camera, Sterilizer, Goggles, Lab Coat,
Gloves, First Aid Kit, Incubators, Ovens,
Refrigerator, and Freezer.

Discussion

Biologist Jane Goodall, found that some primates, such as chimpanzees, use tools like humans. Do students know other animals that use tools? Most animals have adapted over time to find or make tools to help them survive. A dog's nose, the shape of a bird's beak, and opposable thumbs are all useful tools. The first tools a scientist uses are often some combination of their five senses: touch, taste, smell, sight and hearing. Ask your students what tools they think are the most useful. What other natural tools can they name?

Section 2: In the Lab with the Women

The women in this book have been carefully chosen to illustrate the importance of women's contributions in biology and the world. Their discoveries play an essential role in the way we go about our daily lives, impacting our understanding of everything from medicine to genetics.

The activities in this section allow students to further delve into these women's discoveries and conduct experiments of their own.

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Maria Sibylla Merian

1647–1717

Frankfurt, Germany

Artist, botanist, naturalist, entomologist

Most known for her realistic drawings of plants and insects that had never before been documented.

Contributions

In the 17th century, much of the natural world remained unknown. Merian traveled the world to closely observe insects and plants, all of which she documented with detailed descriptions and life size paintings. In her artwork, Merian depicted insects as an ecological composition, showing their habitat, food sources and different stages of life in one painting. Oftentimes she would sit through the night to observe an insect progressing through metamorphosis.

It was such careful observation that allowed her to reveal never-before seen characteristics. For instance, Merian was able to see that at the adult stage in the sphinx moth's life cycle, two tongues combine to form one tube for drinking nectar.

After traveling from her home in the Netherlands to South America to study the jungle insects, she compiled her drawings and analyses into the book, *Metamorphosis Insectorum Surinamensium* (Metamorphosis of the Insects of Suriname). Biologists today are still studying this text to learn more about Merian and the natural world.

Challenges

Merian's images captured such exotic creatures that she received both praise and criticism. In one image, she painted a large spider eating a hummingbird, shocking her audience. In the later Victorian era, however, some people said such bizarre and exotic images were "womanly silliness," despite the fact that she was correct.

Scientific Error

As Merian's contributions show, new discoveries are constantly being made in biology and science as a whole, so it isn't surprising that Merian had some errors in her work. In one image, she painted four eggs in a hummingbird's nest even though they typically have only two offspring at a time. In another painting, she incorrectly grouped army and leaf-cutter ants together. These errors don't invalidate Merian's contributions to science; rather, they demonstrate how challenging doing pioneering work can be.

Social Justice

While fighting prejudice against women, Merian was also vocal about the injustices of slavery and colonization. In the description of her travels to South America, she documents the unfair treatment of the Native people and the African slaves by the Dutch colonizers.

This information was adapted from, *"A Pioneering Woman of Science Re-Emerges After 300 Years"* by JoAnna Klein. https://www.nytimes.com/2017/01/23/science/maria-sibylla-merian-metamorphosis-insectorum-surinamensium.html

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Activity: The Linnaean System

Grades: 2–5

Subject: Scientific classification, reasonable doubt, biodiversity

Skills: Identifying, sorting, observation, active reading

Materials: *Women in Biology/Las mujeres en la biología*

Next Generation Science Standards
ETS1.A: Defining and Delimiting an Engineering Problem
LS1.A: Structure and Function
LS4.D: Biodiversity and Humans

Common Core English Language Arts
CCSS.ELA-LITERACY.CCRA.R: Key Ideas and Details

Background

Classification is how biologists categorize all organisms; the science of classification is called ***taxonomy***. Carolus Linnaeus, a Swedish botanist, zoologist, and physician, created this system of grouping species according to their physical traits in the 1730's. After ***Charles Darwin*** revolutionized the idea of adaptation and ***natural*** selection in 1859, the ***Linnaean system*** was revised to group organisms with common ascent. Linnaean taxonomy uses a hierarchy to divide organisms into the following groups: Domain, Kingdom, Phylum, Class, Order, Family, Genus, Species. There are 3 Domain: Archae, Bacteria, and Eukarya. When Linnaeus first described the system, the highest level was Kingdom and there were just two – animals and plants. Scientists continue to expand this group. Now they have added fungi, protista, and monera, and more may come soon. The other groups use Latin terms to further categorize an organism. Here is the full classification of a human and a dog:

	Human	**Dog**
Domain	Eukarya	Eukarya
Kingdom	Animalia	Animalia
Phylum	Chordata	Chordata
Class	Mammalia	Mammalia
Order	Primates	Carnivora
Family	Hominidae	Canidae
Genus	Homo	Canis
Species	Homo sapiens	Canis Lupus Familiaris

Activity

1. Go over the background with your students and read Merian's section in *Women in Biology*. Depending on their level, introduce the above classification of a human and a dog.

2. Read through *Women in Biology/Las mujeres en la biología*, paying special attention to the images and what the women are studying. Ask questions. What Kingdom does this organism belong to? How might further classification help this scientist? Help the students to recognize that the scientists would have to classify their findings and organize their data throughout their research.

Discussion

Ask your students why they believe it is important to classify organisms. Tell them to imagine going to a supermarket where apples and bananas were on opposite sides of the store, ice cream was next to the vegetables and boxes of pasta were spread throughout packets of meat and cheese. Would it be easy to find the items you needed? How would your students sort the items? Classifying and shopping are made easier by grouping similar items together, and so is biology! If a scientist comes across something no one has ever seen before, they are able to use classification to determine to which species it might be related.

Bonus Discussion

Though scientists work very hard to be consistent, reliable, and valid, new information is discovered each day. The Linnaean system existed before natural selection and adaptation was discovered and it had to be changed when Charles Darwin's research became well-known. Again, when DNA was found and studied, the system was modified again. Most recently, 'Domain' was added above Kingdom.

Because scientists are always working to solve problems and answer questions, they never say that they know anything to be 100% true. Ask your students why it is important to leave room for updates and new discoveries. Ask them for examples in their own lives when things have been developed, such as new cellphones, TV technology, and electric cars.

Activity: Paper Plate Life Cycles

Grades: K–2

Subject: Life cycles, characteristics of organisms, development, growth, aging, milestones

Skills: Identifying, researching, presenting, organizing, reading

Materials: Paper plates, drawing materials

Next Generation Science Standards
LS1.A: Structure and Function
LS1B: Growth and Development of Organisms
ETS1.B: Developing Possible Solutions

Background

All organisms have a ***life cycle***. Though everything is born, grows, reproduces, and dies, these stages differ greatly between species. Insects—including butterflies, bees, ants, moths, fleas, and mosquitoes—undergo complete metamorphosis in their life cycles, growing from eggs, to larvae, to pupas, and finally into adults. As a larva, the insect can eat several times its own body weight in order to grow fast. At the end of a larval stage, the insect forms a hard shell around itself and becomes a pupa. In this stage, the larva does not eat or move, but transforms into an adult.

Activity

1. Go over the background information with your students and review Merian's Biography (page 27 of this guide).

2. Have students pick their favorite animal or insect and research their life cycle. For younger students, consider preparing a list of organisms to choose from ahead of time and accompanying information sheets.

3. Pass out paper plates or a piece of paper with a large circle drawn on it. Have your students divide the plate into as many slices as their animal has stages. Tell them to draw the different stages in each slice and write a short description. This can be done in groups, with each student taking a stage of life, or individually.

4. Optional: have your students present their findings to the class.

Discussion

Ask your student's questions. Have them compare and contrast the different life cycles. What makes them similar? Do they have a similar classification (page 29 of this guide)? How does an organism's habitat affect their life cycle?

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Hildegard of Bingen

1098 - 1179

Bermersheim vor der Höhe, Germany

Botanist, theologian, doctor, musician, natural historian

Most known for her contributions to music and medicinal texts.

A Woman of Many Talents
Hildegard was elected to be the abbess, or head of her community of nuns, in 1136 BCE. While at the monastery, she wrote several biblical commentaries, two biographies, and composed many Gregorian chants in addition to her medical and natural-scientific texts. She even created an alternate alphabet so that she could write in secret code! Though faith was an important part of her life, Hildegard's scientific texts are not rooted in theology, but natural science. Throughout all of her texts, she referred to the power of the Christian God as greenery and the power of life.

Botany
Hildegard worked in the monastery's herbal garden and hospital, which helped her gain skills in identifying, predicting, and treating diseases. In addition to practicing physical methods of healing, she also practiced holistic methods which incorporated spiritual healing. By studying Latin texts and experimenting on her own, she grew adept at using herbs as medicine.

Scientific Texts
Hildegard wrote two texts on her medical theories and practices. The first, *Physica* (Physical Health), documents scientific and medical properties of various plants, stones, and animals. The second, *Causae et Curae* (Causes and Cures), details the human body's connection to the natural world and the causes and cures of numerous diseases.

Scientific Error
In the ancient world, the four humors—blood, phlegm, black bile, and yellow bile—were viewed as the cause of health and maladies in the human body. Too much of one, and the balance would be upset and disease would set in. Hildegard adapted this line of thinking, linking the four humors to the four elements: fire, air, earth, and water. This demonstrates how far modern medicine has come: though Hildegard was wrong about the humors and elements, her scientific texts provided important information about medicine and the natural world. With each generation, new contributions are made to science.

This information was adapted from the article *"Hildegard of Bingen and the Greening of Medieval Medicine"* https://www.jstor.org/stable/44445287?seq=1

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Activity: Germs

Grades: K–4

Subject: Medicine, pathogens, water pollution, germs, hygiene, inference

Skills: Identifying, researching, sorting, analysis

Materials: *Women in Biology/Las mujeres en la biología,* two dishes, water, soap, pepper

Next Generation Science Standards
LS4.D: Biodiversity and Humans
ETS1.A: Defining and Delimiting an Engineering Problem
ETS1.B: Developing Possible Solutions
ETS1.C: Optimizing the Design Solution

Common Core English Language Arts
CCSS.ELA-LITERACY.CCRA.R: Key Ideas and Details

Background

Not everyone has access to clean water even in modern society, but when Hildegard of Bingen was living, people didn't understand the importance of clean drinking water. ***Pathogens***, types of ***microorganisms*** that can cause disease, often live in water. Bacteria, viruses, and parasites can all be in water, depending on how contaminated it is. Drinking this dirty water can cause symptoms such as fever, abdominal pain, intestinal issues and headaches. Boiling water is one way of killing these harmful microorganisms. However, they don't only live in water. Pathogens can live on any surface, which is an important reason why people need to wash their hands, avoid touching their faces, and cover their mouths when they cough or sneeze.

Activity

1. Go over the background information with your students and read Hildegard of Bingen's section in *Women in Biology.* Explain to the students that this experiment will mimic how germs are removed from hands with soap.

2. This activity can be done in groups, or as a class with some volunteers. Fill one dish with water and sprinkle pepper in it. Mix a good amount of soap with water in a separate dish. Have some students put their finger in the pepper dish. Note that some pepper might get on their fingers. Next, have other students dip their finger in the soap dish and then put it back in the pepper dish. Note how the pepper will immediately move away from the finger.

3. Return to the Teacher's Guide for a discussion.

Additional Information

Treating water is a costly and time-consuming process, which is part of the reason why not everyone has access to clean drinking water. In 2014, the city of Flint, Michigan decided to switch their water source to the Flint River to save money. Inadequate treatment and testing of the water caused major health issues, such as skin rashes and hair loss, for the Flint residents. One of the biggest contaminants was lead, a metal which causes brain development issues. Much of this **pollution** occurred because local industries were illegally and unofficially dumping waste into the river. After these issues were uncovered, many people left Flint, dropping the population from 200,000 to 100,000. Those who remained could not afford to move, which is why almost half of the current residents live below the poverty line.

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Activity: Plants in Medicine

Grades: 1–4

Subject: Biodiversity, medicine, pollution, bioindicators, ecosystems, natural resources

Skills: Identifying, researching, sorting, analysis

Materials: *Women in Biology/Las mujeres en la biología,* paper or whiteboards

Next Generation Science Standards
ETS1.B: Developing Possible Solutions
ESS3.A: Natural Resources
LS4.D: Biodiversity and Humans
ETS1.A: Defining and Delimiting an Engineering Problem

Common Core English Language Arts
CCSS.ELA-LITERACY.CCRA.R: Key Ideas and Details

Background

Botany is the scientific study of plants. Botanists can study anything from the structure of plants, to plant cells. Some botanists study ***ecology***, or how organisms interact with the environment and other organisms. Botanical research increases our understanding of medicine, food, building materials, and more. Though we may not always realize it, plants and humans have an important relationship: about 40% of prescription medicines are plant-based, and plants create oxygen—which humans need to live—through a process called photosynthesis.

The plants listed below are used in modern medicine.

Aloe Vera
Inside the leaves of the aloe vera plant there is a gel that can be used to treat various skin conditions. The gel can also be used to make juice or tablets to take internally.

Mint
The leaves of mint are used in lozenges, creams and other medicines to relieve itching, relax muscles, and alleviate congestion. Mint can also be used in tea and foods.

Penicillium Mold
Penicillium mold naturally produces the antibiotic penicillin. Scientists have since learned how to grow this in fermentation tanks and purify it to treat bacterial infections such as pneumonia, scarlet fever, and various infections.

Willow
The bark of this tree has an ingredient called Salicin, which is used in medicine such as Aspirin to alleviate pain, reduce fever and inflammation, and prevent heart attacks.

Activity

1. Go over the background information with your students and review Hildegard's Biography (page 34 of this guide).

2. Ask your students to take out a sheet of paper or use the whiteboard to write their answers. You will tell them the name of a malady and they will write the name of the plant that can be used to alleviate their symptoms. The maladies are: sore throat, sun burn, ear infection, fever, rash, pneumonia, knee pain, and scarlet fever.

3. Come back to the Teacher's Guide for answers.

Answers

Sore throat	Mint
Sun burn	Aloe vera
Ear infection	Penicillium mold
Fever	Willow
Rash	Aloe vera
Pneumonia	Penicillium mold
Knee pain	Willow
Scarlet fever	Penicillium mold

Expand the Activity

A great way to elaborate on the different uses of plants is to introduce your students to herbs through tea. Make this lesson interactive by bringing in different dried herbs. After explaining their different properties, steep them in boiling water and let your students have a taste. Three tasty recipes are provided below.

Herbal Chamomile
Caffeine free

2 tbs of dried chamomile
1/2 tsp dried licorice root
1 tsp dried ginger

Homemade Chai Tea
Caffeinated

2 tbs black tea leaves
1 tsp dried ginger
1/2 tsp black pepper
1 tsp cardamom
1 tsp cloves
1 tsp honey

Refreshing Hibiscus
Caffeine free

2 tbs dried hibiscus
1 tsp mint leaves
1 tsp lemongrass

Additional Information

Many plants also help remedy pollution and combat climate change naturally—without any interference from scientists. Plants can be used as a ***bioindicator***, which is an organism that provides clues about the health of an environment. For example, the disappearance of lichens, which make up fungi and algae, tells scientists about environmental stressors, such as an overload of nitrogen caused by excessive fertilization of crops. Wetlands and swamps with high biodiversity help purify water by absorbing excess nutrients and pollutants from the water.

Jane Cooke Wright

1919-2013

New York, United States

Surgeon, oncologist

Received her medical degree from New York Medical College

Wright is most known for her contributions to oncology, the study of cancer, and chemotherapy.

Cancer Research
At a time when ***chemotherapy***, the use of chemical agents to kill cancer cells, was an experimental treatment for cancer, Dr. Wright focused on researching and performing patient trials on anti-cancer chemicals. Prior to her work, many blood cancers were seen as incurable. She also pioneered efforts in studying tumor biopsies (samples that are removed from a patient and then tested), which revolutionized the medical field.

Moving Up
Dr. Wright was constantly moving up in the scientific field because of her brilliance. After graduating from New York Medical College with honors, she became a physician and was later chosen as the head of the Cancer Research Foundation at Harlem Hospital in 1952. She was then appointed to the President's Commission on Heart Disease, Cancer, and Stroke by President Lyndon B. Johnson.

Overcoming Adversity
Not only did Dr. Wright have to prove her worth as a woman in science, but she was also had to break through race barriers. At this time, only a few hundred African American women physicians existed in the entire United States. In her time, Dr. Wright was the highest ranked African American woman in any medical institution. This was before the Civil Rights Act was established, which was a big step in alleviating racial discrimination.

Sharing Her Work
Over the course of her career, Dr. Wright took groups of doctors to China, the former Soviet Union, Africa, and Eastern Europe to spread her research and treat cancer patients. She also founded the American Society of Clinical Oncology, which strives to educate and provide grants for doctors.

Information adapted from the article *"Women In Science: Jane C. Wright Revolutionized Cancer Research (1919-2013)" https://www.jax.org/news-and-insights/jax-blog/2016/november/women-in-science-jane-wright#.*

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Activity: Cell Diversity

Grades:1-3

Subject: Cell biology, biodiversity, parts and functions

Skills: Identifying, researching, sorting, analysis, inference

Materials: Worksheet: Cell Diversity (page 45 of this guide), playdough, paper, markers

Next Generation Science Standards
LS1.A: Structure and Function
LS1.D: Information Processing
LS3.B: Variation of Traits

Background

Every living thing is made of cells. Human beings have more than 75 trillion! Many-celled organisms have groups of cells that perform different functions; their shape, size and parts have adapted to these specific roles. There are two main types of cells:

Prokaryotes: These cells have no nucleus but have a tail like appendage, the flagella, which helps them move. Prokaryotes are simple organisms like bacteria.

Eukaryotes: These cells have a nucleus and are typically much bigger and complex than prokaryotes. The nucleus houses the cell's DNA.

There are two main types of eukaryotic cells:

Plant Cells: These cells have a rigid wall structure made of cellulose. The stiff walls are what enables a plant to grow tall. Plant cells also contain chlorophyll, which gives them a green color and helps them convert sunlight into food.

Animal Cells: These cells do not have cell walls, which allows them to be more diverse in shape and size. Animal cells have either a flagella or cilia, hairlike structures, that help the cell move.

Activity

1. Go over the background with your students and read Dr. Wright's section in *Women in Biology*.

2. Students will match the description of a cell to the name of the cell using inference and context clues. Remind students that cells have specific parts and traits that help them complete their function.

3. After students have completed the worksheet and discussion, break students into groups. Give each group various colors of playdough to work with. Either assign each group a different cell to make with the dough, or have each group make each type of cell covered on this activity.

4. Have students label the different parts of their cell with paper and markers. Then, have students present their cell to the class, explaining their artistic choices and the different parts of their cell.

Discussion

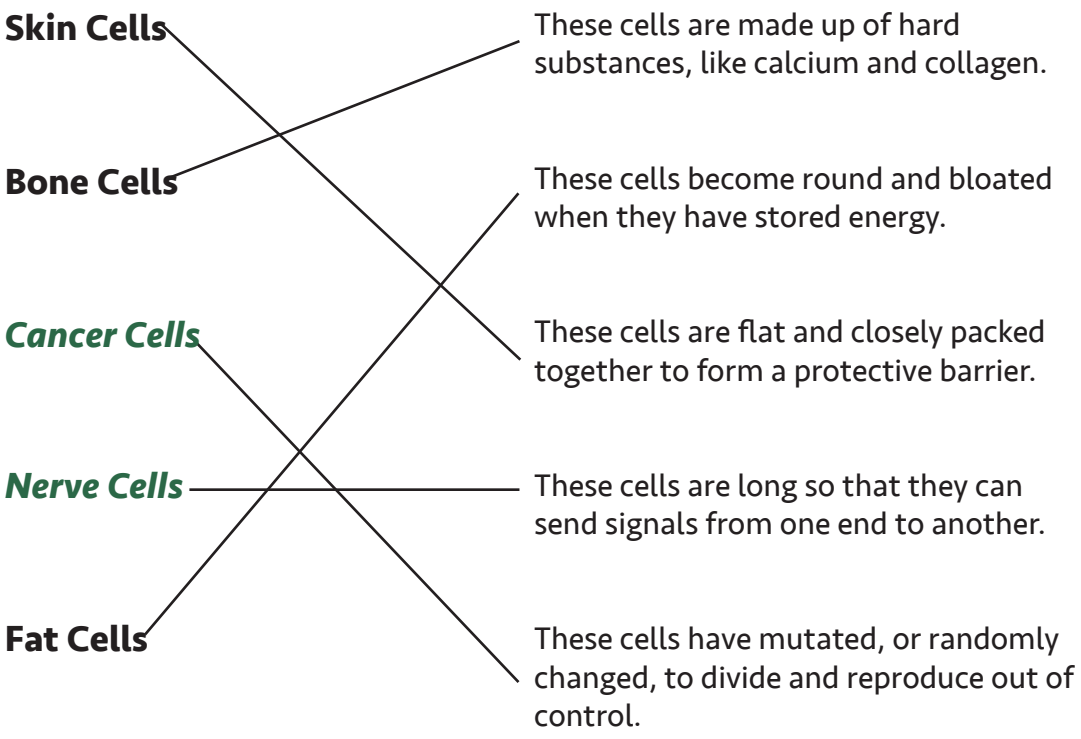
What clues led your students to the answers? Each cell has specific parts that help it accomplish its function. Why do they think cells have specialized jobs? Would it be better if every cell could do every job? Ask your students to think about the world at large. Everybody grows up to have a specific job; instead of everyone trying to accomplish everything for themselves, people work together. What other organisms can they think of that have specialized parts to help get the jobs done?

Expand the Activity

Now that your students have a better understanding of cell biology, use playdough to create models of the different cells! Be sure to label the different parts and pay close attention to the defining features of the cell.

Answers: Cell Diversity

The activity worksheet can be found on the following page. The answers are provided below.



Worksheet: Cell Diversity

Every organism has adapted to have characteristics that best help it survive. There are many different types of cells in the human body; each group is designed to best accomplish its job and keep the body healthy and functioning. Carefully read the descriptions of different cells and, using context clues, match the description to the type of cell in the human that fits best.

Skin Cells	These cells are made up of hard substances, like calcium and collagen.
Bone Cells	These cells become round, bloated, and big when they have stored energy.
Cancer Cells	These cells are flat and closely packed together to form a protective barrier.
Nerve Cells	These cells are long so that they can send signals from one end to another.
Fat Cells	These cells have mutated, or randomly changed, to divide and reproduce out of control.

Fun Fact!

Eggs are single cells. The largest cell is an ostrich egg!

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Linda Buck

1947-present

Washington, United States

Molecular Biologist

Received her PhD in immunology from University of Texas

Most known for her work with olfactory receptors, which awarded her the Nobel Prize in Physiology or Medicine in 2004.

Know the Nose
Doctor Linda Buck obtained her Bachelor of Science in Microbiology and Psychology from University of Washington, and went on to pursue her doctorate degree in Immunology from University of Texas Southwestern Medical Center. Dr. Buck used ***molecular biology*** to trace the travel of odors through the ***olfactory*** cells in the nose to the brain and to discover how odors are detected by the nose. She discovered olfactory receptors in the nose and determined how the nervous system organizes and interprets these signals and odors.

The Nobel Prize
Each year, the prestigious Nobel Prize is awarded to several people from anywhere in the world. The categories are for literature, peace, physics, chemistry, physiology or medicine, and economic sciences. Dr. Buck was awarded the 2004 Nobel Prize in Physiology or Medicine for her paper on olfactory receptors.

Pheromones
Currently, Dr. Buck studies how the olfactory system detects ***pheromones***, which are chemicals released by animals that trigger behaviors in other animals. According to her website, "Linda Buck Lab," Dr. Buck hopes her work will provide clues about certain human disorders that involve fear, stress and appetite, which are behaviors closely tied to pheromones.

Advocate for Change
Dr. Buck has used her influence as an accomplished woman in science to advocate for equality for women in academia, as she believes women are less comfortable in promoting their accomplishments than men.

This information was taken from Dr. Buck's website, fredhutch.org.

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Activity: Nervous System Telephone

Grade: 1

Subject: Cell biology, senses, human body, physiology, nervous system

Skills: Reading comprehension, analysis, inference

Materials: *Women in Biology / Las mujeres en la biología*

Next Generation Science Standards
LS1.A: Structure and Function
LS1.D: Information Processing

Common Core English Language Arts
CCSS.ELA-LITERACY.CCRA.R: Key Ideas and Details

Background

Nerve cells are called ***neurons***. These are long cells specifically designed to transmit information to other nerve cells through electrical impulses so that the body knows to complete an action. When you touch an object, neurons fire and tell the brain what you are touching and what to do about it.

One end of a neuron has ***dendrites***, which receive messages from other neurons. The other end has ***synapses***, which send the message. In between the dendrites and synapses is the ***axon***, a long, thin structure which accelerates transmission.

Activity

1. Go over the background information with your students and read through Buck's section in *Women in Biology/Las mujeres en la biología*.
2. Students will be imitating the nervous system through a modified game of Telephone and Simon Says. Divide them into two equal groups, picking one person from each group to be that side's "body." Each group will form two lines, imitating the axon, with one end near their "body" and the other near the teacher.
3. The person closest to the teacher is the synapse and will send the message; the person at the end of the line is the dendrite and will receive the message; everyone in the middle is the axon. The message will be passed down the line by whispering, like a game of telephone. Once the message has been received by the dendrite, they will tell the body, who must then act out the message.
4. The teacher (or a student, if you have an uneven number) will begin the game by secretly telling the synapses an action, such as "raise your right hand" or "sit down." When the teacher says "go" the two teams will send their message down the line. The first "body" to complete the action correctly wins a point. Rotate positions and repeat as wished.

Discussion

What made the winning team successful? How is working together in the game reflect how cells work together in the body? How are cells designed to do specific actions? If there was a time when someone did the wrong action, what was the cause? When the nervous system is damaged, how would someone's life be impaired?

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Activity: What's That Smell?

Grades: 1-3

Subject: Cell biology, senses, human body

Skills: Identifying, researching, sorting, analysis, inference

Materials: *Women in Biology/Las mujeres en la biología,* blindfolds, fragrant items to smell (this can range from foods, such as berries, to liquids, such as vinegar, to things with a distinct odor, such as flowers)

Next Generation Science Standards
LS1.A: Structure and Function
LS1.D: Information Processing
LS3.B: Variation of Traits
ETS1.A: Defining and Delimiting an Engineering Problem

Common Core English Language Arts
CCSS.ELA-LITERACY.CCRA.R: Key Ideas and Details

Background

Olfaction, or the sense of smell, is a complicated process that begins with tiny receptors in the nose. Though smells are invisible to the eye, they are really tiny molecules of chemicals that float through the air. The deeper you sniff, the more molecules enter your nose, making it easier to smell the odor. Our sense of smell helps us understand the environment. If you smell smoke or something burning, you will know that there might be a fire nearby. Interestingly, smells often are connected to memories. You might be able to remember the smell of your grandparent's house. Some smells, like smoke in a house, might make you scared. In this way, smell is connected to other senses and functions in the body.

Activity

1. Go over the background information with your students and review Buck's Biography (page 47 of this guide).

2. Have students break into groups of two and hand each group a piece of paper. Have them fold it in half length-wise. Then, have your students label one side "Item" and the other "Hypothesis."

3. One student will be the smeller, who will sit blindfolded (or with their eyes closed). One student will place the fragrant items near the smeller's nose. The third student will record which item was held up under the "Item" column and the smeller's guess under the "Hypothesis" column. After all items have been smelled, have the groups mark which items the smeller guessed incorrectly.

4. As a class, go over which items people got correct and incorrect most often. Encourage your students to use vocabulary from the background information and make educated guesses as to why some smells were harder to identify. Note that although all humans are similar, their individual traits may vary, and something that smells good to one person might smell bad to another (i.e. coffee, mowed grass, perfume, etc).

Expand the Activity

Different species have different olfactory capacities because they have adapted to best survive. Ask your students to rank, from lowest to highest, a human, a rabbit, or a dog by their number of olfactory receptors. **Answer: human, rabbit, dog.** According the Social Issues Research Centre, a human has about 50 million receptors, a rabbit has 100 million olfactory receptors, while a dog has about 220 million. Why might this be the case? Animals rely on their sense of smell to find food and recognize danger while humans have many other abilities that dogs do not have.

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Activity: The Mating Game

Grades: 1-3

Subject: Senses, reproduction, genetic variation

Skills: Identifying, sensing, analysis

Materials: *Women in Biology/Las mujeres en la biología,* blindfolds, and scented objects (two of each kind)

Next Generation Science Standards
LS1.A: Structure and Function
LS3.B: Variation of Traits
LS1.D: Information Processing

Common Core English Language Arts
CCSS.ELA-LITERACY.CCRA.R: Key Ideas and Details

Background

Humans smell with their noses, but most insects have olfactory receptors on their antennae. An insect's sense of smell is much better than that of a human. Insects rely on olfactory information for finding food and mates and for exploring their environment safely. Certain odors, called ***pheromones***, can even change the behavior of insects.

Activity

1. Divide your students into two groups after reviewing Buck's Biography (page 47 of this guide) and discussing the background information. One group will form a circle (the boundary of the game) and the other will be inside the circle. Those who are inside will be the "male" and "female" moths.

2. Blindfold half of the insiders, who will be the "male" moths, and give them each a different scent. Give the duplicate scents to the other half, who are the "female" moths. Have the "female" moths stationed randomly in the circle. The blindfolded "male" moths must use their sense of smell to locate the "female" moth with the same scent.

3. When successful, the pair will join the outer circle. Repeat with the inside and outer groups switched.

Discussion

All organisms are different, even within the same species. This differentiation arises from genetic variation, which means that all organisms have a different set of genetic material that causes them to have different traits. Ask your students what the world would be like if every animal was exactly the same. ***Natural selection***, the process by which the organisms best adapted to their environment survive and reproduce, relies on genetic variation to ensure the survival of the population.

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Barbara McClintock

1902-1992

Connecticut, United States

Cytogeneticist

Received her PhD in Botany from Cornell University

Most known for her work with the chromosomes in corn, which won her the 1983 Nobel Prize in Physiology or Medicine

Cytogenetics

Cytogenetics is a branch of ***biology*** that combines elements of anatomy, cell biology, and ***genetics***. It is primarily concerned with how ***chromosomes***, which carry the genetic information of a cell, affect cell behavior. McClintock was one of the first cytogeneticists, and her work with the chromosomes of corn led to serious advancements in the field as she created new methods of studying cells.

Jumping Genes

Genetics is the study of inherited traits, otherwise known as genetic material. The complete set of an organism's genetic material is present in their genome, which is found in chromosomes. A gene expresses itself in the characteristics of that organism, such as hair, eye and skin color. Before McClintock's discovery of jumping genes, or ***transposons***, scientists thought that a genome was immobile. McClintock found that some genes could move themselves, changing the way other genes were expressed.

Maize

Maize, the Spanish word for corn, was the main subject of McClintock's work. She looked at corn cells under microscopes and used special dyes to better see the different parts of the cells. Corn is often used in genetics because each kernel is produced from individual fertilization—this means that each cob has hundreds of offspring with different genetic codes on them.

The Importance of Communication

McClintock's discovery took a long time to be fully accepted in the scientific community. It is important for scientists to join in scientific conversation and make their research accessible to others. ***Cytogenetics*** was a new and complicated field, making her research difficult to understand. Being a female researcher did not help her credibility. Because of these communication struggles, her discovery of transposons did not immediately revolutionize genetics. It was only in 1983, over 30 years after her discovery, that McClintock was awarded a Nobel Prize, making her the third woman to receive the prestigious award in Physiology or Medicine.

Information adapted from the article *"Barbara McClintock and the Discovery of Jumping Genes,"* https://www.pnas.org/content/109/50/20198

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Activity: Design a Dog

Grades: 3–5

Subject: DNA, cell biology, genetics, genetic variation

Skills: Identifying, researching, sorting, analysis, inference

Materials: Envelopes, genetic code key (page 58), DNA symbols (page 59), paper, and drawing materials

Next Generation Science Standards
LS3.A: Inheritance of Traits
LS3.B: Variation of Traits

Background

Genetics is the study of how genes and traits are passed down from one generation to the next. Genetics affects characteristics such as hair color, sex, gender, and personality traits. Genetic information is carried in DNA, the blueprint and building blocks of all organisms. DNA is made up of four coding molecules, the order of which determines the genetic code. The DNA of humans is located in 23 pairs of chromosomes; one chromosome from each pair is inherited from each parent.

Activity

1. Go over the background information with your students and review McClintock's Biography (page 55 of this guide).

2. Students will be broken into groups, but before the activity begins, prepare an envelope for each group. Each envelope should have three cards in it: one card for each of the three "DNA" symbols (page 59 of this guide).

3. Hand out one genetic code key (page 58 of this guide) and one envelope to each group. Each student should also be given a blank piece of paper on which to draw their dog.

4. Each group will draw one card from the envelope at a time, creating a pattern of three symbols. The pattern will correspond to a characteristic on the genetic code key. Return the cards to the envelope and repeat for each part of the dog: head, ears, body, tail, and color. Students will draw their dog according to the patterns they picked from the envelope, therefore each group will have a different-looking dog at the end.

5. End the activity with a discussion about genetic variation and DNA with help from the Teacher's Guide.

Discussion

Genetic variation is an important part of evolution. Natural selection, the process by which the organisms best adapted to their environment survive and reproduce, relies on genetic variation to ensure the survival of the population. Tell your students to imagine a world where every turtle had the same type of lumpy shell. What would happen if a disease that killed all lumpy-shelled turtles were to spread? Turtles would become extinct. Now imagine the same scenario but with turtles that have all kinds of shells: lumpy-shelled turtles might die, but the other turtle species would still survive. Genetic diversity makes a species more resilient to environmental changes.

This activity was adapted from Teach Genetics Utah. https://learn.genetics.utah.edu/#

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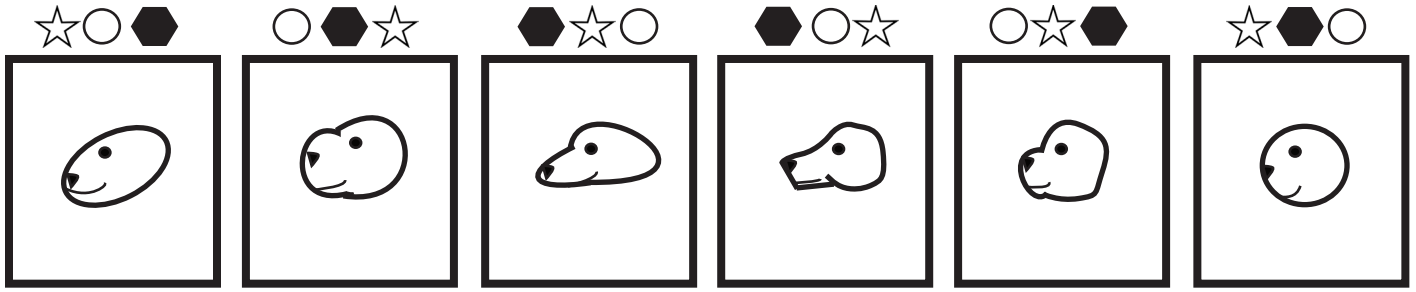
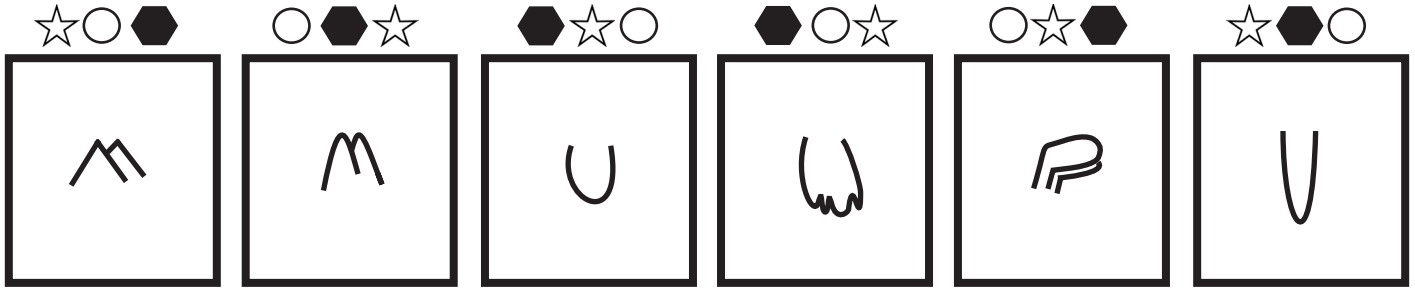
Design A Dog: Genetic Code Key

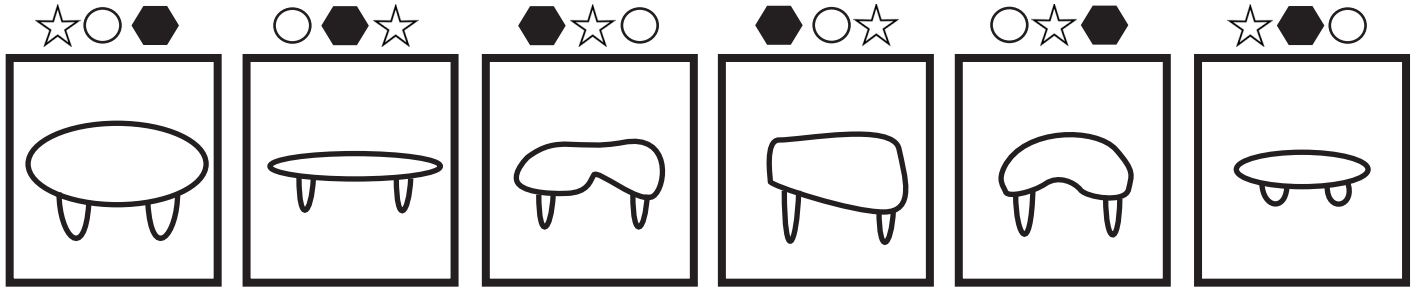
Head Shape



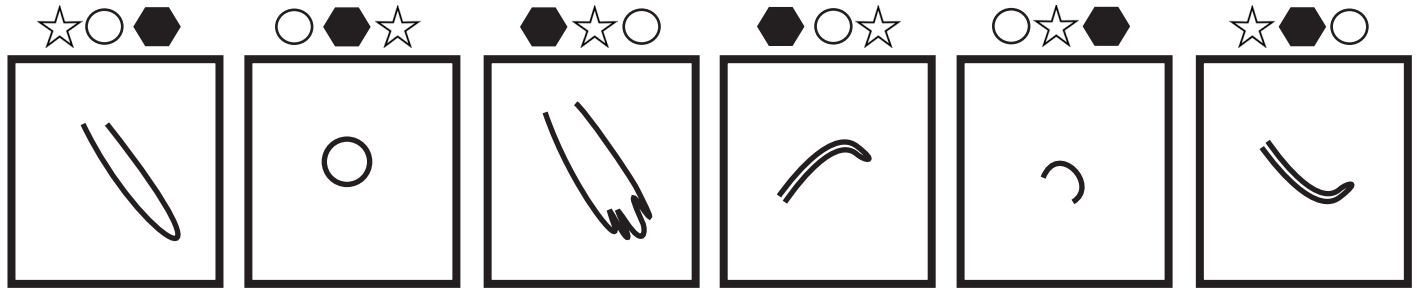
Ear Shape



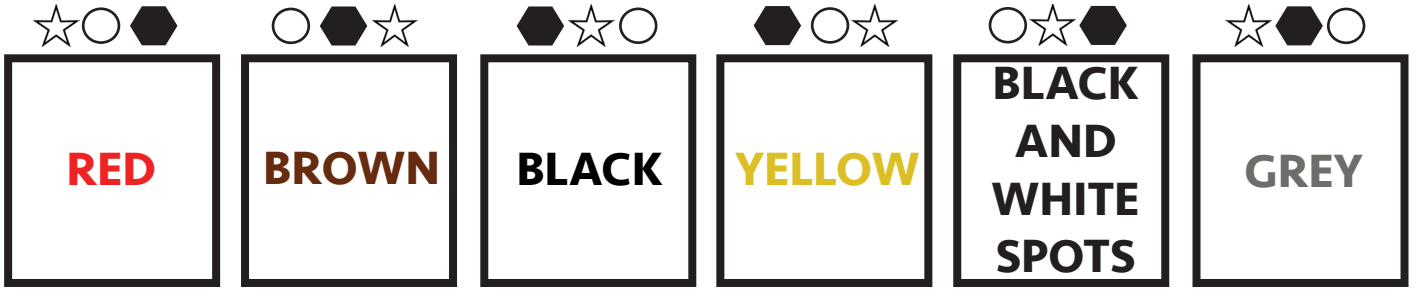
Body Shape



Tail Shape



Color



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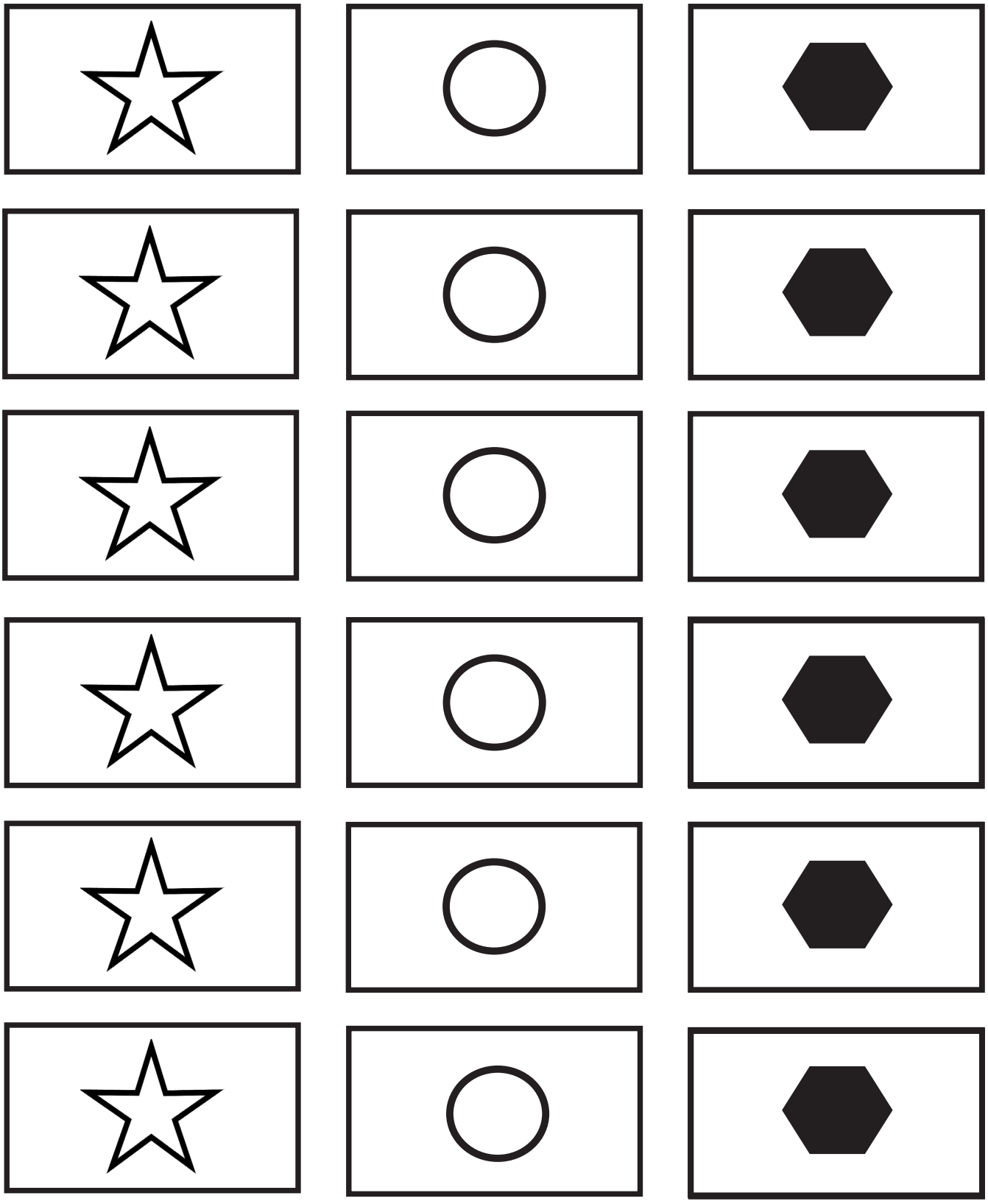
Design a Dog: “DNA” Symbols



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Section 3: Hands-on Activities

Eager for more? Biology is the perfect way to introduce children to the world of science. These activities will introduce students to the basic concepts of science through some of the many subjects in biology, laying a foundation for success when these concepts are reintroduced later in their education.

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Activity: Matching Biologists

Grades: K-2

Subjects: Biology, collaboration

Skills: Identifying, sorting, memorizing, problem solving

Materials: Women in Biology/Las Mujeres en la biología, worksheet

NGSS: LS1.A: Structure and Function; LS1.D: Information Processing;

Background

Now that your students have read *Women in Biology/Las mujeres en la biología*, they should have a good understanding of the women featured in the story, as well as their accomplishments.

Explain to your students that teamwork/collaboration is working with other people cooperatively to accomplish the same goal. Scientists work together sometimes to find cures to diseases and make a diagnosis, among other reasons.

Activity

1. Read Women in Biology/Las mujeres en la biología and be sure to point out the women's hometown, name, and accomplishment. Tell the students to remember these important points for a worksheet they will fill out later. Also, go over the background information with your students.

2. Pass out the worksheet, provided on the next page, and allow students time to match the female biologists with their hometown and accomplishment. They can work in pairs or in groups to brainstorm their answers.

3. When all of the pairs/groups have completed the worksheet, go over the answers with the students.

Activity Answers

Frankfurt, Germany; Maria Sibylla Merian; Created incredibly detailed and beautiful drawings of insects and plants that are used in the Linnaean system.
Washington, USA; Linda Buck; Discovered that nose cells have tiny message receivers called receptors that help people smell.
Connecticut, USA; Barbara McClintock; Discovered and named jumping genes and transposons.
Bermersheim vor der Höhe, Germany; Hildegard of Bingen; Found out that water needs to be cleaned before people drink it to prevent them from getting sick.
New York, USA; Jane Cooke Wright; Observed how medicines affected cells, which helped pick the best treatments for patients.

Discussion

Ask the students what clues lead to their answers. Why did they choose to match certain answers together? Also ask them what it was like to work as a team. Was it helpful to work together to find the answers? What are the advantages to working in teams? Ask the students if they think scientists work together, and how.

Name:_____ Date:_____

Match the female biologist to her fascinating discovery and humble hometown!

Hometown	Name	Discovery
Frankfurt, Germany	Hildegard of Bingen	Observed how medicines affected cells, which helped pick the best treatments for patients.
Washington, USA	Jane Cooke Wright	Created incredibly detailed and beautiful drawings of insects and plants that are used in the Linnaean system.
Connecticut, USA	Maria Sibylla Merian	Discovered that nose cells have tiny message receivers called receptors that help people smell.
Bermersheim vor der Höhe, Germany	Barbara McClintock	Discovered and named jumping genes transposons.
New York, USA	Linda Buck	Found out that water needs to be cleaned before people drink it to prevent them from getting sick.

Activity: Biographical Report

Grades: 2–5

Subject: Biology, research, biographies, presenting and sharing information

Skills: Researching, presenting, organizing

Materials: Biology Biography (page 67)

Next Generation Science Standards
ETS1.B: Developing Possible Solutions

Common Core English Language Arts
CCSS.ELA-LITERACY.CCRA.R: Key Ideas and Details
CCSS.ELA-LITERACY.CCRA.SL Presentation of Knowledge and Ideas

Background

Now that your students have read *Women in Biology/Las mujeres en la biología*, they are ready to create reports of their own. The ability to research, organize, and present information is vital to academic success. Children who develop these skills from a young age are better prepared for the future.

A ***biography*** is an account of someone's life. A life story can be presented in many different ways, but the most common is through writing. There are many famous people, both in history and modernity, who have made important scientific contributions to the world. A biographical report is one way to explore and learn more about these people; it helps ensure their accomplishments do not go unrecognized and inspires children to think outside the box. New solutions and problems are discovered by learning how people approach problems and building upon what people have already done.

Activity

1. Read *Women in Biology/Las mujeres en la biología* and go over the background information with the students. Let them know before that they will be making a biographical report about a biologist of their choice.

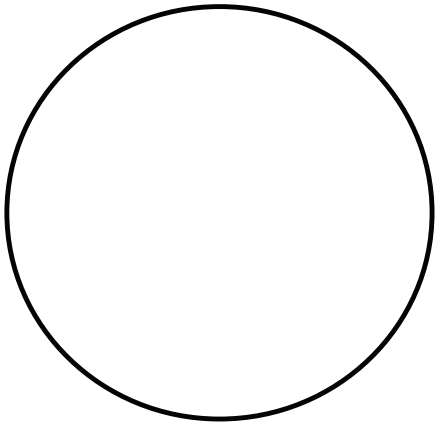
2. Have the students choose and research their own biologist, filling out the biographical report template, provided on the following page, as they go.

3. When all of the students have finished their reports, have them present their biologist to the class. For added fun, have them dress as the scientist dressed.

Discussion

The goal of this discussion is to have students recognize that a biographical report is just one way to present information. A book, such as *Women in Biology/Las mujeres en la biología*, is another way. Ask students how they decided to choose the information that they did. Was there a lot of information to choose from? By choosing what they felt was the most important information, they put together a short report; the more information you choose to include, the longer their report would be. Is a report the best way to present a biography? For example, would a skit, a movie or drawing be just as good, better, or worse?

Worksheet: Biology Biography



Photograph or drawing

Biography of: _____

Born:_____ **Died:**_____

Field in Biology:_____

(The study of _____**).**

Most Known For:_____

_____

Early Life:

Education:

Scientific Contributions:

Fun Facts:

Quotes:

Time Line of Major Events:

Report Author:_____ Date:_____

Activity: What's in the Bucket?

Grades: K–5

Subject: Scientific method, hypotheses, senses

Skills: Researching, presenting, organizing

Materials: Bucket, cloth or t-shirt to cover the bucket, safe objects that can fit in the bucket

Next Generation Science Standards
LS1.D: Information Processing
ETS1.A: Defining and Delimiting an Engineering Problem

Background

A ***hypothesis*** is a possible solution to a scientific question. For a ***hypothesis*** to be viable, it must be testable, which means that an experiment will produce the same results each time it is repeated. The best ***hypothesis*** are educated guesses. The more research and knowledge a scientist has gathered on their subject, the more likely they are to prove their ***hypothesis*** correct. If a ***hypothesis*** is proven wrong, it is not a failure; it means that you have found new information and can change your ***hypothesis*** for the better.

Activity

1. Before the activity begins, in an area your students cannot see, gather objects for which your students will make ***hypothesis***. Make sure you do not choose anything sharp or dangerous. Select one object first and place it in a bucket or container. Place a cloth or t-shirt over the bucket, making sure that there is an opening to access the item.

2. Go over the background information with the students.

3. Randomly select students or volunteers to come up and place their hand in the bucket, making sure that they cannot see the item that they are touching. If you have picked many diverse objects, give your students a hint, such as where they would find the item. Tell them to describe the object to the class using one adjective. Repeat for 5–8 students.

4. When enough clues have been provided, have students hypothesize what could be in the bucket. Provide some examples of objects – stuffed animals, binder clip, keys, etc. If many get it right, have them test their hypothesis by looking in the bucket. If they are wrong, ask them if they want to conduct more research and repeat step 3. Repeat the activity for as many objects as you would like.

6. Return to the Teacher's Guide for the discussion

Discussion

Tell your students to identify when it became easy to hypothesize about the item. Was it when they had more information or less? This is why it is important to conduct research before making a hypothesis. The more research your students have done, the more likely their hypothesis is to be correct. Ask your students to identify what tools they used to conduct research in this experiment. **Answer: some of their senses!** Scientists use many complex tools, like microscopes to conduct research, but organisms are also equipped with traits, like the senses, that help them navigate and succeed in the world.

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Activity: Scientific Method

Grades: 3–5

Subject: Scientific method, accuracy, research, experimentation

Skills: Researching, presenting, organizing

Materials: Experiment Template (page 71)

Next Generation Science Standards
LS1.D: Information Processing
ETS1.A: Defining and Delimiting an Engineering Problem

Common Core English Language Arts
CCSS.ELA-LITERACY.CCRA.R: Key Ideas and Details
CCSS.ELA-LITERACY.CCRA.SL: Presentation of Knowledge and Ideas

Background

The ***scientific method*** is the process of experimentation that almost all scientists use to observe and test their subjects. In science, accuracy is important; following these steps ensures that other scientists can repeat an experiment and make sure that the results are reliable. The method has six basic steps:

Observe and Ask Questions: What do you notice in the world that interests you? The questions you ask will help determine which mystery to solve.

Make a Hypothesis: A hypothesis is a possible answer to the question you propose. A hypothesis must be testable, which means that an experiment will produce the same results each time it is repeated.

Experiment: In this stage, the hypothesis is tested. If you think plants will grow better with mineral water than tap water, you would get two plants and water one plant with mineral water and the other with tap water. Then you would wait and see which plant grew the best. For the experiment to be reliable, all other factors need to be the same amount of sunlight, same soil, same background noise, etc.

Analyze the Data: A scientist records information as their experiment progresses. Once you have all of the **data**, you can analyze it to discover if your hypothesis was correct or incorrect.

Repeat: To ensure results are random, the experiment should be repeated three times.

Share the Results: A scientific discovery isn't useful if it isn't shared with the world. Making sure that the scientific method was followed will help other scientists see the value and accuracy of an experiment and test the hypothesis themselves.

Activity

1. Go over the background information with the students.

2. Select, or have your students select, an experiment to conduct. For a younger group, the entire class can complete the experiment together, while older groups can work individually or in smaller divisions. Give them the Experiment Template provided (page 71 of this Guide).

3. Have students present their results to the class.

Experiment Template

Question:

Hypothesis:

Materials

Method (What steps did you follow?)

Data (What did you observe?)

Conclusion

Activity: Echolocation

Grades: 2–5

Subject: Mammals, echolocation, senses, zoology

Skills: Sensing, active listening, inference, analysis

Materials: Blindfolds

Next Generation Science Standards
LS1.A: Structure and Function
LS1.D: Information Processing

Background

Zoology is a branch of biology that is concerned with the behavior, physiology, structure and classification of animals. A zoologist might study the methods animals use to get food, find mates or survive in the environment. Bats and moths are two animals that use echolocation to find prey and navigate the world. Echolocation is the method of using sound waves to sense the location of an object. To do this, bats and moths will send out a sound. When the sound reaches an object, it will bounce back like an echo and return to the animal, letting the animal know the distance and size of the object.

Activity

1. Go over the background information with your students before dividing them into two groups. One group will form a circle that will be the boundary of the game; they will play in the second round. The second group will be placed inside the circle.

2. Choose one of the insiders to blindfold; they will be the "bat." The other insiders will be moths. The bat will periodically yell "BAT!" and the moths must respond with "MOTH!" Using only the sense of hearing, the bat must tag the moths, who are attempting to avoid capture. When a moth is tagged, they will join the outer circle. The group that is forming the circle will tap those who are getting too close to the edge.

3. Repeat the activity, having the students take turns at being boundaries, bats, and moths.

Fun Fact

Dolphins and whales also use echolocation!

Additional Information

Bats are the second largest group of mammals in the world, after rodents, and they live on every continent except Antarctica. Ask your students if they like bats and have them explain why. Bats are often misunderstood as being rabid or scary, but they are very important to our ecosystems. Farmers love bats because their diet consists of insects that can harm crops. Pesticides can accidentally harm organisms that aren't trying to eat a farmer's crops and can pollute the environment, but bats will eat insects without damaging the environment—and free of charge! Bats are mammals like humans, which means that they are warm-blooded, have backbones, have hair or fur, and nurse their live young. They are the only mammals that can fly!

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Activity: Ecosystem Musical Chairs

Grades: 2–5

Subject: Biodiversity, ecosystems, habitat loss, food chains

Skills: Sensing, active listening, inference, analysis

Materials: Chairs, music source, paper, marker, tape

Next Generation Science Standards
LS4.D: Biodiversity and Humans
ESS3.A: Natural Resources

Background

Ecology is a branch of biology dealing with the relationship of organisms to other organisms and to their environment. Humans use natural resources daily, which means that they interact with ecosystems daily. Humans have a tremendous impact on the environment. Every time humans use fossil fuels for energy, pollute he water, or destroy habitat that houses wild animals, all the organisms in the environment are affected.

Activity

1. Go over the background information with your students.

2. This is a game of musical chairs. It can be played with up to 8 people at a time, making sure there is always one less chair in the circle than the number of students playing. If you have less than twelve, exclude labels from the beginning of the list. Make and tape labels to each chair with the following terms: white olive trees, parrots, yellow snake, banana plants, farmers, children, fish. Place chairs in a circle.

3. Explain that the labels on the chairs represent a Jamaican ecosystem of organisms living together. Because of pollution, the system is starting to collapse. When you play music, students will walk around the chairs. When the music stops, they must find a place to sit; the student left standing is out. Every time a chair is removed, explain why (detailed below).

4. Pull out chairs in the order of the labels, each time explaining the connections in the ecosystem: remove the trees, as they were cut down to build mines; remove the parrots, as they needed to trees to build homes; remove the snakes, as they needed the parrots to eat; remove the banana plants, as they were eaten by rats because the snakes were not alive to eat the rats; remove the farmer, as his crops were all eaten by rats; remove the children, as they were sad they couldn't eat the farmer's food; remove the fish, because the villagers had to eat fish as there were no crops.

5. Repeat the activity to make sure all students get a turn. Have the students join on the story telling so that they fully understand the story.

Discussion

Ask your students to list any endangered or extinct animals that they know of. Do they know why that happened? The red panda, for example, is an endangered species because they live in trees that are being cut down by the logging industry. Deforestation and resource draining have caused many animals to lose their homes, which affects every organism in an ecosystem. Ask your students why it is important to try their best to leave nature as they found it.

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Activity: Magnify It!

Grades: K–2

Subject: Biodiversity, magnification, biology, tools

Skills: Observation, sketching

Materials: magnifying glasses, drawing materials, clipboards, nature area

Next Generation Science Standards
ETS1.A: Defining and Delimiting an Engineering Problem

Background

Biologists study a wide variety of living things and often need to use special tools to help them research their subjects. The magnifying glass helps scientists take a closer look at what they are studying. It has a curved glass or plastic lens that bends light to make objects appear bigger. A magnifying glass must be held at the correct distance between the eye and the object for the object to be in focus.

Activity

1. Go over the background information with your students. Remind your students that studying parts of nature can disturb the organisms there and interfere with ecosystem processes, but scientists try their best to study their subjects with as little disruption as possible and to put things back exactly how they found them.

2. Hand out drawing materials, magnifying glasses, and clipboards to each student.

3. Explain to your students that they are to find different things in nature to look at closely with their magnifying glass. On their paper, they will draw an object as it appears without magnification, then again, as it looks under the magnifying glass.

4. This activity can be done inside the classroom by pre-selecting objects and distributing them to students on paper plates.

Discussion

After the activity, ask your students how their information about an object changed when they looked at it under a magnifying lens. Did things that look smooth from afar have a different texture up close? Try to encourage your students to use descriptive language. (You might consider pairing this activity with a lesson on adjectives.)

Expand the Activity

Expand the activity by having your students look at objects that seem very similar but might have different details. Try bringing in table salt, sugar, baking soda or powder or different kinds of soil and leaves.

This activity was adapted from the Boston Children's Museum: https://www.bostonchildrensmuseum.org/

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Activity: Growing Beans

Grades: K–5

Subject: Plants, root systems, life cycles

Skills: Observation, sketching, data gathering

Materials: glass jars or bottles, cotton balls, lima beans, water, window ledge, paper, Observation Worksheet (page 86)

Next Generation Science Standards
ETS1.A: Defining and Delimiting an Engineering Problem

Background

All plants need light, air, water, nutrients and space to grow. The various parts of a plant help them capture everything they need to grow. Plants use their leaves to capture energy from light, which they then convert and store as a type of sugar called ***glucose*** in a process known as photosynthesis. Light also provides heat; different plants require different temperature levels to grow, which is one reason why different farm crops grow in different seasons. The stems and roots of a plant help carry nutrients and water throughout the plant. Roots anchor a plant to the ground and store the products of photosynthesis.

Activity

1. Go over the background information with your students.

2. Have students break into groups that will each grow two beans. Pass out the materials to each group. For younger students, the class can grow one bean together.

3. Have students label their jar and stuff cotton balls into it. They will then place one bean toward the bottom of either side of the jar, so they can watch them grow.

4. Have or help students water their beans until the cotton balls are damp but not too wet.

5. Place jars in a sunny window. Return each day and have students observe the growth and record their observations on a piece of paper. Depending on the age of the children, consider measuring the beans each day or drawing pictures. Such recordings can be made on the Observation Worksheet (P 86 of this guide).

Additional Information

In nature, plant growth is helped along by other organisms in an ecosystem. Earth worms, for example, loosen soil and deposit mineral-rich waste that help the root system of a plant. Ants also loosen soil by digging tunnels, which helps make space for root growth.

Not all roots look the same. While the roots of the bean are small and thin, the roots of trees are thick and large. Ask students if they know any roots that humans eat. Carrots, yams, potatoes, turnips, and beets are some of the many kinds of roots that are in the human diet.

This activity was adapted from The Imagination Tree: https://theimaginationtree.com/growing-beans-on-cotton-balls/

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Activity: Breathing Leaves

Grades: K–5 **Subject:** Plants, photosynthesis **Skills:** Observation, sketching, data gathering	**Materials**: Clear bowls, water, leaves, magnifying glass, Observation Worksheet (page 86) **Next Generation Science Standards** LS1.A: Structure and Function LS1.D: Information Processing

Background

Photosynthesis is the process by which a plant creates food for itself. To do this, a plant needs ***carbon dioxide*** from the air, water, and sunlight. ***Carbon dioxide*** is taken from the air by tiny holes, called ***stomata***, in a plant's leaves; water is absorbed by the roots and carried to the leaves by the stem; sunlight is absorbed by a green chemical in leaves.

Activity

1. Go over the background information with your students.

2. Fill a clear bowl with lukewarm water.

3. Remove a leaf about the size of the bowl from a tree (the leaf needs to be active for this experiment, so it cannot come from the ground).

4. Place the leaf in the bowl of water and place a small rock on top so that the leaf is fully submerged. Put the bowl in a sunny spot and wait a few hours.

5. Return to the leaf and note the bubbles that have formed around the leaf and edge of the bowl. Use a magnifying glass to take a closer look. Students can record their observations on the Observation Worksheet (page 86 of this guide).

Discussion

Ask your students to consider what would happen if they held their breath and released it underwater. Their air would leave bubbles in the water. When humans breathe, they take in oxygen and release carbon dioxide. Plants do the opposite: they take in carbon dioxide and release oxygen. The bubbles around the submerged leaf are pockets of oxygen that the leaf is releasing. When a plant is not underwater it still releases oxygen, but bubbles do not form because there is no water to trap the air.

Expand the Activity

Mix red dye with water in a glass. Place a leaf (with the stem attached) or a stalk of celery in the cup of dyed water and observe how the plant "drinks" water over the course of several days. Have students write or draw their observations on a piece of paper.

This activity was adapted from Edventures with Kids: https://www.kcedventures.com/outdoor-fun

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Activity: Moldy Bread

Grades: K–3

Subject: Germs, mold, fungi, moisture

Skills: Observation, sketching, data gathering

Materials: Bread with no preservatives, gloves, two clear lunch bags, spray bottle, water, Observation Worksheet (page 86)

Next Generation Science Standards
LS1.A: Structure and Function
LS1.B: Growth and Development of Organisms

Background

There are many types of mold, but all are made up of tiny organisms called ***fungi***, which is the plural form of fungus. Fungi are not plants or animals. They are their own kingdom of organisms that produce spores and feed on organic matter. Mushrooms, yeast, and mold are all fungi. In the natural world, mold plays an important role in helping dead animals and plants decay. Indoors, however, mold is often a health risk. Mold travels by releasing spores that float through the air and land on different objects and organisms.

Activity

1. Go over the background information with your students.
2. Label one bag "clean" and one bag "dirty." Using gloves, place one slice of bread into the "clean" bag.
3. Pass a different slice of bread around the classroom, giving everyone the chance to rub their hands on the bread. Immediately after touching the bread, have students wash their hands.
4. Place the second slice of bread in the "dirty" bag. Before closing it, lightly spray the dirty bread with water.
5. Put both bags near a sunny window.
6. Discuss with students what they believe will happen. As you start to notice the bread change over time, discuss what they think is happening and what will happen. Students can record their observations on the Observation Worksheet (page 86 of this guide).
7. Return to the bread at various times throughout several weeks to watch the mold grow.

Expand the Activity

This activity can be done with petri dishes and tape for older students. Have students break into groups and give each a petri dish and piece of tape. Send them to find the dirtiest/germiest place they can find. They will use the tape to pick up germs from that place (for example, they might stick a piece of tape on the door handle of a bathroom). After touching the tape to their chosen location, they will stick and remove the tape on the petri dish. Place the petri dishes in a warm spot to help speed up the growth process. Make sure students label where they obtained their sample. Follow steps 6 and 7 from above.

This activity was adapted from Mrs. Byrd's Learning Tree: http://mrsbyrdskinder.blogspot.com/2013/01/yucky-germs.html

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Activity: Nature Sleuth

Grades: 2–5

Subject: Leaves, habitats, research

Skills: Research, observation, inference, computer skills

Materials: Fresh leaves, dark color crayons, paper, local plant life books (optional)

Next Generation Science Standards
LS1.A: Structure and Function
LS1.D: Information Processing

Background

In biology, ***habitat*** can refer to a variety of spaces. In ***ecology***, a habitat can designate the resources and area used by a specific species, or it can refer to an entire environment such as a pine forest. For a biologist studying something small, like termites, habitat might refer to a single log or tree stump. Ecosystems are dynamic habitats made up of interactions between plant, animal, and microorganism communities and their non-living, or ***abiotic***, environment. Biomes offer a broad way to categorize different habitats. The five ***biomes*** are aquatic, forest, desert, tundra, and grassland. Factors such as temperature, weather, and location determine the classification of a biome and influence what types of organisms live there. Different organisms can be found in each biome and habitat.

Activity

1. Go over the background information with your students.

2. Tell students to pick up an assortment of leaves from the ground.

3. Return to the classroom and distribute drawing materials.

4. Have students make a leaf rubbing by placing their leaves underneath a sheet of paper. Instruct students to remove the wrapping from a dark color crayon and, using the entire length of the crayon, lightly rub it over a leaf until the entire outline of the leaf shows through the paper.

5. Using the leaf and the drawing, have students use a book or computer to research what kind of plant produces that leaf. Have students label their drawings with the correct species.

Expand the Activity

Have students return outside and photograph or write down details about different organisms, including insects and animals. Tell them to note the climate as well. Encourage them to be respectful of the organisms by limiting the changes they make to the environment. Return to their reference books or computers and have them research the different organisms they documented. Have students make an educated guess about what biome they live in and use the computers to verify their hypothesis.

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Name: _____

Date: _____

Observation Worksheet

Project Title: _____

Predictions: _____

_____

_____

Observations:

Conclusions: _____

_____

_____

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Expanded Glossary and Index

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Expanded Glossary

Abiotic: Nonliving conditions that can impact an ecosystem or the organisms in it.

Animal Cells: These cells do not have cell walls, which allow them to be diverse in shape and size. Animal cells have either a flagella or cilia, hair like structures that help the cell move.

Axon: The long, thin part of a neuron that transfers messages from one end of the cell to the other.

Biography: An account of someone's life, written by someone else.

Bioindicator: An organism that provides clues about the health of an environment.

Biology: The scientific study of living things.

Biome: A large, natural area of land that is classified by the plants and animals that live in it.

Botany: The study of plants, including their structure, genetics and ecology.

Cancer Cells: These cells work to destroy the body by spreading rapidly and ignoring signals that tell them to stop.

Carbon Dioxide: A naturally occurring odorless, colorless gas that is produced through respiration and absorbed by plants during photosynthesis.

Cells: The basic structural unit for all organisms. They hold the biological equipment necessary to keep an organism alive and successful.

Cellular Biology: The study of cell structure and function. Cells are the building blocks of all life.

Chemotherapy: The use of chemical agents to kill cancer cells.

Chromosomes: A DNA molecule that holds the complete set of an organism's genetic material.

Charles Darwin: An English biologist who proposed the idea of evolution in the 1800s. His work proposed that all life species descended over time from common ancestors.

Cytogenetics: A branch of biology primarily concerned with how chromosomes, which carry the genetic information of a cell, affect cell behavior.

Data: Facts and observations gathered through research and experimentation in order to be analyzed.

Dendrites: Short, branch-like structures on a neuron that receive information from other neurons.

Deoxyribonucleic Acid (DNA): A molecule in the cells of living things (like plants, animals, and people) that contains the instructions that tell each cell, and as a consequence, the body, how to grow and function.

Experiment: A test to collect information about the world to see if a hypothesis is correct.

Ecology: A branch of biology focusing on the relationships of organisms and their environments.

Eukaryotes: A type of cell with a nucleus and typically much bigger and complex than prokaryotes. The nucleus houses the cell's DNA. It is also a domain classification.

Fungus (fungi): Living organisms that belong to their own kingdom that produce spores and feed on organic matter.

Genes: Smaller sections of DNA that contribute to how specific parts of living things (like the color of corn, or our hair and eyes) will look and grow.

Genetic Variation: The diversity of genes, and therefore traits, within individuals or populations.

Genetics: The study of genes and heredity that helps explain why you look like you do. This subject is closely related to cell biology, as genes are located in cells.

Glucose: The main sugar found in the blood and the cell's source of energy.

Habitat: The natural home for living organisms, such as humans, animals, and plants.

Hypothesis: An educated guess that a person makes to explain something they think is true or will happen.

Linnaean System: Named after Swedish scientist Carolus Linnaeus, a way to organize all living things into groups based on traits that living things have in common.

Life Cycle: The story of an animal's journey through life, including all the stages that a living thing naturally goes through between birth and death.

Metamorphosis: The process of transformation from an immature form to an adult form in two or more distinct stages.

Medicine: A treatment used to prevent, care, or relieve a disease. Medicine is also a science that studies and develops these treatments.

Microorganisms: Organisms that are microscopic, invisible to the naked eye, typically referring to bacteria, viruses, and parasites.

Natural Selection: The process by which organisms slowly change to better adapt to live in their environment, thereby giving them an advantage for survival.

Nerve Cells: A type of cell that carries electrical messages from one part of the body to another.

Nobel Prize: A set of very prestigious annual international awards in recognition of academic, cultural and scientific advances. The awards are named for Swedish Scientist Alfred Nobel, and were first awarded in 1895.

Observation: The act of careful watching and listening to someone or something in order to get information.

Organisms: Any living thing, from the smallest cell to the largest animal.

Pathogens: Microorganisms that can cause disease.

Plant Cells: Cells with a rigid wall structure that contain chlorophyll, unlike an animal cell.

Pollution: The presence of harmful substances in an environment.

Prokaryotes: Cells with no nucleus that are simple organisms like bacteria. It is also a domain classification.

Pheromones: Chemicals released by animals that trigger behaviors in other animals when smelled.

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

Physiology: Closely related to anatomy, this science studies the functions and processes of parts and wholes of organisms.

Receptor: A small part of a cell that allows the cell to sense and respond to things around it.

Research: To investigate and study something to learn new things about it.

Scientific Method: The standardized process of experimentation that scientists may use to observe and test their subjects.

Stomata: Tiny openings or pores, usually found underneath plant leaves, used for gas exchange.

Synapses: Small gaps at the end of a neuron that send messages by electric impulses to other neurons.

Taxonomy: The science dealing with the description, identification, naming, and classification of organisms.

Transposons (Jumping Genes): Genes that can switch places with other genes in a DNA strand.

Zoology: The study of everything related to animals, including behavior, classification, and physiology.

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