

R.E.A.L. SCIENCE ODYSSEY
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Biology

LEVEL 1
GRADES 2-5



WRITTEN BY
BLAIR H. LEE, M.S.



REAL Science Odyssey

Biology Level 1

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This file contains a PDF preview of **RSO Biology Level 1**:

Introduction

A Note about Optional Microscope Labs

What's the Big Idea?

Lab Supply List

Suggested Weekly Schedule

Unit 1 The Study of Life

- Chapter 1 – My Tardigrade
 - Lab #1: My Tardigrade Model
 - Lab #2: Pet Tardigrade Lab + Microscope
- Chapter 2 – What Is Biology?
 - Lab #1: Is It Alive?
 - Lab #2: Nature Photography: Field Research

Unit 2 Building Blocks of Life

- Chapter 3 – Organisms Are Made of Cells
 - Lab #1: Cell Theory
 - Lab #2: Model This! Plant and Animal Cells
 - Lab #3: My Plant: Getting Started
- Chapter 4 – DNA Is the Code That Makes Me
 - Lab #1: Model This! Chromosome
 - Lab #2: Tardigrade Bracelet

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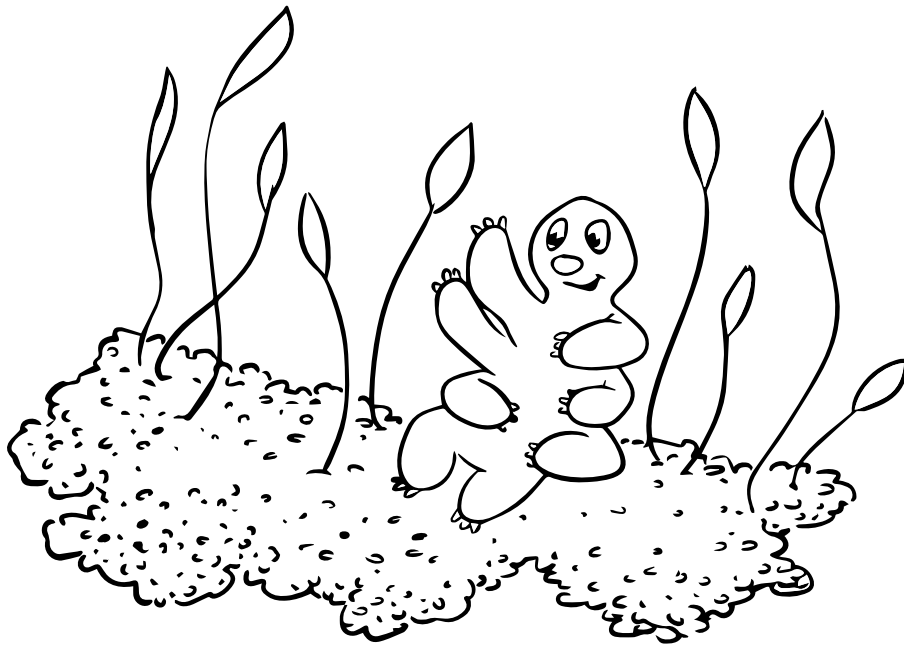
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REAL Science Odyssey

Read 🌱 Explore 🌱 Absorb 🌱 Learn



Biology Level 1

For grades 2–5

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About the Author

Blair H. Lee is the primary author of Pandia Press' critically acclaimed REAL Science Odyssey (RSO) series. She earned her Bachelor's degree in Biology and Chemistry and Master's degree in Chemistry at the University of California San Diego. Blair is a passionate advocate of innovative academics using secular materials. Through her speaking and writing, her goal is to empower parents and teachers to dare to be innovative and create something unique and academically rich when handcrafting their student's journey through learning. When teaching at her local community college, Blair found that many of her students were lacking in basic foundational science upon entering college. She believes science can be and should be taught from the beginning of a child's education. She began working with her own son and his friends on methods of teaching science concepts usually reserved for high school or college students. The results of her research and writing are RSO Chemistry, Biology, Astronomy, and Earth & Environment 1—concept-rich, hands-on courses that engage young people's minds and lay a firm foundation of science concepts. Blair now spends her time writing science for young people. She is the founder of Secular Eclectic Academic (SEA) Homeschoolers, a supportive community that advocates for the exclusive use of secular academic materials. She lives in California with her husband, son, many dogs, and several guinea pigs. When not homeschooling her son and writing textbooks, she loves to ski, cook (most chemists are good cooks), read, and hike.



Books by Blair H. Lee, M.S.

The Stargazer's Notebook: A Yearlong Study of Night Sky

REAL Science Odyssey Chemistry, Level 1

REAL Science Odyssey Biology, Level 1

REAL Science Odyssey Biology, Level 2

REAL Science Odyssey Astronomy, Level 1

REAL Science Odyssey Astronomy, Level 2

REAL Science Odyssey Earth & Environment, Level 1

Dedication

This course is dedicated to every child who looks at the world and wonders about the fascinating life around them.

A Note from the Author

If you were to distill biology into one statement, it would be “similar but different.” It holds true if you are studying individuals of the same species or species of organisms as different from each other as *Amoeba proteus* and *Homo sapiens*. That is because all organisms share fundamental characteristics and processes. The unifying concepts that are foundational to the science of biology and therefore *REAL Science Odyssey Biology 1* are the cell theory, the theory of evolution, genetics, and the processes used to define and describe the concept of organism.

If you wonder if this course and these concepts are appropriate for elementary students, I encourage you to read the first chapters. I have worked hard to make this introductory course on biology accessible for students at the elementary age. One tool for doing this is through the voice of Bear, a friendly, feisty, and funny tardigrade. Early readers of the course told us that Bear made the topics accessible and “fun” to learn for young learners. This is not a surprise, according to the National Science Teaching Association, as “interesting storylines can help students understand and remember concepts better.”

Most courses for this grade range focus exclusively on humans when teaching anatomy and physiology. In addition to teaching these topics for humans, the course includes the anatomy and physiology for other types of organisms. This gives a more complete learning experience for the study of biology—similar but different—and can lead to profound insights about the connectedness of life.

The labs and activities use a scaffolding approach to help students think like a scientist. The scientific method, basic lab report writing, and the use of observation to form conclusions are learning skills incorporated into the course. *REAL Science Odyssey Biology 1* includes scientific modeling. Scientific modeling, using simplified representations to get a better understanding of a real system, is an important skill for learning science. In the labs and activities, students will conduct hands-on experiments and modeling activities, including building a phylogenetic tree and a life-sized anatomical model. This intentional scaffolding and “learn by doing” approach leads to a more complete understanding of how scientists conduct science and of how science works.

Welcome to the fascinating science of biology,

Blair Lee

Introduction to Biology 1

This book is a complete, rigorous, and vocabulary-rich biology curriculum that needs no supplementation. It is not a collection of random labs with no flow from one to the other, nor is it an overwhelmingly long listing of trivial facts to be memorized and forgotten. This course was designed so that even the parent/teacher with little background in science could pick it up and teach science successfully with no need for further organizing or research. This course is the story of life.

This book is a minds-on and hands-on program. If you dislike hands-on learning and have no intention of getting gooey and dirty, RUN NOW! Science is about experimentation, and experimentation can be messy. This course has no fear. Are you still here? If so, roll up those sleeves and get ready to delve into the fascinating world of biology.

This book was intended to be used from start to finish, much like a math book; as such, vocabulary and concepts build upon one another. You may encounter words and concepts that you feel the need to review and practice. Feel free to do that if you wish, but understand that vocabulary words are repeated throughout the course, so your students will hear the same words many times. This approach is intended to help them learn without having to drill. Having said that, review can be good. Anytime you can use a concept to refer to something you see in real life,

your student will benefit. Learn about an organism that lives in your area. What about conducting field research to observe and learn more about the organism? Learn about bees and spiders. Become a citizen scientist using iNaturalist. Start a garden and discuss the lifecycle of plants. Take the time to investigate one individual, and then investigate a group of those individuals while discussing the similarities and differences. Discover the microscopic world of tardigrades. Take the time to learn about the ecosystem and biome where you live. Use real words for what you see. Science is only a foreign language if it isn't used in real life.

Every *For My Notebook* page in this book correlates with several lab activities that build upon and reinforce what children have heard. Labs also teach new material, so it is important to try to do all the labs included, or at least read the Aloud sections. In addition, we have included book and website suggestions for a complete indoor and outdoor experience and further opportunity to dig into whatever your student finds most fascinating. You will notice that some of the labs include elementary-level math. Science is inherently mathematical: measuring, graphing, and calculating. There are also writing sections. If your student struggles with math or with writing, don't let this overwhelm the lesson. *Give students all the help they need.* The idea is to learn and enjoy science. Much of the learning comes from doing and discussing. Read the questions to a pre-writing student and have them dictate the answers back to you, or if you both find the questions tedious, skip them altogether.

For My Notebook (FMN) Pages

1. All the student pages have a boxed outline around the material presented. That way, it is easy to identify what is for the student and what is for the parent or teacher.
2. The FMN pages are the lesson pages that present the majority of new material to the student. They are intended to be read aloud. Some students, who are good readers, may want to read the FMN pages aloud themselves to the parent or class. However orchestrated, these pages are intended to be read aloud and not silently in order to encourage discussion and questions.
3. New vocabulary words are underlined. You will notice that many of the vocabulary words are not presented with a classic dictionary definition. Instead, the explanation is given in content so it is “felt” rather than memorized. Formal definitions for the vocabulary words are offered in the back of the book.

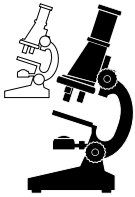
Lab Sheets

1. The lab sheets are those pages that the student writes on. They also have a boxed outline because they are intended for the student, not the parent/teacher, to complete.
2. The lab sheets not only reinforce the material presented in the FMN pages, but they are also the vehicle through which this course reinforces and formalizes scientific method. On the lab sheets, students will be making hypotheses based on questions formed during the lesson. Students record observations and lab results and make conclusions based on those results. They will also practice sketching details of their lab experiences, an important process that reinforces observation skills.
3. If you are working with a student who isn't writing yet, have them dictate the information to be written on the lab sheets. If your student is unable to draw (meaning physically incapable; I'm not referring to artistic capabilities), then have them describe in detail their observations as you create them on the lab sheet.

Instructor Pages

1. The instructor pages contain the supply lists for the labs and the procedure instructions.
2. These pages are written for the parent/teacher, but the procedure is often written as if for the student. For example, “Complete the hypothesis portion of the lab sheet,” is an instruction for the student, not the parent.
3. Instruction pages include a prompt to read aloud to the students. A great deal of course instruction is found in these prompts. If you dislike prompts, then be sure to present the information in your own words.

You will see various icons used repeatedly to indicate an ongoing theme or series of labs throughout this course. This includes:



Several labs in this course have optional microscope work that can be done to add a depth of understanding to the content.



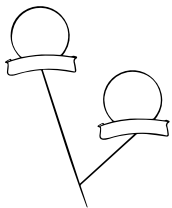
Various labs throughout the course (but mostly in Unit 3) require students to work on a scientific model of a tardigrade, which leads to profound insights about structure, function, connectedness, and divergence for different multicellular animals.



Various labs throughout the course (but mostly in Unit 3) focus on the anatomy and physiology of plants to show that plants also reflect the course's theme of “similar but different.”



This is used exclusively in Unit 3 as your student creates a life-sized scientific model of human organs and organ systems.



This is used exclusively in Unit 6 as your student creates a scientific model showing evolutionary relationships along with the divergence of phyla and classes of the type of organisms covered in the lab.

A Note about Optional Microscope Labs

The microscope sections in *RSO Biology 1* are optional. Microscopy does add a depth of understanding to any general biology course, but they can be left out for elementary students.

If you do decide to purchase a microscope, I suggest you invest in a nice one. This doesn't mean you have to spend your child's college fund, but you shouldn't waste your money on "toy" microscopes. The following are my recommendations:

- A compound light microscope: Compound microscopes have two lenses, the eyepiece, and the objective lens, which work together to magnify the specimen.
- A bright field microscope: Bright field microscopes form a dark image against a more brightly lit background using underlighting.
- An electric light (not battery powered): Choose a microscope that has an electric light. (I prefer direct current because it can be hard to tell when the battery is running down, and this can affect the light coming from the base without you really noticing it.)
- A fine focus knob: This is essential for focusing in on small specimens.

Nice to have, but not required:

- A USB connection in addition to the eyepiece: It is really nice to view specimens on your computer. You should not choose a microscope with just a USB connection. The resolution is less when viewing specimens on your computer. The amount of resolution going from the microscope to the computer can really affect the cost of the microscope.
- A mechanical stage: The mechanical stage holds the microscope slide steady and allows for smooth movements of the specimen.

You can use either a monocular microscope (one eyepiece) or a binocular microscope (two eyepieces). The advantage to the monocular scope is that it generally costs less. In addition, some people have trouble focusing with both eyes open. The advantage of the binocular scope is that for many people it is significantly easier for viewing and it cuts down on eye strain. If using a USB connection, I recommend a binocular scope so that you still have one eyepiece to use for viewing. Either microscope is sufficient, however. The choice is entirely up to you.

Please check Pandia Press' weblinks page for a list of recommended microscopes: pandiapress.com/biology-1-weblinks

What's the Big Idea?

Whenever you study a subject, there are main ideas and details to learn. It's true that in science, there is a lot of new material to discover. But keep in mind that you will cover every subject more than once throughout your student's education. Because of this, don't sweat the small stuff. This outline gives you the big ideas that your student should get from each chapter. The small stuff is an added bonus. If you and your student are timid scientists, just have fun as you learn the big ideas. If you and your student have a strong science background, work on learning the small stuff as well as the big ideas. There are many challenging words in this course that are used because they are the right words, and after hearing them over and over, they will "sink in." They are not here for your student to memorize the first time around. Use difficult words and science concepts gently, not with force, and your student will enjoy their science experience.

BI = Big Idea **SS** = Small Stuff

CHAPTER 1: MY TARDIGRADE

- BI =**
- Living being like tardigrades, humans, and plants are organisms.
 - Scientific models help us understand complicated ideas about the world by simplifying some parts of those ideas.
 - Members of the same species are those that can produce offspring that can then also produce offspring.
- SS =**
- Tardigrades are microscopic organisms that have 8 legs, 2 stylets, and claws. They are hardy animals that live in many places including some extreme environments.
 - The three types of scientific models are visual models, computer models, and mathematical models.
 - Microscopes can help us see things too small to be seen with the naked eye.

CHAPTER 2: WHAT IS BIOLOGY?

- BI =**
- Biology is the science that studies life. Scientists who study life are called biologists.
 - Organisms share traits that are essential for life.
 - Scientists use a special set of steps called the scientific method that incorporates a hypothesis, plan, an experiment with data collection, results, and a conclusion.
- SS =**
- Living things take in energy; get rid of waste; move; grow; reproduce; have circulation; have respiration; and respond to their environment.

CHAPTER 3: ORGANISMS ARE MADE OF CELLS

- BI =**
- Organisms are made of one or more cells.
 - Cells are the basic unit of structure and function in organisms.
 - Plant and animal cells contain different structures called organelles.
 - A scientific theory is a fact-based explanation for why or how something happens in science.
- SS =**
- Single-celled organisms have one cell.
 - Multicellular organisms have many cells with different structures and functions.
 - Plant cells have chloroplasts that make the plant green and make food for the plant.
 - The nucleus is the control center of the cell.
 - Cells only come from other existing cells in a process called cell division.

CHAPTER 4: DNA IS THE CODE THAT MAKES ME

- BI =**
- All organisms have genetic material called DNA, deoxyribonucleic acid, in their cells.
 - The DNA of each organism holds the information for making it.

- SS =**
- DNA determines the species of an organism and its traits.
 - DNA forms structures called chromosomes.
 - Chromosomes are divided into sections called genes.
 - Genes are responsible for each trait.
 - The sequence of the code making DNA is important.

CHAPTER 5: INHERITANCE

- BI =**
- The genes you inherit from your biological parents determine your traits.
 - Half your genes came from your biological mother and half came from your biological father.
- SS =**
- When cells divide, chromosomes divide too.
 - Chromosomes are passed on in a random process called independent assortment.

CHAPTER 6: ORGANISMS GROW

- BI =**
- All organisms grow.
 - How organisms grow depends on the species.
 - Organisms have lifecycles that vary depending on the species.
 - The cells of multicellular organisms differentiate to different types of cells.
- SS =**
- The integumentary system includes skin, hair, fingernails, and toenails.
 - Some animals go through metamorphosis, which affects their cell differentiation.
 - Differentiated cells group together to form organs.
 - Organs work together to form organ systems.
 - Tardigrades have a hard-outer covering called an exoskeleton that they must shed (molt) when they grow.

CHAPTER 7: ORGANISMS RESPOND

- BI =**
- All organisms respond to their environment.
 - Your nervous system's job is to take in information and to tell your body what to do about the information.
 - Your sensory organs are used to see, smell, taste, hear, and touch.
- SS =**
- Your brain, spinal cord, and nerves make up your nervous system.
 - Some, but not all, organisms respond to their environment using a nervous system.
 - Different species of organisms have different types of organs.
 - Different parts of your brain process different types of information.
 - Form fits function for the eyes and pupils of nocturnal and diurnal animals.
 - The nervous system of a tardigrade has a brain, nerve cords, and eyespots.

CHAPTER 8: ORGANISMS TAKE IN ENERGY AND GET RID OF WASTE

- BI =**
- All organisms take in energy and get rid of waste.
 - Your digestive system takes the food you eat, saves the nutrients and water that your body needs, and sends the rest back out of your body.
 - Your urinary system gets rid of water waste.
 - Animals get their energy from the food they eat.
 - Photosynthesis is the process where plants take sunlight, water, carbon dioxide, and nutrients from the soil to make food.
- SS =**
- The food you eat is used to make new cells and to repair your body.
 - Your teeth, esophagus, stomach, liver, anus, and intestines make up your digestive system.
 - Your urinary system is made up of two kidneys, two ureters, a bladder, and a urethra.

- Plants get rid of waste through small openings in their leaves called pores.
- A tardigrade's digestive system is made up of stylets, tubular pharynx, sucking pharynx, esophagus, stomach, and rectum.
- The plant cells where photosynthesis takes place have chloroplasts in them.

CHAPTER 9: ORGANISMS HAVE CIRCULATION

- BI =**
- All organisms have circulation.
 - Circulation for organisms with blood is the process where blood carries food, oxygen, and water to cells, and transports waste away from cells.
 - Plants have tubes called xylem and phloem that circulate water and other materials throughout the plant.
- SS =**
- Your circulatory system is made up of your heart, blood, and blood vessels called arteries, veins, and capillaries.
 - Arteries carry blood away from your heart. Veins carry blood back to your heart. Capillaries branch off veins and arteries and are where food gets in and waste gets out of your blood.
 - When there is no water available to them, tardigrades form a tun. When water becomes available, they absorb it, come out of their tun state, and become active again.

CHAPTER 10: ORGANISMS HAVE RESPIRATION

- BI =**
- All organisms have respiration.
 - Organisms combine oxygen and food particles in their cells to make energy in a process called respiration.
- SS =**
- Air goes into your trachea and then to your lungs. Your diaphragm is responsible for your lungs expanding and contracting.
 - Your respiratory system is made up of your trachea, bronchial tubes, lungs, and diaphragm.
 - Instead of lungs, fish have gills that absorb the oxygen they need.
 - Plants use the food they make during photosynthesis for respiration.
 - You breathe in oxygen needed for respiration from the air. You breathe out carbon dioxide, a waste product.
 - Tardigrades do not breathe like humans do. They absorb oxygen through their skin and release carbon dioxide out into the air through their skin.

CHAPTER 11: ORGANISMS MOVE

- BI =**
- All organisms move.
 - People use bones in their skeletal system and muscles in their muscular system to move.
 - Vertebrates have an endoskeleton.
 - Invertebrates have an exoskeleton covering the outside of their body.
- SS =**
- Some of the major bones are the skull, ribs, humerus, femur, vertebrae, pelvis, and patella.
 - Your bones are made from compact bone, spongy bone, with bone marrow inside. Your bone marrow is where new blood cells are made.
 - Vertebrate animals, such as mammals and birds and reptiles, have a vertebrate, a spine made of bone or cartilage.
 - Invertebrates use muscles attached to their exoskeleton to move.
 - The rigid cell walls around plant cells, as well as xylem and phloem filled with water, allow plants to stand upright and move.

CHAPTER 12: ORGANISMS MAKE MORE

- BI =**
- All organisms make more offspring; they reproduce.
 - There are two types of reproduction: sexual and asexual.
 - With sexual reproduction, sperm fertilizes an egg.
 - With asexual reproduction, one organism makes copies of itself through cell division.

- SS =**
- Female reproductive organs are the ovaries, fallopian tubes, the uterus, and the vulva.
 - Male reproductive organs are the testicles and penis.
 - Eggs are made in the ovaries. They travel down the fallopian tubes to the uterus. A baby is born when it travels from the uterus and through the vulva.
 - Sperm are made in the testicles.
 - In sexual reproduction, organisms get half their DNA from their biological mother and half their DNA from their biological father.
 - Parthenogenesis is asexual reproduction when offspring are produced from an egg that is not fertilized.

CHAPTER 13: PLANTS MAKE MORE

- BI =**
- Plants reproduce.
 - A seed is a baby plant. It is enclosed in a protective coating called a fruit.
 - The reproductive organ of flowering plants is the flower.
 - The lifecycle of a flowering plant starts with a seed that germinates to form a seedling that grows to an adult plant. The adult plant grows flowers, which make fruit that have seeds in them, and then those seeds germinate.
 - Pollinators are a necessary part of the reproductive process for some flowering plants.
- SS =**
- Flowering plants called angiosperms are the most common type of plant.
 - Seeds have three parts: the seed coat, embryo, and cotyledon.
 - The stamen is the male reproductive organ of an angiosperm. Pollen is produced in the stamen. The anther and filament make the stamen.
 - The pistil is the female reproductive organ of an angiosperm. The ovule (egg) is produced in the pistil. The stigma, style, and ovary make the pistil.
 - Bees are important pollinators.

CHAPTER 14: COMMON ANCESTORS

- BI =**
- Changes in the DNA in an organism's genes are called mutations.
 - If a species accumulates enough mutations, a new species might evolve.
 - All organisms evolved from a common ancestor.
 - Fossils are the solidified remains of an organism or an imprint, like a footprint, from the organism.
 - When a species has no living organisms alive today, that species is extinct.
- SS =**
- Mold fossils form as a hole in the surrounding soil that is shaped like an impression of an organism that died and decomposed. Cast fossils are organism-shaped rocks that form when particles fill in a mold fossil.
 - Paleontologists are scientists who study fossils. They use a methodical process when they work.
 - Whales and dolphins are called cetaceans. Through a series of evolutionary events, cetaceans evolved from land-dwelling mammals to ocean-dwelling mammals.
 - Cetaceans and hippos shared a common ancestor 55 million years ago. A branched diagram can be used to show this.

CHAPTER 15: NATURAL SELECTION

- BI =**
- Organisms of the same species have a range of traits.
 - When a trait varies in a species, it is called an adaptation. Some adaptations help an organism survive and some don't.
 - Differing environmental conditions in a population's environment can lead to selection for a trait.
 - A habitat is the natural home that has everything an organism needs to live.
 - Animals that hunt and eat other animals are called predators.
 - Animals that predators eat are called prey.

- SS =**
- When people select for certain traits, like is done with dogs, it is called artificial selection.
 - Natural selection is selection that happens without human interference.
 - To survive in a habitat, an organism needs air, food, water, shelter, a place to raise their offspring, and a method for escaping danger.
 - The genes an organism inherits determine their traits.

CHAPTER 16: THE ECOLOGY OF ECOSYSTEMS

- BI =**
- In each area on Earth, there are limited resources, like food, water, or space.
 - An organism's niche describes what it eats, where it lives, how it escapes danger, and how it interacts with others in its ecosystem.
 - Ecosystems include the living, or biotic, and non-living, or abiotic, parts of an area.
 - Biodiversity is the number and species of organisms in the ecosystem.
- SS =**
- There is less competition for resources when species in the area occupy separate niches. The science that studies the interaction of organisms in ecosystems is called ecology. Scientists measure the health of an ecosystem by its biodiversity.
 - Pollinators fill a niche that is essential for many ecosystems.

CHAPTER 17: THE ECOLOGY OF TAKING IN ENERGY

- BI =**
- Organisms, like plants, that make their own energy are called autotrophs.
 - Organisms, like humans, that eat other organisms to take in energy are called heterotrophs.
 - Symbiotic relationships happen when two different species have a close relationship with each other.
- SS =**
- Heterotrophs can be herbivores, carnivores, or omnivores.
 - A food web shows how the organisms in an environment take in energy.
 - Niches, which decrease competition, are important for organisms and the health of ecosystems.
 - Plants use the strategy of seed dispersal to transport seeds away from the parent plant and reduce competition.
 - When a symbiotic relationship benefits both partners, it is called mutualism.
 - When a symbiotic relationship benefits only one partner, it is called commensalism.

CHAPTER 18: THE ECOLOGY OF CLIMATE – BIOMES

- BI =**
- Ecologists organize ecosystems into biomes.
 - The kinds of organisms that can live in an area depends on the climate.
 - There are aquatic biomes—fresh and salt water. There are terrestrial biomes, which are those that are on land.
 - The community is the biotic part of the ecosystem.
- SS =**
- Two adaptations for dealing with changing conditions in biomes are migration and hibernation.
 - Climate measures the weather, temperature, rain, snowfall, and wind in an area for more than 30 years.
 - The four major terrestrial biomes are the grassland biome, tundra biome, desert biome, and forest biome.
 - All the individuals of the same species in the same area make a population.
 - All the populations of all the different species of organisms in an area make a community.

CHAPTER 19: THE ECOLOGY OF THE ENVIRONMENT

- BI =**
- An endangered species is one where the number of individuals has dropped so low that it is in danger of extinction.
 - There is a combination of four main issues endangering organisms: pollution, invasive species, loss of habitat, and climate change.

- Through our actions, we can have a positive impact to help the ecology of the environment.
- The decline or loss of one species in an ecosystem can lead to the decline or loss of other species.

- SS =**
- Pollution happens when substances that cause harm are added to the environment.
 - Native species are those that originated in an area without humans bringing them there. If people bring an organism into an area that the species colonizes, they are considered an invasive species.
 - Loss of habitat happens when people change a natural ecosystem to an area where wildlife no longer lives.
 - The changing climate is changing biomes. This affects the plants and animals, including bees and butterflies, that can survive in the changing biomes.
 - Feeding native birds can help their population numbers.
 - Growing native flowering plants can help pollinators.
 - Volunteering for clean-up days at local areas can help minimize the problem of pollution.

CHAPTER 20: SHARING TRAITS! AN EVOLUTIONARY TALE

- BI =**
- Life evolved 3.5 billion years ago.
 - New species of organisms evolve from other species through a process called speciation.
 - Evolution and speciation are responsible for the many species of organisms that have existed during the past 3.5 billion years.
 - Scientists organize organisms using a scientific model called a phylogenetic tree that shows evolutionary relationships.
- SS =**
- Each time speciation occurs, the two new species share a common ancestor.
 - Because all species share a common ancestor, all species have some shared traits.
 - The further in the past two species shared a common ancestor, the fewer shared traits the two species have. The more recently speciation occurred, the more shared traits they have.
 - There are six kingdoms, or groups of living things. Two are the plant and animal kingdoms.
 - Scientists give each species a scientific name that distinguishes it from other species.

CHAPTER 21: CELLS EVOLVE

- BI =**
- Cells are defined as eukaryotic cells and prokaryotic cells, depending on whether they have a nucleus around their DNA or do not have a nucleus.
 - Bacteria and archaea—two types of unicellular organism—have prokaryotic cells with no nucleus.
 - Other organisms—animals, including humans, and plants—have eukaryotic cells with a nucleus.
 - Cells evolved through endosymbiosis, which is the process where one unicellular organism engulfed another and they both lived.
 - All species share a common ancestor. The last universal common ancestor of all life is called LUCA. LUCA existed over 3 billion years ago.
- SS =**
- According to the endosymbiotic theory, the cell that was engulfed became a functional part of the other organism. This occurred through evolutionary steps.
 - Eukaryotic cells evolved when a unicellular bacterium was engulfed by a unicellular archaeon.
 - The evolution of the mitochondria occurred when an early prokaryotic cell engulfed another prokaryotic cell.
 - LUCA existed after the endosymbiosis of mitochondria but before the evolution of bacteria or archaea.

CHAPTER 22: PLANTS EVOLVE

- BI =**
- Scientists have identified 350,510 different species of plants that make up the Plant Kingdom.
 - Plants evolved about 1.6 billion years ago.

- SS =**
- All members of the Plant Kingdom are multicellular with cell walls around their cells. They are autotrophs that photosynthesize.
 - The first photosynthetic eukaryotic cell evolved through endosymbiosis when a eukaryotic cell engulfed a photosynthetic bacterium.
 - Biologists separate different types of plants into four divisions: bryophytes (mosses), pterophytes (ferns), gymnosperms (conifers), and angiosperms (flowering plants).

CHAPTER 23: ANIMALS EVOLVE

- BI =**
- All animal species are in Kingdom Animalia.
 - Animals evolved 640 million years ago.
 - The reason for the many different species on Earth has to do with genes, mutations, natural selection, and evolution.
 - Evolution and extinction are common throughout the history of life.
- SS =**
- Animals are multicellular and usually have organs. They have cells that do not have cell walls. Animals are also heterotrophs.
 - There are 9,000 species of cnidarians including corals, sea jellies, and sea anemones.
 - Cnidarians evolved 580 million years ago.
 - Cnidarians are “Frisbee”-shaped with a sac-like body with one mouth and tentacles.
 - Positioning on the phylogenetic tree gives information about when species last shared a common ancestor. It does not mean one group is more advanced than another.

CHAPTER 24: WORMS, CLAMS, AND BUGS, OH MY!

- BI =**
- Annelids, mollusks, and arthropods are invertebrates.
 - Annelids are worms. They can be segmented with muscles, bristles, and setae.
 - Mollusca include snails, slugs, octopuses, squids, clams, and oysters. They have soft bodies. Most also have a shell.
 - Arthropods have exoskeletons made from chitin, jointed legs, segmented bodies, and (except for arachnids) antennae.
- SS =**
- Phylum Arthropoda is the largest and most diverse animal phylum. It can be divided into several Classes, including Crustacea, Myriapoda, Hexapoda, and Arachnida.
 - Earthworms are important nutrient recyclers in soil. As they tunnel through the soil, they eat the soil, digesting nutrients, and excrete the soil as poop. This is an important part of healthy soil.
 - Some organisms have a hard shell, like mollusks, but other organisms have a light flexible shell, like insects. The answer to which is better for the organisms has to do with the niche they fill.
 - Comparative anatomy is the study of the similarities and differences of groups of organisms.
 - Insects have six legs and three body parts, and most insects have wings. Spiders have eight legs, two body parts, and no wings. Lobsters and centipedes have more than eight legs.

CHAPTER 25: RADIANT RADIAL ANIMALS

- BI =**
- Sand dollars, sea stars, and sea urchins are in Phylum Echinodermata.
 - Echinoderms are spiny-skinned with a five-sided, star-like appearance.
 - A controlled experiment has an experimental group (that the experiment is tested on) and a control group (that the experiment is not tested on).
- SS =**
- Sea stars have special adaptations for prying open mollusk shells, using a digestive enzyme to dissolve its tissues, and then eating the mollusk inside it.

CHAPTER 26: THE BACKBONE EVOLVES

- BI =**
- All animals in Phylum Chordata share the trait of having endoskeletons that grow with them.
 - All fish have a bullet shape with fins that help them swim. They also all live in water and breathe using gills. Most fish species also lay eggs.
 - Frogs, toads, newts, and salamanders are amphibians. They are ectotherms that have permeable skin that gas and liquids can pass through. This allows them to breathe and get moisture. It also makes them susceptible to harmful substances.
- SS =**
- The first members of Phylum Chordata evolved 530 million years ago.
 - A notochord is the skeletal rod that first develops in all chordates before they are born or hatched.
 - The three classes of fish are Agnatha (hagfish and lampreys), Chondrichthyes (sharks and manta rays), and Osteichthyes (most other fish).
 - Fish evolved 500 million years ago. About 130 million years afterward, the first sea-dwelling organisms evolved.
 - Class Osteichthyes is the most diverse class of fish. It has more species in it than any other class of vertebrates does.
 - The first amphibians evolved 370 million years ago.

CHAPTER 27: WHY ARE BIRDS DINOSAURS BUT LIZARDS AREN'T?

- BI =**
- Lizards, crocodiles, turtles, snakes, birds, and dinosaurs are reptiles. They lay eggs that have tough, leathery shells, and when baby reptiles hatch, they look like miniature adults.
 - When other dinosaurs went extinct, birds did not. Birds have beaks, feathers, and wings. Most birds can fly.
 - Endotherms control their body temperature inside their bodies. Most animals, including reptiles, are not endotherms.
- SS =**
- Reptiles evolved 300 million years ago.
 - Birds evolved 150 million years ago from theropod dinosaurs.
 - Scientists think birds survived the extinction event due to their small size, omnivorous feeding strategies, and ability to fly.
 - The wings of birds are an important adaptation for flight.
 - The body temperature of an ectotherm changes with the temperature of their environment. If it is too hot, some ectotherms go through estivation. If it is too cold, some ectotherms go through brumation.
 - Some of the shared traits of birds and dinosaurs are three-toed feet, hard ovoid eggs, nests and nesting behavior, feathers, honeycombed bones, and some other important skeletal features.

CHAPTER 28: MAMMALS AND THE EVOLUTION OF ME

- BI =**
- All mammals have hair, are vertebrates, breathe through their lungs, are endotherms, and—when they have babies—the biological mothers make milk that they feed to their young.
 - There are three main groups for mammals based on the development of their babies when they are born: monotreme, marsupial, and eutherian mammals.
- SS =**
- Mammals evolved 200 million years ago.
 - Modern humans evolved 200,000 years ago.
 - Eutherian mammals, like humans, give birth to babies that are further along in their development than the other two groups. They are native to every continent except Antarctica.
 - Marsupial mammals give birth to babies that are not as developed. They are native to Australia, South America, and North America.
 - Monotreme mammals lay eggs. The eggs are leathery like reptile eggs. They are only native to Australia.
 - Humans have the adaptations of speech, opposable thumbs, and bipedalism.

Lab Supply List

Items below are listed in alphabetical order. Most items are common household items. Please review the Suggested Weekly Schedule (p. xxiii) or the individual lab exercise for more information about the lab supplies.

Access to one of the following movies: <i>Finding Nemo</i> , <i>The Lion King</i> , <i>Happy Feet</i> , <i>Brother Bear</i> , <i>FernGully</i> , <i>Epic</i>
Bag for collecting trash
Baggie, sealable
Baking pan, 8" x 8"
Baking soda
Balloon
Banana
Bathroom scale
Bathtub or large container
Binoculars (optional)
Bird feeder, store-bought or homemade
Bird food / seed
Bowl
Bread, cubed, white
Bucket with water
Bush bean seeds (not pole beans)
Butcher paper
Butter or butter substitute
Cake-pops, donut holes, cherries, or strawberries
Calculator
Candy chips, different flavors, such as white chocolate, chocolate, or butterscotch
Cardboard, 8.5" x 11"
Cardstock, 8.5" x 11"
Carnations, white
Celery stalks
Cell phone (with charging cord)
Chicken, cooked and cut to 1/4-inch by 1-inch by 1-inch
Chocolate bars
Clam or oyster shell
Clay

Clean plastic toy
Clipboard
Closet or dark room
Clothing with buttons and a zipper
Coffee filter (or paper towels)
Coin
Colored pencils
Confectioners' sugar
Containers, microwave-safe
Containers, small or medium-sized
Cookie dough, plain, raw
Cotton balls
Crackers
Craft foam, 0.5"
Cutting board
Digital camera (or a cell phone)
Dish, small and shallow (optional)
Dowel or wooden spoon
Dried black beans
Dried garbanzo beans colored green or dried split peas
Drinking glass
Drinking straw
Dropper (optional)
Duct tape or masking tape
Egg cartons, cardboard
Egg or egg substitute
Eggs, hard-boiled
Eggs, raw
Elastic strings, 12 inches long
Fan, small or blow dryer
Felt, green (optional)
Field guides for local insects, animal tracks, birds, plants, etc. (optional)

Flour
Flower
Food coloring, blue
Food coloring, red
Freezer
Fruit with seeds in it
Glue (liquid white)
Glue sticks
Granulated sugar
Grapes, green
Gravel
Ground pepper or ground coffee
Hairbrush or comb
Hammer
Hat (bowl can be used instead)
Helmet (optional)
Highlighter
Hole punch
iNaturalist account
Internet access
Iron shavings
Jar with a lid
Kitchen scale that measures ounces or grams
Knife
Knife with a serrated edge
Lab partner
Lard or bacon grease
Large flower with easily visible parts (e.g., lily, iris, poppy, daffodil, tulip)
Lemon-lime Gatorade or pineapple juice
Lemon-lime soda or white vinegar
Light brown sugar
Lima bean seeds
M&Ms, red
M&Ms, yellow
Magnet

Magnifying glass (optional)
Markers or crayons
Materials students gather to build a shelter
Meat tenderizer
Metal brad, small
Microscope (optional)
Microscope slide
Microwave
Milk carton, cardboard
Milk or dairy substitute
Mirror
Models for bird food, such as rubber bands, peanuts, raisins, jellybeans, rice, popcorn kernels, marbles, Legos, kosher salt, unrefined sugar
Models for different shaped beaks, such as clothespin, eyedropper, basting tool, tweezers, tongs, spoon, skewer, chopsticks, drinking straw
Moss (optional)
Multi-generational family
Nail
Newspaper (or other floor covering)
Nonperishable food items
Nontoxic paint (optional)
Notepaper or printer paper
Objects, such as Legos, plastic eggs, building blocks (3 each of 5 different colors)
Outdoor area for a nature walk (rural or urban)
Packing box or shoebox
Pan, small and round
Pan, small and square
Paper cups
Paper plate
Paper towels
Peanut butter
Peanuts
Pencils
Pennies
Photographs of student as a baby and recently

Pictures of animals from the ecosystem (optional)
Piece of fruit
Pillow
Pine cone
Pine cone with pine nuts (optional)
Pipe cleaners
Plant (houseplant or other small, potted plant)
Plants, store-bought (optional)
Plastic pony beads (10 red, 10 blue, 2 yellow, 2 green)
Plastic wrap
Plate
Play-Doh
Posterboard, 22" x 28"
Pot, cooking
Pots, one-gallon clay or plastic
Potting soil
Pretzels
Printer
Protective gloves
Pudding mix, 3.4 ounces (or a package of pudding cups)
Raisins
Refrigerator
Rope
Ruler or measuring tape
Salt
Sandpaper
Scissors
Scotch tape
Shaving cream, white
Shoe with laces
Shovel
Shrimp shell
Skewer
Sock
Sofa
Spatula

Spice bottle lid, round
Sponge
Spoon
Spray oil for cooking
Sprinkles in two different colors
Stapler
Stove
Strainer
String
Student information about birth length, weight, head circumference, and footprint
Stuffed sock or fuzzy stuffed animal
Styrofoam
Sunny area
Thermometer, exterior
Thermometer, internal
Timer, clock, or stopwatch
Tissue paper, blue (optional)
Toilet paper roll tube
Toothbrush
Toothpicks
Unsweetened cocoa
Vanilla extract
Variety of seeds and fruits, such as dandelion, coconut, burr, 2 nuts with shells, bean pod, berry, 2 avocados
Velcro dots, two-sided (optional)
Velcro, small pieces
Walnuts
Water
Watering can or hose
Wildflower seeds or a young tree
X-Acto knife or box cutter
Yarn

RSO Biology 1 – Suggested Weekly Schedule

The following schedule is suggested for those wishing to complete the course in a 36-week school year, teaching science twice a week. We anticipate an average of 45-60 minutes per session; however, some labs will take less time and others will take more. Note that these are just estimated times and that you know your student(s) best and will be better able to judge whether a lab might take them less or more time. General lab supplies needed for each week are listed. Refer to the lesson specified for quantities of each material. Some labs require early preparation before the lab time with your student(s) so make sure to reference the lab instructions prior to the day you plan to teach the lab. Those labs are marked below with an asterisk.

Wk	Chapter/ Lab #	Lab Title	Estimated Time	Supplies Needed for the Week	Dates / Notes
1	Chapter 1, Lab 1	My Tardigrade Model	60 min.	Internet access; Optional: Glue, Cardboard, Microscope, Moss, Water, Dishes, Slide, Dropper	
	Chapter 1, Lab 2	Pet Tardigrade	60 min.		
2	Chapter 2, Lab 1	Is It Alive?	45-60 min.	Internet access, Plant, Magnet, Cell phone, Iron shavings, Charging Cord, Fruit with seeds, Flower, Outdoor area, Digital camera or smart phone, iNaturalist account, Paper, Pencils, Pens, Glue; Optional: Magnifying glass, Binoculars, Field guides, Access to <i>The Photo Ark</i>	
	Chapter 2, Lab 2	Nature Photography	1-3 hr.		
3	Chapter 3, Lab 1	Cell Theory	45-60 min.	Colored pencils, Pudding mix, Milk or dairy substitute, Square pan, Round pan or bowl, Plastic wrap, Plate, Refrigerator, Bag of candy chips, Green grapes, Cake-pops, Banana slices	
	Chapter 3, Lab 2	Model This! Plant and Animal Cells	60 min.		
4	Chapter 3, Lab 3	My Plant: Getting Started	60 min.	Bush bean seeds, Sealable baggie, Paper towels, Clay or plastic pots, Potting soil, Sunny area, Water, Ruler or measuring tape, Colored pencils or markers; Optional: Store-bought plants	
	Chapter 4, Lab 1	Model This! Chromosome	30-45 min.		
5	Chapter 4, Lab 2	Tardigrade Bracelet	45 min.	Plastic pony beads, Elastic strings, Sprinkles, Bowl	
	Chapter 5, Lab 1	New Baby in the Family	30 min.		
6	Chapter 5, Lab 2	Family Traits	1-2 hr.	Multi-generational family, Butcher paper, Markers or crayons, Scissors, Glue, Stapler; Optional: Yarn	
	Chapter 6, Lab 1	Model of Me! Keeping Insides In	60 min.		

Wk	Chapter/ Lab #	Lab Title	Estimated Time	Supplies Needed for the Week	Dates / Notes
7	Chapter 6, Lab 2	Model This! A Frog Grows Up	60 min.	Glue, Scissors, Colored pencils or markers, Ruler, Packing box or shoebox; Optional: Blue tissue paper, Green felt	
	Chapter 6, Lab 3	Tardigrade: Molting to Grow	30 min.		
8	Chapter 6, Lab 4	Plant: Charting Growth*	45-60 min.	Student birth information, Photos of student, Measuring tape, Bathroom scale, Cardboard egg carton(s), Pipe cleaners, Craft foam, Skewer, Colored pencils, crayons, or markers, Scissors, Stapler, Glue stick, Tape	
	Chapter 7, Lab 1	Model of Me! My Thinking Cap	60 min.		
9	Chapter 7, Lab 2	Protecting My Thinking Cap	60 min.	Raw eggs, Cotton balls, Styrofoam, Paper cups, Egg carton cups, Duct or masking tape, Tape, Newspaper, Lab partner, Colored pencils, Closet or dark room, Mirror, Timer; Optional: Helmet	
	Chapter 7, Lab 3	Nocturnal or Diurnal? Check the Eyes	60 min.		
10	Chapter 7, Labs 4 and 5	Tardigrade: Using Their Brain Plant: Plants Respond Too	60 min.	Colored pencils, Small potted plants, Freezer, Sunny windowsill; Glass of water, Crayons or markers, Scissors, Glue, Balloon, String or yarn, Drinking straw, Tape; Optional: Microscope, Tardigrade live specimen, Water, Toothpick, Slide, Dropper	
	Chapter 8, Lab 1	Model of Me! I'm Mostly Water	30-45 min.		
11	Chapter 8, Lab 2	What's Inside My Stomach?	30-45 min.	Baggies, White bread, Lemon-lime soda or white vinegar, Strainer, Coffee filter or paper towels, Bowl, Stopwatch, Crayons or markers, Drinking straws, Yarn or string, Thicker rope or yarn, Crackers, Scissors, Ruler or measuring tape, Tape, Glue	
	Chapter 8, Lab 3	Model of Me! Building Cells	45-60 min.		
12	Chapter 8, Labs 4 and 5	Tardigrade: Digestion Plant: Where Is a Plant's Mouth?	60 min.	Colored pencils, Small potted plants, Water, Sunny windowsill, Dark closet, Crayons or markers, Yarn, Scissors, Tape, Glue; Optional: Microscope, Slide, Knife, Plant	
	Chapter 9, Lab 1	Model of Me! My Blood Gets Around	30-45 min.		
13	Chapter 9, Labs 2 and 3	Tardigrade: The Tun Stage Plant: Circulation	60 min.	Brown clay, Glue, Colored pencils, crayons, or markers, Food coloring, Celery stalks, White carnations, Drinking glasses, Clock, Knife, Cutting board, Magnifying glass, Water, Crayons or markers, Yarn, Scissors, Glue, Tape	
	Chapter 10, Lab 1	Model of Me! How I Make Energy	45-60 min.		

Wk	Chapter/ Lab #	Lab Title	Estimated Time	Supplies Needed for the Week	Dates / Notes
14	Chapter 10, Lab 2	Organ Systems Work Together	45 min.	Timer, Lab partner(s), Colored pencils, Small potted plants, Scissors, Drinking glasses, Coffee filter, Water	
	Chapter 10, Labs 3 and 4	Tardigrade: Respiration Plant: Plant Greens	45-60 min.		
15	Chapter 11, Lab 1	Model of Me! Pulling Me to Move	45 min.	Crayons or markers, Cardstock, Metal brad, Yarn, Scissors, Glue, Tape, Hole punch, White paper, Toilet paper roll tube, Sponge, Serrated knife, Shaving cream, Liquid white glue, Food coloring, Bowl, Spoon, Toothpicks, Knife or spatula; Optional: Velcro dots	
	Chapter 11, Lab 2	Modeling How Bones Are Made	45 min.		
16	Chapter 11, Labs 3 and 4	Tardigrade: Call Me Knight Bear! Plant: Plants Stand Tall and Move	60 min.	Colored pencils, Measuring tape, Calculator, House plant, Colored pencils or camera with printer, Glue, Crayons or markers, Scissors, Tape	
	Chapter 12, Lab 1	Model of Me! How I Make More	45 min.		
17	Chapter 12, Labs 2 and 3	Organisms Reproduce in Different Ways How Tardigrades Make More	60 min.	Play-Doh or clay, Glue, Plastic wrap, Colored pencils, crayons, or markers, Large flower, Magnifying glass; Optional: Microscope, Knife, Slides	
	Chapter 13, Lab 1	Angiosperm Flower Parts	45-60 min.		
18	Chapter 13, Lab 2	Lifecycle of an Angiosperm	30-45 min.	Colored pencils, crayons, or markers, Scissors, Glue, Tape, Lima bean seeds, Glass, Water, Magnifying glass	
	Chapter 13, Lab 3	Angiosperm Seed Parts	30 min.		
19	Chapter 13, Lab 4	"Beeing" a Pollinator	30 min.	Scissors, Juice boxes, Orange and white cheese puffs, Crayons or markers, Lab partner(s), Notepaper, Pencil, Hat or bowl, Timer	
	Chapter 14, Lab 1	Everyone Makes Mistakes	30 min.		
20	Chapter 14, Lab 2	Whale Evolution	30 min.	Colored pencils, Chocolate or other flavored candy chips, Disposable cup, Spoon, Knife, Plate, Clean plastic toy, Cooking spray, Microwave-safe containers, Microwave	
	Chapter 14, Lab 3	Chocolate Fossils	45 min.		

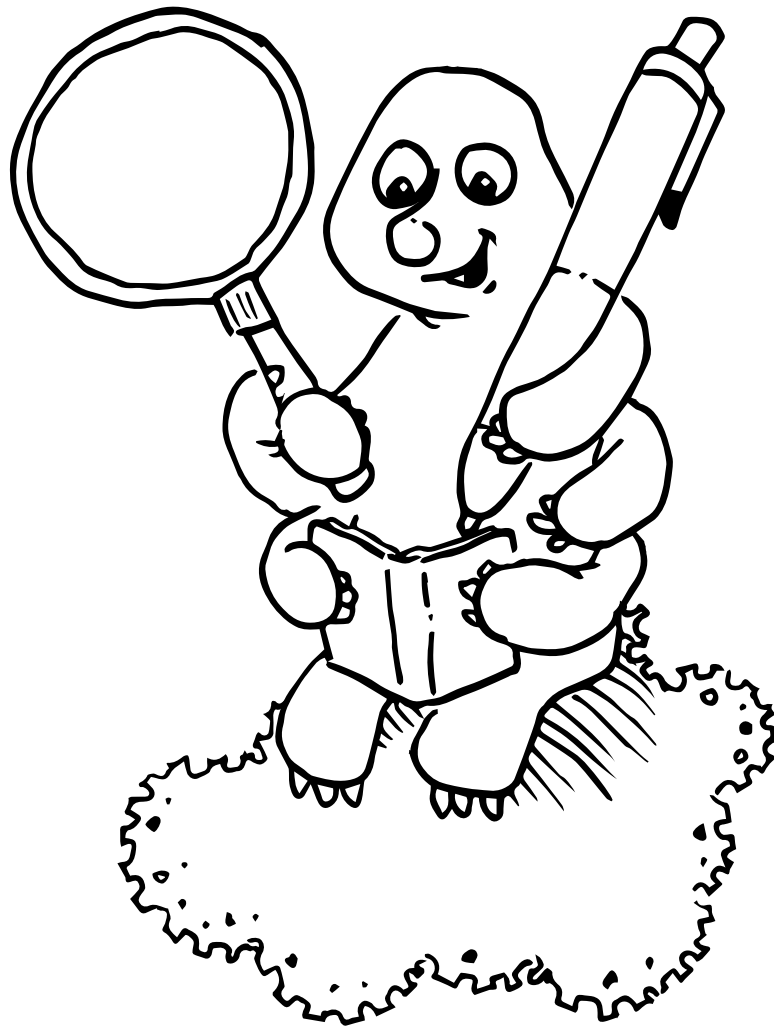
Wk	Chapter/ Lab #	Lab Title	Estimated Time	Supplies Needed for the Week	Dates / Notes
21	Chapter 14, Lab 4	Paleontology at Cookieopolis	45 min.	Baking pan, Raw cookie dough, Pretzels, Red and yellow M&Ms, Peanuts, Walnuts, Raisins, Chocolate bars, Toothpicks, Colored pencils, Knife, Spatula, Plate, Crayons or colored pencils, Objects to hide	
	Pre-reading Activity Chapter 15 & Chapter 15, Lab 1	My Favorite Color Is Invisible	45 min.		
22	Chapter 15, Lab 2	Natural Selection of Deer	30 min.	Bird beak models (Clothespin, Pipette or eyedropper, Basting tool, Tweezers, Tongs, Spoon, Skewer, Chopsticks, Drinking straw); Bird food models (Cut rubber bands, Peanuts, Raisins, Jellybeans, Rice, Popcorn kernels, Marbles, Lego blocks, Kosher salt or unrefined sugar)	
	Chapter 15, Lab 3	Which Beaks Are Best Adapted?	30-45 min.		
23	Chapter 16, Lab 1	The Living and Non- Living Parts of My Ecosystem	1-2 hr.	Clipboard, Natural outdoor area; Optional: Field guides, Binoculars, Magnifying glass, Crayons, markers, or colored pencils	
	Chapter 16, Lab 2	Anatomy of a Perfect Pollinator	30 min.		
24	Chapter 17, Lab 1	Food Web for My Ecosystem	30-60 min.	Colored pencils, Internet access; Optional: Animal pictures, Glue, Scissors	
	Chapter 17, Lab 2	Predators and Their Prey Adapt	30 min.		
25	Chapter 17, Lab 3	How Seeds Get Around	30-45 min.	Variety of seeds (Dandelion, Coconut or cranberry, Burr, Two types of nuts with shells, Bean pod, Berry, Two avocados), Small fan or blow dryer, Stuffed sock or fuzzy stuffed animal, Bucket with water, Knife, Colored pencils; Optional: Pine cone (needs to have pine nuts)	
	Chapter 18, Lab 1	Types of Biomes	30 min.		
26	Chapter 18, Lab 2	Migration and Hibernation	45 min.	Paper, Scissors, Tape, Toothpick, Gathered materials to build a shelter, Nonperishable food items, Paper plate, Access to one or more of the listed movies; Optional: Glue, Clay	
	Chapter 18, Lab 3	At the Movies with Biomes	2 hr.		
27	Chapter 19, Lab 1	Ecosystem Clean- Up Day	A few hours	Bag for collecting trash, Protective gloves, Adult, Wildflower seeds or a young tree, Potting soil or area to plant, Clay or plastic pots, Shovel, Watering can or hose; Optional: Internet access	
	Chapter 19, Lab 2	Bring Back Native Habitat	45 min.		

Wk	Chapter/ Lab #	Lab Title	Estimated Time	Supplies Needed for the Week	Dates / Notes
28	Chapter 19, Lab 3	Helping Native Birds	45 min.	Bird feeder, Bird food, Internet access, Cardboard milk carton, X-Acto knife or box cutter, Hole punch, Dowel or wooden spoon, String, Pine cone, Birdseed, Lard or bacon grease, Pot, Stove, Plate, Refrigerator; Optional: Nontoxic paint, Internet access	
	Chapter 20, Lab 1	Puzzling Over Scientific Names	30 min.		
29	Chapter 20, Lab 2	Tardigrades on the Tree	60-75 min.	Scissors, Tape or glue, Colored pencils, Posterboard, Flour, Unsweetened cocoa, Baking soda, Salt, Granulated sugar, Light brown sugar, Butter or butter substitute, Peanut butter, Vanilla extract, Egg or egg substitute, Confectioners' sugar	
	Chapter 21, Lab 1	Endosymbiotic Cookies	90 min.		
30	Chapter 21, Lab 2	Cells on the Tree	30-40 min.	Play-Doh, Dried black beans, Scissors, Glue, Colored Pencils, Magnifying glass, Dried garbanzo beans or dried split peas; Optional: Field guide for plants, Clipboard, Microscope, Baggies, Scissors	
	Chapter 22, Labs 1 and 2	A Plant Hunt Plants on the Tree	1-3 hrs.		
31	Chapter 23, Lab 1	Cnidarians Move but Go Nowhere	45-60 min.	Pencil, Round lid of spice bottle, Bowl, Bathtub or large container, Water, Spoon, Ground pepper or ground coffee, Measuring tape, Scissors, Glue, Colored pencils, Play-Doh, Velcro, Ruler, Potting soil, Container; Optional: Internet access	
	Chapter 24, Lab 1	Annelids Tunnel Deep	45 min.		
32	Chapter 24, Lab 2	Homes for Mollusks	60-75 min.	Clam or oyster shell, Shrimp shell, Kitchen scale, Nail, Sandpaper, Plastic bag, Gravel, Hammer, Magnifying glass, Scissors, Glue, Colored pencils	
	Chapter 24, Lab 3	Classes for Arthropods	45 min.		
33	Chapter 25, Lab 1	Echinoderms Eat Oysters*	45 min.	Meat tenderizer, Lemon-lime Gatorade or pineapple juice, Water, Cooked chicken, Containers, Scissors, Glue, Colored pencils	
	Chapter 26, Lab 1	Fish in Classes	60 min.		
34	Chapter 26, Lab 2	Amphibians Are Very Thin-Skinned	60 min.	Hard-boiled eggs, Food coloring, String, Ruler, Drinking glasses, Water, Spoon, Knife, Scissors, Glue, Colored pencils, Clay or Play-Doh, Thermometer, Outside thermometer, Timer, Exposed and shady outdoor areas	
	Chapter 27, Lab 1	Lizards and the Three Bears	60-75 min.		

Wk	Chapter/ Lab #	Lab Title	Estimated Time	Supplies Needed for the Week	Dates / Notes
35	Chapter 27, Labs 2 and 3	Birds and Dinosaurs Bird Bones	75-90 min.	Clay, Pipe cleaners, Lab partner, Printer paper, Tape, Paper plate, Soft sponges, Pennies, Scissors, Glue or tape, Colored pencils, Internet or library access; Optional: Printer	
	Chapter 28, Lab 1	Mammals Make Milk	45 min.		
36	Chapter 28, Lab 2	What Makes Me Human, Part I	60 min.	Highlighter, Internet or library access, Tape, Clothing with buttons and a zipper, Masking tape, Pencil, Paper, Sock, Shoe with laces, Coin, Spoon, Something you eat with a spoon, Piece of fruit, Toothbrush, Hairbrush or comb, Jar with a lid, Pillow, Sofa, Scissors, Glue, Colored pencils, Lab partner(s), Bowl, Stopwatch, Student picture	
	Chapter 28, Lab 3	What Makes Me Human, Part II	45 min.		

Unit 1

The Study of Life



Unit 1: Introduction for Instructors

Unit 1 is planned as a 2-week introduction to *REAL Science Odyssey Biology 1*. This unit contains new concepts with vocabulary. Don't worry if students do not seem to grasp them fully. These are introduced here so that they can be used throughout the course, which will lead to your students having a solid understanding of the concepts.

In Chapter 1, students meet a feisty, funny, microscopic tardigrade named Bear, who narrates many sections of this course. In Lab #1, students begin creating a poster they will work on throughout the course. This is an important teaching model emphasizing the theme "similar but different" through the inclusion of lessons on the anatomy, physiology, and nomenclature of tardigrades. To get the most out of this course, this lab should be done, and the poster saved so students can continue working on it. Lab #2 is an optional microscope lab. If you do not have a microscope or you don't have access to a place to find tardigrades, you can watch an online video showing tardigrades.

Chapter 2 is an introduction to biology. Important concepts and vocabulary are introduced. Lab #1 focuses on the unifying characteristics connecting all (non-viral) life. The lab incorporates the concepts introduced in the chapter into an application of the scientific method. Weaving relevant vocabulary through an application of the logical process incorporated into the scientific method is the best way to teach this. Lab #2 is a field research lab where students

make observations and create a scientific model based on those observations. This lab extends the concept of scientific modeling, introduced in Chapter 1 Lab #1, to guide students through the process of making their own model. It does not matter if the model students create is detailed or simple. The goal is to have students begin to understand how observations and fieldwork are used to develop models for the natural environment.

Chapter 1 – My Tardigrade

For My Notebook

Hello! My name is Bear, which is short for “Little Water Bear.” I’ll be your guide this year as you study the incredible living world that’s all around us. I have *so much* to tell you! But first, let’s learn a little bit about me.

Little Water Bear is the name given by the scientist who discovered me, Johann August Goeze (say “goes”). My scientific name is Tardigrade, which in Latin means “slowly stepping.” But I prefer to be called Bear because I do not think I step that slowly. I have eight legs, and I am so small you need a microscope to see me. I may seem slow to you, but if you were my size, you would see that I can get around pretty well!



Scientists who study tardigrades are called tardigradologists. Which is funny if you think about it. That means those scientists are called “slowly stepping studiers.” I wonder how fast they would move if they were microscopic in size?

Have you ever used a microscope? A microscope is a tool scientists use to look at very small, microscopic, things that you cannot see with just your eyes. Tardigradologists need to use a microscope to study tardigrades. Even though tardigrades are too small to see without a microscope, we are alive. Tardigrades are organisms. An organism is a living being. There are many types of organisms like plants and animals.

Did you even know that there are microscopic animals? I am not the only microscopic animal, just the cutest, toughest, and most ferocious!

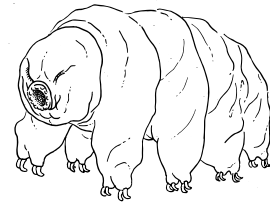
Seriously, I am not making that last part up. I have two long, sharp teeth-like structures called stylets. I eat by stabbing prey with my stylets and sucking them dry. How is that for ferocious! I should probably be named Vampire Bear.

Sometimes, people call me Moss Piglet. I like that nickname too because it reminds me of the best place in the whole world—a patch of moss. I live, play, and hunt in it. I eat the moss too! My sharp claws on my eight legs are very useful for digging in my mossy home.

Moss is the most common place to find tardigrades, but we live in other areas, too. In fact, tardigrades live just about everywhere, including deep in the ocean, the top of Mount Everest, the ice in Antarctica, the sand at the beach, the trees in the rainforest, and in your neighborhood. Tardigrades have even been to space! In 2007, the European Space Agency launched tardigrades into space for 10 days. Tardigrades are the only animal to ever survive the cold vacuum of space. I told you I was tough! And cute, don't forget the cute part.

In the next two labs, you will learn more about me and other tardigrades like me, create a poster of a tardigrade, and even observe us in action!

Lab #1: My Tardigrade Model



Materials

- “My Scientific Model of a Tardigrade” poster from Appendix A on page 443
- Lab sheet
- Pencil
- Glue (optional)
- Cardboard (optional)

Aloud: Today you will begin making a poster of a tardigrade. You will not do very much on it today, but as you learn more, you will add to the poster. When you are finished today, put your poster somewhere safe, like maybe on your wall, so you can work on it later.

The poster you will make is a type of scientific model. Scientific models are used to help people understand science. They describe and/or predict things in the real world. Some models, like this poster, are visual models. Visual models show how things look to help you understand them better. They can show you how the parts of something fit together, or what the inside of something looks like, or what something very small looks like close-up. You will add to this poster throughout the course as you learn more about biology and about tardigrades like me! Scientific models are often simpler than the thing they are showing in the real world. This is true for this model too because tardigrades are a lot more complicated than the model you will make on your poster.

Tardigrades are too small to see without a microscope. The enlarged model you make will help you understand tardigrades better.

There are 1,200 different types of tardigrades. Each type of tardigrade is a different species. Members of the same species are those that can produce offspring (have babies) that can then also produce offspring (have more babies). Every species of tardigrade can only produce offspring with other tardigrades of the same species. Different species of tardigrades cannot have offspring with each other.

Even though each species of tardigrade has its differences, all tardigrade species share things in common too. This is what makes us tardigrades! Your poster, or visual model, shows a female tardigrade. Every other type of tardigrade will have many things in common with her.

Procedure

1. Glue all the pieces from page 443 and 445 on the cardboard. (Optional)
2. At the top of the poster, write a name for your tardigrade. She is a female tardigrade.
3. Color the heading entitled, “My Scientific Model of a Tardigrade.”
4. Complete the sentences on the lab sheet using words from the word bank provided.

Continued on the next page

Possible Answers

1. Like all living beings, tardigrades are organisms.
2. There are 1,200 species of tardigrades.
3. Tardigrades are so small that they are microscopic.
4. Tardigrades use their sharp claws to dig, capture prey, and hold onto moss.
5. Tardigrades have eight legs.
6. Tardigrades have two stylets that they use to bite their prey.
7. The name tardigrade means slow stepper.

Instructor's Notes

- This is the first lab in an ongoing series titled My Tardigrade. All the labs in this series are identified by the tardigrade picture on the instructions page. Students will continue to work on this poster throughout the course.
- The term *biology* is introduced here without definition and the term species without the context of genetics and evolution. These will be explained later in the course.
- Scientific modeling is used throughout this course. This visual model is a very simple one. Instead of overwhelming students with an entire discussion about modeling, the language and information is woven through the course in a scaffolded manner.

More Lab Fun

- Search the internet to learn more about tardigrades.
- Use clay, Play-Doh, or Sculpey to make a three-dimensional model, a tardigrade sculpture.
- If you view a tardigrade with a microscope, as detailed in the next lab in this chapter, have students add new observations to the tardigrade poster

Name _____ Date _____

My Tardigrade Model

Complete the sentences using the words from the word bank.

Word bank

microscopic

slow stepper

species

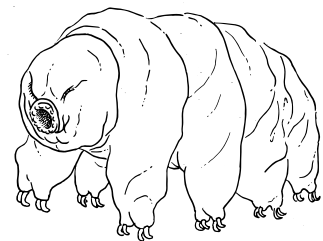
claws

eight

organisms

stylets

1. Like all living beings, tardigrades are _____.
2. There are 1,200 _____ of tardigrades.
3. Tardigrades are so small that they are _____.
4. Tardigrades use their sharp _____ to dig, capture prey, and hold onto moss.
5. Tardigrades have _____ legs.
6. Tardigrades have two _____ that they use to bite their prey.
7. The name tardigrade means _____.



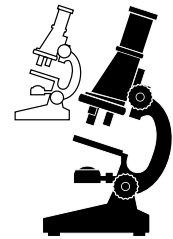
Lab #2: Pet Tardigrade Lab + Microscope

Materials

- Internet access

Optional Microscope:

- Microscope
- Moss (Don't use store-bought or moss that has been sprayed with insecticide.)
- Water
- 2 small, shallow dishes
- Slide
- Dropper



Aloud: Did you know that some people keep tardigrades as pets? They make very nice pets if you think about it. Tardigrades are free. They are easy to find. You do not have to walk them or feed them. Tardigrades never poop on the carpet, and they're even quite cuddly.

Tardigrades are really too small to hold, though, and you need a microscope to see them. Today you will search the internet for videos of tardigrades (made using microscopes) and observe them in action. If you happen to have a microscope, you can easily find and observe tardigrades yourself.

Procedure

1. Look up tardigrades on YouTube. There are a lot of good videos showing tardigrades in action. You can also visit Pandia Press' weblinks page for a curated list of videos to watch.

Optional Microscope:

1. Find and collect a sample of moss about two inches in diameter.
2. Place the moss in the shallow dish and a bit of water about halfway up the sides of the moss. Do not flood the moss.
3. Let the moss soak 8 to 24 hours. Longer than 8 hours is better, but it is really fun to start viewing samples at 8 hours and then look again at 24 hours.
4. Squeeze some water out of the moss into another small dish.
5. Use the dropper to make a slide with this water. Do not use stain and do not use a slide cover.
6. Put the slide under the microscope. If you do not see a tardigrade in the first sample, make another slide. Tardigrades are abundant and found everywhere. You should, hopefully, be successful on your first try.

More Microscope Fun

Continue observing the tardigrades in your moss sample. If tardigrades are there, so is a food source. Look for amoebas, rotifers, and other organisms. If you are not sure what you are observing, search the internet for microscopic organisms that live in the environment and area where you collected the sample. It is really fun to continue looking every 24 hours for a week. You will see so many cool organisms! You will also get an idea of the reproductive rate of the organisms in the sample. In a week, there will be a proliferation of certain organisms over all the rest. If you choose to do this, leave your moss sample in the water for the entire week adding more water if necessary.

Continued on the next page

Instructor's Notes

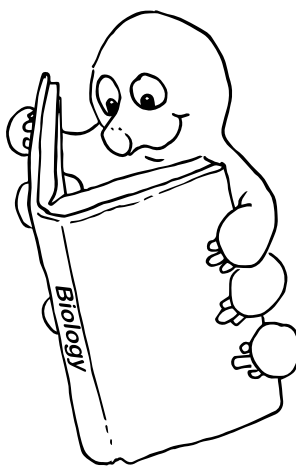
There are discussion questions presented in the next reading, Chapter 2 – What Is Biology?

Possible answers:

1. I am taller now than I was last year.
2. I laugh when someone tickles me.
3. I eat food.
4. I pee and poop.
5. I have blood flowing through my body.
6. The food I eat is used to make energy.
7. I run, dance, and jump.
8. My mom and dad made me.

Chapter 2 – What Is Biology?

For My Notebook



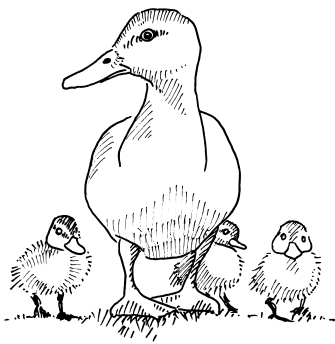
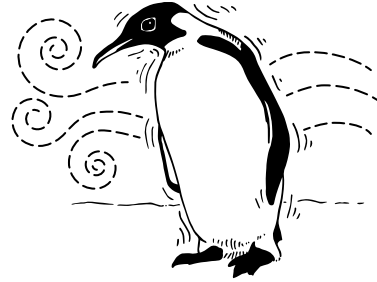
Biology is the science that studies life. Scientists who study life are called biologists. Tardigradologists are a type of biologist because, of course, tardigrades are alive—walking faster than we are given credit for, stalking our prey, sucking them dry, and then cuddling down in some nice, fluffy moss.

As you know, you are also alive. You are a type of organism called a human. How about dogs and cats? They are alive, too. You probably just know that without knowing exactly why. How about worms, trees, or coral? Well, humans, cats, dogs, worms, trees, tardigrades, and coral are all alive. They are all different types of organisms, but they all share some common traits, or characteristics, too. A trait is a quality or a feature of something. For instance, your house may be painted blue and have six windows and a door. Those are traits, or characteristics, of your house. Well, there are certain traits that all organisms share, just like all houses have doors.

On the next page is a list of eight traits that are common to all living things. Think about how your own body does each of these. Write down or discuss how humans do each of the characteristics that are common to all organisms.

All organisms . . .

- #1 Grow
- #2 Respond to their environment
- #3 Take in energy
- #4 Get rid of waste
- #5 Have some type of circulation. (Hint: What travels throughout your body?)
- #6 Have some type of respiration. This is the process where energy is released from food.
- #7 Move on their own. Some species such as plants—but not tardigrades!—move very slowly.
- #8 Reproduce, or make offspring.



Many objects that aren't alive do some of these things, too. But only living things do *all* of them. For example, a car gets rid of waste through its exhaust system, but a car can't move on its own and can't reproduce.

Lab #1: Is It Alive?

Materials

- Lab sheets and pencil
- Internet access
- Plant
- Magnet
- Cell phone
- Iron shavings
- Charging cord
- Fruit with seeds
- Flower

Aloud: When scientists perform science labs and activities they use a special set of steps called the scientific method. The first step of the scientific method is to make observations and use those observations to form a question. The next step is to predict the answer to the question. This prediction is called a hypothesis. Sometimes people think a hypothesis is a guess, but it is more than that. A hypothesis is a prediction based on things you already know about the topic from observing or studying.

After forming a hypothesis, you will plan a procedure, or experiment, to test the hypothesis. Next you will conduct the experiment, researching and collecting data as you go along. Based on your research and data, you will determine results and make a conclusion (an answer) about your question.

You might learn that your hypothesis was correct, or maybe it was incorrect. People do not like to get things wrong, but an incorrect hypothesis is not that type of wrong answer. It means that as you investigated and learned more, you came to understand that whatever you were investigating behaved differently than you thought it would before your experiment. A hypothesis is valuable even if it is not correct because it helps you get one step closer to a better understanding.

In this lab, you will make a hypothesis about whether a person, cell phone, plant, and magnet are alive. Now, you may know the answers to these questions right away. But we are using these questions to practice thinking like a scientist, using the steps of the scientific method, and discovering why these things are alive or not. Before you make your hypothesis, you will think about things you have observed in the past about each of them and decide if they are alive based on what you know about characteristics of living things.

After you form a hypothesis, you need to plan a procedure, or experiment, to determine which things are alive and which are not. To do this, you will need to look at the list of characteristics of living things. You will record the information you collect in the data table on your lab sheet. Based on the results from this data, you will make your conclusions. Living things will do all of the things on the list. Things that aren't alive can often do some of the things on the list, but not all of them.

Procedure

1. First, look at the characteristics for living things listed in the Data Table on your lab sheet. Think about which of these things you have seen people, magnets, cell phones, and plants do. Discuss how people, magnets, cell phones, and plants will all do some of these things, but they are only alive if they do *all* of them.
2. Complete the Hypothesis section of the lab sheet. Have students circle whether they think each test subject is alive or not and complete the “because” statement. Remember, things that are alive will have all the characteristics of life. Things that are not alive will not exhibit one or more of them. Form your hypothesis based on what you have observed in the past.
3. Test each characteristic for each test subject. Work methodically. Record the tests you used for each one and record your observations in the Data Table by writing “yes” or “no” for each characteristic. Below you will find some suggested tests for certain items, but feel free to brainstorm your own!

Continued on the next page

4. If you use videos to test/show a characteristic—for example, how plants grow over time—try to use videos from real-life. Cartoons are recreations and not good examples for making conclusions in a scientific experiment.
5. Students can also use their own observations over time, such as for whether cell phones reproduce.

Here are some suggested tests:

All Organisms Grow

- Magnet: The magnet will attract things to it and therefore grow in size. However, this can be likened to putting on clothes and shoes with heels. You are bulkier and taller, but you haven't grown when you do this.
- Plant: Students can use their own observations over time. Time-lapse videos of plants doing this are also a good way to observe this.

All Organisms Respond to Their Environment

- Person: There are many tests students can conduct to prove that people respond to their environment. This is a great characteristic to brainstorm together and come up with a test of your own!
- Magnet: Put the magnet in the presence of the iron shavings. Discuss with students the behavior of the iron shavings. Did the magnet respond to the presence of iron shavings (respond to their environment)? (Yes.) The magnet made the iron shavings move. Do magnets and iron shavings respond to their environment? (Yes. Students might respond that it is only under certain situations, but nothing on the list responds to every change that occurs in their environment.)
- Plant: Search for time lapse videos to observe plants moving toward sunlight or wilting from lack of water. Try searching for sunflowers or tomato plants turning toward the sun.
- Cell Phone: Begin a text message and type in the word "My." Watch as your phone makes suggestions for what the next word will be. Choose one of these words and then choose another word until you have a complete sentence. Repeat. This time ask students to choose a different second word. Did the cell phone respond to its environment? (Yes & No. Ask students to defend their answer. Neither is wrong. It is a matter of how you define this characteristic.) A cell phone functions like a computer. Extend the conversation beyond the cell phone to discuss video games, computers, and robots.

All Organisms Take in Energy

- Person: Ask students to take one or more bites out of the fruit enough to expose the seeds. Explain that the fruit is converted to energy in their body.
- Magnet and Plant: Set the magnet and plant in sunlight (or another source of light that will cause them to warm up) for 10 minutes. Both should be warmer. Sunlight (and light from a lamp) is energy.
 - Discuss if the magnet is taking in energy that it uses? (No.)
 - Discuss if the plant is taking in energy that it uses? (Yes.)
- Cell Phone: Charge your phone. Is the phone taking in energy that it uses? (Yes.)

Continued on the next page

All Organisms Get Rid of Waste

- Plant: This is a difficult one to observe. You can discuss this or look up videos using the keyword “leaf transpiration.”
- Cell Phone: Heat that is auto-generated is a type of waste. Cell phones do generate heat that they release to the environment. Discuss this with students.

All Organisms Have Circulation

- Person: Water circulates through a person's body, and the waste is released as urine. You can look up videos using the key phrase “circulation of blood people” to view blood circulating. Be careful you do not choose one that is too graphic if your children are sensitive to watching organs function and blood flowing.
- Magnet: Technically, magnetic current does circulate through a magnet. If students answer yes to this, ask them to explain their answer.
- Plant: If students have watched a video about leaf transpiration, a good follow-up question is, where did the water come from? It came from the absorption of water through their roots, which circulated through their bodies until the excess was released as waste through their leaves.
- Cell Phone: Technically, electrical current does circulate through a cell phone. If students answer yes to this, ask them to explain their answer.

All Organisms Have Respiration

- Plant: This is a difficult one to observe. You can discuss this or look up videos using the keyword “plant respiration.”

All Organisms Move

- Magnet: The same test for “All Organisms Respond to Their Environment” tests for this characteristic in magnets. (The magnetic attraction between the iron shavings and magnet goes both ways. For the magnet, because of the mass, this is so slight that either a Yes or No should be considered correct.) Or place your magnet close to an object like the refrigerator and slowly move it closer until the magnet “snaps” to it.
- Plant: The same test for “All Organisms Respond to Their Environment” tests for this characteristic in plants.
- Cell Phone: Set the phone on vibrate. Set it on a hard surface, and then call it.

All Organisms Reproduce

- Plant: Pull out the fruit with seeds showing and the flower and explain to students that the seeds will mature and grow to become a plant that makes flowers that will release more seeds that will grow into more plants.
6. Complete the Results and Conclusions portion of the lab sheet. Remind the students that if even one characteristic of life is missing, the object is not alive.

Continued on the next page

Possible Answers

1. All Organisms Grow: People (Yes), Magnet (Yes / No), Plant (Yes), Cell Phone (No)
2. All Organisms Respond to Their Environment: People (Yes), Magnet (Yes), Plant (Yes), Cell Phone (Yes)
3. All Organisms Take in Energy: People (Yes), Magnet (No), Plant (Yes), Cell Phone (Yes)
4. All Organisms Get Rid of Waste: People (Yes), Magnet (No), Plant (Yes), Cell Phone (Yes)
5. All Organisms Have Circulation: People (Yes), Magnet (Yes / No), Plant (Yes), Cell Phone (Yes / No)
6. All Organisms Have Respiration: People (Yes), Magnet (No), Plant (Yes), Cell Phone (No)
7. All Organisms Move: People (Yes), Magnet (Yes / No), Plant (Yes), Cell Phone (Yes)
8. All Organisms Reproduce: People (Yes), Magnet (No), Plant (Yes), Cell Phone (No)

Results and Conclusions:

People: Yes Magnets: No Plants: Yes Cell Phones: No

Conclusion / Discussion

People and plants are alive and magnets and cell phones are not. It can be hard to observe all the characteristics for plants. However, students will be conducting experiments throughout the course that give evidence of plants exhibiting all the characteristics needed to define something as living.

Instructor's Notes

- Your student will probably know right away which test subjects are alive and which are not. The purpose of this lab is to get them thinking like a scientist and discuss why a subject is or is not alive. For that reason, do not skip over the “because” portions of the hypothesis. This is where students express that they think a test subject is alive because it exhibits all the characteristics of life or is not alive because it does not exhibit one or more of the characteristics of life.
- An important part of this lab is the vocabulary used to describe the parts of the scientific method. Take the time to discuss what students know to form their hypothesis. Give guidance if needed, but, for the most part, let students add some activities for testing their hypothesis. However, do not let students get frustrated with this either. When conducting the experiment, discuss the observations made for each part of the data table and how these are used to form conclusions about which items are alive and which are not.
- If students need help with the writing portion of this lab, it is okay to have them dictate their answers to you.
- If students are bothered that they cannot directly observe all the characteristics for plants at this time, use the internet to find videos of plants doing necessary things to show they are alive. Let them know about the upcoming experiments.

More Lab Fun

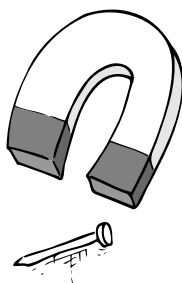
Add other items to your tests, or devise tests that show more living characteristics for a cell phone and a magnet, for example glaciers grow and move and a car gets rid of waste.

Name _____ Date _____

Is It Alive?

The Question

Are the items listed below alive? Think about what you have learned about what makes something alive or not as you fill in the blanks.



My Hypotheses

I think people (are are not) alive, because they _____

_____.

I think magnets (are are not) alive, because they _____

_____.

I think cell phones (are are not) alive, because they _____

_____.

I think plants (are are not) alive, because they _____

_____.

Testing My Hypotheses

All organisms grow.

Do people grow?

I tested this by _____

Do magnets grow?

I tested this by _____

Do plants grow?

I tested this by _____

Do cell phones grow?

I tested this by _____

All organisms respond to their environment.

Do people respond to their environment?

I tested this by _____

Do magnets respond to their environment?

I tested this by _____

Do plants respond to their environment?

I tested this by _____

Do cell phones respond to their environment?

I tested this by _____

All organisms take in energy.

Do people take in energy?

I tested this by _____

Do magnets take in energy?

I tested this by _____

Do plants take in energy?

I tested this by _____

Do cell phones take in energy?

I tested this by _____

All organisms get rid of waste.

Do people get rid of waste?

I tested this by _____

Do magnets get rid of waste?

I tested this by _____

Do plants get rid of waste?

I tested this by _____

Do cell phones get rid of waste?

I tested this by _____

All organisms have circulation.

Do people have circulation?

I tested this by _____

Do magnets have circulation?

I tested this by _____

Do plants have circulation?

I tested this by _____

Do cell phones have circulation?

I tested this by _____

All organisms have respiration.

Do people have respiration?

I tested this by _____

Do magnets have respiration?

I tested this by _____

Do plants have respiration?

I tested this by _____

Do cell phones have respiration?

I tested this by _____

All organisms move.

Do people move?

I tested this by _____

Do magnets move?

I tested this by _____

Do plants move?

I tested this by _____

Do cell phones move?

I tested this by _____

All organisms reproduce.

Do people reproduce?

I tested this by _____

Do magnets reproduce?

I tested this by _____

Do plants reproduce?

I tested this by _____

Do cell phones reproduce?

I tested this by _____

Observations

The table below contains a list of some of the characteristics needed for something to be considered an organism (a living being).

Data Table

Characteristic	Person	Magnet	Plant	Cell Phone
All organisms grow				
All organisms respond to their environment				
All organisms take in energy				
All organisms get rid of waste				
All organisms have circulation				
All organisms have respiration				
All organisms move				
All organisms reproduce				

Results and Conclusions

What can you conclude from the data you collected? For something to be alive it must be able to do all the characteristics listed in the table. After doing the lab, do you think the things on the list are alive? Write “Y” for yes or “N” for no.

Person _____ **Magnet** _____ **Plant** _____ **Cell Phone** _____

Lab #2: Nature Photography: Field Research

Materials

- Lab sheet and pencil
- Outdoor area
- Digital camera or smart phone (It's recommended each person has their own camera.)
- Internet access
- iNaturalist account
- Paper, pencils, pens, and glue

Optional Recommended Items:

- Handheld magnifying glass
- Binoculars
- Field guides of local insects, animal tracks, birds, fungi, and plants
- Access to *The Photo Ark* by Joel Sartore (Sartore has several books in print, a website with images, and Facebook and Twitter pages with hundreds of images.)

Aloud: Today you will conduct field research where you live by taking a nature walk through your neighborhood. Your job is to document the non-pet animals (don't forget insects), plants, and fungi (mushrooms) growing wild in your area. You can take pictures of what you observe and upload them to a website called iNaturalist. iNaturalist is a website where people share information about the organisms in their area. You can also get help with identifying those organisms through the site. Plus, it is a citizen scientist project where the organisms you document in your area help others who use the site, including scientists!

As you walk, observe closely. Many organisms are so tiny you may walk right over them, or even ON them without even knowing they are there. Just think of all the tardigrades you've stepped on!

Are you wondering if you will see tardigrades today? We are everywhere, especially if the area is wet or moist. In 2018, a tardigradologist in Japan discovered a new species of tardigrade in a parking lot!

Procedure

1. Take a nature walk. Use a digital camera to document the animals, plants, and fungi in your area. Tended gardens filled with plants bought at a store should not be included, neither should pets. If you see the tracks or scat (a fancy word for poop) of wild animals, take pictures of that. That is evidence those animals live there.
2. While walking or when you get home, use field guides to learn more information about what you photographed.
3. Complete the questions on the lab sheet.
4. Set up an iNaturalist account and upload your photos to it.
5. I recommend looking through Joel Sartore's work to see his photo journals (books and collections). But this is not necessary to complete the journal.
6. Create a journal by drawing, photographing, or a combination of the two, to document the animals, plants, and fungi you observed. If you observed tracks or scat include those. For animals you saw but were not able to photograph, either print a photo someone else took or draw a picture of it.
7. Write the names of the organisms, or type them and print out the names, and glue them onto the page of the book.

Continued on the next page

Conclusion / Discussion

- Discuss what were the most common types of organisms that were observed.
- Discuss how this study underreports animals that are nocturnal like owls, migratory like Canada geese, or very shy like mice.

More Lab Fun

- Students can keep taking photos and documenting what is in their neighborhood or even other areas when they travel. They can become active participants in the iNaturalist community.
- Participate in the Audubon Great Backyard Bird Count that takes place every February. Check out their website for more information.
- If you have a microscope, you can also look for microscopic organisms. Follow the same procedure outlined in Chapter 1, Lab #2 Pet Tardigrade Lab for wet or moist areas. For dry areas, mist the sample and use the dropper to suck up a water sample for a slide. That way, hopefully, you will not drown any organisms that do not live in water.

Name _____ Date _____

Nature Photography

If you were asked to make a scientific model for the animals, plants, and fungi in your neighborhood, what would you include?



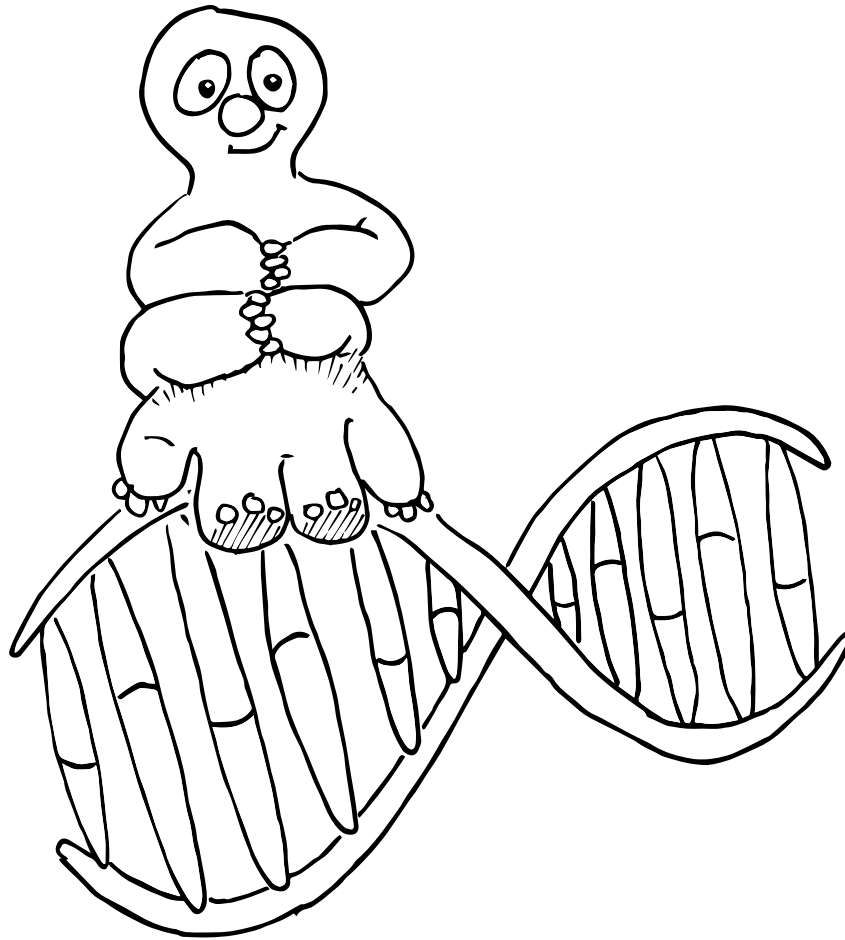
Based on your observations, what type of animal is the most common in your neighborhood? Answer with a photo, drawing, and/or words.

Based on your observations, what type of plant is the most common in your neighborhood? Answer with a photo, drawing, and/or words.

Do you think your observations were enough to create a good model of all the organisms in your entire neighborhood? Would you need to conduct more field research in smaller areas of your neighborhood to accurately show the animals and plants that live there?

Unit 2

Building Blocks of Life



Unit 2: Introduction for Instructors

Unit 2 is planned as a 3 1/2 week introduction to *REAL Science Odyssey Biology 1*. It covers important basic cell biology and genetics that are woven through later sections of the course. Unit 2 also contains new concepts with vocabulary. The explanations around the concepts can feel a bit dense. The explanations are necessary for understanding. Students will become more proficient with these concepts as they use them throughout the course.

Chapter 3 covers cell theory, unicellularity and multicellularity, and the structure of cells. In Lab #1, the concept of scientific theory is introduced through the lens of the cell theory. A series of guided fill-in-the-blank sentences are used to help students make the connection for how cells are the functional unit for life. Lab #2 uses edible models of the cell to teach the basic structure of plant and animal cells. Lab #3 is the first in a series of plant labs. Growth through cell division is introduced. This is a good lab for showing the type of data collection that is important for science observations.

Chapter 4 is a basic introduction to the vocabulary and concepts of genetics. In Lab #1, students make a scientific model of a chromosome to help connect the vocabulary and concepts presented in the text. In Lab #2, students make a bracelet that uses alphabet beads in an actual section of the genetic code of a tardigrade. This reinforces the concept of the genetic code and base pairs.

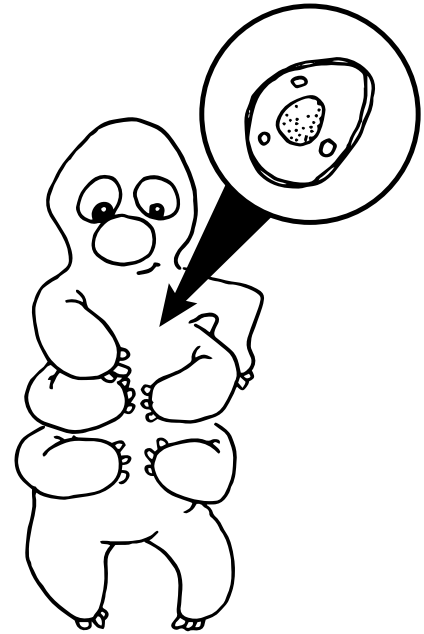
Chapter 5 covers the connection between genes and physical traits. A basic understanding of the concepts in this chapter are important for making the connection of similar but different. All organisms have cells with genetic material. These are essential for non-viral life. However, there are differences, and it is the information in genes that determines those. Lab #1 was written many years before this course when a friend called me asking for help teaching her child how you get traits from both parents. An activity using sprinkles to teach independent assortment popped into my head, and I wrote it down. My friend tested it, and it was a big success. In Lab #2, students make a family tree. After collecting the data, they create a genealogy chart focused on inherited traits.

Chapter 3 – Organisms Are Made of Cells

For My Notebook

There is something else all organisms have in common. All organisms are made of one or more cells. Most cells are even smaller than a tardigrade, but if you put enough cells together you can make something the size of an elephant, a giant redwood tree, or you.

For most species of organisms, different adults have different numbers of cells. For example, your grandmother and grandfather do not have the same number of cells as each other. This is just one more way in which tardigrades are special because, for many tardigrade species, all individuals have the exact same number of cells! When all the members of a species are made from the same number of cells, it is called eutelic. All tardigrades of my species have 40,000 cells.

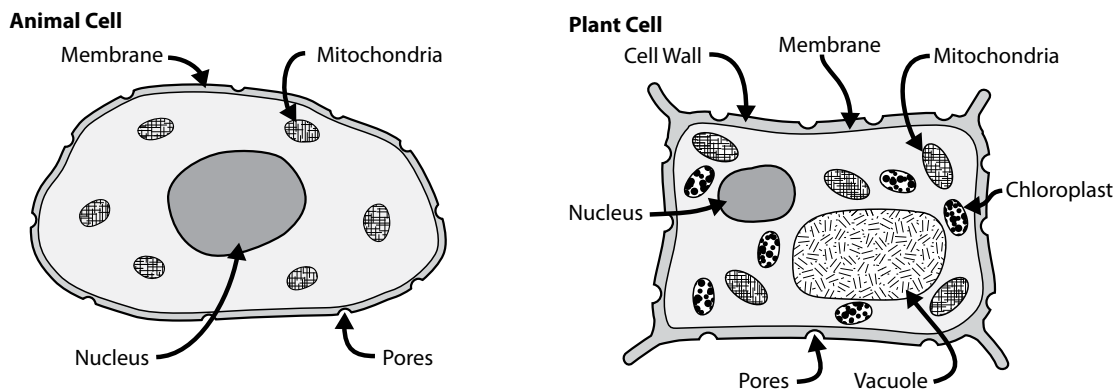


Your function is your job or what you are supposed to do. If I were to ask you what your function is, you might say something like, “study science, keep my room clean, and play with my pet tardigrade.” But from a science standpoint, your function is to take in energy, get rid of waste, move, have some type of circulation and respiration, grow up, reproduce, and respond to what’s around you. All organisms have these functions.

In addition to their functions, organisms also have a structure. For example, trees have the same general structure, or arrangement of parts, to other trees. You have the same general structure as other humans. And I have the same general structure as other tardigrades.

The structure and function of organisms starts with cells. Cells are the basic unit of structure and function in organisms.

Cells only come from other existing cells. In a process called cell division, one cell divides to become two cells. This is an important process because it is how you grow. Cells are *really* tiny. My mom and I are both made of 40,000 cells, and we are microscopic. Think how many cells you must be made of! You started as just one cell that divided to two cells, then both of those cells divided, and now you are made from so many cells that you can be seen without a microscope. As you grow to be an adult, your cells will divide many more times. In addition to growth, cell division is important for organisms so they can have babies, or reproduce.



Animals and plants have different types of cells. People and tardigrades are made from animal cells. Grass and trees are made from plant cells.

Lab #1: Cell Theory

Materials

- Lab sheet and pencil
- Colored pencils

Aloud: You've been reading and learning about the scientific theory called cell theory. A scientific theory is a fact-based explanation for why or how something happens in science. The cell theory is one of the basic principles of biology. It explains the relationship between cells and organisms. Scientists develop scientific theories doing a large number of experiments using the steps in the scientific method.

Cells are really, really small. You need a microscope to see them. Take a look at your hand. Even though you can't see an individual cell, there are billions of cells in your hand all working hard so you are able to do things like drawing, waving, scratching an itch, and feeding yourself snacks!

Single-celled organisms are living things made of just one cell. All structure and function come from just that one cell because the organism only has one cell. Multi-celled or multicellular organisms, like people and tardigrades, are made from many cells. Multicellular organisms have different types of cells. In your hand, you have skin cells, muscle cells, nerve cells, and blood cells to name just a few. Birds are multicellular organisms, too. They also have many different types of cells. For example, they have cells that make their feathers, cells that make their hearts, and cells that make their eyes. These types of cells all have different functions and structure.

Procedure

1. Complete the lab sheet. For #1, color the single-celled amoeba (very much enlarged) and the multicellular bird.
2. For #2, use the words in the word bank to complete the sentences and describe what each amoeba cell in the pictures is doing. Use each word one time.
3. In #3, the process of cell division is illustrated. Explain that, in one of these steps, one cell divides to make two cells. Ask your student to draw a circle around the illustration that shows that step.

Possible Answers

- #2. This amoeba is eating. This is how an amoeba takes in energy.

After it's done eating, the amoeba needs to get rid of waste.

Food the amoeba eats helps it get larger. It helps the amoeba grow.

The single-celled amoeba divides to make two amoebas. That is how amoebas reproduce.

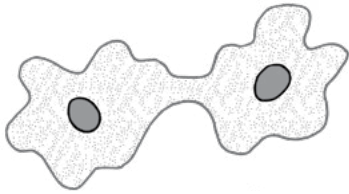
You cannot see it, but there is fluid circling around inside the amoeba. This type of movement is called circulation.

This single-celled organism is about to be eaten by an amoeba. The organism is responding to this by quickly moving out of the way. Not today, amoeba!

The amoeba uses the food it takes in for respiration. That is how the amoeba makes energy to do things like move away from organisms that want to eat it.

Continued on the next page

#3. Cell division occurs at this step:



Instructor's Notes

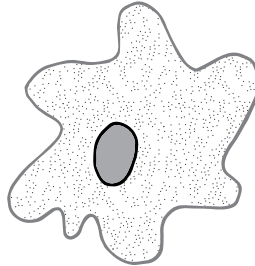
- The cells of the bird look like they are all the same. The different types of cells in multicellular organisms will be covered in the following two labs.
- Respiration is covered in more detail in *RSO Biology 2*. Of all the functions of cells, that is probably the hardest to understand at this stage. It is the last function to be filled in on the lab sheet to help kids figure out where it goes.

Name _____ Date _____

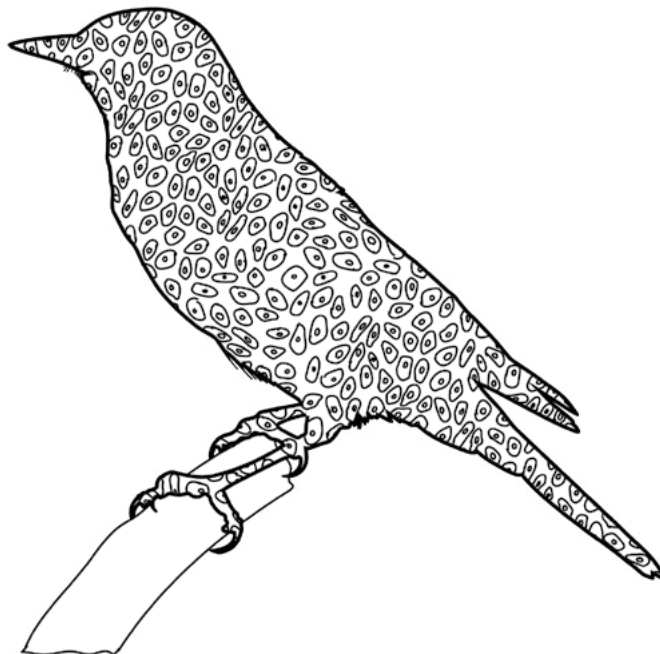
Cell Theory

1. All organisms are made of one or more cells.

An amoeba is an organism that is made of one cell (single-celled).



A bird is an organism that is made of many cells (multicellular).



2. Cells are the basic unit of structure and function in organisms.

Use the words below to fill in the blanks to describe what each amoeba cell is doing. Use each word one time.

Word bank

energy

respiration

grow

responding

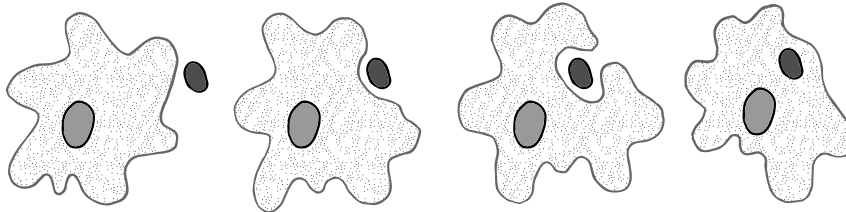
waste

moving

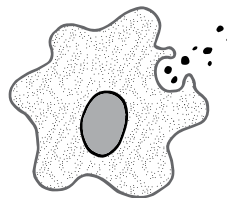
reproduce

circulation

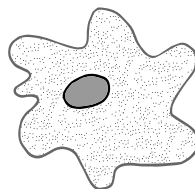
This amoeba is eating. This is how an amoeba takes in _____.

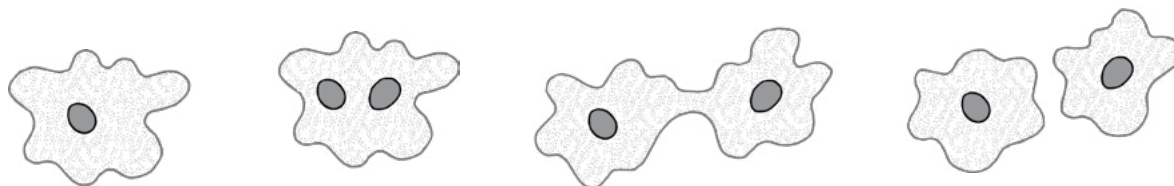


After it's done eating, the amoeba needs to get rid of _____.

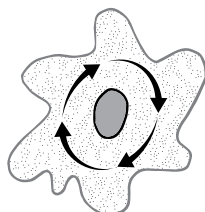


Food the amoeba eats helps it get larger. It helps the amoeba _____.

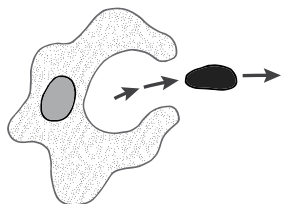




The single-celled amoeba divides to make two amoebas. That is how amoebas _____.

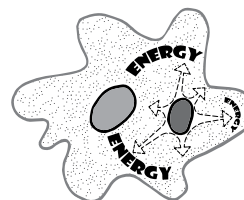


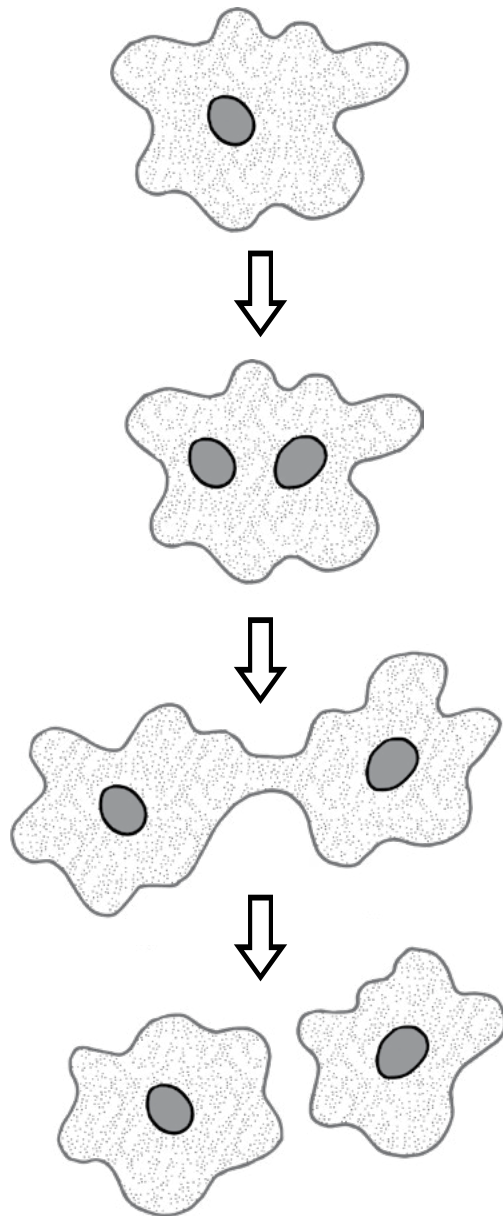
You cannot see it, but there is fluid circling (that's a hint) around inside the amoeba. This type of movement is called _____.



This single-celled organism is about to be eaten by an amoeba! The organism is _____ to this threat by quickly _____ out of the way. Not today, amoeba!

The amoeba uses the food it takes in for _____. That is how the amoeba makes energy to do things like move away from organisms that want to eat it.



3. Cells only come from existing cells.

One of the illustrations above shows cell division occurring, where one cell divides to make two cells. Draw a circle around that illustration.

Lab #2: Model This! Plant and Animal Cells

Materials

- Lab sheet and pencil
- 2 boxes of pudding mix (3.4 ounces) or a package of pudding cups (use vanilla, lemon, or other light-colored pudding)
- 2 cups milk or a non-dairy substitute (if making the pudding)
- Small, square pan (to hold about 2 cups of pudding)
- Small, round pan or bowl (to hold about the same amount of pudding)
- Plastic wrap
- Plate
- Refrigerator
- Bag of white chocolate, chocolate, or butterscotch chips (for cell wall)
- 10 to 20 green grapes (for chloroplasts), cut into half lengthwise
- 2 cake-pops without sticks, donut holes, cherries without stems, or strawberries (for nuclei)
- 10 banana slices (for mitochondria)

Aloud: Plants and animals are very different types of organisms, so it is no surprise that they have different types of cells. All plant cells have some things in common with other plant cells, and all animal cells have some things in common with other animal cells. This means that tardigrade cells have things in common with people cells. Isn't that cool?

Today you are going to make two visual models, a scientific model of a plant cell and an animal cell, to show what they have in common and how they are different from each other.

Cells are made from organelles, specialized structures, inside and covering the other side of them. There are some organelles that only a plant cell or an animal cell has and some that both have. For example, plant cells are surrounded by an organelle called a cell wall. These are rigid, making plant cells mostly rectangular and held together like Legos. Animal cells do not have cell walls. Both animal and plants cells are surrounded by an organelle called a cell membrane. This membrane is inside the cell wall of plants and is not rigid like a cell wall is. Cell walls and cell membranes protect cells, but they both also have small openings called pores that let small particles pass into and out of cells.

Animal and plant cells have different ways of getting food from their environment. Plant cells have a green-colored, oval-shaped organelle called a chloroplast (klor-o-plast), something animal cells do not have. Chloroplasts turn the sun's energy into food for plants. Both plant and animal cells need to convert food to energy. The organelles that do that are called mitochondria (my-toe-kon-dree-ya).

Plant cells also have a vacuole, which is a space on the inside of plant cells. Vacuoles help plants keep their shape.

Both plant and animal cells have an organelle called a nucleus (new-klee-us). The nucleus is a very bossy organelle. Its job is to tell the cell what its structure and function is.

Continued on the next page

Procedure

1. Complete the “Before Making the Cell Models” section of the lab sheet.
2. Put the square pan into the refrigerator.
3. Put the plate with a piece of plastic wrap on top of it into the refrigerator.
4. Prepare pudding as instructed on the box.
5. Melt the chips and pour 3/4 of the melted chips into the cold square pan to form a hard shell around the bottom and the sides of the pan. Let this harden.
6. Pour the rest of the melted chips onto the plastic wrap on the plate. Make it square-ish in shape with rounded corners. This shape should fit inside of the square pan, taking up most but not all of that space. Put this back into the refrigerator until it hardens.
7. Line the pan and bowl with plastic wrap (cell membranes).
8. Pour about 2 cups of pudding into the square pan and about 2 cups into the round pan. Put both pans into the refrigerator until the pudding is firm.
9. In the middle of the plant cell (square pan) place the now-hardened shape made from melted chips. This is the vacuole. (Make sure to remove the plastic wrap from it.)
10. Add the cake pop or other item you are using for the nucleus to each model, but not on top of the vacuole.
11. Add five banana slices (mitochondria) to each model. Scatter these throughout, but not on top of the vacuole.
12. Add the cut grapes (chloroplasts) to the plant cell (square pan). They should be scattered over the surface, flat side down, but not on top of the vacuole.
13. Complete the “After Making the Cell Models” section of the lab sheet. Draw the cell models that you made. The rectangular shape is for the plant cell, and the circle is for the animal cell. Use the key to help you remember which organelles to include. You can color-code the bubble beside each organelle name in the key to identify them in your drawings. Draw a border around both shapes showing the cell membrane and a cell wall around the plant cell. Add small dots on the borders to show the pores.
14. If you wish, you can eat your model cells!

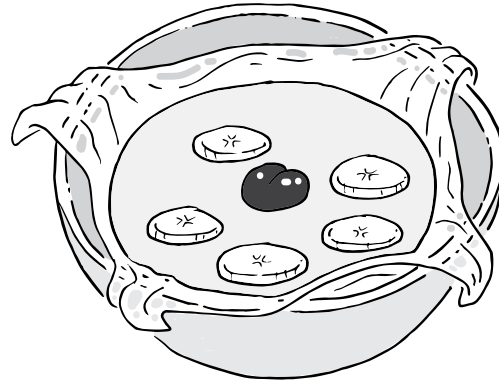
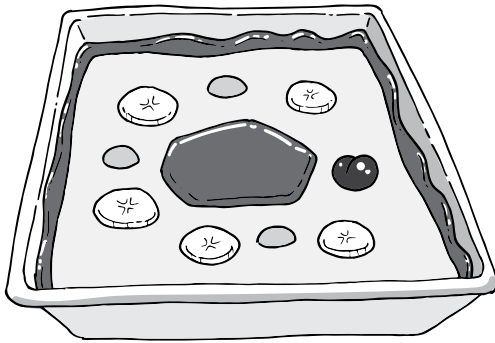
Answers

- #1. The rectangular one is the plant cell. The round one is the animal cell.
- #2. The vacuole goes into the plant cell.
- #3. Chloroplasts go into the plant cell.
- #4. Mitochondria go in both.
- #5. Cell walls and cell membranes both have pores in them OR cell walls and cell membranes surround the outside of a cell.
- #6. Plant and animal cells both have nuclei, mitochondria, and a cell membrane.
- #7. Only plants cells have chloroplasts, a vacuole, and a cell wall.

Continued on the next page

Discussion

- When plant cells do not get enough water, the vacuole shrinks. Discuss what you think happens to the plant's shape when the vacuole shrinks. (The plant wilts.)
- Animals get their structure from their skeleton, which can be inside of them, like yours, or outside of them, like tardigrades. Besides the vacuole, what other parts of a plant cell gives plants their structure? (The cell wall also gives plants their structure.)



Instructor's Note

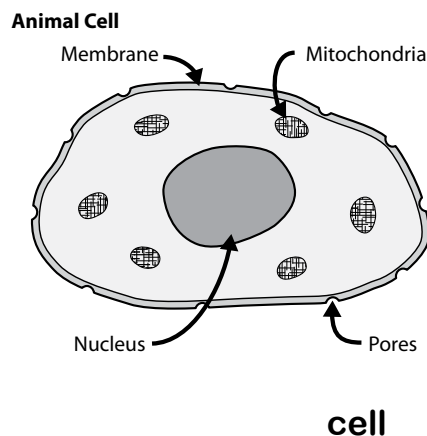
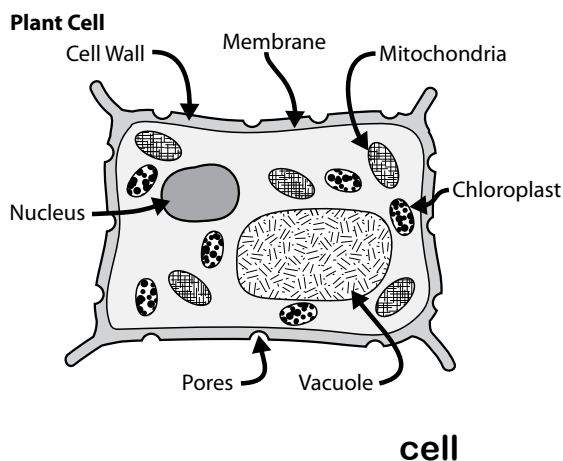
- The models you make will show the organelles that almost all animal and plant cells have in them. They do not show any one type of plant or animal cell.

More Lab Fun

- Go online and investigate the other organelles found in cells. Add those to both models.
- Label the cell parts with flags on toothpicks. Make sure to include a label for the chloroplast, nucleus, mitochondria, cell wall, vacuole, and cell membrane.

Name _____ Date _____

Model This! Plant and Animal Cells

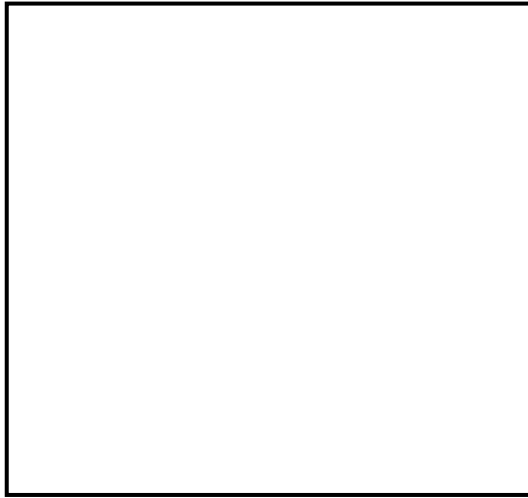


Before Making the Cell Models

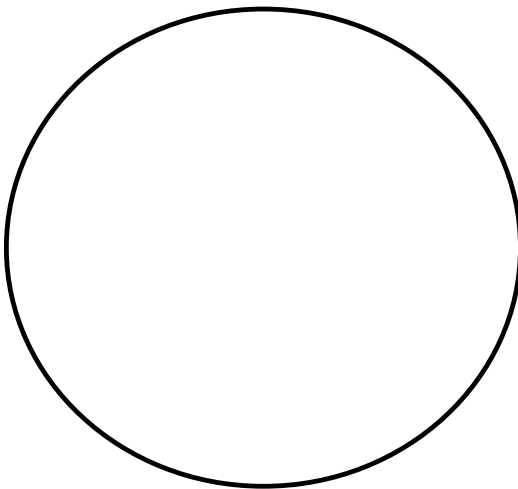
1. Label the drawings above either Animal Cell or Plant Cell.
2. In which cell model will you put the vacuole (chocolate square)?
3. In which cell model or models will you put chloroplasts (the grapes)?
4. In which cell model or models will you put mitochondria (the bananas)?
5. What do cell walls and cell membranes have in common?
6. Which organelles are found in both plant and animal cells?
7. Which organelles are only found in plant cells?

After Making the Cell Models

Draw your cell models in the shapes below.



_____ cell



_____ cell

Organelle Key

☐ Cell wall

☐ Chloroplast

☐ Nucleus

☐ Cell membrane

☐ Mitochondria

☐ Pores

☐ Vacuole

Lab #3: My Plant: Getting Started



Materials

- Lab sheet and pencil
- 8 bush (not pole) bean seeds, or the seeds of another flowering plant that is easy to germinate and harvest the seeds (Do not use hybrid seeds.)
- Sealable baggie
- Paper towels
- 2 one-gallon clay or plastic pots
- Potting soil to fill the two pots
- Sunny area
- Water
- Ruler or a measuring tape
- Store-bought plants, if you prefer not to germinate seeds

Aloud: When some tardigrades—like Bear—are born, they have 40,000 cells. These cells grow and grow until the tardigrade is adult-sized. But even though they are bigger as adults, grown-up tardigrades are still microscopic!

An important part of getting bigger, for tardigrades and humans like you, is that they eat food. We need food to grow. Tardigrades love sticking their stylets into plant cells, especially moss, like tiny vampires and sucking those cells dry! They also like the taste of amoebas.

What about you? What is your favorite food? I bet you've never tried an amoeba! You and tardigrades eat because your cells need food to make energy to do all the things you do, like playing and learning about biology. Your cells also need the food you eat to grow and to make more cells. Unlike tardigrades like Bear—but like you—as a plant grows from a seedling, its cells divide to make more cells.

You might have noticed that plants do not have mouths or stylets. You will learn how they do it later in the course, but plants make their own food! That's right; plants make the food they need in order to grow. You know what that means? Plants can never complain about how their food tastes.

Today, you will begin an experiment to observe how plants grow. In Chapter 6 Lab #4, you will use the growth chart from this lab.

Procedure - Day 1

1. Measure the length of one of the seeds. Write the measurement in the box provided on your lab sheet and keep it handy. This will be used for the growth chart students will make starting in Chapter 6. If you are using a store-bought plant, look online to learn the length of a typical seed from that type of plant.
2. Plant seeds in soil, two to a container. Follow the instructions on the seed packet for planting. Place the pots somewhere with sunlight and warm temperatures, and do not forget to water them regularly—but not with too much water. Plants like the soil moist, not soggy. You are planting seeds in two pots just in case something happens to one of them.

Aloud: Are you curious about what happens to the seeds underneath the soil? When a seed grows into a plant, it is called germination. You can watch beans germinate without digging in the soil, which would damage your plants. All you need are beans, a baggie, water, and a paper towel to hold the water.

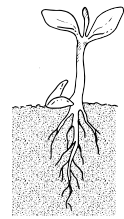
3. Fold and wet the paper towel sheets. Squeeze most of the water out. You want the paper towel wet but not sopping. Put the paper towel into the baggie. Put four seeds (beans) in the baggie on top of the folded paper towel. Place this somewhere that gets sunlight, such as a windowsill. Make sure the baggie is sealed tightly. If the paper towel starts to dry up, mist the inside of the baggie with more water.

Continued on the next page

4. Observe the seeds in the baggie and fill in your lab sheet for Day 1 “What My Seeds Are Doing.” You can use words, photos, or drawings to record your observations.

Day 2 to Germination

5. Fill in your lab sheet for “What My Seeds Are Doing” each day until you observe seed germination (growth). You can use words, photos, or drawings to record your observations. After they fully germinate, the seedlings in the baggie are no longer needed for this lab. You can carefully plant them if you want. The roots are very delicate, however, so be careful.
6. Monitor your pots every day. On your lab sheet under “How High My Potted Plants Are Growing,” record the day the seedlings in each pot begin to push up (Day 1) and grow out of the soil. When this happens, give the seedlings a couple of days, and then, in each pot, pull out the seedling that is the shortest. There should only be one plant per pot.



The Rest of the Growing Season

7. Every day after the plants start growing out of the soil, measure their height and record it on your lab sheet in the “How High My Potted Plants Are Growing” chart. You are collecting this data for a growth charting activity in Chapter 6—Organisms Grow. Write the units used for measurements (e.g., cm or in.). It is good practice for students to get used to writing their units whenever they record science data.

Instructor's Notes

- If you do not want to grow plants from seeds, purchase a young plant and track its growth as described in step #7 above. Measure the height of the plant on the day you bring it home and for each successive day after.
- You might not need 30 days to record data. If you get to Organisms Grow in Chapter 6 before 30 days, you can stop recording growth data unless students are enjoying the activity.
- There are several more labs to come that use plants, which are marked with this icon on the instructions page. There are three options for the plant labs: 1) Use the eight plants from this lab for all the plant labs. 2) Purchase inexpensive plants for each lab. 3) Omit the plant labs. Note that the plant labs are sequenced so you can use the bean plants started in this lab for the remaining plant labs. But you may need to purchase plants at some point if your bean plants are not viable.
- You will still want to do the seed germination part of this lab. It is a nice activity that every student should do at least once.
- The plant labs in this course meet several Next Generation Science Standards for grades K-5.



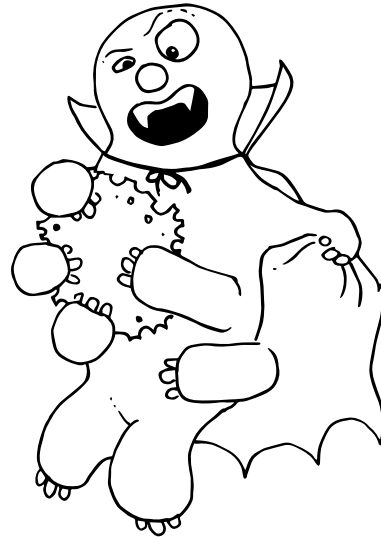
More Lab Fun

- Plant a garden.

Name _____ Date _____

My Plant

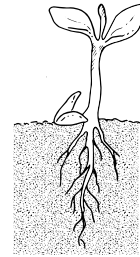
Bean seed measurement:



What My Seeds Are Doing

Day 1	Day 2	Day 3	Day 4	Day 5
Day 6	Day 7	Day 8	Day 9	Day 10
Day 11	Day 12	Day 13	Day 14	Day 15

Date when the beans sprouted from the soil:

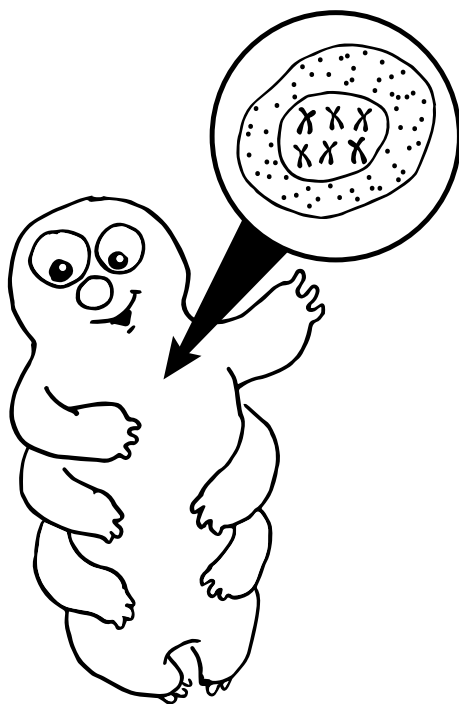


How High My Potted Plants Are Growing

Day 1	Day 2	Day 3	Day 4	Day 5
Day 6	Day 7	Day 8	Day 9	Day 10
Day 11	Day 12	Day 13	Day 14	Day 15
Day 16	Day 17	Day 18	Day 19	Day 20
Day 21	Day 22	Day 23	Day 24	Day 25
Day 26	Day 27	Day 28	Day 29	Day 30

Chapter 4 – DNA Is the Code That Makes Me

For My Notebook



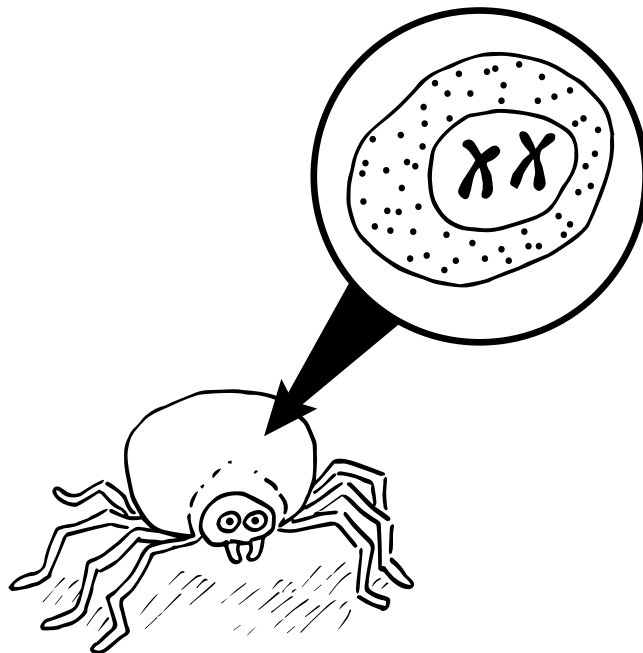
You've learned about so many traits that organisms have in common, but there is another characteristic all organisms share. All organisms have genetic material in their cells. This is true for single-celled organisms, like amoebas, and multicellular organisms, like plants and people. This genetic material has a special name, deoxyribonucleic acid. What a mouthful! No wonder scientists nicknamed it DNA.

Each organism's DNA has all the information, or the code, for making that organism, almost like a recipe for making an organism. DNA determines the species of an organism and all the traits that organism has. Your DNA is what makes you a person, and my DNA is what makes me a tardigrade. The DNA of all people has many things in common. But no other person in the world has the exact same DNA you do, which is why no person has the exact same traits you do.

It takes a lot of DNA to make you who you are. If the DNA in one of your cells was stretched out, it would be thinner than a tardigrade, too thin for you to see it, and it would stretch to two meters, over 6 1/2 feet. If you put all the DNA from all the cells of an average-size adult human lengthwise end-to-end, it would stretch to the moon and back about 1,500 times!

Strands of DNA condense to form structures called chromosomes. The number of chromosomes is specific to the species. Humans have 46 chromosomes and my species of tardigrade has 12.

Chromosomes are divided into sections called genes. Genes are what make an organism's traits, like the color of your eyes, the length of my stylets, and the size of a spider mite.



The DNA of a spider mite has the information that makes it a spider mite.

Lab #1: Model This! Chromosome

Materials

- Lab sheet and pencil
- Colored pencils or markers (at least ten colors)

Aloud: The DNA of each organism holds the information for making it. Even in an organism that does not have as many specialized functions as a human, like a spider mite, there is still a lot of information needed for the structure and function of that organism. There needs to be a way to package the long, thin strands of DNA or the chromosomes would be a gnarly mess, full of knots and tangles. That wouldn't be good for passing information along!

In fact, the way DNA strands fit together is like an intricate puzzle. Your DNA coils tightly to form a chromosome. Chromosomes are divided into genes. Genes are where the instructions are for each of your traits. Each gene has one set of instructions for a trait. It takes all the genes on the 23 pairs of chromosomes in each of your cells to make you exactly who you are. So think of your DNA like a library for making you. Each row of books is like a chromosome. Each book is like a gene with instructions for making one trait.

Today you will make a visual model of one of the chromosomes in your cells. Each individual segment of the chromosome on your lab sheet represents a gene, except the center section, which is the centromere that holds the chromosome together.

Procedure

1. On the lab sheet, color each gene pair and the centromere. Each gene pair—those directly across from each other—should be the same color. You will need ten different colors—one for each gene pair, and one for the centromere. See the shaded diagram on the next page for guidance.
2. Assist your student with labeling parts of the chromosome as shown on the diagram.

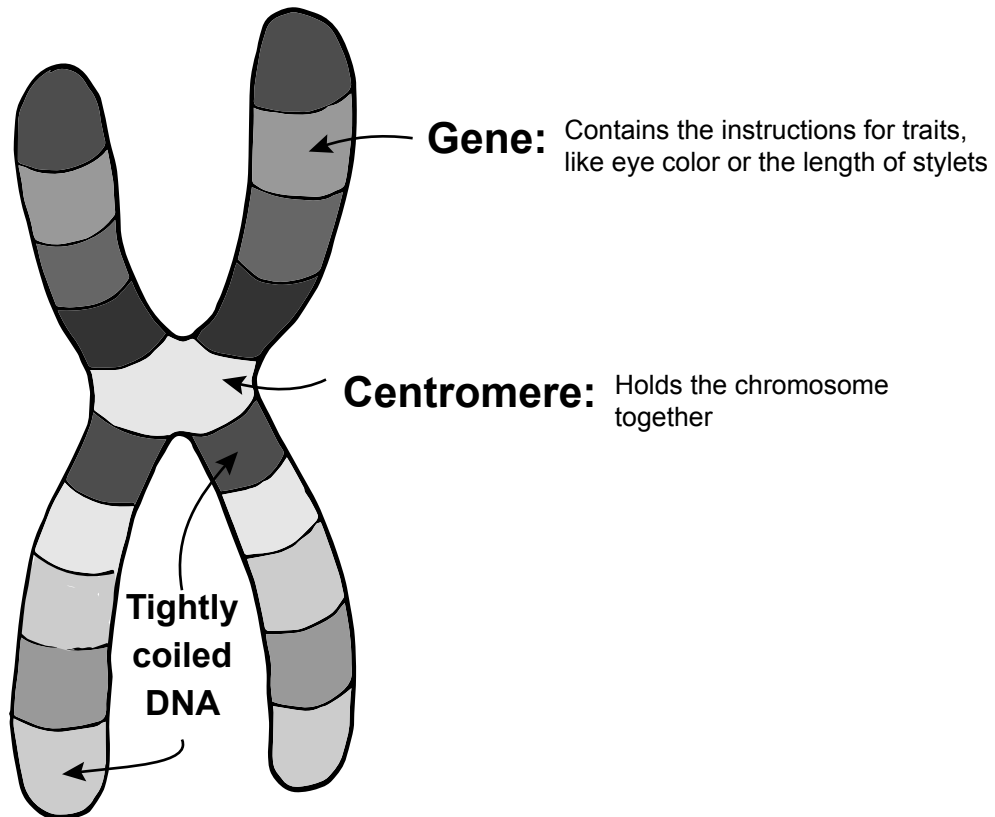
More Lab Fun

- Make a second chromosome with a different arrangement of colors. Label one chromosome “From my mother” and one chromosome “From my father.” Decide which traits are on different genes like eye color, hair color, and texture. For example, if you decide the top gene on the chromosome should determine eye color, write your parents' eye colors on the top gene of each of their chromosomes.

Continued on the next page

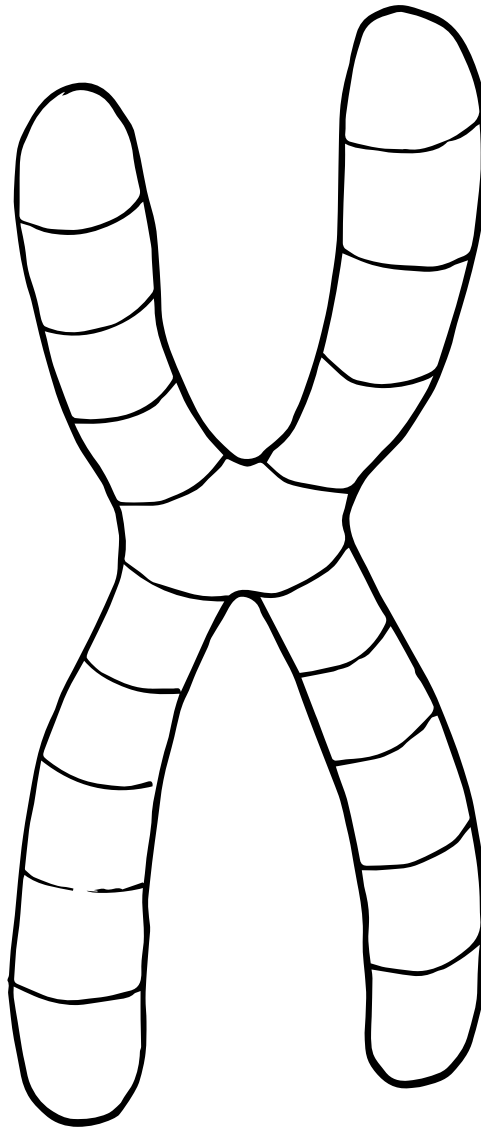
Chromosome Color Key

Chromosome: Your unique chromosome makes you who you are



Name _____ Date _____

My Chromosome Model



Lab #2: Tardigrade Bracelet

Materials

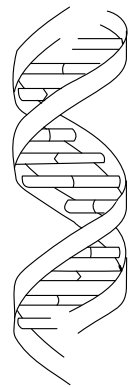
- 24 plastic pony beads:
 - 10 red = A
 - 10 blue = T
 - 2 yellow = C
 - 2 green = G
- 2 elastic strings, each about 12 inches long

Aloud: Genes are made from DNA. The DNA that codes for a trait has a special sequence or order. It is sort of like the letter sequence in a word. Take the word “bread.” It has to be spelled b-r-e-a-d. If the sequence is reordered to b-e-a-r-d or b-a-r-e-d, you no longer have “bread” now you have “beard” or “bared”! It works the same way with DNA. If you rearrange the code, you make something entirely different or you make nothing at all, like if you rearrange the letters for “bread” and made “rdbea.” You still have all the same letters, but “rdbea” is not a word.

Today you will make a bracelet that is a wearable model of a short sequence of DNA from a tardigrade.

Scientists use a four-letter code, A, T, C, and G, to show DNA sequences. You will use colors to represent these letters. Red will stand for A, blue for T, yellow for C, and green for G.

What looks like one strand of DNA is actually two strands coiled around each other like a spiral staircase. The coding of each of the two coiled strands is very specific. And only certain letters pair with each other. A pairs with T, and C pairs with G. You will not be able to tell what the sequence codes for, but the good news is, when this code is in a tardigrade cell, the cell knows exactly what to do with it. It is like a special language that only cells can interpret.



Procedure

1. Tie the two strings together about 2 inches from one end of the strings.
2. String the beads on one string as follows: Red, red, red, red, *green*, red, red, red, *yellow*, red, red, red.
3. Have someone hold the end of this string or place a clothespin on it to keep the beads from falling off while you string the other beads.
4. String the beads on the other string as follows: Blue, blue, blue, blue, *yellow*, blue, blue, blue, *green*, blue, blue, blue.
5. Tie the end together leaving at least 2 inches of the strings after the knot.
6. Have someone tie the ends together around your wrist for a wearable bracelet.

More Lab Fun

- Check out Pandia Press’ weblinks page to find a link to the entire gene sequence. You can make more bracelets or necklaces for other gene sequences.



Appendix A – Tardigrade Poster

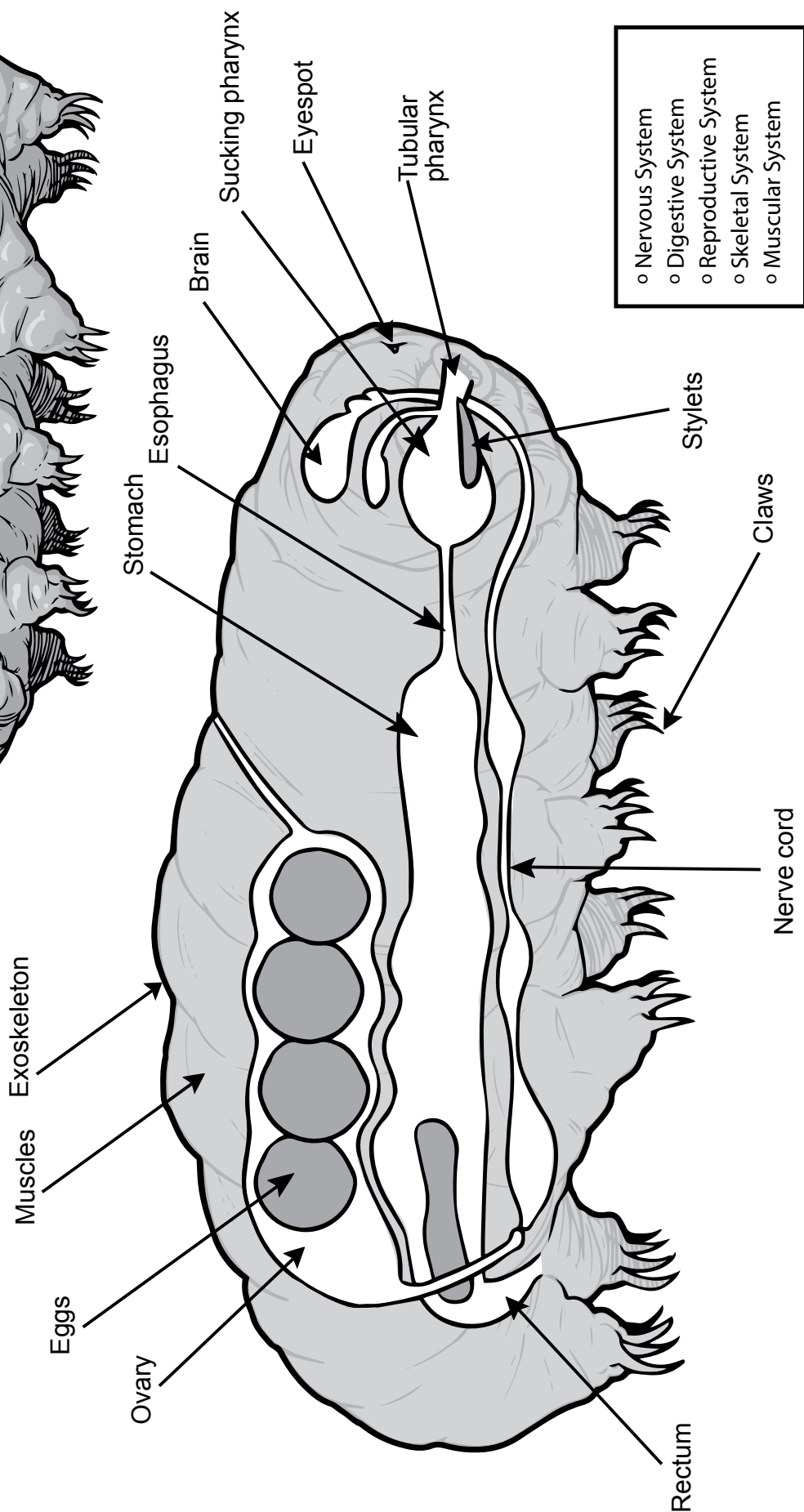
Students will cut out the contents of this page and the following page to create a poster in Unit 1, Chapter 1 and use it regularly in Unit 3, Chapters 6–12 as well as Unit 6, Chapter 20.

Kingdom: _____
Phylum: _____
Class: _____
Order: _____
Family: _____
Genus: _____
Species: _____

Tun Stage

Egg

My Scientific Model of a Tardigrade



- o Nervous System
- o Digestive System
- o Reproductive System
- o Skeletal System
- o Muscular System

